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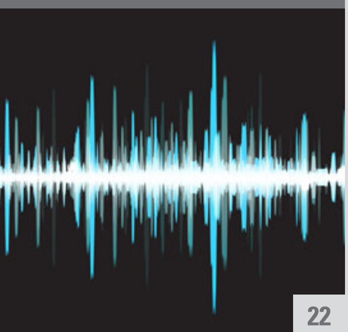
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ON THE COVER:

Top image:
Northrop Grumman is supplying and integrating mission avionics equipment for a digital cockpit upgrade of the U.S. Army's UH-60L Black Hawk helicopters. Courtesy of Northrop Grumman Corp.

Bottom image:
An MQ-9 Reaper equipped with an extended range modification sits on the ramp on Kandahar Airfield, Afghanistan5. U.S. Air Force photo by Tech. Sgt. Robert Cloys.


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Funding for radar, electronic warfare, C4ISR, in DoD budget request

By John McHale, Editorial Director

The president's Fiscal Year (FY) 2017 budget request for the U.S. Department of Defense (DoD) means that the nation has had back-to-back years with a budget increase, a nice change after the budget constraints and sequestration seen earlier this decade. Increased funding for radar, electronic warfare (EW), and communications programs, as well as a significant bump in cybersecurity, promise growth for defense electronics suppliers.

The total FY 2017 budget request is $582.7 billion, up $2.4 billion from the $580.3 billion enacted in FY 2016. The FY 2017 budget also "complies with the Bipartisan Budget Act of 2015, giving the department both funding stability and protection from the damage of sequestration in FY 2016 and FY 2017," according to the DoD. The overall Research, Development, Test, & Evaluation (RDT&E) budget for FY 2017 is $71.765 billion, an increase over the FY 2016 enacted total of $69.968 billion. Funding dropped slightly, however, for the DoD's Science and Technology program, from $13 billion in FY 2016 to $12.5 billion for FY 2017.

Designers of embedded computing, signal processing, open architectures, and other commercial off-the-shelf (COTS) solutions should find a steady market as the DoD's missions continue to rely more and more on cyber; command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR); radar; and EW systems both on battlefields and during peacetime. Below are key areas within the DoD budget that leverage embedded hardware and software.

Cybersecurity

Cyber operations get a $900 million increase in the FY 2017 budget program, with a total of $6.7 billion requested. For more on the DoD's cyber strategy, visit http://bitly.com/1Usabu0.

EW RDT&E

Total EW funding in the FY 2017 RDT&E budget is $298 million, more than $100 million over the FY 2016 enacted total of $184 million. The Navy gets most these funds, with $183 million requested for the service. The Army and Air Force are slated to receive $102.5 million and $12.5 million, respectively. Procurement for the Navy's AN/SLQ-32 Electronic Warfare Suite is down slightly from the FY 2016 enacted total of $296 million, to about $275 million.

Radar

RDT&E funding for radar programs comes in at about $755 million for FY 2017, down about $5 million from the FY 2016 enacted total of $760 million. Key programs getting FY 2017 RDT&E funding include Air and Missile Defense Radar (AMDR) at $144.3 million, Ground/Air Task Oriented Radar (G/ATOR) at $83.538 million, and Three Dimensional Long-Range Radar (3DELRR) at $49.5 million.

Radar program procurement for the FY 2017 RDT&E request comes in at about $560 million, a slight decrease over the FY 2016 enacted total of $568 million. Counterfire radars for the Army top the radar procurement request at $314 million, an increase of more than $100 million over the FY 2016 enacted total of $198 million.

The continued investment in radar and EW systems will empower the military radio frequency (RF) and microwave market. "I actually think the overall aerospace and defense market will be flat to growing at a slight percentage, but RF content in this market will continue to expand faster than the market itself," says Doug Carlson in an interview with the *McHale Report* this month (go to http://bitly.com/1QIYwks).

Communications and networking

Two key programs focused on communications and networking are the Warfighter Information Network-Tactical (WIN-T) and the Handheld, Manpack, and Small Form Fit (HMS) program: Each receives funding in the FY 2017 budget, but only HMS gets an increase

The FY 2017 WIN-T request procures and fields 283 Battlefield Video-Teleconferencing Center III systems and provides program management support for Single Shelter Switch, High Capability Line of Sight, and Troposcatter Communications systems as they transition to sustainment by the end of FY 2017. Total funding in this area – procurement, research, and development – in FY 2017, however, drops from $771 million in FY 2016 to $462 million.

HMS, which consists of the Rifleman Radio, the Manpack Radio, and the Small Form Factor Radios, gets procurement funding for Rifleman and Manpack Radios, support equipment, fielding, nonrecurring engineering expenses, and platform vehicle integration. Total funding – procurement, research, and development – in FY 2017 rises for HMS from $59 million in FY 2016 to $292 million.

These numbers indicate healthy demand for embedded computing technology for military systems. However, uncertainty still reigns. I'm writing this on Super Tuesday: Hillary Clinton and Donald Trump are set to sweep the Democrat and Republican primaries, respectively. Democratic presidents are traditionally not as pro-defense spending as Republicans and Trump is an unknown at this point. So enjoy the funding increase for now.

For a distraction from the crazy election atmosphere, read the budget documents in full at http://comptroller.defense.gov/BudgetMaterials.aspx. By the time you're done reading, we may have a new president.

Major DoD program procurement and modernization budget highlights

By John McHale, Editorial Director

The DDG 51 Arleigh Burke-class guided missile destroyer USS Stout is shown as it transited the Mediterranean Sea. The FY 2017 budget request slates $3.498 billion for DDG 51 destroyers. U.S. Navy photo by Petty Officer 1st Class Christopher B. Stoltz.

WASHINGTON. Funding slated for Department of Defense (DoD) major weapon systems programs for Fiscal Year 2017 totals $183.9 billion. The entire DoD budget request for FY 2017 is $582.7 billion, a $2.4 billion increase over the FY 2016 enacted total.

The funding request includes base funding and Overseas Contingency Operations (OCO) funding. The DoD's "Program Acquisition Cost by Weapons System" booklet has $112.1 billion for procurement and $71.8 billion for Research, Development, Test, and Evaluation (RDT&E) of these weapon system programs. Of the $183.9 billion, $72.7 billion is for programs that have been designated as Major Defense Acquisition Programs (MDAPs) or Major Automated Information Systems (MAIS). Program highlights from the booklet are below.

For budget information on major helicopter platforms, see our Special Report on helicopter avionics upgrades on page 28. For budget information on unmanned aircraft, see the Mil Tech Trends article on UAS safety certification on page 32. For other budget insight, see Editor's Perspective on page 7.

Long Range Strike

Long Range Strike (LRS) is intended to counter the post-2020 challenges to DoD's power-projection capabilities, according to the DoD. The LRS initiatives, collectively termed "Family of Systems" (FoS), will provide a synergistic, more cost-effective force multiplier power-projection capability in the post-2020 threat environment, says the DoD. LRS includes the next-generation and legacy bombers. Current bombers in the Air Force inventory are the B-1, B-2, and B-52 aircraft. The Long Range Strike Bomber (LRS-B) is a new high-tech long range bomber that will eventually replace the Air Force's aging bomber fleet. The FY 2017 program looks to begin engineering and manufacturing development of the next generation LRS-B and continue modernization of legacy strategic bombers. Total funding – procurement, research, and development – in FY 2017 increases from $1.508 billion in FY 2016 to $2.198 billion. (See Figure 1.)

F-35 Joint Strike Fighter

The F-35 Joint Strike Fighter (JSF) is the next-generation strike fighter for the Navy, Marine Corps, Air Force, and U.S. allies. The F-35 consists of three variants: the F-35A Conventional Take-Off and Landing (CTOL), the F-35B Short Take-Off and Vertical Landing (STOVL), and the F-35C Carrier variant (CV). The F-35A CTOL replaces the Air Force F-16 and A-10 and complements the F-22; the F-35B STOVL replaces the Marine Corps AV-8B and F/A-18A/C/D; the F-35C CV complements the F/A-18E/F for the Navy and will also be flown by the Marine Corps. The FY 2017 program aims to continue development of the F135 single-engine propulsion system; conduct systems engineering, development, and operational testing; and support follow-on development. The request procures a total of 63 aircraft: 43 CTOL for the Air Force, 16 STOVL for the Marine Corps, and 4 CV for the Navy in FY 2017. Total funding – procurement, research, and development – drops from $11.602 billion in FY 2016 to $10.504 billion in FY 2017.

P-8A Poseidon

The P–8A Poseidon is a multimission platform designed to replace the P-3C

Figure 1 | Air Force officials announced the first images of the Long Range Strike Bomber (LRSB), also known as the B-21. Photo courtesy of the U.S. Air Force.

Orion propeller-driven aircraft. The P-8A will carry a new radar array, which is a modernized version of the Raytheon APS-149 Littoral Surveillance Radar System. The FY 2017 program calls for procurement of 11 P-8A aircraft, acquisition of support equipment and spares, and funding for advance procurement for future aircraft. Total funding for the Poseidon program – procurement, research, and development – in FY 2017 drops from $3.373 billion in FY 2016 to $2.165 billion.

F-22 Raptor

The F-22 Raptor program is a fifth-generation aircraft fighter that penetrates enemy airspace and achieves first-look, first-kill capability against multiple targets. The FY 2017 program calls for continuing the planned modernization for F-22 aircraft via incremental capability upgrades and key reliability and maintainability improvements. It also continues development and testing of advanced air superiority capabilities to include integration of AIM-120D and AIM-9X, additional electronic protection, and improved geolocation. The FY 2017 program also looks to continue fielding of Increment 3.1 advanced Global Strike capabilities such as Small Diameter Bomb I, synthetic aperture radar (SAR) and Geolocation, and funding to support the 3.2B retrofit in FY 2017. Total funding – procurement, research, and development – in FY 2017 increases slightly from $556 million in FY 2016 to $704 million.

KC-46 tanker

The KC-46, an aerial refueling tanker, will provide aerial refueling support to the Air Force, Navy, and Marine Corps as well as U.S. allied aircraft. The first phase of aerial refueling tanker recapitalization will procure 179 aircraft, about one-third of the current KC-135 tanker fleet, according to the DoD. Envisioned KC-Y and KC-Z programs will ultimately recapitalize the entire tanker fleet over a period of more than 30 years. The FY 2017 program continues the development efforts of a militarized variant of the Boeing 767-2C aircraft, the building and integration of military capabilities into four development aircraft, and developmental and operational testing. It continues a third year of low-rate initial production (LRIP), procuring 15 aircraft in FY 2017. Total funding – procurement, research, and development – in the FY 2017 budget increases from $2.996 billion in FY 2016 to $3.319 billion.

V-22 Osprey

The V-22 Osprey is a tilt-rotor, vertical takeoff and landing aircraft designed to meet the amphibious/vertical assault needs of the Marine Corps, the strike rescue needs of the Navy, and the long-range special operations forces missions for U.S. Special Operations Command (SOCOM). The FY 2017 program looks to fund the fifth and final year of a follow-on five-year multiyear procurement contract (FY 2013 to 2017) with the procurement of 16 MV-22 aircraft for the Marine Corps. The last year of procurement for the Air Force-SOCOM CV-22 was FY 2014; however, the FY 2016 Appropriations Act added one CV-22 for Air Force attrition reserve. Total funding – procurement, research, and development – in FY 2017 decreases slightly from $1.609 billion in FY 2016 to $1.475 billion.

M1A2 Abrams modification

The M1A2 Abrams is the Army's main battle tank, which first entered service in 1980. It was produced until 1994. Since then, the Army has modernized it with a series of upgrades to improve its capabilities, collectively known as the System Enhancement Package (SEP) and the Tank Urban Survival Kit (TUSK). Current modifications to the M1 Abrams include Vehicle Health Management and Power Train Improvement & Integration Optimization. FY 2017 funding calls for development of mine-blast survivability improvements and continues Engineering Change Proposal (ECP) 1B (lethality improvements) development. It also aims at continuing to procure hardware for ECP 1A for installation during vehicle recapitalization in FY 2018, as well as many approved modifications to fielded M1A2 Abrams tanks, including the Ammunition Data Link (ADL) to enable firing of the Army's new smart 120 mm ammunition, and the Low Profile Commander's Remote Operating Weapon Station (CROWS). Total funding – procurement, research, and development – in FY 2017 rises from $509 million in FY 2016 to $559 million.

