ATCA Carves Out Niche in Mil Applications

ATCA has made impressive inroads into the military market mindshare. Its communications bandwidth and high-availability features help seal the deal.

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ATCA has become a preferred form factor for certain types of military and aerospace applications, despite its origins as a telecommunications architecture. ATCA and its smaller cousin MicroTCA have made it into applications outside of the bases and depots and can now be found in everything from shelters to aircraft.

In contrast to the majority of military applications from five or ten years ago, today's military programs, such as FCS (Future Combat Systems), JTRS (Joint Tactical Radio System) and WIN-T (Warfighter Information Network – Tactical), are heavily communication-centric. It's not surprising therefore that the embedded computing architectures of yesterday are hard pressed to keep pace with the demanding communication bandwidth requirements of today's applications.

VME and CompactPCI, for example, while still viable for many applications, do not support the processing and communication bandwidth required for these applications. Switched-fabric extensions to these architectures (VITA 31, VITA 41 and PICMG 2.16) offer more bandwidth, but still do not meet the communication demands inherent in the new advanced programs. The ATCA standard has risen to address this issue. Ratified in 2002 as PICMG 3.0, ATCA offers extremely high communication bandwidth, extremely high processing capacity, and up to five nines availability (99.999% uptime).

Although originally designed as a telecom standard, design teams have deployed ATCA into a wide range of application spaces, including defense, government, aerospace and medical. Applications in these spaces present some similar requirements, including the need for a very dense computing platform with high communication bandwidth in a fairly rugged form factor.

The biggest advantages of ATCA are its extremely high computing power, high communication bandwidth and high availability. Up to 14 blades can exist on a single backplane, and each blade can

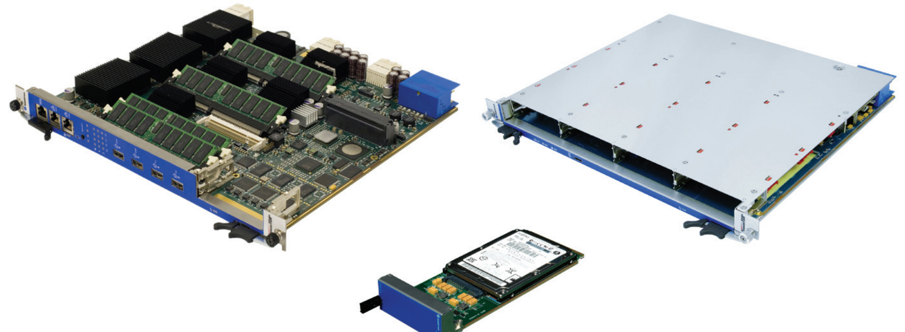

Figure 1

The Kontron AT8030 (left) has three Intel dual-core processors on a single blade, and its mezzanine can be populated with an AMC such as a fourth processor or a peripheral such as the AM4500 SATA storage AMC (center). The flexibility of ATCA can be realized via Kontron's AT8404 (right), which allows any four AMCs to be used in order to best meet the project requirements.

typically have up to four CPUs on board. Combined, this allows up to 56 (multi-core) processors in an 8U x 19-inch rack-mount system.

The processing blades communicate over the backplane via high-bandwidth channels, typically Gbit Ethernet or 10 Gbit Ethernet, in either a star, dual star, or full mesh topology. Peripherals such as storage drives, graphics cards and security modules also communicate over the backplane, typically via PCI Express, Serial Rapid IO, SATA, or SAS. These communication lanes can also be redundant.

The redundancy of the dual star and full mesh topologies is a key factor in making ATCA systems highly available. There is no single point of failure in a properly designed redundant ATCA system. Other features of ATCA that support high availability include the ability to hot swap all LRUs (line-replaceable units), redundant IPMI (Intelligent Platform Management Interface) buses for health monitoring, and shelf management.

ATCA provides very high compute density blades communicating over 10 Gigabit Ethernet. For example, Figure 1 shows the Kontron AT8030 with three Intel dual-core processors on a single blade, and its mezzanine can be populated with an AMC such as a fourth processor or a peripheral such as the AM4500 SATA storage AMC. The flexibility of ATCA can be realized via Kontron's AT8404, which allows any four AMCs to be used in order to best meet the project requirements.

High Availability a Requirement

In the past, high availability was not a requirement for military systems, but it is growing in desirability for military applications. High availability in this context means maximizing system uptime via redundancy and the ability to "heal" it in the field. The features above, if properly leveraged through judicious use of middleware and/or application support, can provide systems with up to five nines (0.99999) availability.

ATCA systems are more than rugged enough for benign environments, such as those in ground installations or on airborne platforms. ATCA boards and systems are designed to meet NEBS Level 3, which includes requirements such as thermal margins, fire suppression, emissions, and the ability to remain operational during a severe earthquake.

Figure 2

The P-8A Poseidon, based on the Boeing 737-800, and other military derivative aircraft use ATCA because of its processing power and relative ruggedness.

