



## Why AdvancedTCA Merits Serious Consideration for Defense Systems

**Developing modular computing platforms with AdvancedTCA can help speed time to fielding, reduce lifecycle costs, and fuel innovation**

*By Scott Burgan  
Consultant, The Corner Group*

Chances are you have heard little or nothing about this family of computing and communications specifications. Even those who know about the AdvancedTCA standard (also known as PICMG 3.x) may dismiss it as a commercial technology, not suited to the rigors of war-fighting systems.

In fact, AdvancedTCA (ATCA) may very well be the catalyst that finally allows the Department of Defense (DoD) to deploy its Global Information Grid (GIG) and achieve Network-Centric Warfare. Core to this mission is the timely, reliable ability to share data, without regard to the sender's or receiver's platform, system, transport method or application.

This paper discusses the merits of the AdvancedTCA specification and explains why it is important for DoD and its vendors to give it more than a cursory look. Furthermore, we explain how the adoption of a single, standardized framework (like ATCA) can lead to shorter design cycles for new systems, lower overall costs and faster time to fielding. You will also learn why ATCA is an ideal architecture from which to build modular computing platforms (MCPs) that allow vendors to quickly and continuously implement new capabilities through spiral evolution. Most importantly, you will finally understand how ATCA – and the related smaller form factor known as MicroTCA ( $\mu$ TCA) – provide the flexible, open architectural framework necessary for many defense-related computing and communications needs.

## The Goal: Timely, Reliable Data Sharing

For more than a decade, the US government has been on a mission to integrate and network all of the communications and information-sharing systems related to our national defense. The goal: provide one fully integrated, completely interoperable, high-performance backplane for all networking, computing and communications across DoD and its affiliated organizations. (See figure 1). DoD uses the term “Global Information Grid” (GIG) to describe this backplane.

According to our national leaders, it is a mission vital to our national defense: “The success of network-centric warfare is directly tied to the reliability, integrity and timeliness of information sharing.”<sup>1</sup> Perhaps the government’s inability to prevent the terrorist attacks of 9/11 underscores that harsh truth.

Even so, establishment of the GIG is a formidable task. And interoperability among hardware and software has been described as “the entry fee” to development of the GIG.<sup>2</sup> True interoperability means that all components, equipment, software and systems will work together, no matter which vendor makes it. It also means that different programs and platforms can readily share information, regardless of the software that created it or the mechanism that delivered it.

## The Standards of Success

The government can take a significant step towards interoperability by standardizing all networking and communications systems on an