Paladin

The M109 family of vehicles consists of the M109A6 Paladin 155 mm Howitzer and the Field M992A2 Artillery Ammunition Support Vehicle (FAASV), an armored resupply vehicle. The Paladin Integrated Management (PIM) program addresses obsolescence, space, weight, and power concerns and ensures sustainment of the M109 FOV through 2050. The PIM replaces the current M109A6 Paladin and M992A2 FAASV vehicles with a more robust platform, integrating the M2 Bradley common drive train and suspension components, according to the DoD. The PIM fills the capability gap created by cancellation of the Non-Line of Sight Cannon (NLOS-C) (a component of the Future Combat System program) in 2009. The PIM is now in LRIP. The FY 2017 program funds support of final developmental testing and procures 48 PIM systems. Total funding – procurement, research, and development – in FY 2017 rises from $426 million in FY 2016 to $636 million.

Stryker

Stryker is a 19-ton wheeled armored vehicle that provides the Army with a family of ten different vehicles. The two basic versions are the Infantry Carrier Vehicle (ICV) and the Mobile Gun System (MGS). Existing Strykers are being upgraded with a Double-V Hull (DVH) for improved protection against improvised explosive devices (IEDs). There are 81 vehicles that are receiving the Stryker Lethality Upgrade funded by the European Assurance Initiative (ERI) in FY 2016. The FY 2017 request funds completion of the fielding of the third DVH Stryker Brigade Combat Team (SBCT) and converts 123 Stryker vehicles to the DVH configuration to support the fourth DVH SBCT. Total funding – procurement, research, and development – drops from $1.181 billion in FY 2016 to $727 million in FY 2017.

Figure 2 | The Amphibious Combat Vehicle (ACV) will replace the aging Amphibious Assault Vehicle. Photo courtesy of BAE Systems, prime contractor on the ACV program.

Amphibious Combat Vehicle

The Amphibious Combat Vehicle (ACV) is a Major Defense Acquisition Program and will replace the aging Amphibious Assault Vehicle. The FY 2017 request calls for funding manufacturing and delivery of 32 Engineering, Manufacturing, and Development (EMD) test vehicles; and conducts contractor development test activities supporting the ACV Increment 1.1 program. Total funding – procurement, research, and development – in FY 2017 drops from $212 million in FY 2016 to $159 million. (See Figure 2.)

Littoral Combat Ship

The Littoral Combat Ship (LCS) is a small surface combatant capable of operations close to shore. It is designed for operations in three primary anti-access mission areas: surface warfare (SUW) operations, mine warfare (MIW), and anti-submarine warfare (ASW). The FY 2017 program looks to fund construction of two LCS seaframes, outfitting, trainers, and other support equipment. Total funding – procurement, research, and development – in the FY 2017 budget rises from $1.816 billion in FY 2016 to $1.599 billion.

DDG 51 Arleigh Burke

The DDG 51 class is made up of four separate variants: DDG 51-71 represent the original design, designated Flight I ships, and are being modernized to current capability standards; DDG 72-78 are Flight II ships; DDG 79-123 ships are Flight IIA ships; DDG 124 will become the first Flight III variant. Flight III ships will feature the Air and Missile Defense Radar (AMDR) capability. FY 2017 program funding calls for two Flight III DDG 51 AEGIS-class destroyers as part of a multiyear procurement for ten ships from FY 2013 to FY 2017, plus outfitting costs. Total funding – procurement, research, and development – in FY 2017 drops from $4.449 billion in FY 2016 to $3.498 billion.

CVN 78 aircraft carrier

The CVN 78 class ships will include new technologies and improvements to improve efficiency and operating costs as well as reduced crew requirements. USS Gerald R. Ford is the first aircraft carrier designed with all-electric utilities, eliminating steam service lines from the ship, thereby reducing maintenance requirements and improving corrosion control. The new A1B reactor, Electromagnetic Aircraft Launch System, advanced arresting gear, and dual-band radar all provide improved capability with reduced personnel. The FY 2017 program looks to fund the fifth year of construction costs for USS John F. Kennedy (CVN 79), long lead items for USS Enterprise (CVN 80),

outfitting and training costs, and continued development of ship systems. Total funding – procurement, research, and development – in FY 2017 rises slightly from $2.772 billion in FY 2016 to $2.786 billion.

LHA America amphibious assault ship
USS America (LHA 6)-class ships are large-deck, amphibious assault ships designed to land and support ground forces. This class of vessel can transport a combination of helicopters and vertical takeoff and landing aircraft. The first two ships, LHA 6 and USS Tripoli LHA 7, are designated as Flight 0 Variants. LHA 8 will be designated the first Flight 1 ship and will reincorporate a well deck for operational flexibility. The FY 2017 program funds construction of LHA 8, outfitting costs, and continuing research and development efforts. Total funding requests – procurement, research, and development – rise significantly, from $498 million in FY 2016 to $1.648 billion in FY 2017.

Ohio Replacement Program
The Ohio Replacement Program (ORP) is designed to replace the current Ohio class of Fleet Ballistic Missile Submarine (SSBN), delivering 12 SSBNs with the necessary capability to counter credible threats through 2080, according to the DoD. The platform is currently in the research and development stage, but the ORP requirements and specifications are being refined. The ships will begin construction in FY 2021 for FY 2028 delivery, when the first Ohio class ships are due to be decommissioned. The FY 2017 program provides funding for advance procurement of long-lead items, detail design, and research and development of nuclear technologies and ship systems such as the propulsion system, combat systems technology, and the common missile compartment. Total funding – procurement, research, and development – for FY 2017 rises from $1.391 billion in FY 2016 to $1.864 billion. A prime contractor has yet to be named.

AEHF System
The Advanced Extremely High Frequency (AEHF) system will be a four-satellite constellation of communications satellites in geosynchronous orbit that will replenish the existing EHF system, Military Strategic Tactical Relay (MILSTAR), at a much higher capacity and data-rate capability. AEHF-1, AEHF-2, and AEHF-3 are in orbit and operational, according to the DoD. The launch of AEHF-4 is planned for 2017, while AEHF-5 and AEHF-6 are scheduled to replace AEHF-1 and AEHF-2 at the end of their useful life. The FY 2017 program looks to continue funding for the procurement of the space vehicles AEHF-5 and AEHF-6, along with continuing selected MILSATCOM Space Modernization Initiative (SMI) development activities focused on inserting new technologies to replace obsolete parts and materials and improve capabilities. Total funding – procurement, research, and development – in FY 2017 rises from $556 million in FY 2016 to $709 million.

GPS program – GPS III
The DoD's Global Positioning System (GPS) provides worldwide, 24/7,


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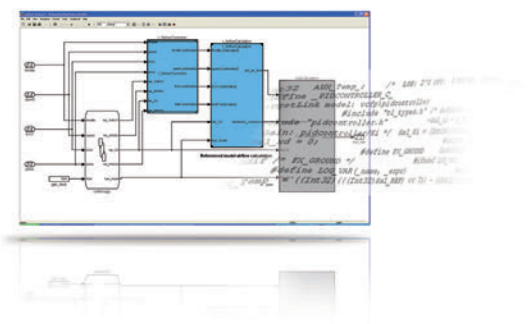

all-weather 3-D position, navigation, and precise timing information for military and civil users. The GPS III space vehicles will be fully backward-compatible with legacy signals while delivering new capabilities and enhancements to include a new Galileo-compatible (civil) signal, a more powerful M-code (military) signal, and the possibility to on-ramp future capabilities. The GPS Next Generation Operational Control System (OCX) will enable operational use of all modernized GPS signals and permit improved position, navigation, and timing (PNT) performance. The FY 2017 request looks to complete GPS III Space Vehicle 01 and 02 for available launch activities, continue development of GPS OCX Blocks 1 and 2, and fund the technology development and lead platform integration of Military GPS User Equipment (MGUE) Increment 1. The FY 2017 request also funds the GPS Program Office's responsibility as the Prime Integrator (Enterprise Integration) to synchronize space, control, and user segment programs and manage civil/military specifications and requirements. Total funding – procurement, research, and development – in FY 2017 drops slightly from $871 million in FY 2016 to $847 million.

Space Based Infrared System (SBIRS)

The Space Based Infrared System (SBIRS) will field a four-satellite constellation in Geosynchronous Earth Orbit (GEO) and a two-hosted payload constellation in Highly Elliptical Orbit (HEO) with an integrated centralized ground station serving all SBIRS space elements. The SBIRS is the follow-on system to the Defense Support Program (DSP). The GEO payload has a scanning infrared (IR) sensor, which provides a higher revisit rate and increases the sensitivity of DSP, and a staring IR sensor, which provides a higher fidelity and persistent coverage for areas of interest. The HEO payload consists of a single IR sensor and was delivered to the host satellite program in June 2013 and is now in orbit. The GEO-5 and GEO-6 satellites are scheduled to launch as replenishment satellites for GEO-1 and GEO-2 at the end of their useful lives. The GEO-3 satellite will be delivered from storage for launch in September 2017, while SBIRS Flight 4 and the GEO-4 satellite will be moved directly from production for launch this summer as SBIRS Flight 3. The FY 2017 request looks to continue incremental funding for procurement of the space vehicles GEO-5 and GEO-6 to fund ground segment development; it also seeks to continue the Space Modernization Initiative development activities to reduce future production costs by improving insertion of new technologies to replace obsolete parts and materials. Total funding – procurement, research, and development – in FY 2017 drops for SBIRS from $834 million in FY 2016 to $545 million. **MES**

Avionics FACE lift

By Charlotte Adams

An Abaco Systems perspective on embedded military electronics trends

Software portability has long been a goal of military procurement officials. Think of all the money that could be saved if each new software project did not have to start from scratch and if modules could be integrated more quickly and less expensively. Hardware – within a wide range of performance options – is roughly interchangeable, so why not software? Until recently, however, their reach exceeded their grasp.

Early software-interoperability initiatives went nowhere because they lacked consensus and drive. Success in this arena requires a strong hand and top-down support. Instead, waivers were allocated and standards went unmandated.

In response to these early attempts, the standards efforts became smarter, focusing on business as well as technical issues. The probability of success also was boosted by the unquestionable need to control runaway software-development costs. The upshot was the formation of FACE, the Future Airborne Capability Environment consortium, a government/industry group – backed by the U.S. Navy and Army aviation procurement organizations – under the umbrella of the Open Group, an organization with deep experience in standards development. FACE looks not only at technology but also at issues such as intellectual property, conformance verification, military specs, and procurement requirements. The avionics industry likewise is reengineering its own business models.

FACE grows and develops

More than six years from power-on, FACE is reaching critical mass. Standards have emerged for the interfaces between the different levels of software, as part of an avionics common operating environment. Developers of software modules residing at the application, transport services, platform-specific services, and I/O services levels must build application programming interfaces (APIs) that conform to FACE standards. The consortium also has identified standards for functions within these software layers. Once approved, reusable software modules will be housed in a repository accessible to system developers. Verification authorities, which will opine on the conformance of software modules to the FACE standards, are being named; some already are listed on the FACE website.

Although FACE aficionados like to compare the software repository to an app store, developers won't be able to pop software components from the repository into a mission computer, for example. There will have to be some integration and test activity to make sure that the various components work together as a system. However, because a component from the repository already will have been proven to conform to FACE standards, the time and cost of system integration are expected to be much less than is the norm today. That's what will make the effort worthwhile.

Progress, development

Progress is being made. A technical interchange meeting in February 2016 highlighted the breadth and depth of FACE software development. Around 30 companies, including prime contractors, application developers, hardware developers, and suppliers of software utilities, took part in interoperability demonstrations. The FACE consortium now includes more than 80 companies, with a growing number of procurements committed to its standards.

Although the standards are still evolving and the projected cost savings are not yet within view, the consortium has moved closer to the goal of software portability and reusability than any initiative in the past. The ability of military managers to pick and choose between different vendors' software components with confidence that these elements will work together would be a sea change, compared with the traditional way of doing business, in which each capability is built from the ground up with software that is unique to the platform.

Figure 1 | The Abaco Systems FORCE2 display computer is an example of hardware designed to run FACE applications.

