Brainstorm - Military & Aerospace Electronics

What key technologies will enhance thermal management in military/aerospace equipment in the next three years?

Vic Berger, CDW-G

Military bases and Defense agencies – motivated by awards for “green” movements and aided by funding for environmental conservation efforts – will benefit from creative, incremental changes that draw down their power consumption.

Take the military’s data centers, for instance. To keep equipment from overheating, agencies spend thousands of dollars on 24/7 air conditioning, with costs increasing significantly during the winter. In turn, that air conditioning produces heat, which is exhausted to the outdoors....But it doesn’t need to be that way. During the winter, agencies can bring ambient air into the data center to cool the machines and then draw the heat produced by the machines out of the data center and into the surrounding work space with a heat pump. Air flow technology redistributes the air to supplement, or in some cases, entirely heat the work environment.

Other incremental technology investments will significantly draw down on power use. ...Lights, computers, and peripheral devices such as printers never shut down, even when no one is working. Military agencies implementing

Doug Patterson, Aitech Defense Systems

Not every embedded computing problem needs multicore processors, terabytes of local data storage or GigaFLOPs of raw processing horsepower supported with a plethora of DSP math libraries. In many instances, simple RISC or DSP-based microcontrollers are more than sufficient to do the job cost-effectively. And, by design, they are highly power-efficient, placing less demand on already-strained platform electrical systems. However, it can be easily assumed that the proper management and removal of electronics heat byproducts will always remain challenging.

In the near future, liquid cooling “plumbing” and ECS (Environmental Control Systems) will be integrated into next generation military and avionics applications providing a platform-wide, cost-effective thermal transfer point.

Lower power, highly integrated and higher performance microprocessors and supporting IC components will incorporate advances in packaging to allow improved heat and thermal transfer by direct conduction to the die, thus making the removal of heat more smart power switches can shut off most computing devices during non-productive hours. In doing so, they cut power and cooling costs, resulting in a tremendous return on investment in a very short time.

Moving out of the data center, we will see the military increasingly adopting solar technology to offset power costs. Equipping one home with solar technology can produce enough power for up to two homes. While the return on investment is less immediate than simply turning off the lights, with thousands of military housing units across the country, the long-term savings potential is huge.

manageable than just blowing air across a bolted-on, aftermarket heat sink. Advances in Aluminum-Graphite/carbon composite, environmentally sealed enclosures will make internal heat more readily circulated and transmitted to the enclosure sidewalls as well as to the top and bottom covers, increasing thermal efficiency.

While it’s always been an interesting technology, spray cooling has proven to present too many design tradeoffs to be cost effective at the platform level – that is, the addition of duplicate pumping subsystems within each enclosure (in multi-enclosure platforms), fluid filters (and related filter maintenance), internal sump locations to support all potential enclosure orientations in 3D space (and the effects of G Forces), high initial mechanical components costs, costs associated with the retro-ruggedization of board-level modules, in addition to the environmental concerns over the leakage of fluids, in-field training, logistics and maintenance difficulties.

Ivan Straznicky, Curtiss-Wright Controls Embedded Computing

Over the last decade, increasing processor power and functional density have increased interest in thermal management in the military/aerospace market with power dissipation per unit board area rising at an almost exponential rate.

While air-cooling has met these power increases with more efficient heat sinks, better thermal interface materials (TIMs), and higher air flow rates/velocities, limits are quickly being reached. Heat pipes may be used to transport heat to larger areas, but the demands of military applications limit the cooling gains (for example, equipment orientation, shock and vibration, acceleration). Thermoelectric coolers promise a negative thermal resistance but their inefficiencies obviate any improvement.

Conduction-cooling is widely used on rugged, deployed circuit cards due to inherent advantages like shock and vibration resistance. Like air-cooling, conduction cooling has continued to meet power increases with improved TIMs and heat pipes. Conduction-specific enhancements include reduced contact resistance. New engineered composite materials promise to significantly decrease thermal resistance along the heat removal path. Also, liquid cooled chassis are being used to remove more heat from conduction-cooled cards.

The next step in cooling military/aerospace computing equipment appears to be liquid flow through (LFT) cooling, where the liquid now flows through a cold plate attached to the circuit card. Recent designs have been proven to cool over 650 Watts, which represents about a four- to eight-times improvement over air and conduction cooling.