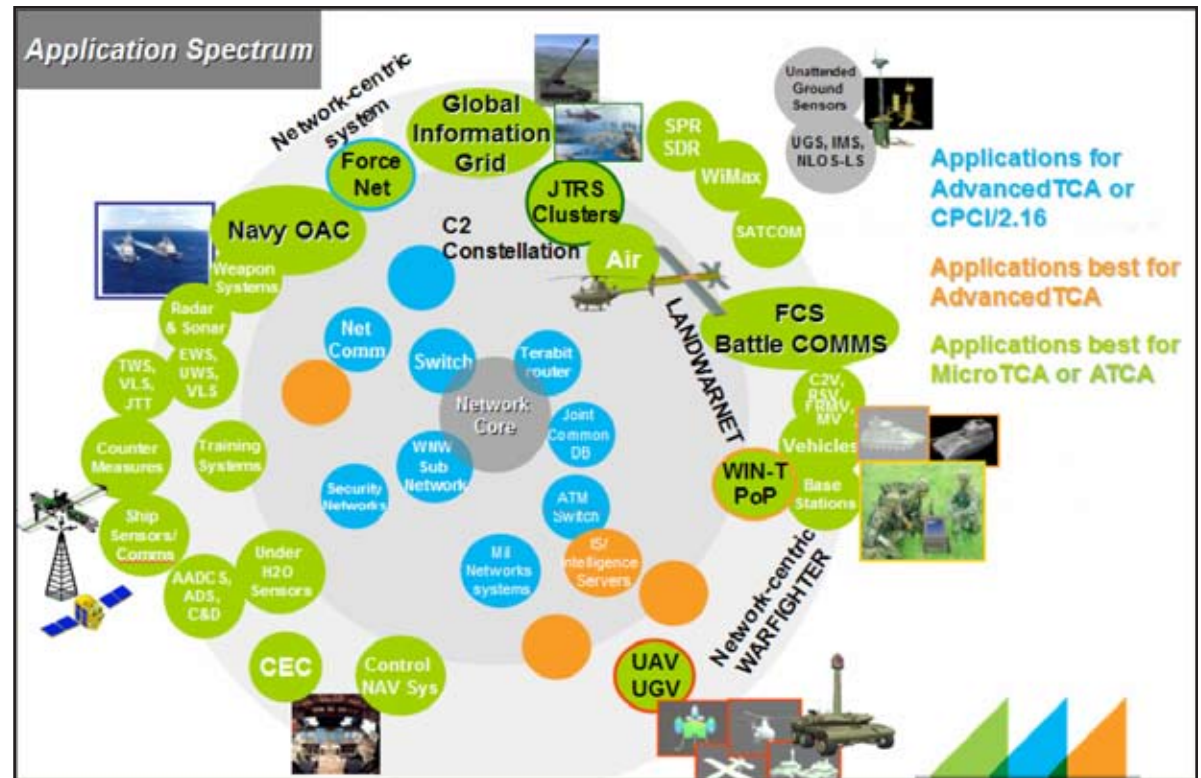


Figure 1: Application of Modular Communications and Computing Platforms to the Global Information Grid extending from the Network Core to the Tactical Edge.

open technology framework. Because open standards are embraced by many commercial vendors, this strategy would give the DoD the freedom to choose from a wider assortment of solutions built by more vendors. Such choice also speeds the time it takes to begin fielding new systems, and it fuels the competition and innovation that keeps costs down.

There are two important elements to this strategy. One is the need to use the modular communications platform (MCP) approach to

the design and construction of DoD programs. The other is the need to choose one set of carrier-grade technology standards to ensure interoperability, scalability and the greatest likelihood of future reliability. We recommend the family of AdvancedTCA specifications, also known as ATCA or PICMG 3.x. (More about these recommendations below.)

<sup>1</sup> Sense of the Report, DoD report to Congress on NCW, Assistant Secretary of Defense Arthur Money, March 2001, p.16

<sup>2</sup> VADM Arthur K. Cebrowski, USN, and John J. Garstka. “Network Centric Warfare: Its Origin and Future,” Proceedings of the Naval Institute 124:1 (January, 1998), <http://www.usni.org/Proceedings/Articles98/PROcebwrowski.htm>

## Modular Communications Platforms (MCPs)

Many DoD organizations, defense system integrators and product vendors are convinced about the merits of MCPs. These fully integrated, solution-ready computing and/or communications modules can be readily inserted into an existing standards-based network or used to develop new ones. OEM vendors build MCPs using a variety of off-the-shelf, commercially available components (including COTS) and are designed and architected to facilitate rapid insertion of technology solutions for mission-critical applications in the telecommunications industry. There is absolutely no reason that MCPs cannot be used in the same manner to facilitate NCW. The important point to make here is that COTS are not necessarily MCPs.

The MCP paradigm is rooted in technology standards and spans a broad range of carrier-grade (NEBS-3 compliant) COTS solutions that are widely implemented in high-availability telecom applications. MCPs are comprised of standards-based building blocks that include silicon, boards, chassis, carrier-grade operating systems, real-time operating systems (RTOS), middleware and applications. Modular, truly “off-the-shelf” architectures use standard backplane interfaces and have no custom pins, as found in the proprietary implementations of several defense systems.

By their very design, MCPs enable evolutionary development for faster time to fielding and incremental advancement in communications and networking. When compared to proprietary

systems, standards-based MCP solutions provide improved flexibility, optimal vendor choice, and cost-effective development, even while accelerating the delivery of new applications and systems. Of equal importance, the MCP framework is designed to meet the highest reliability, stability, and scalability requirements for applications from the edge to the core of the communications network.

MCPs offer another benefit related to cost and availability of supply. With a set of common building blocks there are fewer part numbers and less to manage from a life-cycle, configuration management and logistics perspective. This makes it much easier to sustain field operations and find alternative components should the supply chain become compromised.

