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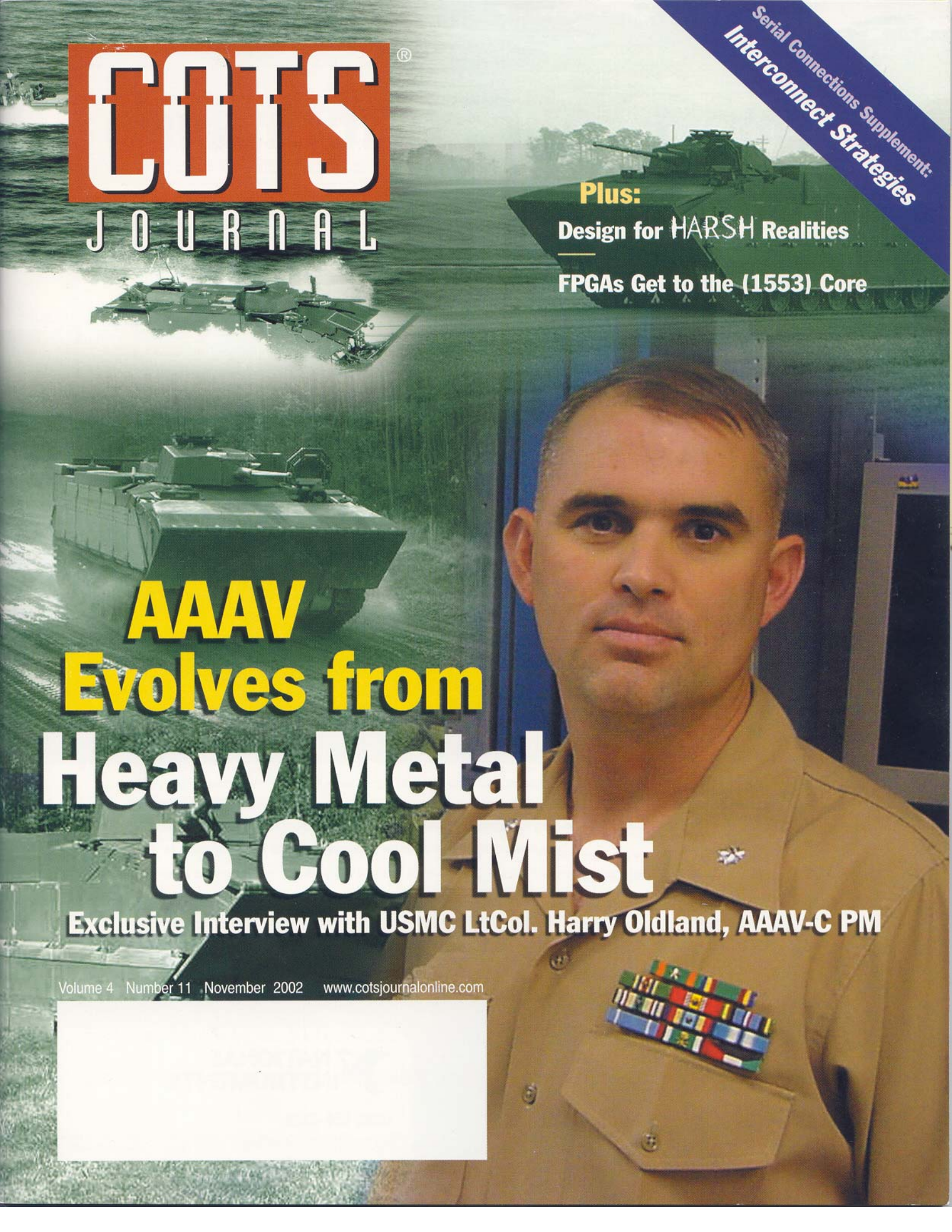

