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John McHale
Unmanned systems

Mil Tech Trends
UAV payloads

Field Intelligence
Software development tools

Mil Tech Insider
UAVs and COTS

UNMANNED SYSTEMS ISSUE

UUVs MODERNIZE NAVY MINE-HUNTING EFFORTS

P 24

New electronic warfare architectures based on tight coupling of FPGA and CPU processing – By Thierry Wastiaux, Interface Concept

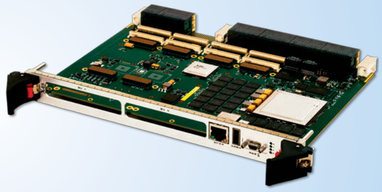
UAVs and high-performance connectivity

P 44

Module and System-Level Solutions from X-ES

Intel® and Freescale™ Single Board Computers

XPedite7570
4th Gen Intel® Core™ i7-based 3U VPX SBC with XMC/PMC



XCalibur1840
Freescale QorIQ T4240-based 6U VPX SBC with dual XMC/PMC

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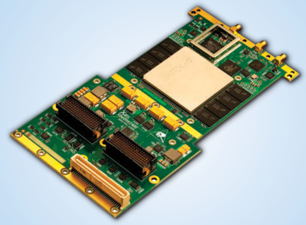

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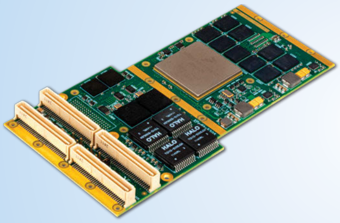

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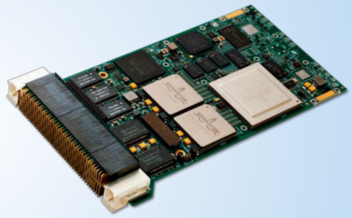
Secure Gigabit Ethernet router XMC utilizing Cisco™ IOS®



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ON THE COVER:

Top photo: The Navy is using Unmanned Underwater Vehicles (UUVs) like the Knifefish from Bluefin Robotics Corp. Photo courtesy of Bluefin Robotics Corp.

Bottom photo: The MQ-9 Reaper – a UAV produced by General Atomics Aeronautical Systems, Inc. and used by the U.S. military for long-duration reconnaissance – sits on the flightline. Photo courtesy of TE Connectivity.

April/May 2014 | Volume 10 | Number 3

COLUMNS

Editor's Perspective

8 DoD unmanned systems report maps out technology development for next 25 years
By John McHale

Field Intelligence

16 Software development tools as force multipliers
By Charlotte Adams

Mil Tech Insider

18 UAV payload designs turn to COTS
By Val Zarov and Jacob Sealander

BONUS: DoD Budget Highlights

10-14 Modernizations and retrofits highlight DoD FY 2015 budget request
By John McHale

DEPARTMENTS

20 **Defense Tech Wire**
By Amanda Harvey

48 **Editor's Choice Products**

53 **Connecting with Mil Embedded**
BLOG – Reviewing DMSMS 2013: Collaboration brings new beginnings
By Kaye Porter, GDCA

54 **Connecting with Mil Embedded**
By Mil-Embedded.com Editorial Staff

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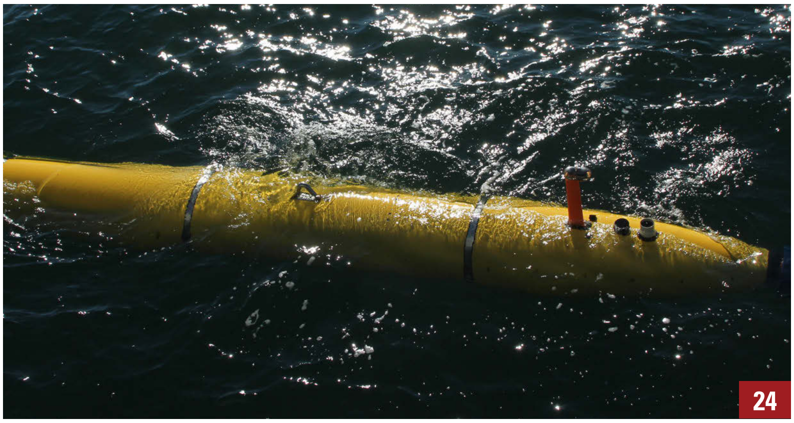

SPECIAL REPORT | Unmanned surface and undersea systems

24 Unmanned underwater vehicles modernize U.S. Navy's sea-mine-hunting capabilities
By Sally Cole

MIL TECH TRENDS | ISR payload designs for UAVs and UGVs

32 New electronic warfare architectures based on tight coupling of FPGA and CPU processing
By Thierry Wastiaux, Interface Concept