FACE hardware

While FACE is most critically concerned with application-level software, nothing can run without lower-level software and the underlying hardware. That reality leaves room for innovation at these levels, as well. An example of hardware designed to run FACE applications is Abaco Systems' soon-to-be-announced FORCE2 display computer, which hosts the VxWorks 653 operating system together with an avionics data bus, Ethernet, and graphics drivers aligned with FACE standards (Figure 1).

At present the FACE enterprise is like an aircraft taxiing down the runway: It has yet to take off or reach cruise altitude. As the standard matures, there probably will be additional room for hardware differentiation and optimization. In the future, we may see board manufacturers leverage not only their own high-performance processing architectures but also distinct sets of built-in test, platform-specific, and I/O software to improve system performance and reduce program costs.

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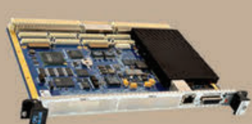

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Long live VME!

By Aaron Frank
An industry perspective from Curtiss-Wright Defense Solutions

While the "V" in "VME" actually stands for "Versa" (as in "Versa Module Eurocard"), it could arguably also stand – especially in the defense and aerospace commercial off-the-shelf (COTS) market – for "venerable." For the decades prior to the advent of the VPX architecture in 2006, VME was unquestionably a de facto board standard for rugged open architecture systems. Today, there are thousands of VME boards installed in the field and untold millions of dollars invested in hardware and systems software currently used on those deployed systems.

That's why the 2014 announcement that the popular Tempe TSI148 VMEbus bridge chip was being declared end-of-life (EOL) by its supplier made major news in the industry. Predictably, many COTS board vendors announced the EOL of some VME boards, and vendors responded with a range of proposed strategies and workarounds to the bad news, including board last-time buys. The good news is that the "V" in VME can now also stand for "vitality" thanks to the emergence of field-programmable gate array (FPGA)-based VME interface solutions that provide a powerful one-two punch to simultaneously address industry's continuing need for a VME bus interface chip, while at the same time ending the anxiety that another EOL – lurking off in the future – might again raise the specter of obsolescence for these critical devices.

By implementing a VME interface in an FPGA device, it is now possible to develop new VME boards that are 100 percent form-/fit-/function-compatible with earlier VME interface designs. Even better, because the FPGA IP for the VME interface core is managed by the board vendor, the future threat of obsolescence is eliminated. That's because the same VME interface code can be

"... By integrating a VME interface into reconfigurable FPGAs, COTS vendors can now keep their VME legacy systems updated with the latest processor technologies for many years."

Figure 1 | The VME-194B VME SBC is getting an upgrade from the original Tempe-based design; the board will feature Curtiss-Wright's new FPGA-based VME interface while remaining pin- and feature-compatible with previous generations of VME boards.

later moved into newer FPGA devices to maintain long-term availability. This approach enables system designers to replace their older Tempe-based VME modules with new boards that maintain the same VME interface capability, but are updated with an FPGA VME interface solution to provide plug-and-play technology refresh options for legacy systems.

New VME module designs, built with an FPGA-based interface, will provide a much-needed technology roadmap for system designers who aren't yet ready to make the move to VPX or don't need to because of lower-level performance requirements. One advantage of the FPGA approach is that the VME interface can be implemented in a device that requires less power than the older IDT Tempe device, an attractive improvement for size, weight, and power (SWaP)-sensitive COTS systems. Another important result stemming from the adoption of new FPGA-based VME interfaces is the strong message sent to the customer base that COTS vendors are truly committed to ongoing support for VME, both for existing fielded designs and for new designs to come.

One example of the FPGA-based VME board design is the recently announced SVME/DMV-196 single-board computer which is powered by NXP's QorIQ Power Architecture (PA) T2080 processor. Designed for technology insertions, this VME board is fully pin- and feature-compatible with previous generations of Curtiss-Wright's VME SBCs. It promises performance increases of two to six times in a similar power envelope and at a lower price point compared to earlier single- and dual-processor PA VME SBC designs. An additional step to help mitigate obsolescence is the T2080 processor's 15-year life cycle supported by NXP.

By integrating a VME interface into reconfigurable FPGAs, COTS vendors can now keep their VME legacy systems updated with the latest processor technologies for many years. For those customers who are locked into existing VME boards that use the existing IDT Tempe chip and do not have the ability to perform a technology insertion, some vendors have secured large quantities of the EOL device and can offer longevity of supply and longevity of repair plans to ensure that a customer's existing Tempe-based boards will continue to be manufacturable for many more years.

FPGAs are helping to keep VME alive. Long live VME!

Aaron Frank, Senior Product Manager, Intel SBC
Curtiss-Wright • www.cwcdefense.com

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By Mariana Iriarte, Associate Editor

NEWS

P-8 maintenance training systems procured by Australian air force

Royal Australian air force (RAAF) officials chose Boeing engineers to provide P-8 maintenance training devices for use by P-8A maintenance personnel starting in early 2018.

The devices enable simulations based on actual mission systems software while the hardware-based trainers are full-scale replicas of aircraft components. It also instructs its maintainers on more than 1,400 maintenance procedures, says Tom Wagner, Boeing's P-8 maintenance program manager.

This is the first international sale of P-8 maintenance training equipment that is currently used by the U.S. Navy for its P-8A Poseidon fleet. The RAAF virtual trainers were purchased via the U.S. Navy and RAAF Cooperative Program.

Figure 1 | Boeing's Virtual Maintenance Trainer is part of the maintenance training suite that will provided to the Royal Australian Air Force. Photo courtesy of Boeing.

VITA 48.8 air flow through cooling standard working group formed

VITA officials announced the formation of a working group that will develop new air flow through (AFT) cooling standard, VITA 48.8, for use in 3U and 6U VPX module-based systems.

The purpose of VITA 48.8 is to achieve weight and cost reduction for AFT cooling by eliminating the use of wedgelocks and ejector/injector handles. This standard will aid cooling high density, high power dissipation in 3U and 6U module based systems.

The combination of advanced cooling, small-form-factor AFT, and reduced weight are of special benefit to size, weight, power, and cost (SWaP-C)-constrained platforms such as rotorcraft and unmanned vehicles. Curtiss-Wright Defense Solutions will chair the VITA 48.8 Working Group and Lockheed Martin will serve as the standards editor. Officials say the goal is to submit the finalized VITA 48.8 draft for ANSI ratification later this year.

Engineers demo all segments of FACE aligned cockpit display at Army Aviation meeting

At the Army Aviation FACE Technical Interchange meeting in Huntsville, Alabama, engineers from different companies joined forces to demonstrate all segments of the FACE (Future Airborne Capability Environment) aligned cockpit display application.

The integrated application included ENSCO Avionics' IData Tool Suite with IDataMap; Core Avionics & Industrial Inc.'s safety critical OpenGL Driver; Lynx Software Technologies' LynxOS-178 real-time operating system; and Curtiss-Wright Defense Solution's VPX3-131 3U VPX single-board computer and XMC-715 high-performance graphics controller.

The demonstration at the Army Aviation FACE Technical Interchange meeting had a cockpit display that included a Primary Flight Display (PFD) and a digital moving map. It also exhibited segmented interchangeable subframes in the display architecture.

Exoatmospheric Kill Vehicle demonstrates redesign thrusters for missile defense

During a Missile Defense Agency flight test, engineers gathered data and observed in-flight performance on Raytheon's Exoatmospheric Kill Vehicle (EKV).

The vehicle demonstrated the redesign of the EKV thrusters, which provide the control necessary for lethal impact with incoming threats while safely outside of the Earth's atmosphere. During the flight test with the Ground-based Midcourse Defense system, a ballistic missile target was launched and purposely not intercepted to demonstrate for maximum maneuvering and data collection.

Raytheon's sea-based X-band radar (SBX) and AN/TPY-2 radar supported the test. Engineers designed EKV to destroy incoming ballistic threats while they are still in space.

Figure 2 | EKV demonstrates thruster redesign during testing. Photo courtesy of Raytheon.

Military officials greenlight the RQ-21A Blackjack UAS for operation

U.S. Navy and Marine Corps officials have given the go-ahead for the RQ-21A Blackjack unmanned aircraft system (UAS). With the program achieving its Initial Operational Capability (IOC), the first Marine Unmanned Aerial Vehicle Squadron (VMU) is sufficiently manned, trained, and ready to deploy with the RQ-21A system, says Lt. Gen. Jon Davis, Marine Corps Deputy Commandant for Aviation.

VMU-2 received the first system from low rate initial production (LRIP) lot 3 last summer and will be in direct support of the 22nd Marine Expeditionary Unit (MEU), based in Cherry Point, North Carolina. The Marines will make their first shipboard deployment with this system in the summer.

A Blackjack system is comprised of five air vehicles and two ground control systems, including launch and recovery support equipment. It is eight feet long, has a wingspan of 16 feet, and has an endurance of 10 to 12 hours.

Figure 3 | The first Marine Unmanned Aerial Vehicle Squadron (VMU) is ready to deploy with the RQ-21A system. Photo courtesy of the U.S. Navy.

C4ISR market to reach $119 billion by 2019

The global market for command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR)-related products is growing as nations focus on filling the gaps in their C4ISR capabilities, say analysts at Frost & Sullivan. They estimate that C4ISR procurement will reach $119 billion by 2019.

The increased application of commercial off-the-shelf (COTS)-based computing, storage, security, networking, and collaboration tools will further boost revenues. To cost-effectively meet military C4ISR operational goals, market players will have to harness COTS hardware and software as well as the Internet of Things (IoT) concept.

Despite the overall market optimism, the rising trend of equipment-sharing agreements among budget-constrained nations will limit C4ISR spending, according to Frost. Therefore, across geographies, moderately priced mature and proven systems will gain market share. Maintenance, spares, logistics, and training services will also become essential components of new sales.

Advanced cockpit display tech leveraged for military ground vehicles

In an agreement with the Defense Advanced Research Projects Agency (DARPA), Honeywell will provide DARPA's Ground X-Vehicle Technologies (GXV-T) program with its virtual reality instrument panel that replaces glass windows with display technology.

The GXV-T program partly focuses on exploring new vehicle technologies that could improve survivability, agility, and mobility for military ground vehicles. Honeywell's concept of a virtual reality instrument panel could provide drivers with an outside 360-degree view, officials say.

Drivers of ground vehicles will no longer just rely on windows; this technology provides them with situational awareness that could impact survivability. "We are leveraging our cockpit display technology coupled with advanced visualization research to meet the needs of DARPA's GXV-T program," says Carey Smith, president of Defense and Space at Honeywell Aerospace.

The display system projects a wide-angle, high-definition view of external conditions by using near-to-eye and display technologies. The first phase of the virtual windows development began in July 2015 and will continue through June 2016.

U.S. Air Force's GPS IIF-12 satellite joins constellation to undergo on-orbit testing

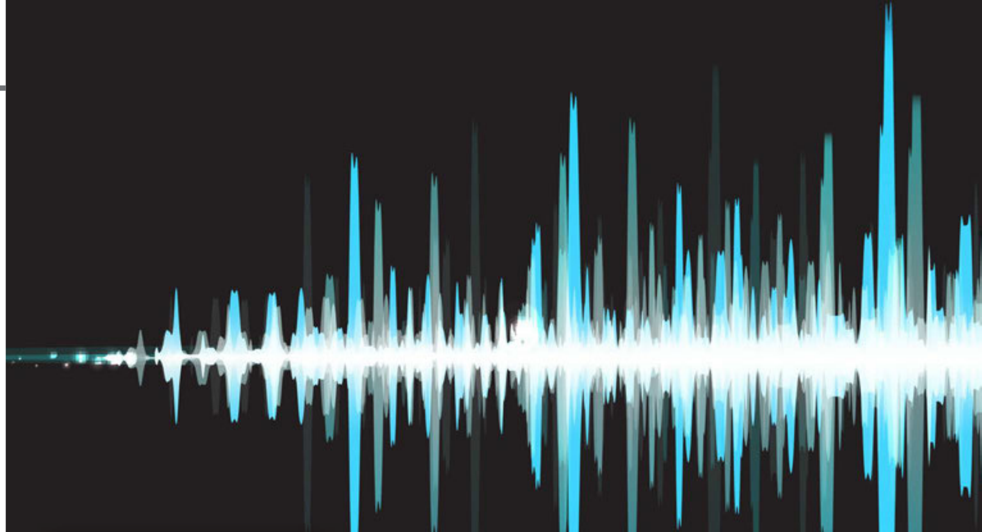
The U.S. Air Force has completed the GPS IIF constellation with the launch of the 12th Boeing-built satellite. GPS IIF-12 still needs to undergo on-orbit testing to be declared operational.