AAAV Evolves from Heavy Metal to Cool Mist

Exclusive Interview with USMC LtCol. Harry Oldland, AAAV-C PM

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Interview

Lieutenant Colonel Harry Oldland, C4I Division Head and AAAV-C Program Manager

COTS Equipment Capabilities Emerge from the Mist on Marine Corps AAAV

Because of his aggressive endorsement of leading-edge commercial technology, LtCol. Harry Oldland has justly earned the name "Mr. COTS" applied toward the Marine Corps' Advanced Amphibious Assault Vehicle. In order to add C4ISR and fire control capabilities for today's requirements, AAAV is bucking the typical vetronics trend toward costly conduction-cooled modules by using a revolutionary technology called spray cooling. With it, thousands of leading-edge air-cooled modules are now available to provide unprecedented battlefield capabilities.

CJ: **Please tell us what AAAV is all about.**

LtCol. Oldland: AAAV stands for Advanced Amphibious Assault Vehicle. It is a revolutionary armored amphibious vehicle that can be described in many ways, but it is the next generation of assault vehicle for the Marine Corps. It is not an improved version of its predecessor, the AAV; it is more revolutionary than that because it includes up-to-date technology along with its hallmark capability of high water speed. The current vehicle, the AAV, does about 6 knots, which is no different than what our fathers and grandfathers used during WW II. The AAAV will do 25 knots in the water, and that's just the beginning of its more advanced capability. Additionally, it has an NBC [nuclear, biological, chemical] over-pressure system and a 30 mm cannon with a full fire control system allowing it to engage targets on the move. It also has a coaxial 7.62 mm machine gun. It has a crew of three, which consists of the driver, the vehicle commander and the gunner. Additionally, it will hold 17 combat-loaded Marines. It provides armor protection against effects from 14.5 mm rounds and there are numerous other systems that make it a vast improvement over the old AAV.

CJ: **Are all AAAVs the same?**

LtCol. Oldland: There are actually two variants of the AAAV. The one I was just describing is the personnel variant called AAAV-P (Figure 1). It also has a laser range finder for precision targeting capability. On the C2 side it has SINCGARS radios, UHF satcom radio, UHF line of sight radio for air-to-ground communications, inertial NAV system to complement the GPS and it also has the capability for an EPLRS radio, which is a higher bandwidth data radio for tactical data networks. Also, we use the Marine Corps Command and Control Personal Computing software, which is our C2 software for navigation, text messaging and position reports. It's implemented at the driver's position, the vehicle commander's position and the troop commander's position. The troop commander is the senior infantry Marine aboard the vehicle. The AAAV has the land mobility equal to that of the M1 Abrams tank.

CJ: **Does the AAAV represent a Marine Corps doctrine/strategy shift?**

LtCol. Oldland: The concept of employment is that the AAAV will carry out what we call STOM—the Ship to Objective Maneuver part of the Marine Corps' amphibious warfare, working in concert with the MV-22 Osprey and the Navy's landing craft air cushion [LCAC]. Launching at 25 nautical miles out to sea using the sea space as maneuver space, the AAAV can attack at littoral penetration points [LPP], which most people would think of as the beach. But instead of using

the beach to build what we refer to as a "steel beach", we now just use those LPPs as a waypoint en route to the final inland objective. This might be an airfield, city or major industrial complex; but whatever that objective is, it's no longer the beach. We are able to make this fundamental strategy change because of the mobility capabilities that the AAAV provides.

CJ: **You mentioned two variants of the AAAV. What is the other variant?**

LtCol. Oldland: The other vehicle is the command variant [AAAV-C], and it's perhaps 75-80% identical to the personnel variant for the obvious reasons of supportability and associated cost savings. What is different is that the command variant does not have a turret; that's been replaced with cupola that now becomes the work area for Marine staff acting as a tactical echelon headquarters for a Marine Battalion or Regimental staff (Figure 2). There are seven staff workstations that consist of a screen, keyboard and a pointing device as well as an intercom system. In addition to those seven staff workstations and three man crew, there are also two jump seats that consist of a seat, fold-down table, intercom connection and a data connection for two additional Marines to come in and use laptops or palm-top computing devices while connected to vehicle's network and utilize the infrastructure provided by AAAV-C.