36 UAV ISR payloads demand lighter weight, faster processing
By Amanda Harvey

INDUSTRY SPOTLIGHT | Rugged connectors for unmanned systems

44 Next-generation UAVs require high-performance end-to-end connectivity
By Gregory Powers, TE Connectivity

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Page	Advertiser/Ad Title
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47	**Elma Electronic** – Elma's J-series platforms – Performance computing of EPIC proportions
13	**Excalibur Systems, Inc.** – Dragon – it's not a myth
55	**GE Intelligent Platforms, Inc.** – The more real-time data your ISR system sees, the better we look
52	**IMS Engineering Products** – AMCO Enclosures strong-yet-flexible aluminum framing system
31	**Interface Concept** – Intel Core i7, VPX FPGA boards
42	**Kimdu Corporation** – Protocol Converters
35	**LCR Embedded Systems** – Rugged systems engineered for your application
23	**Mercury Systems** – Innovation that computes
9	**North Atlantic Industries** – Rugged systems from NAI
11	**North Atlantic Industries** – 3U cPCI systems
12	**Omnetics Connector Corp.** – Latching Nano-D Bi-Lobe connectors
15	**Parvus Corporation** – Parvus DuraMAR 5915 router
56	**Pentek, Inc.** – Critical recording in any arena – when you can't afford to miss a beat!
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43	**Proto Labs** – Product(ive) development
28	**RTD Embedded Technologies, Inc.** – Rugged boards and solutions – We know PCIe/104. And we do it best.
34	**Sealevel Systems, Inc.** – Serious performance for serious challenges
33	**SIE Computing Solutions, Inc.** – Rugged and ready when you are
42	**Spectracom Corporation** – Nav testing via simulation
39	**SynQor** – VPX – Military DC-DC power supplies
41	**Technologic Systems** – Superior embedded solutions
26	**TeleCommunication Systems, Inc. (TCS)** – Rugged solid state drives built to last
18	**United Electronic Industries** – Will your VME I/O system go EOL this year?
14	**VadaTech Inc.** – The 100GB revolution is taking off
37	**WDL Systems** – The power inside tomorrow's technology
42	**Wind River Aerospace & Defense Division** – Wind River solutions for unmanned systems
50	**Wind River Aerospace & Defense Division** – Building interoperability into unmanned aerial systems
5	**WinSystems, Inc.** – Rugged ARM single board computers
27	**Wolf Industrial Systems, Inc.** – Rugged NVIDIA CUDA GPGPU in OpenVPX
2	**X-ES** – Module and system-level solutions from X-ES

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DoD unmanned systems report maps out technology development for next 25 years

By John McHale, Editorial Director

A 25-year roadmap for unmanned systems released by the U.S. Department of Defense (DoD) earlier this year recommends more open standards and commonality in technology.

The report, titled "Unmanned Systems Integrated Roadmap," lays out predictions, plans, and recommendations for technology development and combat strategies for Unmanned Aerial Systems (UASs), Unmanned Ground Systems (UGSs), and Unmanned Maritime Systems (UMSs). To read it from start to finish, visit http://www.defense.gov/pubs/DOD-USRM-2013.pdf.

Recent budget cuts have forced a drive toward commonality across DoD platforms and this roadmap confirms that trend, calling for more use of "open standards and interface definitions" to mitigate the interoperability challenges related to "unmanned systems communication infrastructures." The report says that enforcement of open standards and "government-owned data rights will promote the leveraging of common components and facilitate reuse among heterogeneous unmanned system platforms."

In other words, suppliers that produce Commercial-Off-The-Shelf (COTS) hardware and software are well-positioned to weather the current economic challenges in the military market and even thrive in the long run as embedded signal processing and open architecture-based computing solutions will likely dominate unmanned system payload development. Intelligence, Surveillance, and Reconnaissance (ISR) payloads already play a large role in current DoD UAS operations and that is likely to continue. For more on this see our Mil Tech Trends article this issue, titled "UAV ISR payloads demand lighter weight, faster processing" on page 36.

Last fall Ron Stearns, Research Director at G2 Solutions, told me he'd call the next 10 years "the sustainment decade" for unmanned aircraft as the DoD is filling out its unmanned aircraft fleets from large to small, keeping them going through sensor, communications, and weapons upgrades. This roadmap confirms that, stating that DoD inventories and funding of UAS platforms "are expected to have a gradual upward trend through 2015 and then trend downward in 2016 and beyond."

These trends are noticeable in the President's Fiscal Year (FY) 2015 DoD budget request. For example, with the Air Force Global Hawk RQ-4 program the DoD is looking to fund development efforts for the RQ-4 Block 30, Block 40, ground stations, and Multi-Platform Radar Technology Insertion programs in the FY 2015 request. RQ-4 Block 30 consists of a multi-intelligence suite for imagery and signals intelligence collection while the Block 40 has multi-platform radar technology for Synthetic Aperture Radar (SAR) imaging, and moving target detection. The DoD also decided to restore the 21 Block 30 systems and continue funding of modernization efforts for the platform to operate beyond FY 2023. The FY 2015 program also funds upgrades to system hardware and performance-based logistics support for the RQ-7 Shadow and procurement of upgrades, training, and contractor logistics support for the RQ-11. For more on the FY 2015 budget request see the bonus section on page 10.