The GPS IIF-12 launched from Cape Canaveral Air Force Station aboard a United Launch Alliance Atlas V rocket. Signal acquisition was confirmed once the spacecraft was released into its medium Earth orbit of about 12,000 miles, officials announced.

The Air Force Global Positioning System modernization program conducted its first launch on May 27, 2010. The purpose is to improve accuracy and security while introducing new civilian and military capabilities, officials say.

Figure 4 | GPS IIF-12 is the final satellite in the IIF-block of satellites. Photo courtesy of United Alliance Launch.

EXECUTIVE INTERVIEW



Military spectrum management and EW challenges driving wireless monitoring tech

By John McHale, Editorial Director

Nick Balon

Designers in the military radio frequency (RF) world are faced with evolving challenges such as sharing bandwidth in a crowded spectrum and electronic warfare (EW) threats that can adapt faster than legacy EW systems can respond. In this Q&A with Nick Balon, General Manager for CRFS, he discusses how multinode networks are enabling high-performance spectrum monitoring and how kits that leverage software-defined radio (SDR) can reduce latencies when tracking electronic intelligence (ELINT) signals. Edited excerpts follow.

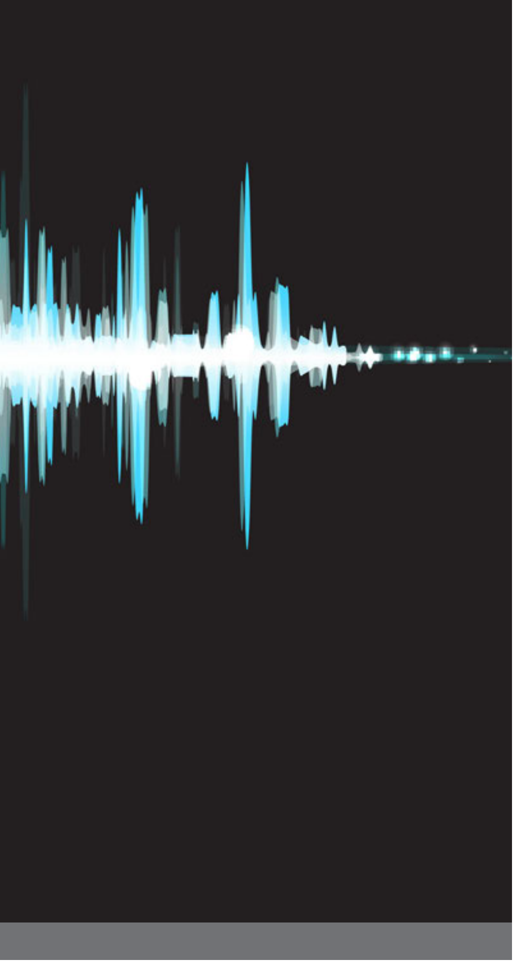
MIL-EMBEDDED: *Please provide a brief description of CRFS, such as the markets it serves, key technology areas, etc., and your role within the company.*

BALON: Since 2007 we have been a private company based in Cambridge, U.K., and in Fairfax, Virginia. We are international with activity not only in the U.S. but in Europe and Asia as well. CRFS designs and manufactures RFeye receivers, detectors, and spectrum monitoring systems and provides all the software for these solutions. Our whole philosophy is to provide cost-effective, high-performance spectrum-monitoring nodes and multinode networks so that nothing gets missed. We look for potential threats like GPS jammers providing the ability to geolocate the threat or the point of interference. It is all about distributed real-time 24/7 monitoring to gain actionable intelligence from the wireless environment. Our company started in the regulatory sector, but now has moved into military markets such as EW, spectrum monitoring, and electronic support measures (ESM) for defense, and security.

MIL-EMBEDDED: *What are the challenges facing military end users regarding spectrum management and allocation of the spectrum?*

BALON: It starts with the government spectrum sale – The Federal Communications Commission's (FCC's) Advanced Wireless Services 3 (AWS3) – which happened about a year and half ago, when licenses to use the 1695 to 1710 MHz, 1755 to 1780 MHz, and 2155 to 2180 MHz bands were sold to commercial carriers. Until then, the military had exclusive use of certain bands of frequency; they now have to share it with commercial providers for satellite and broadcast. As you can imagine, if someone paid $48 billon for spectrum commercial enterprise they would want to recoup that cost. For example, if a military platform is turned on and blanks out service to a customer base, this would be unacceptable. The spectrum is going to get more and more crowded, creating the prospect for increased disruptions of service, so being a good neighbor is increasingly important.

The challenge is how to manage the spectrum to best effect ensuring successful military operations without disruption to commercial networks that could result in the loss of millions of dollars in revenue. For instance, it is reported that the National Oceanic Atmospheric Administration (NOAA) has experienced interference issues on satellite weather data resulting in periodic data loss, affecting their ability to continuously monitor regional weather events. The same things could happen on military platforms. Defense users



DEFENSE USERS NEED TO AVOID POTENTIAL INTERFERENCE WITH COMMERCIAL NETWORKS BY MONITORING THE RF ENVIRONMENT WITHIN THEIR THEATERS OF OPERATION SO THEY CAN ADJUST ACCORDINGLY.

need to avoid potential interference with commercial networks by monitoring the RF environment within their theaters of operation so they can adjust accordingly.

Congress mandated that some of that money from the spectrum sale be put back into the system to manage this for the benefit of the public. DISA (Defense Information Systems Agency) asked industry to set up the National Spectrum Consortium to help manage the spectrum. In the first year, about $500 million was funded and there has been about $1.5 billion in funding to date via solicited proposals to help manage the spectrum for military and commercial use.

Our tools monitor broad swaths of spectrum from 9 KHz to 18 GHz to record, map, and play back spectral data to let users know where and what their interference issues are. It can also geolocate the emitters that may be causing interference. In addition, our software tools provide the ability to collect, record, analyze, and display spectral data so spectrum managers can make informed decision on how and when to deploy assets and plan missions. In the defense world, our devices are used at key government test ranges. The challenge for the military is how to still complete missions in this new commercial environment. They do so via efficient spectrum management.

MIL-EMBEDDED: ***What challenges are driving requirements in EW applications?***

BALON: In EW the challenges are different than with spectrum sharing. With EW you have fast-hopping systems such as radar. These systems present new challenges to legacy EW and spectrum monitoring platforms. These platforms continue to be upgraded and patched, but new threats come out daily, and EW systems need the ability to quickly adapt and change to meet these new threats.

Software-defined radio (SDR) is the enabler for this. SDR is adaptable and responds quickly to new waveforms. Our system is SDR in the ELINT world. We are providing kits to monitor and track ELINT threats as well as artifact testing. Our systems use the latest in general-purpose processor (GPP), graphics-processing unit (GPU), and field-programmable gate array (FPGA) technology for compute intensive real-time signal and data processing. This gives our customers the flexibility to adapt to a wide range of operational requirements.

Open architectures are in demand, as the prime contractors and the military end user do not want to be left with single-point solutions and systems with architectures that are difficult to upgrade. Billions have been spent on upgrading legacy systems, but they are hard-pressed to keep up with fast-moving threat landscapes using the latest, low-cost commercial technologies. The only way to counter these threats is by integrating open architecture designs that can be adapted within shorter time scales by inserting the latest computing technologies and open middleware to protect the ongoing investment in application software.

MIL-EMBEDDED: ***How is your technology used in the military radar market?***

BALON: The most significant value of our kit for radar systems is in the test and development area where several channels can be very precisely time-linked, coherently if possible, and used, for example, to record a stimulus radar signal and a response radar signal from a jammer to allow the two to be compared in timing, fidelity, and accuracy so the effectiveness of the system can be evaluated in terms of actual RF performance against different types of source radar modulations.

MIL-EMBEDDED: ***It seems every piece of electronic equipment today is getting smaller – GPS systems, radios, etc. How have reduced size, weight, and power (SWaP) requirements affected your spectrum monitoring designs?***

BALON: We have a program working now with unique SWaP requirements. Our distributed system architecture places the RF sensor (receiver) in close proximity to the antenna. We can stream full rate in-phase and quadrature (IQ) and time data over fiber to the compute clusters and solid-state storage arrays. Multiple data streams can be stored, processed, and made available across the sensor network to greatly improve situational awareness. With the distributed sensor approach you can attach small-form factor receivers and processing modules where needed and run fiber back to the processing and data distribution platforms. The solution can also be remotely programmed to perform predefined tasks such as wideband sweeps, trigger-on-event, and spectrum captures.

This modular architecture enables CRFS to provide solutions in multiple form factors: low-SWaP packaged sensors and processing nodes, rackmount board-level hardware such as 3U VPX cards with standard data formats over IP, and VITA49, for example.

MIL-EMBEDDED: ***What are other technology trends affecting the military sector?***

BALON: The industry is moving toward having platforms architected with distributed sensor schemes. Instead of a single high-cost sensor, end users now are looking to have multiple sensors distributed across a platform at a lower overall cost. Traditionally you would have a bunch of antennas in a system that all feed back to a processor. We are putting data conversion and formatting at the sensor head so it can be piped into the multisensor network and distributed to multiple users as needed.

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MIL-EMBEDDED: ***During your career, which technology has been a game changer for the military market?***

BALON: The biggest game changer in the military market in recent years has been the proliferation of commercial technologies for military applications. As we all know, the rate of change in the commercial sector with new wireless technologies, inexpensive drones, handheld computing devices, etc. has been phenomenal. Today the life cycle of commercial technologies is often at the longest a few years, and in some cases it can be measured in months. In the types of warfare we face today, our opponents use this commercially available technology very effectively. The challenge facing our military is to evolve their technologies equally as fast by leveraging commercially available technologies and creating traditional countermeasure systems that can keep up with the emerging threat situation.

MIL-EMBEDDED: ***What will be the next disruptive technology or mindset in your industry?***

BALON: The Internet of Things or the Internet of Everything, however you want to phrase it, this trend is driving the demand for bandwidth and there is only so much spectrum out there. It's not an unlimited resource. When your washing machine, toaster, and house alarm system are networked together and "talking" to each other it eats up bandwidth. Our infrastructure is so dependent on bandwidth that it's driving and fueling the spectrum-management industry. We are right at the cusp of it now, and it's causing all kinds of issues. Problems are occurring at airports where interference is occurring on GPS signals for ground crews. It's becoming a serious concern for officials responsible for public safety within such facilities.

Everything is connected now. State actors and private individuals can track anyone and are going around jamming their signals so you don't know where they are. Down in Dade County, Florida, the state's Emergency Management System (EMS) went down for a week, as it was inadvertently jammed. They used a handheld detector to fly around the city and locate and shut down the jamming sources. There are inexpensive jammers with extenders for Wi-Fi and the like that put out half a watt of power and can disrupt operations. It is a real issue and a real problem. **MES**

Nick Balon, *General Manager for CRFS, is responsible for the day-to-day running of the company. Previously he was General Manager at Xennia, which he helped propel into a leading industrial inkjet company and which was acquired by TenCate Plc in 2008. Prior to Xennia, Nick held senior management positions in the chemical industry at ICI and Ineos. Nick has a BA from Oxford, an MA from Yale, and was a Fox Overseas Fellow at Moscow State University.*


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Military helicopter avionics upgrades embrace COTS, FACE

By Sally Cole, Senior Editor

Many military helicopter avionics upgrades are currently underway to enhance communications and situational awareness, leveraging the Future Airborne Capability Environment (FACE) standard and supporting integration of commercial off-the-shelf (COTS) software and hardware. Meanwhile, avionics designers are also addressing cybersecurity concerns in modern aircraft cockpits.

Lockheed Martin in Bethesda, Maryland, is bringing high-resolution, near-infrared, and color imagery to AH-64E Apache helicopter cockpit displays. Photo courtesy of Lockheed Martin.

Glass cockpits outfitted with flat-panel displays and high-performance embedded computing systems are becoming the new normal as military planners upgrade helicopter cockpits so they can last another decade or two. Avionics designers enable this longevity by leveraging COTS technology, open architectures, and common standards such as the Future Airborne Capability Environment (FACE).

