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Industry Spotlight

ADVANCEDTCA/MICROTCA FOR MILITARY APPLICATIONS

ATCA, a competitive alternative to 6U VPX

Hardware-platform decisions have always been challenging in the aerospace and defense market, as applications in these markets typically require cutting-edge technology and a deployment life cycle that could extend for decades. Developing hardware from the ground up is costly and can lengthen development schedules; however, the advent of open standards such as VITA and PICMG means that many engineering teams have started using these standards to reduce development cost and time to market.

ATCA technology is being looked at for a variety of military shipboard applications.
U.S. Navy USS Abraham Lincoln (CVN 72) photo by Mass Communication Specialist 3rd Class Jerine Lee.

Open standards enable engineers to start abstracting software from the hardware, and most development teams use the same basic framework for hardware decisions as they look at the application requirements to determine the processor and I/O requirements. Knowledge of a deployment environment gives designers an understanding of the ruggedization required, while system Size, Weight, and Power (SWaP) requirements provide the final information to allow them to make decisions on hardware.

The deployment environment is one of the major factors in determining which standards can be used. In many cases environmental conditions are not friendly to electronics, requiring conductively cooled solutions, so typical choices have been 3U VME, sometimes

3U cPCI, or 6U VME. In applications where the environment is benign and air-cooled solutions can be used, platforms are typically based on 6U VME or cPCI. With the release of the VPX standard, most developers assumed that the majority of applications would transition to either 3U or 6U VPX. The transition to 3U VPX has begun with 3U VPX offering new features to help kick-start the transition, but the 6U transition seems to be stuck in neutral.

Advanced Telecom Computing Architecture (ATCA), now seeing increased adoption in the air-cooled aerospace and defense market, has the potential to be the successor to 6U VME. This shift is driven by two major factors: To begin with, the application I/O requirements are changing due to the network-centric warfare concept, while sequestration with defense-budget cuts has taken the concept of "affordability" and made it a reality, where performance and price are key factors in funding decisions.

While ATCA and VPX have many aspects in common, their backgrounds are very different. ATCA was brought about by a completely new architecture driven by network equipment to provide a high-performance, high-bandwidth solution for wireless commercial networks. In contrast, VPX was a significant improvement to VME, which is mainly focused on the aerospace and defense markets. The biggest difference between these standards is the physical board size (see Table 1), in which ATCA's larger board size and bigger pitch allows more real estate on the front panels, a larger board area for components, and better cooling.

Key Considerations	VPX	ATCA
Board Size	6U: 233 x 160 mm Area: 373 cm^2	8U: 355.6 cm x 280 cm Area: 996 cm^2
Backplane Technology	1 Gbps and 10 Gbps, plans for 40 GbE	10 Gbps, moving up to 40 Gbps
Pitch	Typically 1 inch	1.2 inches
Adoption of Standard	2009	2004

Table 1 | A comparison of VPX vs. ATCA chassis specifications.

Changing I/O requirements

Several years ago the Department of Defense (DoD) started pushing the concept of network-centric warfare. The general idea was to get different systems to easily communicate with each other in order to provide the warfighter with better situational awareness. However, many system architects have taken this to the next level, where a network now means that every device is connected to switched Ethernet. This shift is driving two different types of requirements – one consisting of many small pipes and another using a few fat pipes.

The "many small pipes" concept is starting to be widely adopted where every end device is connected via Ethernet, and all devices need redundant connections via two separate switches. The end device could be a user, sensor, or control point. This requires the endpoint to do some front-end processing of the data to convert it to Ethernet. This architecture can drive a significant amount of 1 GbE connections to the system. In some cases the requirement is as high as 48 1 GbE redundant (a total of 96) 1 GbE connections. A more typical architecture is 10 redundant (a total of 20) 1 GbE connections. Many of the new ATCA boards will have 14 10 GbE/1 GbE connections, and can handle this requirement with as few as two to four switches per system. However, as VPX switches are a smaller form factor and typically have six to eight 10 GbE/1 GbE connections, you would need four to six switches per system. This setup would significantly decrease the payload capacity of the systems in the long term and would also have a detrimental effect on SWaP.