DoD inventories and funding of UGSs are expected to decrease in 2014, according to the roadmap, then gradually increase in 2016 and onward as new programs of record are fielded.

Funding for UMSs, which consists of Unmanned Surface Vehicles (USVs), Unmanned Undersea Vehicles (UUVs), and their related payloads and support systems, will grow in the long-term – especially as the DoD orders more Littoral Combat Ships (LCSs), which will be supported by UMSs.

UUVs got quite a bit of press recently in their search for the missing Malaysian airliner – specifically a UUV from BlueFin Robotics. They're also getting press from *Military Embedded Systems* this month in our Special Report, titled "Unmanned underwater vehicles modernize U.S. Navy's sea-mine-hunting capabilities" on page 24 this month, which also has more information on how UUVs are searching for the lost passenger jet.

While military programs, and DoD ones especially, dominate unmanned system use and development today that will probably not be the case 25 years from now. Commercial applications as well as civilian and consumer use of unmanned technology will eventually surpass that of the military. In fact the morning I wrote this column, the *Wall Street Journal* reported that Google purchased UAS-maker Titan Aerospace, allegedly beating out Facebook on the deal. According to the story they are looking to unmanned aircraft to beam Internet access to remote parts of the globe not covered by cell towers and phone wires.

The roadmap authors say commercial use of unmanned systems will be good news for U.S. taxpayers because increased commercial use of unmanned system technology could "reduce the price point of these systems for the military." A larger market for unmanned system payloads is good news for embedded COTS suppliers too.

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Modernizations and retrofits highlight DoD FY 2015 budget request

By John McHale, Editorial Director

The President's Fiscal Year (FY) 2015 budget request for the Department of Defense (DoD) is not in any sense a wish list for new, high-priced platforms, but more a roadmap for extending the life of current weapons systems, aircraft, and ships through targeted retrofits and upgrades.

The FY 2015 Department of Defense (DoD) budget request continues funding for the F-15E radar modernization program. (DoD photo by Tech. Sgt. Christina M. Styer, U.S. Air Force)

"Modernization" may be the most used word in the President's Fiscal Year (FY) 2015 budget request for the Department of Defense (DoD) as the department looks to upgrade the radar systems; Intelligence, Surveillance, Reconnaissance (ISR); electronic warfare suites; and avionics systems' current aviation, ground, and naval platforms. While numbers remain down compared to past years in procurement and Research, Development, Test and Evaluation (RDT&E) funding, these modernization efforts mean that opportunities still exist for embedded computing, signal processing, software, etc., that enable capability upgrades in these applications.

The overall DoD FY 2015 budget request is essentially flat compared to 2014 with the base budget providing $495.6 billion, a reduction of $0.4 billion from the FY 2014 enacted budget of $496 billion. The FY 2015 DoD acquisition funding request totals $153.9 billion and includes $154.2 billion in new budget authority for FY 2015 that is offset by the cancellation of $0.3 billion of prior year funding, according to the DoD. The $154.2 billion for the base budget includes $90.7 billion for procurement funded and $63.5 billion for RDT&E funded programs. Of this amount, $69.6 billion is for programs that have been designated as Major Defense Acquisition Programs (MDAPs). Below are some MDAP aircraft and ground vehicle highlights from this year's budget request. (For unmanned aircraft highlights, see column on page 8.)

Fixed-wing aircraft

For FY 2015, the DoD is continuing the F-15E (Eagle) Radar Modernization Program (RMP), which replaces the old radar using existing technology from other platforms on 394 F-15s (219 F-15E and 175 F-15 C/D) and solves obsolescence challenges to enable improved reliability and performance (increased synthetic aperture radar range and resolution), including air-to-air and air-to-ground modes. Also continued is the radar upgrade for the F-15 C/D, which replaces the mechanically-scanned antenna on F-15 C/D aircraft with an Active Electronically Scanned Array (AESA), APG-82(V)1 system, and upgrades to the environmental control system. For this platform, the FY 2015 budget continues procurement for the Joint Helmet Mounted Cueing System and Beyond Line of Sight capability and development efforts for the Eagle Passive/Active Warning Survivability System. Procurement funding for this program increased from about $346 million in FY 2014 to about $387 million in FY 2015. RDT&E funding increased from $230 million in FY 2014 to $330 million in the FY 2015 request.

For the F-35 Joint Strike Fighter (JSF), the FY 2015 program procures a total of 34 aircraft: two F-35C Carrier Variants (CVs) for the Navy, six F-35B Short Take-Off and Vertical Landing (STOVL) variants for the Marine Corps, and 26 F-35A Conventional Take-Off and Landing (CTOL) for the Air Force. Procurement funding for the F-35 increases from $5.884 billion in FY 2014 to $6.323 billion in FY 2015. RDT&E increases from $1.487 billion in FY 2014 to $1.641 billion in FY 2015.

