PRODUCT GUIDE FEATURE:

MISSION CRITICAL

Military COTS-based systems: Not necessarily right off the shelf

By Bill Ripley

There is no longer a debate about using commercial off-the-shelf (COTS) solutions in the military. That's because government agencies find it much more cost-effective to use inexpensive, off-the-shelf boards and assemblies in lieu of proprietary boards. Using COTS doesn't mean heading out to a retail store and buying the same systems found in a typical office. Many of the military's COTS-based systems require modification to withstand the harsh conditions common in the soldier's environment. Instead of starting from scratch, many designers are using a building-block approach, purchasing a basic COTS system and then adapting the configuration to meet application-specific requirements.

Historically, the price of military hardware has been astronomical due to the demand for it to operate reliably in the harsh conditions of the battlefield. Problems arose when the pace of technological change accelerated in the commercial marketplace as military technology lagged. The military realized if it could adopt or adapt commercially available components, boards, and systems, it could benefit from both the advanced technology and the economies of scale enjoyed by commercial products. As a result, in the mid-'90s the government mandated that military contractors begin using COTS technology to reduce costs and keep abreast of current technology.

Can COTS products meet the military's need for reliable service in harsh environments? Military specifications often require operation at ambient temperatures from –55°C to +125°C, in high and low humidity, while withstanding extreme vibration and shock. In addition, can a military contractor find a COTS system that performs the exact function required for a sophisticated project required by armed forces?

The answer to both questions is *yes* and *no*. That's because using COTS doesn't mean that military systems incorporate boards and modules that were designed for a desktop environment. It means that the parts and designs are not unique to specific military programs. Many military applications use some of the same basic boards and assemblies.

To deal with increasingly harsh environments, most military COTS vendors design boards as commercial products with a ruggedization option. They also take care to understand the thermal and mechanical characteristics of their boards instead of building custom products from scratch. Many vendors now take a building-block approach, offering basic systems that may include an SBC, data bus, analog and discrete I/O, power supply, and ample spares to accommodate growth.

The most important key to making COTS work for the military is building systems around open-standard interfaces. Using open standards allows developers to capitalize on technology insertion or upgrade individual modules while maintaining backplane compatibility. By using cards based on open standards, designers get reduced nonrecurring engineering (NRE) costs at the initial design phase. When the time comes for technology insertion or refreshment, not using proprietary hardware interfaces significantly lowers NRE costs. In most cases one or more vendors make a functionally similar COTS module. The technology insertion usually does not require paying for the design of new modules as long as the module and associated software adheres to industry standard bus interfaces, form factors, operating systems, and application programming interfaces (APIs). Often this approach enables system upgrades and performance increases without re-engineering.

In support of such a building-block approach, SBS offers the Advanced Mission Computer (AMC-cPCI 3000 Series), a rugged, yet highly flexible 3U CompactPCI-based COTS computing platform suited for mission-critical applications. A 500MHz PowerPC-based CM4 SBC runs the system, along with proven real-time operating systems such as WindRiver's VxWorks and Green Hills' Integrity. The AMC-cPCI 3000 series easily integrates with other CompactPCI and PMC modules as well.

The system has three internal compartments, one containing the CompactPCI card slots, the second containing the power supply, and the third containing the external I/O connections.

To make the system rugged, a PC board routes the external I/O signals through the backplane to the printed circuit board (PCB) interconnect and the D38999 series front panel connectors. For cooling, the system removes heat primarily through thermal conduction. By careful selection of components, optimizing component placement and mounting, and providing thermal conductivity between the CompactPCI modules and the chassis to radiate heat efficiently, the system operates at temperatures up to +85°C.

Since a system is only as good as its power supply, the AMC uses a COTS filter and power supplies from a leading manufacturer of high-reliability microelectronic power conversion products that are integrated into a separate shielded plug-in module. This module slides into its own aluminum compartment, acting as a shield to prevent possible Electromagnetic Interference (EMI) emissions from radiating to the adjacent critical circuit modules.