A number of military helicopter avionics upgrades are currently underway; the charge is being led by avionics integrators such as Rockwell Collins in Cedar Rapids, Iowa; Lockheed Martin in Bethesda, Maryland; Northrop Grumman in Woodland Hills, California; and Honeywell in Phoenix, Arizona.

U.S. Air Force combat rescue helicopters

Sikorsky selected Rockwell Collins in Cedar Rapids, Iowa, to provide the U.S. Air Force Combat Rescue Helicopter (CRH) program with state-of-the-art avionics and mission equipment, including the cockpit flight and mission display system, navigation radios, and the ARC-210 VHF/UHF communication system.

"The CRH is a Black Hawk derivative, and we're supplying the four multifunctional displays across its instrumentation panel," says Dan Toy, principal marketing manager of Airborne Solutions for Rockwell Collins.

CRH replaces the aging HH-60G helicopter with the HH-60 Pave Hawk, the Air Force version of the Army's UH-60 Black Hawk, modified for Combat Search and Rescue (CSAR) in all types of weather situations, says the Department of Defense (DoD), according to the President's Fiscal Year (FY) 2017 budget request documents. The CRH program is expected to eventually procure 112 aircraft. The FY 2017 request funds Engineering and Manufacturing Development (EMD) activities, including developmental efforts on aircraft, mission systems, training systems, and associated product support, according to the DoD. It also funds the acquisition of the five System Demonstration Test Article (SDTA) aircraft. Total funding in the FY 2017 request has risen to $319 million, up from $156 million in FY 2016.

Rockwell Collins engineers are providing not only hardware, but also the majority of the software that goes into these displays. This is equipment that the company already has on the U.S. Army's Black Hawk. "Sikorsky chose essentially the same cockpit design for the Air Force CRH program, but we're modifying the software – with very few other changes overall – to meet their requirements," notes Toy.

In terms of displays, Rockwell Collins is "using the exact same hardware that's already in production for the U.S. Army," which the company is delivering currently. "Only small software changes are being made to allow Lockheed Martin to go in and efficiently integrate their CRH mission systems on the aircraft," Toy says.

While Rockwell Collins' advanced technology group is exploring how larger pieces of glass can be used in the cockpit in the near future – the technology to go larger is ready – many questions remain about the ruggedization of this type of technology for helicopters. "Because we're dealing with cockpit avionics, we need to worry about not only ruggedization but also long-term survivability, the need for redundancy, and ballistic survivability," Toy elaborates. "What happens if you take a bullet through the glass? Does the pilot suddenly lose everything on the display or is it designed so they only lose part of it?"

Another concern centers on how pilots can effectively use that large surface area: How can they most effectively manage the display surface to be able to provide the right information at the right time so the pilot is not overloaded with information?

"We're focusing on how to help reduce pilots' workload … not simply giving them a bigger surface and pushing more information up in front of them," Toy says. "We don't want them to have to sort through the information or data they see. The goal is to bring up what's important for them in the phase of the mission they're on. So these are areas we're studying before these types of technologies can be effectively fielded for the warfighter."

How do military avionics differ from nonmilitary avionics? Two key differences: ruggedization and performance. "The Black Hawk display system, which is being used on the CRH, offers higher performance. It has more embedded processing and the displays are smarter than those used within the commercial world," Toy explains. "By embedding more processing into the displays, we can minimize the amount of extra or remote-mounted mission computers that need to be added to the aircraft."

One more key difference is that displays on the CRH and Black Hawk tend to be designed to eliminate over-the-component cooling. All of the cooling air gets "circulated through the chassis of the display – none of it is blown directly over the electronics," Toy points out. This layout is to ensure that within high sand or dust environments, such as those in Iraq and Afghanistan, the equipment will perform reliably throughout the entire mission. These displays must also be able to handle exposure to ocean saltwater spray or any of the other harsh environments military electronics might encounter.

Yet another way military avionics differ from that of civilian craft is that the displays typically provide greater luminance levels and are fully night-vision goggle (NVG)-compliant, Toy adds.

Like other military helicopter upgrades currently underway, Rockwell Collins is leveraging COTS components directly out of the consumer electronics industry. "We're able to use microprocessors and Ethernet components … many of these parts can be brought into our designs very easily," Toy says. "This gives us a great advantage in terms of continuity of supply and ensures that we're delivering the latest technology to our customers."

FACE standard

Rockwell Collins is also embracing the FACE standard for this upgrade. "We use software that comes from the avionics systems that our commercial systems organization produces, such as Pro Line Fusion," says Jeff Howington, also a principal marketing manager of Airborne Solutions for Rockwell Collins. "For our flight management software, which is brought over from the commercial side, the core pieces come to us 'as is' and we add to it to meet the needs of Navy, Army, or Air Force programs. The power of FACE is gathering these standards and organizing them in a way that all military vendors can use."

In the past, much of the avionics capability "was implemented as part of the hardware," adds Howington. "Now, it's transitioning to software. So the industry is moving toward standards like FACE … to help capture this trend on the technology side."

U.S. Army Apache helicopters

Lockheed Martin in Bethesda, Maryland, is bringing high-resolution, near-infrared, and color imagery to AH-64E Apache helicopter cockpit displays as part of the Modernized Target Acquisition Designation Sight/Pilot Night Vision Sensor (M-TADS/PNVS) upgrade.

These upgrades are designed to help pilots identify targets at farther distances by adding another field of view and extended-range picture-in-picture capability.

"Our enhancements enable faster situational understanding for aircrews and more accurate coordination with ground troops," says Matt Hoffman, M-TADS/PNVS director at Lockheed Martin Missiles and Fire Control. "The Apache is expected to be in service through 2045, so we're continuing to invest in sensor upgrades to ensure aircrews have the capabilities they need to address emerging threats."

The AH-64E Apache program is a remanufacture effort that results in a zero-time Longbow Apache, which restarts the Apache's service life and upgrades the aircraft with updated technologies and performance enhancements to keep the Apache viable throughout its life cycle, according to the DoD FY 2017 budget request. The FY 2017 program funds the remanufacture of 48 AH-64D aircraft to the AH-64E configuration in the first year of a five-year multiyear procurement contract (FY 2017 through FY 2021) and continued development of upgrades to enhance operational capabilities. The program looks to procure four AH-64E aircraft, with total funding – procurement, research, and development – in FY 2017 decreasing slightly to $1.132 billion from $1.419 billion in FY 2016.

U.S. Army UH-60L Black Hawk helicopters

Northrop Grumman is supplying the mission avionics equipment for a digital cockpit upgrade of the U.S. Army's UH-60L Black Hawk helicopters, now designated as UH-60V. (Figure 1.)

Improving military helicopter situational awareness

Honeywell Aerospace engineers are working with the U.S. Defense Advanced Research Projects (DARPA) to continue improving three-dimensional visibility and safety for U.S. military helicopter pilots flying in inclement weather and harsh environments, including rain, snow, dust, fog, or any other elements that make it difficult to operate or land the helicopter.

As part of DARPA's Multifunction Radio Frequency program, Honeywell engineers are programming, updating, and integrating the company's synthetic vision avionics backbone (SVAB) solution on U.S. military test helicopters, such as the UH-60 Black Hawk. SVAB uses a sensor-impartial approach that relies on multiple sensors and databases to create an integrated 3-D scene for pilots.

When helicopters enter landing zones and kick up dust or snow, pilots need a way to both increase situational awareness and reduce their workload by having information presented on glass cockpit displays to help them understand what the aircraft is doing relative to the terrain and the environment around them.

"By processing data from multiple sensors and developing a 3-D synthetic rendering of the exterior view in degraded conditions, we can create a safe environment in which military pilots can turn degraded visual environments into a tactical advantage," says Howie Wiebold, manager of business development at Honeywell Aerospace.

Honeywell's updated synthetic vision system, which includes SVAB, supports fusing information from DARPA's advanced sensor radar with terrain and obstacle databases and satellite imagery to provide pilots with the most accurate "out the window" view on their primary flight displays. This feature is particularly critical in low-visibility environments that mask hidden dangers such as treacherous terrain, other aircraft, or utility wires.

This upgrade includes a scalable, fully integrated mission equipment package that replaces older analog gauges with digital electronic instrument displays.

"Our integrated mission avionics solution is built on mature, proven technology and an open architecture approach for superior performance, affordability, growth potential, and reliability," says Ike Song, vice president of Situational Awareness Systems for Northrop Grumman Electronic Systems.

Northrop Grumman's design has been demonstrated through a flight test on a UH-60L helicopter. It features a centralized processor with a partitioned, modular operational flight program with an integrated architecture that enables new capabilities through software-only solutions, rather than hardware. The system is also smaller in size, lower in weight, and requires less power than legacy processing systems.

It's worth noting that this next-gen avionics system is aligned with the FACE standard as well and supports integration of COTS software and hardware, to enable rapid insertion of capabilities while reducing cost and risk for system integration and upgrades. Additionally, Northrop Grumman is providing unlimited government-purpose rights to technical data software to eliminate vendor lock-in and to mitigate obsolescence issues.

The President's FY 2017 budget request for the Black Hawk funds the continued development of the digital upgrades to the UH-60V (UH-60L) as well as procurement of 36 UH-60M aircraft in the first year of a follow-on five-year multiyear procurement contract (FY 2017 – FY 2021), according to the DoD. Total funding in the FY 2017 request decreases from $1.768 billion in FY 2016 to $976 million.

Cybersecurity of aircraft electronics a shared priority

One common challenge all of these contractors face today is that of cybersecurity, the effort to protect military avionics and aircraft from attacks or hacks.

Figure 1 | Northrop Grumman is supplying and integrating mission avionics equipment for a digital cockpit upgrade of the U.S. Army's UH-60L Black Hawk helicopters. Photo courtesy of Northrop Grumman Corp.

"Cybersecurity is becoming more of a recognized threat within this realm," acknowledges Rockwell Collins' Toy. "We see it within our business computer systems, and we're concerned about aircraft electronics as well. Much of the functionality on flight decks is software-driven, so this means that computer architectures are involved and they're vulnerable to attacks. We don't know just how vulnerable … so we're working closely with the government to understand how to do vulnerability assessments. And we'll fix any problems we find."

Rockwell Collins is working with the Defense Advanced Research Projects Agency (DARPA) as lead contractor on the High-Assurance Cyber Military Systems (HACMS) cybersecurity program for unmanned air vehicles. The goal is to develop cybersecurity solutions with applicability to other network-enabled military vehicles. Software that's designed correctly from the start is "paramount to guaranteeing" the security of military computing platforms, says the company. **MES**

Unmanned aircraft lack stringent certification process

By Mariana Iriarte, Associate Editor

All types of unmanned aircraft systems (UASs) are popping into the national airspace, resulting in increasing numbers of accidents and near misses. Safety incidents are getting more frequent with military unmanned aircraft as well. This environment is forcing military commercial and aviation officials to speed up efforts to create the strict safety certification rules for unmanned aircraft as exist for manned aircraft.

Soldier performs maintenance on MQ-9 Reaper. Photo courtesy of U.S. Air Force/Photo by Staff Sgt. Evelyn Chavez.

UASs provide a compelling alternative to sending personnel on manned missions that may be too dangerous or difficult to access. However, UASs – military and civil – do not currently undergo the same rigorous safety certification process as that of manned aircraft. That situation may change in the near future due to the increase in safety incidents involving military and commercial UASs.

"As more and more flights will be in civilian airspace instead of military or foreign conflict airspace, there's a need for a more stringent safeguard to prevent casualties resulting from a malfunction," says Wayne McGee, vice president of sales and general manager of Creative Electronic Systems, North America (CES) in Raleigh, NC. "The rate of malfunction is substantially higher than for civilian certified aircraft." If you drop a UAS on a civilian installation in a war zone they call that collateral damage; if you drop that on elementary school while it's in session someone's head is going to roll. More and more of these UASs are being used in civilian airspace, and they are going to have to meet far more stringent guidelines than they do currently."

"The trend in the industry is a lot of near misses due to lack of regulations and integration into airspace," says Gary Gilliland, technical marketing manager at DDC-I in Phoenix, Arizona. "The Federal Aviation Administration (FAA) has taken the action to have these regulations integrated. They can see this is a growing trend. I was just reading about one, where a UAS came within a 20 meters of a commercial jet over the Houses of Parliament in the U.K. That's 60 feet, that's very close. This is a huge safety concern for the flying public and the people on the ground."