The F-22 Raptor program will continue its modernization through incremental capability upgrades together with reliability and maintainability efforts that include the Reliability, Availability, and Maintainability Maturation Program (RAMMP). The FY 2015 program request continues funding for retrofitting the combat-coded F-22 fleet with Increment 3.1, which provides an initial ground attack kill chain capability via the inclusion of ground-looking synthetic aperture radar modes, emitter-based geo-location of threat modes, electronic attack capability, and start of Small Diameter Bomb (SDB-I) integration. It also funds development of Increment 3.2, which provides radar electronic protection, Advanced Medium Range Air-to-Air Missile-120D and Air Intercept Missile-9X integration, enhanced speed and accuracy of target geo-location, Automatic Ground Collision Avoidance System, intraflight data link improvements, and other enhancements. Also included is funding for beginning the 3.2B retrofit. Procurement funding for this program continues to shrink, from $232 million in FY 2014 to about $208 million in FY 2015.

For FY 2015 the DoD will continue funding development efforts and modification of strategic bombers, to include the Fully Integrated Data Links for the B-1 aircraft; the B-2 Defensive Management System (DMS); and the Combat Network Communication Technology for the B-52 aircraft. Strategic bomber procurement in FY 2015 is $344 million, an increase of about $132 million from FY 2014. RDT&E funding in this area is down from $375 million in FY 2014 to $291 million in FY 2015.

Surveillance aircraft

The P-8A Poseidon, a multi-mission platform designed to replace the P-3C Orion propeller-driven aircraft, will have a new radar array, which is a modernized version of the Raytheon APS-149 Littoral Surveillance Radar System. The Navy plans to procure as many as 117 Poseidons. Eight P-8A aircraft will be procured under the FY 2015 program at a cost of about $3.359 billion, with plans for procurement for 15 aircraft in FY 2016. The P-8A ASW, ASuW, and ISR capabilities will be delivered incrementally to the aircraft.

FY 2015 requests funding for four Advanced Hawkeye E-2D aircraft at $1.029 billion in the second year of a Multiyear Procurement (MYP) contract that has a total of 25 aircraft being procured from FY 2014 through FY 2018. It includes associated support, and funds advance procurement for five FY 2016 aircraft (the third year of the MYP). The FY 2015 program supports non-recurring engineering for the Identification Friend or Foe (IFF) system, follow-on test and evaluation, trainers, and in-flight refueling capability. Five aircraft were procured in FY 2014 at $1.208 billion.

E-3 Airborne Warning and Control System (AWACS) aircraft are being reduced in number in FY 2015, as the Air Force will divest seven of these aircraft, reducing the fleet to 24. Meanwhile, modernization of the remaining AWACS aircraft will continue under the Block 40/45 Upgrade, which has upgraded communications and navigation systems, new open-architecture PC-based mission systems, and enhanced electronic support measures.

Figure 1 | The FY 2015 Department of Defense budget request supports construction of three Littoral Combat Ships (LCSs). Photo courtesy of Lockheed Martin.

Rotary-wing aircraft

The V-22 Osprey, a tilt-rotor, vertical take-off and landing aircraft, has support for procurement of 19 MV-22 aircraft for the Navy/Marine Corps in the FY 2015 budget request at about $1.532 billion, down from 23 aircraft at $1.677 billion in FY 2014. The request is based on the third year of a follow-on five-year multiyear procurement contract, for FYs 2013 to 2017. FY 2014 was the last year of procurement for the Air Force-SOCOM CV-22.

The AH-64E Apache program consists of a remanufacture (A) and a new-build (B) effort, which integrates a mast-mounted fire control radar into an upgraded and enhanced AH-64 airframe. The FY 2015 program funds support for the remanufacture of 25 AH-64D aircraft to the AH-64E configuration at $651 million, down from $759 million for remanufacture in FY 2014.

Naval assets

The FY 2015 program for the Littoral Combat Ship (LCS) calls for construction of three seaframe designs as well as procurement of mission modules at $1.785 billion. In FY 2014 four of these ships were built at a cost of $2.017 billion. The seaframe designs are a separate and distinct acquisition program from the mission module program. The two programs are synchronized to ensure combined capability (see Figure 1).

The Ship-to-Shore Connector (SSC) is the replacement for the existing fleet of Landing Craft, Air Cushioned (LCAC) vehicles, which are nearing the end of their service life. The SSC Program requirement is for 73 vessels. For the

FY 2015 program the DoD is looking to procure two vessels and continue research and development of engineering, ship design, and specifications. Total procurement funding for FY 2015 is $123 million and RDT&E is at $124 million.