Designers can use the AMC-cPCI 3000 Series as a starting point, adding a graphics board, discrete I/O, or high-speed serial interfaces that enable the system to become anything from a mission computer to a display processor to the underpinnings of an aircraft communications system. Integration services exist for all

Copyright 2004

SBS AMC-cPCI 3000 Series systems, ranging from shock, vibration, thermal modeling and analysis, to board-level integration, software development, and qualification.

Today, COTS products are available to meet the stringent requirements of military specifications and applications. Many military contractors are finding that by using a building-block approach, they can purchase a basic COTS system and adapt it to meet application requirements, saving time and money.

__Bill Ripley__ is the director of business development, Aerospace Systems, for SBS Technologies Government Group. Bill is currently responsible for all aerospace business development activities of the SBS Government Group. Prior to joining SBS, Bill spent 23 years at Bell Helicopter Textron, working as a lead engineer for avionics system development, integration, simulation and flight test for military programs.

For further information, contact Bill at:

SBS Technologies
2400 Louisiana Blvd. NE
Suite 5-600
Albuquerque, NM 87110
Tel: 505-875-0600 ext. 845
Fax: 505-875-0400
E-mail: bripley@sbs.com

mission critical sidebar

Safety critical vs. mission critical: Understanding the difference

Overview

When deciding on an RTOS it is important to understand the context in which the system will operate. More important, it is imperative to understand what applications the RTOS has already undertaken. Has the RTOS been applied in a manner similar to current application needs? Two very distinct applications for an RTOS in the commercial and military industry are safety-critical applications and mission-critical applications. To help distinguish between these two applications the following paragraphs will discuss their definitions and characteristics, and give examples of each.

Safety critical

When defining safety critical it is beneficial to look at the definition of each word independently. Safety typically refers to being free from danger, injury, or loss. In the commercial and military industries this applies most directly to human life. Critical refers to a task that must be successfully completed to ensure that a larger, more complex operation succeeds. Failure to complete this task compromises the integrity of the entire operation. Therefore a safety-critical application for an RTOS implies that execution failure or faulty execution by the operating system could result in injury or loss of human life.

Safety-critical systems demand software that has been developed using a well-defined, mature software development process focused on producing quality software. For this very reason the DO-178B specification was created. DO-178B defines the guidelines for development of aviation software in the USA. Developed by the Radio Technical Commission for Aeronautics (RTCA), the DO-178B standard is a set of guidelines for the production of software for airborne systems. There are multiple criticality levels for this software (A, B, C, D, and E).

These levels correspond to the consequences of a software failure:

- **Level A is catastrophic**
- **Level B is hazardous/severe**
- **Level C is major**
- **Level D is minor**
- **Level E is no effect**

Safety-critical software is typically DO-178B level A or B. At these higher levels of software criticality the software objectives defined by DO-178B must be reviewed by an independent party and undergo more rigorous testing. Typical safety-critical applications include both military and commercial flight, and engine controls.

Mission critical

A mission refers to an operation or task that is assigned by a higher authority. Therefore a mission-critical application for an RTOS implies that a failure by the operating system will prevent a task or operation from being performed, possibly preventing successful completion of the operation as a whole.

Mission-critical systems must also be developed using well-defined, mature software development processes. Therefore they also are subjected to the rigors of DO-178B. However, unlike safety-critical applications, mission-critical software is typically DO-178B level C or D. Mission-critical systems only need to meet the lower criticality levels set forth by the DO-178B specification.

Generally mission-critical applications include navigation systems, avionics display systems, and mission command and control.

Conclusions

The CsLEOS™ RTOS is a commercially available real-time operating system developed by a safety-critical systems company. In addition CsLEOS is a COTS RTOS that has demonstrated capability in a flight-critical application. In February 2003, CsLEOS played a significant role in the successful flight of Northrop Grumman's Pegasus X-47A experimental unmanned aircraft. The CsLEOS RTOS underpins the aircraft's Avionics and Vehicle Management Computer that is responsible for flight control processing, autopilot control, engine control processing, mission command and control, navigation, and other functions.

For more information, please visit www.csleos.com.

CsLEOS is a trademark of BAE Systems. Other company product and service names may be the trademarks or service marks of others.

 Copyright 2004