Commercial and military drones have increased in numbers in the national airspace. During a training session, Marines were forced to land an unarmed RQ-7B Shadow UAV in the Neuse River, just north of Marine Corps Air Station Cherry Point, North Carolina on September 10, 2015. According to a *Marine Corps Times* article, the aircraft was recovered six hours later after a search and rescue effort.

"The military, especially the Army, are using UASs for surveillance and intelligence. They are often operating in open zones, not always in military zones," says Thierry Wastiaux, senior vice president of sales of Interface Concept in Quimper, France. "For the military, the rules on UAVs are a little bit less stringent because they were only allowed to fly in military zones. Civil aviation was not entitled to impose its restrictions on the military zone. As soon as military UAVs started going into the civilian zones,

Figure 1 | Soldier does preflight checks on RQ-7B Shadow. Photo courtesy of U.S. Army/ Photo by Spc. Margaret Taylor.

however, then the aviation authorities requested certification."

UASs are not only "lost in action," as several past incidents show that drones do malfunction for one reason or another. In 2013, an aerial target drone malfunctioned and crashed into the guided-missile cruiser USS Chancellorsville during an exercise, according to Navy officials. Two sailors were treated for minor burns and the ship sustained damage and had to return to port. In October of 2014, an Air Force MQ-1B Predator crashed in southern Turkey; Air Force officials say that the Predator experienced mechanical failure, and no civilian or military injuries resulted from the crash.

Military buying into safety certification

"Even military UASs are looking at DO-178B/C [certification] as a process. They are not as concerned about interacting in national airspace. Even though the military has a very defined, very mature way of developing software, it is not as stringent as DO-178," says Gilliland.

Engineers use guidelines such as the DO-178B/C and DO-254 as a de facto standard to verify that the safety-critical software and hardware in manned airborne systems will not fail.

"However, the military has a real problem with losing drones due to software or mechanical failures. In research for a presentation last year, I found that about 400 were lost due to these failures in the past 10 years. Those guys are a million-plus apiece. It's a cost-saving measure to keep them intact," Gilliland continues. "What the military was doing was putting things together quick to meet a certain need. We were going into wars and we needed capabilities. The drones were built on foundations of general-purpose software, a lot of cases using Linux – not a platform you would consider safe.

"[They do] see the value in the DO-178 process," Gilliland continues. Over the past 10 years they have been adopting the commercial DO-178 process as the basis for development; prior to that, it was just industry practices to get functionality. For the most critical systems, they are already adopting standards. The military has a stricter process for the aircraft than they do for UASs, but they are looking to reevaluate this process. It's real expensive to lose one of these things. I believe they know what they need to do, I just don't think they have had the requirements to develop their UAS with the same rigor they need to."

Military drones and the friendly skies

UASs are classified into different categories (the information can be found on the FAA's website.) The FAA issues a Certificate of Waiver or Authorization (COA), which enables public agencies and government organizations, including for military training, to operate a particular aircraft in a particular area. UASs do not have strict regulations to follow, while a manned aircraft has to "prove by human reasoning that it will not fail," Wastiaux notes.

"The current practice today is that the FAA issues a Certificate of Waiver or Authorization (COA)," says Joe Wlad, senior director of product management at Wind River in Alameda, California. "This would allow an operator to get permission to operate their unmanned drone in a specified area. The FAA has issued many COAs to organizations such as the Defense Health Agency (DHA), FBI, U.S. Air Force, and universities. The COAs carry substantial operational restrictions."

The way to operational approval has essentially three paths," Wlad says. "One can either use the standard airworthiness requirements and process just like conventional aircraft, or use an experimental aircraft certification process – for research and development only – or use the COA process. The FAA has not yet defined a process by which unmanned vehicles can operate in national airspace in the same way private and commercial aircraft do. Improvements in hardware and software technology on unmanned aircraft will be required to demonstrate an equivalent level of safety that we now enjoy with piloted aircraft. One day, I believe they will be allowed to operate in the same way as certified aircraft do today."

Function determines certification type

As they embrace certification, military UAS designers, like their commercial counterparts, are leveraging automated tools to help with the certification of manned aircraft. The design plays a role in ultimately deciding which certification process the UAS will follow. "You have to start out with assessing each subsystem on the vehicle to assess the criticality," says CES's McGee. "At that point you then develop a plan for each subsystem to determine how it's going to meet that level in which to certify.

"Once you've developed a plan, at each step of the design and manufacturing process including component selection, every step has to be documented as to how it meets the plan and all the evidence is collected," he continues. "When this is all assembled, it becomes a certification package. It's the airframe integrator's responsibility to obtain a certification. They collect all the different certification packages with the evidence and artifacts from the designs for every subsystem on the airframe and they have to present that evidence to the certifying body, which could be the Federal Aviation Administration (FAA), it could be the European Aviation Safety Agency (EASA), or it could be the U.S. Naval Air Systems Command (NAVAIR), among others. All the evidence has to be assembled and presented to apply for the safety certification or airworthiness certification."

MIL-STD vs DO-178 & DO-254

Many military specifications start with MIL-STD-882, but many in the industry believe that "does not meet stringent requirements in DO-178 and DO-254," McGee says. "The process from beginning to end – each subsystem on the UAS has to be studied, along with the function that it's going to provide and the level of criticality. Typically with DO-178 and DO-254, there are five levels of criticality, called a design assurance level. No effect is allowed to be at level 'DAL-E' and it works all the way up to 'DAL-A,'; at 'DAL-A,' if the system fails, the craft comes out of the air."

The certification process is time-consuming and detail-oriented. Therefore, "we use industry standard configuration management software," Gilliland says. "Our internal testing infrastructure is also automated. There are requirements for level A software to do what they call MCDC, which is modified condition decision coverage. When you develop your software, you must trace to all your requirements. Through all your testing, you have to verify that every path, for every logic decision that is exercised, operates the way you expect it to operate. We provide tools to verify what levels of coverage you have on the software."

In the long run the biggest hurdles will be in the design process with

UAS funding highlights from DoD FY 2017 budget request

Predator and Gray Eagle
Funding for the Air Force MQ-1B Predator and the Army MQ-1C Gray Eagle unmanned aircraft system (UAS) programs in the FY 2017 request covers the continued development and integration of the Universal Ground Control Station and a signals-intelligence capability for the MQ-1C Gray Eagle. FY 2016 was the last year for MQ-1C procurement. Total funding for Predator/Gray Eagle – procurement, research, and development – in the FY 2017 budget drops from $454 million in FY 2016 to $121 million.

Reaper
The FY 2017 program for the Air Force MQ-9 Reaper UAS looks to continue development, transformation, and fielding of Reaper aircraft and ground stations with procurement of 26 fixed ground-control stations, a training simulator, and continued modification of MQ-9s to the extended-range configuration. The Overseas Contingency Operations (OCO) request includes procurement of 24 additional aircraft, updated multispectral sensors, and payload modifications. Total funding – procurement, research, and development – in FY 2017 for the Reaper decreases slightly, from $1.103 billion in FY 2016 to $1.086 billion.

Global Hawk, Triton, and NATO AGS
Funding for the Air Force RQ-4 Global Hawk, Navy MQ-4C Triton, and NATO Alliance Ground Surveillance (AGS) UAS programs in the FY 2017 request looks to continue development and modification efforts for the RQ-4 Block 30, Block 40, ground stations, and Multi-Platform Radar Technology Insertion programs; the Global Hawk modernization program; and the U.S. contribution to the NATO AGS. MQ-4C funding covers procurement of two low-rate initial production systems and continues development activities associated with software upgrades and the multi-intelligence effort. Total funding for Global Hawk, Triton, and AGS – procurement, research, and development –drops from $1.384 billion in FY 2016 to $1.102 billion in FY 2017.

Shadow, Raven, Puma, and Blackjack
The FY 2017 program for the RQ-7 Shadow, RQ-11 Raven, RQ-20 Puma, and RQ-21 Blackjack UASs calls for funding upgrades to system hardware and payloads for the RQ-7 Shadow; upgrades and training and contractor logistics support for the RQ-11 Raven; procurement of RQ-20 Puma systems for the Marine Corps and SOCOM; and a total of eight RQ-21 Blackjack systems (base and OCO) and contractor logistic support UASs. Total funding for Shadow, Raven, Puma, and Blackjack – procurement, research, and development – in FY 2017 rises slightly from $278 million in FY 2016 to $298 million.

collision-avoidance technology. In order to get these UASs in the air safely, Wlad says, "So far, no one has obtained approval to operate an unmanned vehicle in the national airspace without restriction. One can imagine that the significant obstacles in obtaining this kind of approval might include demonstrating that the vehicle could detect and actively avoid other aircraft as well as verification of all potential failure modes including loss of function, navigation, or control among other things. More research and development is required before the FAA will formulate further policy.

"Most of the larger unmanned aircraft today are being built by either the military or the social-networking companies," he continues. "This means the operation of these vehicles is confined to either controlled airspace (such as Beale Air Force Base in California) or remote, restricted areas. In order to allow unmanned and manned aircraft to share the same airspace, new FAA regulations are required. For now, designers are trying to target conventional certification regulations used by Boeing and Airbus. It's a tall order, given that many of the current regulations assume that a pilot can intervene as a last resort." **MES**

Motor control in "more electric" aircraft

By Shen Wang

The push for "more electric" aircraft – including the Boeing 787 (shown) and Airbus designs and their military equivalents – means replacing some or all actuators with either electrohydraulic or fully electric actuators. Photo courtesy of Boeing.

As commercial and defense aircraft users and integrators look to reduce their costs we see an advent of "more electric" aircraft (MEA) designs. These aircraft decrease operating and maintenance costs with faster and easier maintenance checks, increase aircraft availability by reducing mean time between failures (MTBFs), and reduce exhaust gas emissions because they are lighter, more efficient, and have fewer bulky systems on board. The MEA concept specifically replaces the traditional hydraulic, pneumatic, and mechanical systems with electrical systems, which weigh less, are easier to install and maintain, and improve fuel consumption. The goal is to ultimately have an all-electric aircraft.

Traditionally, all nonpropulsive power is extracted from an aircraft's engine. Air is bled from the engines' high-pressure compressor; the pneumatic power obtained from this is used to power the environment control system and supply the hot air for the wing ice protection system. The mechanical gearbox transfers mechanical power from the engines to the central hydraulic pumps – using a system of tubing throughout the entire plane – which provide the hydraulic power for the actuation systems of the primary and secondary flight controls, landing gear deployment, retraction, and braking, as well as numerous other systems requiring actuators. Part of the mechanical gearbox also transfers its mechanical power to the electric generator, which provides electric power to the avionics, cabin, and aircraft lighting, in addition to other loads (e.g., entertainment systems).

Benefits of electrical systems over hydraulic systems

Hydraulic systems use mature technology and the possible improvements to efficiency are negligible compared to the improvements obtainable by using electrical technology. The hydraulic system is made up of the central electric pumps that generate hydraulic pressure through tubing that stretches from the engine nacelles, across the firewall, through the pylons, and into the wheel wells, wings, and throughout the entire fuselage. Each of the hydraulic systems requires pressure and return lines plus a case drain for the pumps. These systems are usually triple-redundant, with the tubing protected against the flammable liquids within the hydraulic system. All of this protection, redundancy, and tubing is heavy, however. The MEA, in contrast, enables simpler structural solutions with fewer heat shields and less flammable-fluid protection needed throughout the airplane. This simplification results in lighter aircraft, lower complexity, and lower certification requirements for the structure of the plane.