The second use case is "big pipes" between systems. In this case, the connections between chassis are either difficult to upgrade, or (in cases where they need to be connected in the field), there is the desire to make as few connections as possible. In both scenarios there exists the desire to overprovide the connections between chassis to either provide bandwidth for future upgrades or to limit the number of physical connections between systems. Most new ATCA switches support Quad Small Form Factor Pluggable (QSFP) 40 GbE links via the Rear Transition Module (RTM), while VPX deploys only a 10 GbE connection.

Affordability is key to defense budgets

For the last few years the DoD has been pushing the concept of affordability, in response to the reduction in defense budgets.

Performance is one of the key parameters when looking at affordability, and every process architecture and application has a unique profile. However, for generic performance the Standard Performance Evaluation Corporation (SPEC) focuses on x86 standards and provides a widely adopted set of tests for performance and allows users to post results.

Most 6U VPX boards that support the x86 architecture use Intel Core i7 processors (mobile processors). The newer blades are typically single-socket and are based on the i7-4770TE, which is a long-life, low-power processor. These blades typically have an XMC or PMC site. From the results posted on the SPEC website, the estimated performance for integer-processing performance is around 180, with the floating-point performance around 130. Typical ATCA blades are dual-socket, based on Xeon server processors, and use the E5-2648LV, which is also a low-voltage, long-life processor. The integer performance of these is around 420 with a floating-point of 360. The typical performance for an ATCA board is roughly twice that of a VPX board. While this case is based on an x86 example, the scaling of a large board size will generally apply to other types of processors.

From a system perspective, for the typical system that is air-cooled and fits in a 19-inch rack, a 5U ATCA system can support six boards while a VPX system can support seven boards. If you assume that two switches are required, the total performance of an ATCA system provides a benchmark of 1,540 on integer performance, as opposed to 900 for a VPX system; the ATCA system's performance is roughly 70 percent higher.

Cost is the other key parameter of affordability. A typical VPX board based on the i7-4770TE processor has a list price of approximately $9,000. ATCA has

Figure 1 | LCR Embedded Systems 6U ATCA chassis.

been widely adopted by the network-equipment providers, which has driven a high unit volume and a lower price point, thereby driving down the price of the typical ATCA board based on the E5-2648L to the $7,500 price range.

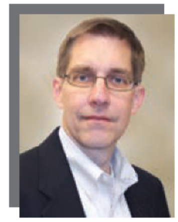
If you look at the total price of the typical system – assuming that a chassis with two 10 GbE switches costs around $20,000 – the ATCA system with four computing blades would be $50,000, while a 5U VPX system with five computing blades would cost closer to $75,000. If you compare the performance per dollar, ATCA provides roughly two-and-a-half times the affordability of a 6U air-cooled solution.

Of course, several other soft factors go into hardware selection, some of which favor ATCA, while others lean towards 6U VPX. One factor is that the physical size of an ATCA is larger than a 6U VPX. For ATCA boards in a horizontal alignment, you need roughly a standard 19-inch rack, while for vertical alignment you need roughly 13 inches. In contrast, 6U VPX can fit in much smaller spaces.

Another component is the perception that ATCA is not as rugged as 6U VPX. However, air-cooled blades are typically only deployed in benign environments. ATCA was designed to handle ambient temperatures of -5 °C to +55 °C, but these ranges can be extended. Moreover, the shock and vibration profiles for the aerospace and defense markets are unique but can usually be handled by a more rugged chassis. LCR Embedded Systems has shipped more than 450 ATCA chassis currently deployed in ground mobile and airborne applications, while other vendors are currently shipping volume for naval deployments (see Figure 1).

One other misconception about ATCA is that it is not a long-life-cycle product. The key driver for product End of Life (EOL) is the silicon used on the board, and because both VPX and ATCA use the same type of processor, it is possible to get 10 years of production life out of a payload blade.

A critical factor for all aerospace and defense applications is the use of the latest available technologies. ATCA has an advantage over VPX in this area as well, as the majority of ATCA users are network-equipment providers. Selling communication equipment to the carriers is a very competitive environment, with customers demanding the very latest technology. Major ATCA blade providers are driven by time to market with the silicon, launching their new products when the silicon vendor announces the availability of the silicon. Most board vendors have had 40 GbE switches available for a year, and are using the latest Intel and packet-processing silicon. **MES**



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