Also advantageous to defense applications is ATCA's inherent separation of control plane and data plane communications. The control plane communicates via Gigabit Ethernet, while the data plane can use higher bandwidth, such as 10 Gigabit Ethernet. The control and data planes have separate communication ports on each blade in the system, and control and data communications are separately and independently switched by the switch blades in an ATCA system.

It should also be noted that ATCA is highly scalable, which makes it a versatile solution for a number of applications. Beyond being scalable in the number of boards (configurations ranging from 2 boards to 14 boards are typical), ATCA is also scalable in terms of functionality. For example, if high availability is not required, some redundancy and/or middleware functionality can be removed, reducing the cost of the system.

As an extreme example of ATCA's flexibility, ATCA's mezzanine cards (AdvancedMCs or AMCs, for short) can be used as line cards in the smaller 2U MicroTCA platform. MicroTCA is basically a smaller version of ATCA, representing a smaller form factor and often lower cost for applications that do not require the compute density of ATCA systems.

ATCA's flexibility has made it a successful platform for a wide variety of application spaces, including defense applications. For example, ATCA is being used in military derivative aircraft programs, datacenter servers, and for multiple programs best categorized as server consolidation programs.

ATCA in Military Derivative Aircraft

Military derivative aircraft were originally designed as commercial vehicles and then retrofitted or modified to be a military platform. One example of military derivative aircraft using ATCA is Boeing's P-8A Poseidon program. The P-8A Poseidon (Figure 2) program modifies a Boeing 737-800 aircraft to make a long-range anti-submarine warfare, anti-surface warfare, intelligence, surveillance and reconnaissance aircraft capable of broad-area, maritime and littoral operations. These capabilities require a great amount of computational power, and it needs to be done in a fairly limited thermal envelope and footprint. Additionally, the systems need to be rugged enough to survive and operate during wartime operations.

ATCA is a logical choice for networked datacenter servers, which can be characterized as high-bandwidth network infrastructure systems. Essentially, these systems ensure that data coming in one port make it to the correct outbound port. These servers often also include functionality like communication priority management, security management and transcoding data, voice, or video from one format to another.

For example, Lockheed Martin selected ATCA for use in its Wideband Data Subsystem (WDS). This system, which is designed to be used in multiple programs, executes four distinct processing functions while translating high-speed serial data to a computer-readable format. Essential to this capability is the requirement to route 10 million 2,000 byte packets per second between the processing blades, a task well-suited to ATCA because of its 10 Gbit communication infrastructure.

It should be no surprise that ATCA is being used for these applications by the military community, as this usage is very close to its telecommunications roots. In fact, in many cases a military ATCA datacenter server located in a base, depot, or shelter is nearly indistinguishable from its cousin sitting in a central Telco office. This is especially true because of the recent push for military programs to use infrastructure based on commercial communication technologies such as Gbit Ethernet, Voice over IP (VoIP), 802.11 wireless standards and WiMax. ATCA is a well-proven technology for these applications.

It is also worth mentioning that significant portions of the WIN-T program are using the MicroTCA architecture. MicroTCA uses the ATCA mezzanine cards (AdvancedMCs) as blades in the system. Like these other datacenter applications, WIN-T is a network-centric program so it is not surprising that a network-centric standard such as MicroTCA is in use for this program.

ATCA for Server Consolidation

Because of its high compute density and high availability, the ATCA architecture is being used as a more compact, more reliable, more powerful alternative to a server farm typically implemented as a number of 1U industrial (or commercial) computers. The military's use of ATCA in this paradigm is usually realized in an upgrade project, such as upgrading servers to increase the processing power on submarines, other naval vessels, or non-mobile ground installations. ATCA is a good technical fit for these applications because of its high compute density and relative ruggedness. Its fault tolerance and high availability make ATCA even more attractive for server applications.

However, the driving factor for ATCA in these upgrades is economic and logistical. A centralized ATCA server farm has a lower Total Ownership Cost and smaller logistics impact than the distributed collection of computers—usually VME or commercial server blades—the new servers are replacing.

Maintenance costs are much lower over the lifetime of the program. For example, a typical server upgrade on a naval platform may be replacing a few dozen commercial-grade servers distributed throughout the vessel with a single ATCA server. This means only one set of fans and filters will need to be periodically inspected and replaced, as compared to dozens. Furthermore, the centralized ATCA server will typically be installed in an easily accessible area, while some of the distributed servers on a submarine or aircraft tend to be in less accessible areas. This reduces the amount of labor and turnaround time for each maintenance event.

Future Uses of ATCA and MicroTCA

To date, ATCA has been selected as the platform of choice for military derivative aircraft, datacenter servers and server consolidation programs. Common to these types of programs are requirements for high compute density, very high communication bandwidth, high reliability and a fairly rugged form factor. MicroTCA's smaller form factor makes it a logical choice when similar requirements are needed in space-constrained applications such as smaller shelters or ground vehicles. Also, recent work in the PICMG standards body has been defining ruggedization levels that MicroTCA can attain and suggesting implementations that would allow it to be used in less benign applications. With the increased push toward commercial platforms and communication technologies, it is reasonable to expect that other types of programs will use ATCA and MicroTCA architectures in the near future.

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