With a hydraulic system, all of this tubing requires maintenance in case of leakage along the entire tube path, while the engine-driven pumps and pressure seals also require constant maintenance checks. The maintenance of these systems is costly, and yet hydraulic systems have a short MTBF. On the other hand, with an electric system of either electrohydraulic or fully electric actuators, the hydraulic tubing is no longer required throughout the aircraft, drastically reducing the total weight. Airbus estimated that it achieved approximately 1,000 pounds of weight reduction on the A380 aircraft when a hydraulic aileron actuator is replaced by electrohydraulic or electromechanical actuator. Eliminating much of the hydraulic systems also improves

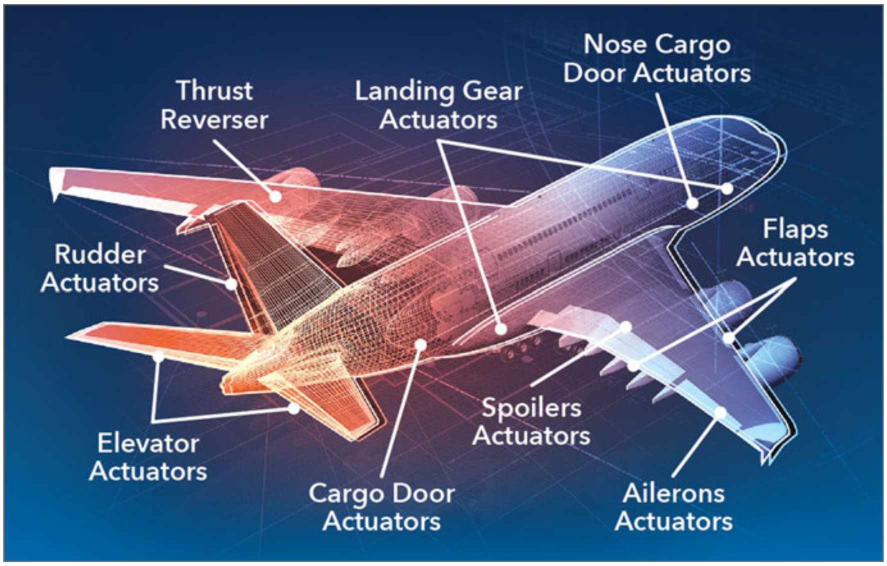

Figure 1 | Electric and hydraulic actuators on the Boeing 787 airliner. Drawing courtesy of Microsemi.

the MTBF of the system and makes it more reliable. There are additional improved performance gains, as the hydraulic pump system is a continuous load on the engine, whereas the electric load is on demand/only when needed. All these savings and improvements reduce the overall fuel requirements of the plane and further reduce the cost of operations. Moreover, the efficient segregation and independence of the actuation power provides for robustness to the entire system. Figure 1 shows the deployment of electric and hydraulic actuators on the Boeing 787 airliner.

Challenges to MEA on actuators

Major challenges exist to the development of more electric aircraft, one of which is the monitoring and distribution of power. There is a need for networked electronic control for all the electrical systems distributed throughout the entire aircraft. With each system now requiring electric power, the controls architecture must be improved and resilient enough to handle the high reliability requirements of systems such as the flight controls system. Each actuator has electronics that perform the motor control and health monitoring of the actuator, providing feedback to the flight controls. These actuator electronics are exposed to harsh environmental conditions in terms of operating temperatures, pressure, and altitude. The newest flash-based field-programmable gate arrays (FPGAs) are capable of performing in these harsh environments with high reliability.

With the MEA concept, the electrical actuators now being designed often use permanent magnet brushless AC motors, which require sophisticated electronics to perform control and monitoring functions. Development of the proportional-integral (PI) controller, space vector modulation, pulse width modulation (PWM), rate limiter, position and speed estimator, and other such tools for the control and monitoring of actuators is time-intensive and requires robust validation and verification before they can be used on aviation actuators. There are many ways to address this issue, including the use of microcontrollers (MCUs), digital signal processors (DSPs), application-specific integrated circuits (ASICs), and FPGAs.

MCUs and DSPs are traditionally used for algorithm processing in single- and dual-axis motor control designs. The MCUs and DSPs are not as capable as a flash-based FPGA solution when dealing with the mounting requirements for health monitoring, reporting, secure communications, and multi-axis or high rotation motors. Flash-based FPGAs offer greater performance than MCU/DSP-based solutions for high-speed, low latency algorithm processing, as well as enabling the integration of additional systems' functionality to further improve the total cost of ownership.

Optimization of power electronics for motor control applications on the aircraft requires a wide band of switching frequencies to improve the performance of the system. The DSPs and MCUs do not perform well in applications requiring operation in the higher range of the switching frequencies. Some DSPs may optimize a few channels for high-frequency switching, but they lack the ability to quickly adapt to the changing requirements. They also lack the ability to add more pulse width modulation (PWM) channels to control the power electronics stage. In current systems, this requirement is often offloaded to an FPGA. ASICs and application-specific standard products (ASSPs) have the same flexibility and scaling challenges that DSPs and MCUs have.

Motor control design benefits greatly from reduced static and total power, especially at high frequencies and temperatures. FPGAs that feature an embedded single-transistor flash cell offer an advantage over alternatives that use a six-transistor SRAM cell that must be configured from an external ROM during power-up. The latest flash-based FPGA solutions use a comprehensive approach to minimize power resulting in 50 percent lower total power and 10 percent lower static power than SRAM-based FPGA solutions.

Many of the problems with the increasing complexity of motor controls for the brushless AC motors being used on MEA actuators can be solved with the implementation and use of flash-based FPGAs as their primary controller.

FPGAs enabling the MEA system architecture

Initial transition towards MEA targets the use of electrohydraulic or electromechanical actuators. This design transition is introduced through the power drive electronics (PDE), which uses the electrical power supply as opposed to the conventional hydraulic supply to control the actuator surfaces. The PDE Power Core Module (PCM) includes the Hybrid Power Drive (HPD), which performs the power conversion and drives the actuation motors. The PCM also contains data conversion and communications features which are implemented and controlled using an FPGA.

The motor control algorithm is embedded within the FPGA, which is located in the PDE Command Module. This FPGA is programmed to perform various functions such as acquisition of position and speed information from external sensors, data processing for motor control and communication.

The Monitoring Module is required to monitor the health of the PDE. This safety-critical function is also implemented using an FPGA.

The integration of power drive electronics is already evident in modern commercial aircraft such as the Boeing 787 and Airbus A380, but advancements in technology, efficiency, reliability, weight, and cost are required before airframers will adopt an all-electric actuation system.

FPGA motor control IP

The newest flash-based FPGAs are featured in a Dual-Axis Motor Control Kit from Microsemi, with its own motor IP suite for permanent magnet synchronous motors (PMSM), brushless DC (BLDC) motors, and stepper motors, all equipped with encoder and hall sensor interfaces for monitoring. The motor control kit also includes Ethernet, UART, and USB connections for communications. The modular IP suite has field-oriented control (FOC) transformations (Clarke, Park, Inverse Clarke, and Inverse Park), PI controller, space vector modulation, core 3 phase PWM, rate limiter, position and speed estimator, encoder interface, and stepper angle generator building blocks. It allows for a plug-and-play approach to implementing designs with its modular blocks. (Figure 2.)

Since the IP is built into the FPGA, it is easier to certify than software running on an MCU or DSP because there is no need for DO-178C certification. There is additional validation and verification documentation available in VHDL that helps designers qualify their designs for DO-254. Associated software is also available that gives the designer full access to motor-control parameters such as reference speed and Kp/Ki gains of PI controllers.

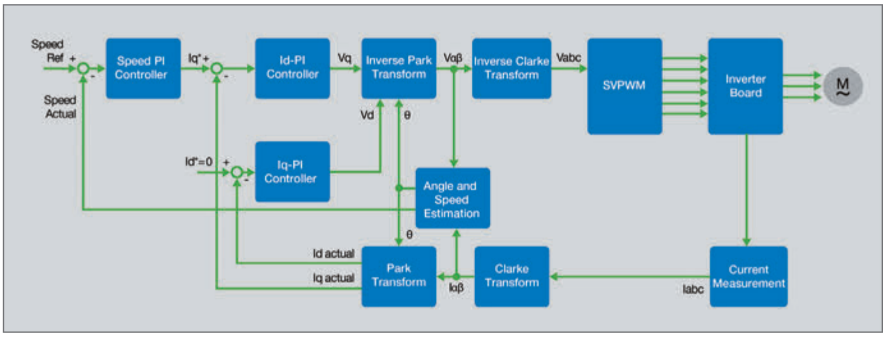

Figure 2 | Motor control kit functional blocks (sensorless field-oriented control technique).

Radiation effects in aircraft

For any electronic equipment on an aircraft, there is the ever-present danger of single-event upsets (SEUs). Electronic devices experience neutron effects as much as 500 times more frequently at aviation altitudes than at sea level. This high level of neutron radiation leaves SRAM FPGAs extremely vulnerable to configuration upsets, which change the functionality of the FPGA until detected and corrected. However, in extensive neutron radiation testing, flash-based FPGAs have seen no single-event configuration upsets or single-event latch-ups (SELs). The testing had over 1.1 x 1,012 neutrons /cm^2 of total exposure, which is equivalent to more than nine million years at sea level in New York City, or 17,400 years at 40,000 feet of altitude above New York City. This intrinsic immunity to configuration SEU and SEL effects reduces requirements for redundancy and radiation protection, thus reducing the complexity of future designs.

The way forward to MEA has begun already with the Airbus A380, A350, and the Boeing B787 designs and their military equivalents, as actuators on MEA will use increasingly sophisticated electronics. Flash-based FPGAs are immune to loss of configuration at aviation altitudes due to neutron radiation and have a large operating temperature range. In addition, a comprehensive suite of motor-control IP is available to support the rapid development of complex control and monitoring functions in electric actuators. For these reasons, actuator control systems for MEA programs are choosing flash FPGAs. **MES**

Shen Wang *is an undergraduate student at the University of Toronto, studying Electrical and Computer Engineering. He is currently serving an internship in technical marketing at Microsemi Corporation, specializing in electronics in commercial aviation applications.*

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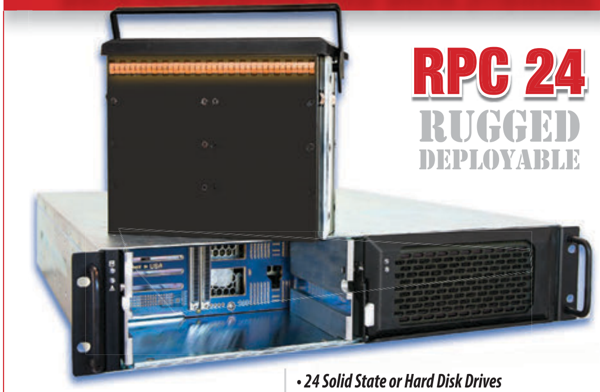

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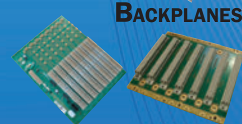

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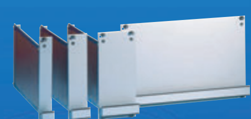


Since 1961 the name VERO has been synonymous with high quality electronics packaging; VEROTEC continues to design, manufacture and integrate a comprehensive range of electro-mechanical products including card cages, instrument cases, rack cases, fan trays, backplanes, power supplies, bus-based systems and components.

Converter delivers data bits on dedicated output pins

The NEXSYS ARINC 429 to Discrete Signal Converter (SR429) from Applied Avionics converts the data bits associated with a single ARINC 429 label and dissects them into 23 discrete output pins, one for each data bit. The unit is software-free as well as firmware-free and does not require a DO-254 or DO-178 certification. The SR429 has been tested to DO-160F and is equivalent to MIL-STD. It can be ordered as preconfigured unit with factory settings to any specific ARINC label and transmission speed or as a universal unit with ARINC label and transmission speed that can be set and reset. For ADS-B applications, Applied Avionics can provide the ARINC 429 Converter, the mandated indicators, and additional "post-processing" logic capabilities via its proprietary NEXSYS LOGIC Module.

The SR429 can also be used as an output expander to any avionics system if all of the system OEM built-in discrete outputs have already been used. Designers can convert an ARINC 429 signal to discrete outputs with the SR429 signal converter from NEXSYS. The SR429 – a compliant ARINC 429 receiver that can be ordered as a high-speed (100 kbps) or low-speed (12.5 kbps) unit – is compatible with a standard 37-pin two-row D-sub connector and weighs 11 ounces.

Applied Avionics | www.nexsysavionics.com | www.mil-embedded.com/p373321

Self-encrypting solid-state drive for sensitive data

Microsemi's 1 TB TRRUST-Stor SATA SLC self-encrypting solid-state drive is aimed at keeping sensitive data from getting in the wrong hands with features including AES-256 encryption, sanitization protocols, and Microsemi's TRRUST Purge technology that renders data unrecoverable in less than 30 ms. Engineers designed the solid-state drive – model MSD01T – for use in rugged environments. The host-accessible capacity is 900 GB (1 GB = 1,000,000,000 bytes), has ATA–7 and ATA–8 commands, with the media SLC NAND flash. Power ranges from 5 V +/-10 percent, with standby power at 1.8 W.