In addition to C2PC, the AAAV-C provides the tactical C2 software applications. This includes the IOS V1 (operation) suite; what we used to call TCO [tactical combat operations] and it provides the friendly force picture command and control capability. The IOS V2 (intelligence) provides the enemy picture. Azdditionally, the AAAV-C provides the Advanced Field Artillery Tactical Data System (AFATDS) for indirect fire support command and control. All of these applications are accessible from any of the workstations.

CJ: **Does this tie into any Navy assets or are these strictly USMC systems that you are describing?**

LtCol. Oldland: What I am describing now are USMC systems that are derivatives of GCCS, the Global Command and Control Systems, and the DoD's operational command and control software system. The Army calls it GCCS-A and Navy has GCCS-M, which stands for Maritime. The application, IOSV1 [operation side] and IOSV2 [intelligence side] all have interfaces to this GCCS package. So, in the AAAV-C we have IOSV1 OP, IOSV2 INTEL, and we also have what the Marine Corps uses for regiment and below C2 called C2PC. This C2PC is also the same software application that the personnel variant uses for command and control.

Finally, in addition to IOSV1, IOSV2 and C2PC, the AAAV-C also hosts the AFATDS [Advanced Field Artillery Tactical Data System], which is the fire support package used by both the Marine Corps and the Army.

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The C-variant also has the capability to function as a tactical data network node that consists of a specific set of systems, servers and routers that the Marine Corps implements to function as major data nodes on the battlefield.

CJ: **Now that we've gotten a feel for how this vehicle's role on the beach/battlefield is different, and what systems it contains, how exactly is COTS being used?**

LtCol. Oldland: The situation presented to us four years ago was that the Marine Corps had a variety of software applications, which were written and designed to run on what we refer to as "white gear"—true commercial desktops in a benign environment. The challenge was to provide a platform for these applications to function in an armored vehicle that works on sea and on land in harsh environments. It gets extremely hot, and the shock and vibration can be intense.

In the case of the Unix applications, there were no militarized processor boards to support Sun-based applications. And our non-Unix applications required Intel architecture processors that either weren't fast enough to support our applications, or not available at all for a harsh environment. For example, the fastest militarized processor at one point in time was the Pentium 166 MHz, but my minimum processing requirement for, say C2PC at that time, was 233 MHz. So I had the technology challenge to be able to provide the necessary hardware for my required software applications. This forced me into examining how I was going to solve the problem of needing COTS but not having a solution for heat transfer while minimizing weight, power and space issues.

CJ: **A dilemma indeed. This is when many applications turn toward conduction-cooled modules and systems.**

LtCol. Oldland: Exactly, but let me get back to that in a moment. I found two other potential solutions while attending a COTS conference. In one case the box was way too heavy and consumed too much power and still didn't solve half the problems we had, primarily dealing with salt air, water immersion and so forth. The other option was looking at spray cooling from Isothermal Systems Research.

Upon closer examination, the basic physics of spray cooling made sense. Spray a nonconductive liquid on electronics to cool them, and then cool the liquid via a heat exchanger or use the box sidewalls, and then repeat the process. In this way potentially *any* commercial air-cooled board could be kept "isothermally" in a temperature-controlled environment. But the question we had was why should AAAV be the first to use this COTS technology? So, we were nervous but saw the potential. To mitigate our apprehension we began working with DARPA to secure some funds to build a test box that would be targeted to our vehicle needs.

LtCol. Oldland: It is all the reasons we've discussed so far: primarily the benefits of COTS. The reasons are to reduce cost, minimize power consumption, and maximize performance, functionality and capability.

