

Integrated embedded systems need well-defined management strategy



By John Wemekamp



Platform and shelf management strategies using standards such as Intelligent Platform Management Interface (IPMI) are well established in the enterprise and telecommunications sectors. Until recently, the diversity of military applications for embedded computing – plus a number of developing military requirements for power management and security – has mitigated against the direct adoption of these types of system management concepts. Most rugged military subsystems are contained in enclosures inaccessible to a maintainer during the normal operational cycle of a platform. Such subsystems need to be removed from the platform to replace modules or to undertake any detailed diagnostic testing. This contrasts with newer concepts of operation and maintenance, which will allow the maintainer in-vehicle access to equipment shelves to diagnose and replace individual modules. This, in turn, will require the development of a standardized management strategy to support embedded computing equipment supplied by multiple COTS vendors.

Condition-Based Maintenance (CBM)

One of the key drivers for management of embedded military subsystems comes from the DoD's concept of CBM, initially developed for the F-35 Joint Strike Fighter. Its principles will be extended to other new programs, such as the Army's FCS and many others. CBM monitors and assesses equipment's condition to determine the maintenance processes to be applied. It is intended to reduce the reactive regime of repairs, which takes place only when something is faulty. CBM has been extended to CBM Plus (CBM+), which now encompasses the life cycle from design to disposal; its aim is to reduce the overall logistics support and maintenance costs of future equipment deployments. CBM+ covers all types of equipment fitted to vehicles. In the case of newly introduced embedded computing equipment such as VPX (VITA 46), an example of which is illustrated in Figure 1, and VPX-REDI (VITA 48), this might typically translate into monitoring the well-being of power and cooling systems, monitoring critical operating temperatures plus mechanical inputs (shock and vibration). In addition CBM+ must support regular maintenance, diagnosis, and repair of equipment plus module replacement.



Figure 1

Military's need divergent from commercial standards maintenance

Many lessons can be learned from the application of concepts such as IPMI to the telecommunications sector. It is anticipated that similar concepts of nonintrusive health monitoring will be applicable to military requirements and that a simple means of

interconnecting modules such as I²C can be used. However, current standards appear over-complex, yet at the same time deficient in key functionality for direct translation into military needs. For example, hot swap is unlikely to be necessary, or even possible, for ground vehicles or aircraft on the move. In addition, densely packed or space-constrained subsystems might not be able to afford the overhead of a separate shelf controller that is commonly required and that also poses a security risk.

A number of additional unique requirements for military operations are not currently addressed by any standards, such as power management, security, and vehicle-level management. The increasing complexity of vehicle systems and the need to remain on-station for prolonged periods of time will require power management at all levels to balance performance and mission capability requirements against power and cooling availability. Under power-saving or battery-only operation, for example, when a vehicle is on silent watch, unused equipment might be selectively powered down or clocked down to conserve energy and reduce thermal loading. While all types of in-vehicle maintenance operations – such as running BIT, changing modules, downloading software upgrades, and so on – should be available to properly authorized service personnel, unsecure remote operation would be unsafe and unacceptable. Similarly, any secure data must be wiped from a module before it is removed from a shelf; secure data must then be reestablished in its replacement prior to normal operation.

Vehicle-level considerations

It is anticipated that all equipment shelves and subsystems comprising a vehicle's systems – regardless of form factor – will provide equipment status data using a common mechanism to a Vehicle Health Monitoring System (VHMS). This will be used to allocate and plan any prognostic or diagnostic maintenance actions. The VHMS will vary considerably from one vehicle type to another depending on its size, complexity, and mission requirements. It might be implemented as a separate subsystem or might be dispersed as an application software module among equipment shelves.

Any management strategy for military embedded systems must accommodate the broad spectrum of potential applications and military requirements from the small Unmanned Aerial Vehicle (UAV) to complex multi-mission infantry fighting vehicles. Curtiss-Wright Controls Embedded Computing (CWCEC) is spearheading a standardization effort, VITA 46.11, with support from industry and end users to address these needs. Its objective is to leverage as starting points the most appropriate commercial practices with additions necessary to provide the flexibility and scalability needed to meet the DoD's future embedded computing system management requirements.

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