### Using Commercial Products Does Not Ensure Low-Cost, Open, Interoperable Systems

It's true that organizations within the DoD encourage the use of standards-based, commercial off-the-shelf technologies (COTS). Many programs are either under development or in the process of fielding systems which use COTS products. The problem is that COTS products, all by themselves, are not a standardized technology platform to ensure interoperability. There are two reasons why reliance on COTS alone will not achieve interoperability between systems:

#### Using COTS within Proprietary/Custom Solutions

Some defense programs have incorporated

COTS into their custom designs in an effort to comply with the government's goal. But these are still proprietary solutions, and the use of COTS alone does not ensure interoperability, vendor choice and the rapid deployment of new applications. As long as the systems themselves are still proprietary, it doesn't matter if some of the components used are COTS. These designs still may not offer complete interoperability, and they will likely have higher overall system life-cycle costs inherent to vendor lock-in.

#### Commercial ≠ Standard

During the search for non-proprietary technologies, many organizations within the DoD have discovered commercial vendors that offer complete end-to-end IP converged solutions

for both enterprise and telecommunications applications. In many cases, these groups have standardized on these commercial implementations. Yes, these commercial products and technologies are available “off the shelf,” and they may even appear to be built using industry standards. But the reality is that they are often based on non-standard, proprietary hardware, operating systems, middleware and/or protocols. Their underlying technologies are not open, and cannot interact with other open, interoperable systems. This limits the extensibility of the system and perpetuates the problems that contribute to lack of interoperability, vendor lock-in, high cost, slow time to fielding, and so on.

## Choosing the Right Technology Framework for Defense-related Systems

AdvancedTCA\* (PICMG\* 3.x) meets carrier-grade requirements for high availability (better than 99.999% uptime), strong processing performance, high bandwidth and easy scalability over extended system lifecycles. This enables the evolutionary insertion of new applications, future processors and interconnect technologies; there is no need to wait for entire new programs or systems in order to upgrade to new ideas. (See the related sidebar: The Application of AdvancedTCA and MicroTCA within the Military Environment.)

This open, board-based, carrier-grade (NEBS-3) architecture is designed for telecommunications applications, but supports all voice, data, and video applications for a truly converged solution. ATCA is suitable for military applications because it can be enhanced by the manufacturer for battlefield ruggedness. AdvancedTCA enables high levels of backplane interconnect bandwidth, performance and flexibility not available in previous generations of standard technologies.

The ATCA specifications provide enough information to allow board, backplane, and chassis vendors to independently develop MCPs that can be combined to form interoperable systems. Details include board dimensions, equipment practice, connectors, power distribution, and a robust system management architecture that can be used independent of the switch fabric link technology.

ATCA provides a managed communications capability which is highly available and sustainable, supporting the latest developments in COTS-based communications technologies (WIMAX, 3G), silicon/

## The Application of AdvancedTCA (ATCA) and MicroTCA within the Military Environment

Whether it is high availability computing or communications, the ATCA family of specifications provides a standardized modular platform that can perform a variety of functions across a converged IP network. The following proof-of-concept ATCA architecture illustrates the convergence of communications (voice, video and data) combined with redundant computing and storage resources required to deliver communication services reliably and at a high service availability (> 99.999%) leveraging the management and hot-swappable service availability framework.

Figure 2 illustrates the application of an ATCA chassis to provide both wireless access and transport via four baseband AMC cards hosted in an ATCA carrier board (WiMAX, Wi-Fi, 3G, CDMA, etc.) with additional interfaces to support legacy networks (E1/T1, SONET, OC-3, Ethernet), emerging transport or communications access (IP MPLS) or non-communications related operational control or diagnostic interfaces (discrete input/output for control, network synchronization to GPS, RS-232 IO to support keysets, bezels or console access). Note that fabric switching for chassis base fabric in this configuration is redundant as well as box management hardware and software. Legacy applications for PCI Mezzanine Cards (PMC) currently could be hosted on ATCA or AMC (e.g. HAIPE Type 1 VPN encryption).

For wireless access or backhaul, the baseband AMC is connected to an RF module. Depending on the application, additional RF processing may be required on the RF front-end, consisting of an RF switch, power amplifier and/or bandpass filter. Low power analog applications such as RF processing and filtering may be hosted within the chassis depending on the application. For commercial implementations of RF modules for WiMAX, 3G and HSDPA, frequency stepping (up conversion/down conversion) may be applied to the RF signal in order to operate outside of commercial bands, supporting a mostly standards-based COTS implementation of WiMAX, 3G for military applications within an ATCA or MicroTCA chassis.