CJ: **Does that imply tech refresh as COTS goes obsolete over time?**

LtCol. Oldland: Absolutely. Tech refresh, given the nature of electronics at least in our lifetime, is a critical part of the architecture and support concept of the AAAV. Spray-cooled technology allows us to use COTS and leverage off of COTS for the tech refresh piece. The theory is to buy air-cooled modules in VME or CompactPCI from any vendor that meets our requirements, and reinstall the system software to run on that module. In fact, we've done this over the past couple of years with our boxes where the processor that was available has been upgraded to coincide with annual or semi-annual USMC software releases. With spray cool, we don't fret about the migration of the hardware; instead, as we ran into trouble we were able to select the best, most capable board to support the functionality of that application. It eases tech refresh, or makes it easy because of the variety you get from using COTS.

There's an important point here I'd like to amplify. Currently the budget we have is to support the R&D effort to design and build AAAV. Long term however, we expect to have a higher tech refresh rate because of the COTS modules we're using. But our estimates show that it will still be *less expensive* with an increased tech refresh rate using COTS than the cost estimates using conduction-cooled processors, which have less capability and may or may not support the requirements. So, our cost assessment shows a performance *increase* and cost *savings* over the life of the vehicle using COTS versus conduction-cooled boards—even with an increased tech refresh rate.

CJ: **Certainly there must be some naysayers who are opposed to spray cooling?**

LtCol. Oldland: There are only a handful of COTS conduction-cooled suppliers versus all the other hundreds of air-cooled vendors. Some have raised their eyebrows about the validity of spray cooling. Here's a quick story: one of the conduction-cooled vendors told me that AAAV shouldn't use a particular type of board because that vendor didn't build it and it couldn't be built by anybody. So the mentality of the traditional conduction vendor base is "this is the best we can do", but their best is not good enough for me. This point is critical with our Intel and SPARC processor boards where we demand performance that's available in air-cooled but unavailable in conduction-cooled boards.

So, does spray cooling work? Yes. I can show test data and prove it to people day in and day out that it works. I installed a first-gen spray-cooled chassis with the latest Sun SPARC boards and the latest PowerPC boards into an AAV [the predecessor to AAAV] and bounced it around Quantico for a month. I did not have a single board failure. I did not have a spray-cool failure. But, do you know what? The militarized hard drives and some of the militarized peripherals failed in multiple quantities.

So, spray cooled works. When people question spray cool, what they are really questioning are the implications of it as a market. If something comes along better than spray cooling, and it is true COTS, I am going to buy it. My target is not spray cooled; my target is COTS, commercial air-cooled, top of-the-line that I can go buy anywhere in the world. Spray cooled facilitates that and conduction technology doesn't.

CJ: **Spray-cooled boxes must be physically larger, certainly once you mount them in a shock tray. Isn't one of these 9-slot boxes bigger than a conduction-cooled 1ATR (long) vetronics box?**

LtCol. Oldland: Actually the boxes are not necessarily larger and are nearly identical in size and weight to their conduction cousin, if you will. Their power consumption is slightly less, and this includes the pump. Understand that with conduction-cooled

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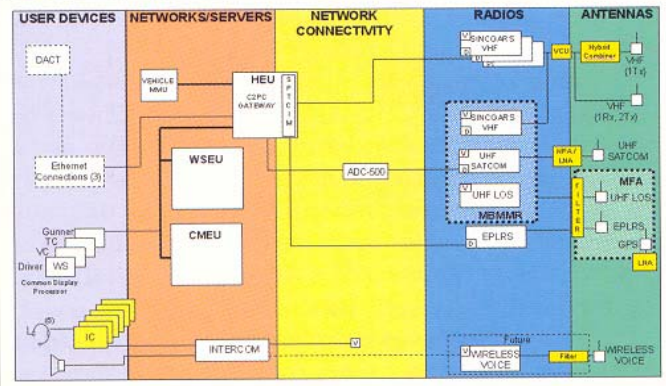

Figure 1

System architecture of AAAV-P (personnel) variant. This version is designed for a crew of three plus 17 additional combat-loaded Marines.