Satellite operations

The Mobile User Objective System (MUOS) is DoD's next-generation advanced narrow band Ultra High Frequency (UHF) communications satellite constellation. The MUOS satellite includes the new networked payload and a separate legacy payload. For FY 2015 the DoD is looking to fund procurement of Evolved Expendable Launch Vehicle (EELV) for satellite #5; remaining testing and preparation efforts to support launch of satellite #3 scheduled for January 2015; and continued production of satellites #4 and #5, scheduled for launch in August 2015 and October 2016, respectively. Procurement funding is increasing from $116 million in FY 2014 to about $208 million in FY 2015.

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 – the Military Strategic Tactical Relay (MILSTAR) – at a much higher capacity and data rate capability. For the FY 2015 budget request, the DoD looks to continue funding for procurement of the space vehicles AEHF-5 and AEHF-6, and continue the Space Modernization Initiative (SMI) development, which looks to reduce future production costs and combat obsolescence by improving technology insertion. RDT&E funding is up for this program from $265 million in FY 2014 to $314 million in FY 2015, while procurement dropped to $298 million from $328 million.

In FY 2015, program funding is included for procurement of Global Positioning System (GPS) III satellite 9, as well as for the advanced procurement for satellite 10. It also continues the development of GPS OCX Blocks 1 and 2, as well as funds technology development for Military GPS User Equipment (MGUE) Increment 1. The fully operational GPS constellation is expected to consist of 27 satellites. Procurement funding for FY 2015 is at $344 million, down from the FY 2014 total of $506 million.

Tactical communications

FY 2015 program funding for the DoD tactical radio communications system, formerly the Joint Tactical Radio System (JTRS) program, includes low-rate initial production of the Army Handheld, Manpack, and Small Form Fit (HMS), Non-Developmental Item (NDI) hardware and software, and the qualification and operational testing and sustainment of fielded radios and certified waveforms. The request also funds development efforts related to Army waveforms and Joint Enterprise Network Manager (JENM), and the Small Airborne Link-16 Terminal (SALT), which is intended for the AH-64 Apache. Operational testing, platform integration, and initial sustainment support for the Mid-Tier Networking Vehicular Radio (MNVR) program also continue to be funded. The JTRS Program of Record(s) transitioned to a Military Department-management program last year. FY 2015 procurement funding request is $330 million for 3,294 systems; in FY 2014 6,499 systems were procured at $542 million. RDT&E funding in FY 2015 is at $211 million, down from $306 million in FY 2014.

The Warfighter Information Network-Tactical (WIN-T) program development consists of four increments. The FY 2015 program funds the upgrade of 81 WIN-T Increment 1 units with modification kits to enhance interoperability with units fielded with WIN-T Increment 2. Funding is also included for procurement of WIN-T Increment 2 for one Brigade Combat Team and one Division. Fielding and support are continued for previously procured Low Rate Initial Production equipment. The request funds development of Network Operations software (Build 4) as part of WIN-T Increment 3 and supports the integration of 179 Modification kits for the AN/TRC-190 line-of-sight radio systems. Tactical NetOps Management Systems to 48 non-WIN-T units are procured and fielded along with program management support for Single Shelter Switch (SSS), Troposcatter Communications systems, and High Capability Line of Sight, Battlefield Video-Teleconferencing Center upgrades. Procurement requested for FY 2015 is at $763 million for 1,280 systems. In FY 2014 1,725 systems were procured at $894 million. RDT&E funding for FY 2015 is at $116 million, down slightly from FY 2014 totals of $122 million.

Missile defense

The Aegis Ballistic Missile Defense (BMD) FY 2015 Program supports the procurement of 30 SM-3 Block IB missiles, procures BMD upgrades for three Aegis ships, and installation onboard five Aegis ships. It also funds continued development of the Aegis BMD 5.0 and 5.1 Weapon Systems. FY 2015 funding requested is $435 million, down from about $580 million in FY 2014. RDT&E funding increased slightly from $909 million in FY 2014 to $929 million in FY 2015.

The Terminal High Altitude Area Defense (THAAD) FY 2015 Program has support for procurement of 31 interceptors and associated components, as well as support and training equipment. It also funds development of the initial Build 2.0 capability; continues development, flight, and ground testing of THAAD components; and supports the four THAAD batteries as well as the planned delivery of the fifth battery in FY 2015. Funding for this program is down from the FY 2014 total of $571 million, to $464 million in the FY 2015 request. RDT&E funding is increased slightly from $255 million to $299 million in FY 2015.

Ground systems

The M1A2 Abrams battle tank, which first entered service in 1980, will see its modernization efforts continued in the FY 2015 program. Funding in this request supports modifications and upgrades to the armor facility and procures multiple approved modifications to fielded M1A2 Abrams tanks, including the Data Distribution Unit (DDU) and Blue Force Tracking 2 for network interoperability, 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). Procurement on this program increased from $279 million in FY 2014 to $349 million in FY 2015. RDT&E also increased slightly from $101 million to $112 million. MES

Software development tools as force multipliers

By Charlotte Adams

A GE Intelligent Platforms perspective on embedded military electronics trends

Situational awareness often requires data center processing speeds in the smallest possible package. The sensors that feed signal and image processing systems siphon up masses of data, which processors must then reduce to useful information within tactical timelines.