Figure 3 illustrates how AMC applications may be re-hosted to address similar functions within a MicroTCA chassis, providing both a smaller overall subsystem with shorter 300 mm depth for the chassis.

Both AdvancedTCA and MicroTCA support full and half heights and widths providing substantial flexibility in the applications that AdvancedTCA and MicroTCA may support. For example, an ATCA shelf may support up to 12 ATCA carrier cards with

up to 48 AMC cards in a full width ATCA chassis or 12 half-height, single-width AMCs may be hosted within a single width MicroTCA chassis. MicroTCA standard also supports double width AMC cards.



Figure 2. AdvancedTCA shelf subsystem (12U chassis with 8U cards) with AdvancedMC Baseband RF, Storage, Processing and Interface cards



Figure 3. Extending AdvancedMC to MicroTCA chassis (support for Single (75 mm) or Double-Wide (150 mm) AdvancedMC cards)

compute technologies (multi-core processing, server virtualization), and network and enterprise services. What's more, ATCA-based modular platforms enable the DoD and systems integrators to make use of commonly available hardware and software components to rapidly integrate and deploy new services and systems.

ATCA is actually a group of specifications designed from the ground up for the telecom industry. All along, it was developed for high performance, high reliability, future scalability, and rugged durability – exactly what's needed for demanding communications systems.

## Comparing ATCA to VME

The ATCA (PICMG 3.x) specifications are oriented around switched fabric technology instead of a

conventional parallel bus (like CompactPCI and VME). The switched fabric is better suited for high availability and high speed telecom applications offering better overall backplane throughput with low-latencies and deterministic delays.. ATCA specifications enable hot-swappable blades, while VME does not. This is important to military operations because many upgrades must be done in the field, on the fly; when at war, there is no downtime option available for changing out systems.

The military will also find that ATCA has a stronger path to future technologies than VME. For example, PICMG has published a well-defined roadmap to the Advanced Mezzanine Card (PICMG AMCx) and MicroTCA (uTCA) standards that will deliver ATCA-type specifications in a smaller form factor (learn more about these two

new smaller standards on the next page).

## Going Wireless: AMC and MicroTCA (uTCA)

Wireless networking and communications are essential to the GIG, which is why it is important to identify the right wireless networking standard for hardware and software development. Roadmaps to future capabilities, like WiMAX broadband wireless services must be factored into this decision. Integration with wired systems is also important.

Wireless computing and communications systems must be implemented using smaller form factors. The soon-to-be-published AMC and MicroTCA specifications – both of which are ATCA/PICMG 3.x compatible – are ideal standards for several Military and Federal wireless programs.

## Lessons from the Commercial Telecommunications Industry

Like the defense industry, the commercial telecommunications industry has long used proprietary and custom-built solutions to power its networking and communications. Viewed as a means for competitive differentiation, proprietary systems were always meant to stand as silo networks.

But the changing global economy and a need to share infrastructure dictated that the industry needed a new approach. AdvancedTCA was born of the need to facilitate better interoperability between carriers, enhanced customer services around the globe, and especially lower costs. As communications systems became more and more complex, it simply became too costly for each company to develop complete end-to-end solutions on their own. ATCA was designed from the ground up to serve as an architecture for the development of carrier-grade telecommunications and networking systems.

ATCA is now widely embraced by equipment manufacturers and service providers as the best means for facilitating interoperability among systems, faster time to fielding, easier scalability, and enhanced quality of service. Although originally developed for the telecom industry, it is well suited to military/DoD applications.

In a very general sense, moving to standards-based solutions has helped the industry offer more types of communications services and bring out new solutions rapidly – all while keeping customer prices low and lowering the cost of development. Because new systems take years to develop, the industry is just now starting to realize the fruits of this decision. Judging from the earliest testimonials, ATCA is quickly replacing VME and CompactPCI as the standard-of-choice among networking and telecommunications industry leaders.

Today, dozens of leading manufacturers in the commercial telecommunications industry back the ATCA family of specifications, including HP, Nortel, Motorola, Siemens, NEC, Kontron, Alcatel, Huawei, Radisys, Fujitsu, and Intel. Similarly, dozens of leading service providers across the globe are adopting ATCA-based solutions.

