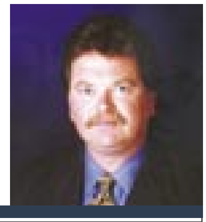
Telecom technology and the military: Initiatives and standards



By Joe Pavlat

Changes in information technology have already affected the global balance of power. The collapse of the Soviet Union was facilitated by these changes. The Soviet style of communism and centralized control of the economy led to its collapse in part because it was not compatible with the requirements of the information age. Improvements in information technologies have helped strengthen free markets and democratic forces worldwide and have also increased international trade and investment.

Some of the global consequences of the changes are reflected in the weakening of government control over society and the shifting of power away from governments to non-governmental organizations, small groups, and individuals. Knowledge gained by more and better information makes individuals and organizations more powerful and is a significant force behind democratization efforts in the Middle East and the former Soviet states.

Militarily, as both Gulf wars have demonstrated, the United States is very good at exploiting advances in information technology, in part due to the high quality of its personnel and training. The US military has an unsurpassed ability to adopt and integrate complex technical systems into preexisting forces and structures. This military technological prowess is backed by a solid civilian technical base and well-established markets for computers, software, and Internet services. With major initiatives such as Commercial-Off-the-Shelf (COTS), there is good cross pollination of civilian and military computer technology, and open standards are an important part of that. Interestingly, most other nations depend on our systems and technology for their civilian and military needs.

Recent advances in technology offer warplanners and warfighters a multitude of new opportunities. One of the major programs underway to exploit these advances is the Warfighter Information Network-Tactical (WIN-T). WIN-T is an evolving and highly integrated Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) network comprised of commercially based COTS components. It is expected that tens of billions of dollars will be spent on this program in the next decade.

Commercial telecom technology is the backbone of the WIN-T architecture, providing simultaneous voice, imagery, data, and video communications in a highly-secure network. Telecom technologies including Asynchronous Transfer Mode (ATM) data transport, wireless high-capacity networks, Voice over Internet Protocol (VoIP), and PCS cellular services are all part of WIN-T.

While people often think of ruggedized military electronics as being the most robust available, commercial telecom systems are arguably much more robust in important ways. Rather than building systems with singular resources that represent single points of failure, telecom systems are usually built using redundant components and software to manage them. Failed components are dynamically and often automatically switched out of the system and replacement resources are switched in. While it is true that military electronics generally must operate in greater extremes of temperature, shock, and vibration, the underlying architectures of telecom systems are usually more robust, fault tolerant, and scalable.

Today, the architecture of both civilian and military electronics is largely determined by the silicon and software developed for civilian commercial products. This silicon and software is undergoing an architectural sea change as technology evolution takes us from conventional parallel bused backplane architectures (including VME and PCI) to switched serial interconnects, often called switch fabrics.

The first open standard, released in 2001, for switched fabrics was PICMG 2.16. The

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PICMG 2.16 architecture supplants (and often entirely replaces) the CompactPCI parallel backplane with a dual, redundant 10/100/1000 Ethernet switch fabric. This architecture has several key advantages over its predecessors.

First, PICMG 2.16 systems with no parallel data bus do not have the weakness that a single shorted data line can bring down the entire system. The links between processors are redundant serial links going through a switch. If a single board fails, it is merely switched out of operation and subsequently shut down. The switching resources themselves are dually redundant, so if a switch fails there is another one available to take over. Second, the sustained data transfer rate in a single chassis jumps from the few hundred MBps seen in VME or traditional CompactPCI to over 40 Gbps. Third, failed boards may be hot swapped out and replacements swapped in without turning off the power or otherwise disturbing a running system.

PICMG 2.16 systems are ideal for packetized data of many kinds, and are a popular choice for VoIP applications. Ruggedized and militarized conduction-cooled versions are available from many suppliers, and the popularity of PICMG 2.16 continues to grow. Figure 1 shows a ruggedized SBS Technologies CompactPCI chassis for avionics applications that equals or exceeds traditional

Figure 1

ATR-style enclosures while leveraging leading-edge telecom standards.

The VME community has adapted the move towards switched serial interconnects with the VITA 31.1 standard, which combines special VME cards with standard PICMG 2.16 switch cards. The emerging VITA 41 VXS standard creates a 2.16-like native VME architecture with a switched fabric, adding system management, an important element for managing redundant resources.