Code hosted on multicore, multiprocessor boards used in these compact signal processing systems is complex and multithreaded, reflecting the intricacies of the host systems and the time constraints of the computing operations. In addition, software must be delivered within the tightest possible deadlines at the lowest possible cost. Ongoing and proposed military budget cuts will increase pressure on program schedules and resources, thus making technology more important as a force multiplier.

Software hosted on these High Performance Embedded Computing (HPEC) platforms, furthermore, must be effective, efficient, and "open" for maximum flexibility, portability, and affordability. Fortunately, developers have been able to marry openness and performance for military systems by leveraging the rock-solid, free, and readily available software and hardware standards used in data centers. Among the software standards borrowed from this world are the Open Message Passing Interface (Open MPI) and OpenFabrics Enterprise Distribution – or OFED – middleware.

Tools

Programming signal and image processing software applications intended for today's most advanced multiprocessor and multicore embedded environments would be difficult without today's software tools. These frameworks, provided by embedded system development companies, include libraries of vector math and Digital Signal Processing (DSP) functions that can help developers construct algorithms from predefined building blocks, graphical visualization tools, code generation and distribution modules, and interprocessor communications optimizers.

Toolkits hosted on multiple "starter systems" include both the software construction aids and non-militarized versions of intended circuit boards so that applications can be tested on the chips and boards intended for the weapons system. The software tools help developers construct the applications, map the applications to the hardware, and wed the code to the architecture of the system. The tools help programmers to use the integrated circuits – whether the latest multicore Central Processing Units (CPUs) or the newest highly parallel General Purpose Graphics Processing Units (GPGPUs) – as efficiently as possible, minimizing development time and ensuring the tightest Size, Weight, and Power (SWaP) tradeoffs.

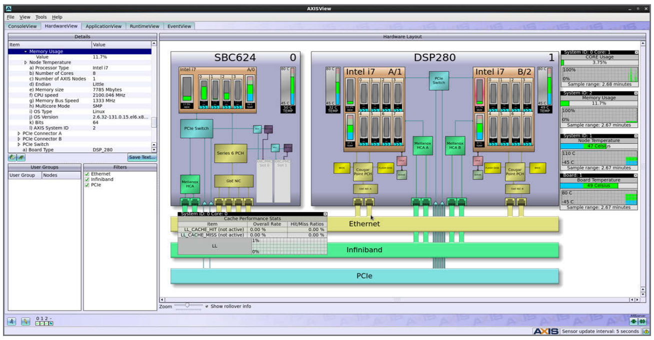

Figure 1 | GE's AXIS (Advanced Multiprocessor Integrated Software) environment supports Open MPI and works with high performance processors for use in various military platforms.

Standards

These software development toolkits enable developers to describe applications as a series of tasks and then set up the data flows between the tasks. Libraries of high-level math and DSP functions free programmers from low-level details so that they can focus on higher-level functions like the Fastest Fourier Transform in the West (FFTW) and data-movement libraries such as Open MPI and Data Distribution Service (DDS).

As algorithms are assembled and code is auto-generated, designers can monitor the real-time execution of software modules, visualize the behavior and interaction of different processes, and tweak performance accordingly. Developers can see the data flows, discover the bottlenecks, diagnose the bugs, and find the timing glitches in order to optimize software before porting it to the target platform.

Like OFED, MPI was developed for the supercomputing world, where communications between processes must be lightning-fast. Equally important, MPI and other data center standards are backed by huge government laboratories and computer companies. Thus, developers of embedded systems can build upon standards developed in the crucible of supercomputing environments and enjoy the fruits without paying the costs.

Military customers require the best hardware and software for the troops – and they want it yesterday. Software development toolkits help to make it possible by accelerating productivity and producing code that has been well-structured and well-tested before it is ultimately incorporated into the platform.

An example of an HPEC application development toolkit is the GE Intelligent Platforms Advanced Multiprocessor Integrated Software (AXIS) environment (see Figure 1). The latest version, AXISPro 6.0, supports Open MPI as well as the latest fourth-generation Intel Core i7 chips, multicore Freescale processors, and parallel NVIDIA GPGPU platforms.