“Modularity has promised a reduction in cost and a time-to-market advantage. That promise has been realized as we deliver AdvancedTCA platforms to the marketplace. Our customers have indicated the most significant benefit has been time to market, which has accelerated by 9 to 15 months, and in the process they've reduced their development expenses by millions of dollars on a typically-sized project.”

*Wade Campbell, Director of Strategic Marketing  
Embedded Communications Computing Motorola, Inc.*

**AMC: Advanced Mezzanine Card\*** (AMC) is the mezzanine standard designed to enhance modularity and high-speed serial connectivity for AdvancedTCA and other platforms. AMC enables manufacturers to bridge between proprietary and standards-based interfaces and to implement a variety of embedded processors, digital signal processors, network processors, and other components in modular Field Replaceable Units (FRUs).

**MicroTCA ( $\mu$ TCA): MicroTCA\*** is designed to deliver improvements in size, weight and power (SWAP) compared to older form factors, maximizing the design and implementation choices available from the industry. The MicroTCA standard includes a standard backplane with built-in redundancy using the proven technology framework of AdvancedTCA. MicroTCA accepts AMC modules and provides high levels of throughput in a compact form factor. Rugged implementations are under development.

### **Carrier-Grade Linux\***

Our proposed standards-based framework also includes software/middleware recommendations. Two groups are responsible for developing the open source Linux operating system to ensure reliable operation in mission-critical, high-availability systems. The Open Source Development Lab (OSDL) and the Service Availability Forum (SAF) have developed standards for the middleware used in telecom systems related to service availability to ensure that these systems can meet the 99.999% high availability required for mission-critical communications. Carrier-Grade Linux meets the standards set forth by these two groups and is an important element in ATCA-based systems.

### **Choosing ATCA Makes Sense**

ATCA is right for the military/DoD because it encompasses the critical elements of networking and communications, including convergence. ATCA specifies numerous technologies and systems, embracing whole infrastructures – both past and present. And because ATCA is a modular architecture, it allows the DoD to make incremental advancements in the course to NCW. This allows MCPs to become the evolutionary mechanism whereby DoD can develop the GIG over time, and without reliance on proprietary networks and systems.

It's time for the DoD and system integrators to make the adoption of a single, standardized framework like ATCA a priority. Such a decision will most certainly accelerate the transition to NCW and bring about the associated benefits of lower cost, faster time to fielding of new warfighting solutions, and rapid innovation.

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*Scott Burgan is a consultant for The Corner Group, LLC providing strategic planning and technical consulting services primarily in the area of systems integration of Information Technology and Communications systems for several top 500 companies. He may be contacted at [scott.burgan@thecornergroupp.com](mailto:scott.burgan@thecornergroupp.com).*

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For more information on the AdvancedTCA or MicroTCA standards, refer to <http://www.picmg.org>. For more information on standards or working groups relating to Service Availability (SA) or standards for Carrier Grade Linux (CGL) operating systems for real-time communications computing, refer to the Service Availability Forum, <http://www.saforum.org> and <http://www.osdl.org>.

### **Boeing Chooses ATCA for its P-8A Multi-Mission Maritime Aircraft Program**

Real-world examples tell the ATCA story best. Boeing is one of several defense contractors that have recently started using this technology. For example, Boeing is using ATCA-based components in the Mission Computing and Display System (MCDS) for Boeing's P-8A Multi-mission Maritime Aircraft (MMA) program. The P-8A program will replace the U.S. Navy's fleet of P-3C Orion maritime patrol aircraft with next generation maritime surveillance aircraft. Currently in development and demonstration the program is scheduled for initial deployments sometime in 2008 or 2009.

As part of the P-8A system development and demonstration phase, Boeing has announced that the MCDS will utilize Intel® NetStructure® Single Board Computer blades built on the AdvancedTCA standard. Boeing engineers selected this solution because the ATCA standard enables deployment of flexible solutions that capitalize on reusable designs and commercially available components for significant savings in development time and investment.

Both Boeing and US Navy engineers have determined that the ATCA architecture and the Intel blades meet or exceed the selection criteria for the U.S. Navy P-8A Multi-mission Maritime Surveillance Aircraft Program. These stated criteria include: high bandwidth, high-performance computing power, reliability, high availability, the ability to handle vibration and shock, and COTS.