Model MSD01T comes in a 2.5-inch (100.45/69.85/9.5 mm) form factor. It also has power-loss protection with no caps or batteries to degrade over time and high temperature. Additional options for model MSD01T include extended burn-in, OEM customization, ruggedized interface connectors, and custom labeling. Data management and protection on the MSD01T includes uncorrected bit error rate of one sector per 10-18, protection from silent corruption (32-bit CRC per sector), mean time between failures of >2,000,000 hours, power loss protection, read and write wear leveling, SMART attributes, write endurance (16 petabytes for the MSD1TB drive), no forced EOL from firmware/controller availability issues, and built-in self-test.

Microsemi | www.microsemi.com | mil-embedded.com/p373322

Rohde & Schwarz transceiver covers frequencies from 30 MHz to 400 MHz

Rohde & Schwarz's MR6000A, an airborne transceiver in the R&S M3AR product family, is intended for applications in military and civil environments including airborne platforms such as helicopters, transport aircraft, jets, and unmanned aerial vehicles (UAVs). The transceiver covers the frequency range from 30 MHz to 400 MHz and supports the NATO frequency-hopping methods (transmission-security, or TRANSEC) HAVE QUICK and SATURN. Integrated NATO encryption (COMSEC) is available as an option to protect voice and data transmissions against eavesdropping. The transceiver is interoperable with the NATO KY-58 and KY-100 encryption devices as well as the ED 4-2 and the Rohde & Schwarz MMC 300.

Set in a housing that complies with the ARINC 600 standard, the MR6000A provides interfaces for connecting external devices such as an automatic direction finder (ADF), a Link 11 data terminal set (DTS), a data modem (IDM), or an external encryption device. If it is equipped with a cooling air intake, the transceiver can be operated continuously with full transmit power even at ambient temperatures of up to +71 °C. The company's SECOS waveform combines TRANSEC and COMSEC functionality in a single waveform and is also available for the MR6000A. As many as 200 presets can be stored in the radio – with all of the information necessary for operating a given waveform.

Rohde & Schwarz | www.rohde-schwarz.com | www.mil-embedded.com/p373324

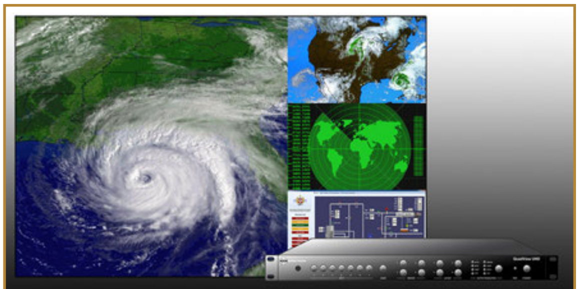
Multiport Gigabit Ethernet aircraft switch

Aeronix's Gigabit Ethernet Switch (GES) GEN2 has a rugged design for use in military, commercial, and industrial environments. The GEN2 is a 12-port Gigabit Ethernet switch designed for integration into aircraft where size, weight, and power are a priority. GEN2 weighs two pounds, 12 ounces, with dimensions of 8.25 inches by 5.1 inches by 1.38 inches. On average, the switch consumes 16 W at 28 VDC with all 12 ports active at Gigabit speeds. It is compliant with MIL-STD-704, MIL-STD-810, and MIL-STD-461.

The GES GEN-2 Layer 2 switch is partially capable of customer-specific configurations. The management functions, which run on an ARM processor, are stored in nonvolatile memory for fixed configurations, or can be loaded at startup for application-specific requirements. No Ethernet data is stored in onboard processor RAM. While the GEN2 Built In Test (BIT) capability covers its internal functionality, the switch also uses Time Domain Reflectometry (TDR) to verify the integrity of connections to all other equipment.

Aeronix | www.aeronix.com | www.mil-embedded.com/p373323

QuadView UHD displays four sources simultaneously



From RGB Spectrum, the QuadViewUHD is a quad-screen splitter and presentation-switcher scaler designed for displaying as many as four sources simultaneously on a single screen in a variety of layouts. It can connect to any monitor or projector from XGA up to 4K resolution. The user can mix and match input resolutions, scale video input up to ultra-high definition (UHD), and route input to any window. Both HD and UHD inputs can be displayed without downscaling. The QuadView UHD enables the user to select audio from any source. The multiviewer also includes high-bandwidth digital content protection (HDCP) authentication and extended display identification data (EDID) management functionality.

Users may control the QuadView by multiple methods – via the front panel, a web interface, or an IR remote. Third-party control is supported via Ethernet and RS-232. The QuadView UHD front panel enables audio, video input, and layout selection. Up to 16 layouts are provided — including quad split, full screen, triple windows, and side-by-side mode; users can select a layout, select inputs, and route to the desired windows. Features include I/O resolutions up to 4K UHD, 4X HDMI input, 2X display port input, 1X RGB input, HDMI 1.4b output, 16 preset layouts, auto scaler for every input, HDCP compliance and EDID management, and analog and optical audio outputs.

RGB Spectrum | www.rgb.com | www.mil-embedded.com/p373325

OpenVPX-compliant board for embedded signal-processing applications

Based on the ANSI/VITA 65 OpenVPX standard, the AV104 board from ApisSys is part of the company's range of high-speed data-conversion and signal-processing solutions. It has default support for the MOD3-PAY-2F1F2U-16.2.1-3 and MOD3-PAY-2F1F2U-16.2.1-4 module profiles, PCIe Gen 1 or Gen 2 on data planes and expansion plane, plus 1000BASE-BX on control planes. The AV104 combines the Xilinx Virtex 7 FPGA with dual 10-bit, three Gsps ADCs and single 12-bit, three Gsps DAC. The AV104 is intended for embedded signal-processing applications such as electronic warfare, wideband radar transmitter/receivers, or LIDAR (light radar).

The AV104 provides internal ultra-low-jitter clock generation and can be used with either an external clock or an external reference for extended flexibility. It includes one Xilinx Virtex 7 FPGA VX330T/VX485T or VX690T for processing capability of up to more than 2 TMACs (Multiply/Accumulate per second), one high-speed 2M36 QDRII+ SRAM memory for data processing, and a 1 Gb synchronous FLASH memory for multiple firmware storage. It also features a 32-bit microcontroller with USB 2.0 and 10/100 Ethernet interfaces intended to be used for system monitoring and supervision.

ApisSys | www.apissys.com | www.mil-embedded.com/p373326

Boot-embedded "energy harvesting" for on-the-go power

By Sally Cole, Senior Editor

Need the ability to charge mobile devices on the go? A new energy harvesting system developed by University of Wisconsin-Madison mechanical engineers ensures that battery power is available whenever you need it, and wherever you are, by simply plugging in to your boot.

The energy harvester is embedded within boot soles to capture the energy generated by footsteps. This energy is then conditioned by a tiny electronic chip and stored in a rechargeable battery. A little more than one watt of power is generated per boot – between two to three watts total – which is enough electricity to power a range of mobile devices such as smartphones, GPS, tablets, laptops, and flashlights.

Devices can be powered by connecting to the boots via USB cable. The device can also be integrated with a broad range of electronic devices embedded in boots, such as a Wi-Fi hotspot, to serve as a middleman of sorts between mobile devices and a wireless network.

"It's typical to also embed electronics that can perform other functions – such as GPS/Bluetooth modules, accelerometers, and gyros," explains Tom Krupenkin, a professor of mechanical engineering at the University of Wisconsin-Madison. "The embedded electronics consume little of the energy generated, so any extra goes to the battery."

The energy harvesting technology features "reverse electrowetting," which was pioneered by Krupenkin and J. Ashley Taylor, a senior scientist in the mechanical engineering department at UW.

How does the technology work? A flow of conductive liquid interacts with a nanofilm-coated surface, and the mechanical energy of the fluid flow is directly converted into electrical energy.

For this boot-specific application, Krupenkin and Taylor had to develop a high-frequency energy source "bubbler" device that combines reverse electrowetting with bubble growth and collapse.

The bubbler device design consists of two flat plates separated by a small gap filled with conductive liquid; it contains no moving parts. Its bottom plate is covered with tiny holes through which pressurized gas forms bubbles. These bubbles grow until they're large enough to touch the top plate, then the bubbles collapse.

This repetitive growth and collapse of bubbles pushes the conductive fluid back and forth to generate an electrical charge. So the high frequency needed for efficient energy conversion doesn't come from a mechanical energy source; instead it's delivered via an internal property of the bubbler approach.

One common misconception about the technology is that you need to walk first to power the battery – but that isn't true for the majority of scenarios. "In most cases, it's already charged and ready to go," Krupenkin says.

If you need to charge a dead cellphone, it can be recharged via boot in the "same amount of time as from a wall outlet … but as soon as a bit of electricity comes into the phone from the boot, the phone should be operational," he adds. In the unlikely event that the battery inside the boot ever becomes completely drained, it will take about four hours to recharge it – the same amount of time as a standard battery used in a typical cellphone.

How reliable and rugged is the technology in extreme conditions? "The system is hermetically sealed, so it isn't affected by factors such as humidity or even salt in underwater conditions," Krupenkin says. "In terms of temperature ranges, it can handle the same range of extreme conditions – Arctic or desert – that the footwear can sustain. You wouldn't want to leave the boots in -50 °F temperatures overnight and then try to put them on your feet … it won't be a pleasant experience. But the system will operate as soon as the heat from your foot warms it up a bit."

Figure 1 | Shoes that harness the energy generated by footsteps could be used to power mobile devices on the go. (Credit: University of Wisconsin-Madison College Of Engineering.)

Before ditching your heavy battery packs, it's important to note that this technology is intended as a supplement. "It can mitigate dependence on batteries; it isn't a complete replacement," Krupenkin notes. "But if you're on a mission that lasts longer than expected, or if you have a dead battery, it will help."

While scaling the technology to 10 watts is possible, it wouldn't be useful in this case because it would become "too bulky and expensive," he points out.

Right now, embedding electronics in footwear is uncommon because there hasn't been a good way to power it. GPS, in particular, makes sense in footwear, however: "Once energy harvesting becomes common, this might change – within the military realm as well," Krupenkin says.

Krupenkin and Taylor have launched a startup, InStep NanoPower, and are working with Vibram to develop the first practical footwear energy harvester (Figure 1). For more information, visit http://instepnanopower.com/.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F7 Group

In each issue, the editorial staff of *Military Embedded Systems* will highlight in this section a different charity that benefits military veterans and their families. We are honored to cover the technology that protects those who protect us every day. To back that up, our parent company – OpenSystems Media – will make a donation to every charity we showcase.

This month we are featuring F7 Group, a foundation dedicated to securing and providing resources, training, support, and mentoring to female veterans and women in military families.

F7 Group sponsors retreats, entrepreneurial training, and skills training with mentoring programs. Additionally, F7 runs corporate training sessions through its "VETPro" program, with the aim of teaching companies how to attract, retain, and accommodate workers currently or formerly associated with the U.S. military.

The organization is open to women serving in active duty or reserve military; veterans, spouses, mothers, or immediate female family members of service members; and other women who serve as support at home for members of the military. According to the group, the term "F7" refers to the seven basic pieces that women transitioning back home from active duty and those in support positions need to realize success: friends and family, freedom, foundation/formation, function, focus, flexible, and fundamentals.

F7 Group founder and CEO Cassaundra Melgar-C'de Baca has been recognized by the White House as a "Champion of Change" for her dedication to service and her continued support for fellow veterans and military families.

F7 Group – originally started in Texas – is now opening what it calls "FOBs," or forward operation bases, in other states: California, Illinois, Wisconsin, New Mexico, New York, and Florida.

For more information, visit http://www.f7group.com.

WHITE PAPER

Tactical LTE networks for military and first responder applications

By John Long, LCR Embedded Systems

Military and first responder personnel must to be able to set up and tear down highly mobile communications networks rapidly, often in areas that are difficult or impossible to support. In the case of the military, users may have particularly demanding anti-jamming and encryption requirements.

This white paper will detail the growing military interest in the LTE standard, as it can offer increased flexibility and lower cost compared with the traditionally used land mobile radio/software-defined radio (SDR) solution. LTE also can bring the lower costs associated with a widely deployed commercial technology. Also discussed: How to integrate existing SDR technology with LTE.

Read the white paper: http://mil-embedded.com/white-papers/white-networks-military-first-responder-applications/

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