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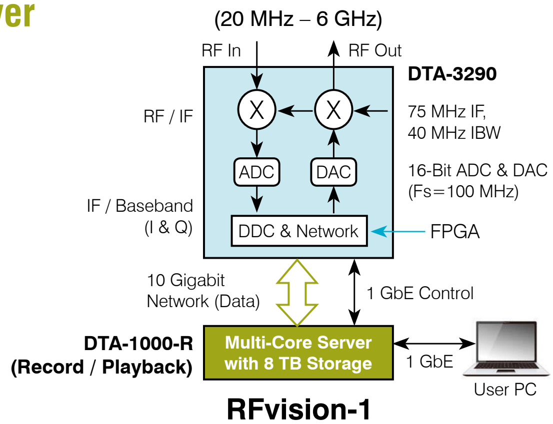

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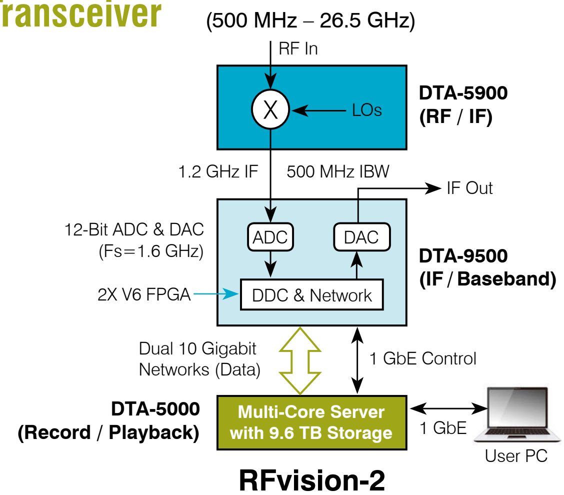

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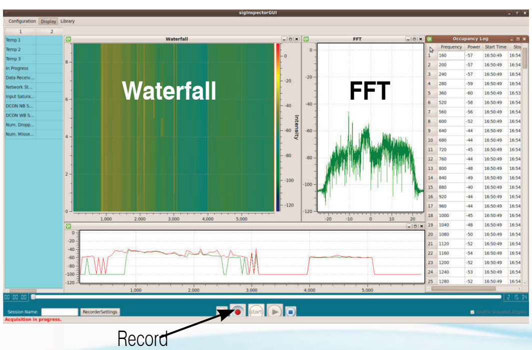

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UAV payload designs turn to COTS

By Val Zarov and Jacob Sealander
An industry perspective from Curtiss-Wright Defense Solutions

On High Altitude, Long Endurance (HALE) platforms Size, Weight, and Power (SWaP) is key, with weight and power typically the most critical. Additional weight can affect capability and reduce flight time. Every unnecessary pound and watt must be eliminated. With SWaP so critical for Unmanned Aerial Vehicles (UAVs), the goal is optimal design. Traditionally, system integrators provide a Commercial Off-The-Shelf (COTS) vendor with a set specification. A better approach is to involve the hardware supplier early in the system design process. This has been proven to significantly improve cost and SWaP, boost reliability, reduce design risk, and combat obsolescence.

For example, for the Global Hawk Northrop Grumman worked with a COTS vendor on the Integrated Mission Management Computer (IMMC) that controls the aircraft's flight, and the Advanced Mission Management System (AMMS) that acts as a central data interface to the onboard payload sensors and relays data to the

Figure 1 | Curtiss-Wright's rugged COTS-based Sensor/Payload Management Unit subsystem is an example of an open architecture solution for unmanned platforms.

UAV communication links. Part of the success of Northrop Grumman's HALE Enterprise stems from its fostering a real dialogue with suppliers, tapping into their expertise. The benefits are numerous: improvements in form factors, data security, meeting program affordability targets, longevity of supply, and product availability. Some recent examples highlight how close communications between a COTS vendor and the system integrator optimizes UAV solutions.

Northrop Grumman encourages suppliers for its HALE Enterprise platforms to provide their insight and suggestions for subsystem architecture optimization. This approach led to significant improvement in the design of the latest generation of the IMMC. Discussions about the previous generation IMMC revealed that, as the UAV evolved, installation/removal of the system became too time consuming. This simple input led us to evaluate the installation process.

The earlier IMMC used a sliding/stacking approach. Installation and removal of the unit was cumbersome and impeded cooling airflow. Provided with an insight into the platform's configuration, the vendor completely redesigned the box with an alternate mounting technique and improved thermal performance that greatly reduced Mean Time To Replace (MTTR) while increasing system reliability.

UAVs that fly in combat environments need high data capacity to confront data security issues. The technology sweet spot's shift to solid-state media created another challenge: if a data storage unit has a performance issue it must be sanitized of all potential classified data before removal. In the past, data sanitization for tape drives and magnetic storage media involved writing specific data patterns to all non-volatile locations to ensure successful data erasure. As a result adequate low-level access (bypassing provisioning) is now available on this system to achieve proper data sanitization without violating manufacturer's warranty.