The most powerful and sophisticated open standard for switched serial interconnect platforms is AdvancedTCA, developed by PICMG, and released in late 2002. AdvancedTCA was developed for demanding telecom applications that often require that a system remain working for 30 years (>250,000 hours) without interruption. AdvancedTCA provides many features that will become highly desirable for military equipment designers as the technology broadens its application space.

AdvancedTCA systems offer fully redundant DC power feeds, hot-swap capability, a sophisticated system management architecture, and 200 W per slot thermal capability. These systems are designed to meet tough telecom NEBS environmental standards. A wide range of fabric topologies and interconnect technologies, including Ethernet, PCI Express Advanced Switching, StarFabric, and Serial Rapid I/O are supported. Heterogeneous processor types, including DSPs, network processors, and general-purpose processors can be used and intermixed. Backplane data rates can exceed 2.5 Tbps in fully loaded 16-slot AdvancedTCA systems using a full mesh fabric topology. Figure 2 depicts two- and six-slot AdvancedTCA systems from Carlo Gavazzi Computing Solutions.

One emerging and soon to be released standard that will be appealing to designers of deeply embedded small military computer systems is the Computer on Module (COM Express) specification. This is an entirely new PICMG specification that defines a feature rich small form factor embedded computer board. It can function alone or serve as a processor mezzanine board that plugs onto a base board containing application-specific I/O. A wide range of peripherals, including

Figure 2

video, USB, Serial ATA, Ethernet, PCI, and PCI Express signals are supported. COM Express boards provide a standardized interface in a small footprint of 95 mm by 125 mm. Figure 3 shows a COM Express single board computer from RadiSys Corporation.

One important benefit of COM Express-based designs is a fair amount of protection from parts obsolescence, which plagues military electronics designers. An important use of COM Express processor boards is as a processor mezzanine board that plugs into a base board that contains application-specific electronics. COM Express processor boards that become obsolete can easily be replaced with newer or more powerful versions. Expensive and difficult software upgrades are simplified as chip specific software that used to be contained in cumbersome board support packages is now provided as a standardized (and free) Application Programming Interface (API) by the chip manufacturer.

While both commercial civilian and military systems will continue to have unique needs, there is a great deal of technology and standards development work coming out of the civilian sector. This directly benefits next generation, highly integrated and sophisticated military communications systems. As the military follows the same course as civilian information technology with its move towards packetized data, open civilian standards will play a greater part in next generation military communications systems. The ability to deliver any data anytime to any warfighter or warplanner anywhere will truly allow the American military to attain Sun Tzu's ultimate acme of skill.

Joe Pavlat *is the editorial director of* CompactPCI and AdvancedTCA Systems. *He has more than 30 years' experience in the embedded computer industry. He is currently president and chairman of the PCI Industrial Manufacturers Group (PICMG), an industry consortium that develops open computer standards for the industrial control, instrumentation, and communications markets. Joe holds a Bachelor's degree in Computer Science from the University of Wisconsin.*

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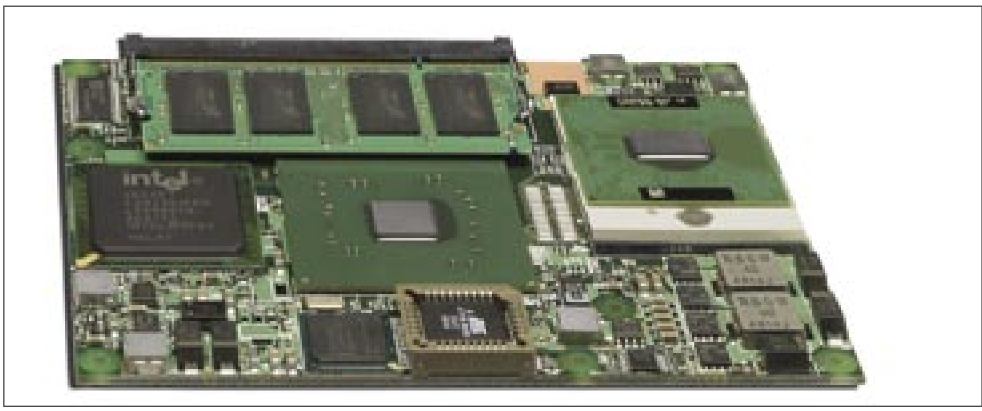

Figure 3