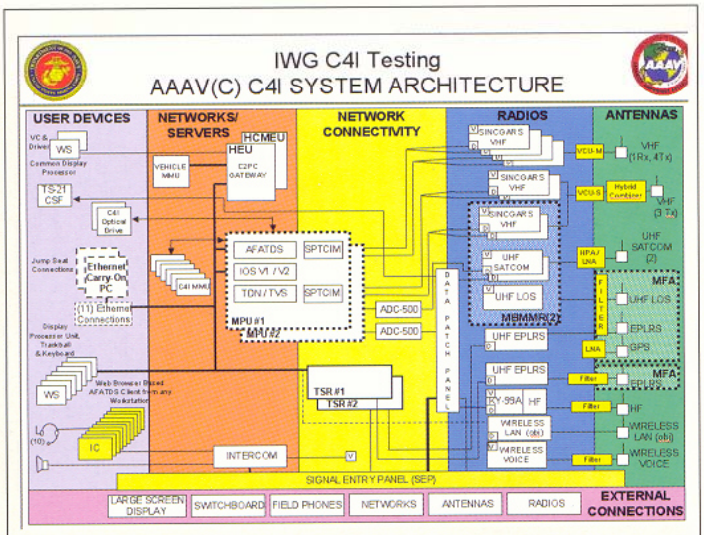

Figure 2

The AAAV-C (command) variant is designed as a tactical echelon headquarters for a Marine Battalion or Regimental staff. Besides the crew of three, up to nine additional Marines can work inside the vehicle, which acts as a forward-deployed C4ISR (and more) asset.

boards, the metal mass you need to dissipate that heat is not small. In the case of one box that we still have, it actually violates the VME spacing standard in order to provide sufficient surface area for the conduction-cooled board to dissipate its heat. So the boxes are nearly identical in size and nearly identical in weight.

The key distinction is that the spray-cooled box builds an environment for my electronics.

CJ: Are any other programs using spray cooling, either within the Marine Corps or any service branch?

LtCol. Oldland: The AAAV program is probably the leader in this right now. We introduced spray cooling to the Crusader program, and the Navy's EA6B program has done some SBIR-level design work. I have also had some discussions with the F16 program. There are a couple of other programs, which I cannot mention, that are using it as well today.

CJ: Based upon what you've said, Isothermal Systems Research is in a sole-source position on AAAV. How are you planning on dealing with this?

LtCol. Oldland: Very good question. Currently we have only worked with ISR for the development of these boxes. The sole-source nature of it is something we have to be concerned about in terms of budgeting and support, and those are issues we are looking at in order to better position the program and to ensure success.

For your readers, I would challenge them to facilitate COTS solutions, because it doesn't take a rocket scientist to figure out that as a war fighter I need the best technology in today's and tomorrow's world in order to sustain a significant, overwhelming advantage on the battlefield. Spray-cooled technology allows me to do that.

CJ: Are there any alternatives to spray cooling besides conduction cooling?

LtCol. Oldland: Yes: highly integrated processing solutions like system-on-chip devices, reconfigurable processors, high-density electronics and additional use of high-density field programmable gate arrays. These are the sorts of civilian technologies found in PDAs and portable wireless devices. They're low cost and miniature, meaning they offer high capabilities with minimal power consumption and heat output. However, none of these are currently capable of supporting our C2 systems.

CJ: The VME International Trade Association's next-generation VME standard called VITA-34 is looking into many different power dissipation techniques, including spray cooling. Were you aware of that?

LtCol. Oldland: Yes, and not only are we watching it closely via my MITRE support, I want to personally encourage the COTS market to continue to innovate. It's the least we can offer for our fighting men and women. ▮▮