Another example of how open communication with the UAV system integrator results in optimal design is found in the retroactive architecture review process. Through dialogue with the customer, the COTS vendor can identify features proven over time to be unneeded or technologically superseded. For example, if data being sent over interfaces can be delivered over Ethernet, those interfaces can be removed. Removing such features provides a cost-effective means of increasing product availability, improving reliability while simplifying logistics without risk or the expense of a technology refresh. Unlike technology refresh that adds functionality, subtracting features from a previously certified solution eliminates the need for re-qualification. The result is improved Mean Time Between Failure (MTBF), lower ownership cost, and extended product availability/support.

Working with COTS vendors is an approach that lowers the total cost of ownership and reduces risk to the program in the long-term.

DEFENSE TECH WIRE

NEWS | TRENDS | DOD SPENDS | CONTRACTS | TECHNOLOGY UPDATES

By Amanda Harvey, Assistant Editor

NEWS

Boeing high-speed Phantom Swift aircraft selected for DARPA VTOL program

Boeing's Phantom Swift prototype has been chosen to be part of the Defense Advanced Research Project Agency (DARPA) Vertical Takeoff and Landing (VTOL) X-plane program. Under the $17 million contract with DARPA, Boeing will continue to develop the Phantom Swift technology to enable vertical take offs and landings, hovering capabilities, and 400-knot speeds. The aircraft features two large lift fans inside the fuselage that provide efficient vertical lift. Once it transitions to cruise mode, the fans are then covered. It also features smaller ducted fans on the wingtips that provide forward thrust, and provide additional lift and control in hover mode. In 2016, DARPA will select a model, among several competitors, for flight demonstration.

Figure 1 | The Boeing Phantom Swift prototype enables vertical take offs and landings, hovering capabilities, and 400-knot speeds. Photo courtesy of Boeing.

Upgrades to Apache targeting and pilotage system to be made by Lockheed Martin

Lockheed Martin won a $14 million U.S. Army contract to design, integrate, and qualify a High Reliability Turret to be used on the Modernized Target Acquisition Designation Sight/Pilot Night Vision Sensor (M-TADS/PNVS) for the AH-64 Apache attack helicopter. The High Reliability Turret interfaces between the M-TADS/PNVS and the Apache airframe. It enhances target track performance and reduces the effects of aircraft vibration on the system. The turret also improves maintainability and reliability, as well as reducing the operations and support costs of the current turret assembly. Lockheed Martin estimates it will save the U.S. Army more than $500 million in support and operation costs over the life of the system.

Northrop Grumman extends partnership with Bell Helicopter to supply LCR-100 AHRS navigation systems

Northrop Grumman has extended their partnership with Bell Helicopter to supply LCR-100 Attitude Heading Reference System (AHRS) flight control and navigation systems for the Bell 412 helicopter. The agreement is through 2017. The LCR-100 AHRS, produced by Northrop Grumman's subsidiary in Germany, has been in service since 2008 on numerous rotorcraft and fixed-wing platforms. The LCR-100 employs a fibre-optic gyro-based Inertial Measurement Unit (IMU) and an advanced micro-electromechanical system triad accelerometer. The unit has a high-performance directional gyro mode, which minimizes compass errors, and exceeds the Technical Standard Order/European Technical Standard Order (TSO/ETSO) C5e/f non-magnetic, gyro-stabilized drift requirement, enabling improved operation at extreme latitudes.

Astro Aerospace delivers JIB antennas for U.S. Air Force GPS III satellites

Astro Aerospace, a division of Northrop Grumman, has delivered 32 self-deploying monopole JIB antennas for the U.S. Air Force's GPS III satellites (3-6). The antennas were delivered to Lockheed Martin, the leader of the team developing the GPS III satellites. Once they have been installed, eight JIB antennas on each GPS III satellite will deploy to form an RF antenna array. This is the first delivery of antennas, with 16 more arriving in the next coming months. The JIB antenna is a stored energy monopole that deploys in approximately 200 milliseconds.

Figure 2 | Pictured here is an artist's rendition of a GPS III satellite. Photo courtesy of Lockheed Martin.

First Lockheed Martin F-35 Lightning II delivered to Luke Air Force Base

The first Lockheed Martin-built F-35 Lightning II has been delivered to Luke Air Force Base in Glendale, AZ. The F-35A Conventional Takeoff and Landing (CTOL) variant, known as LF 5030, is the first of many F-35As scheduled for delivery to the base.

Luke AFB is projected to become the U.S. Air Force's primary F-35 pilot-training base. Starting in 2015, Luke AFB will begin training Air Force pilots destined for deployment; both U.S. and foreign pilots will train at the base before deploying to combat units across the globe. Luke AFB is expecting F-35A deliveries several times per month until the base has six squadrons of 24 planes each. The total number of deliveries is expected to reach 144 aircraft, with the base expecting to receive 15 more planes before the end of 2014.

Figure 3 | The first Lockheed Martin-built F-35 Lightning II arrives at Luke Air Force Base in Glendale, AZ on March 14, 2014. Photo courtesy of Lockheed Martin.

Boeing partners with TrustComm to sell satellite bandwidth to commercial, government users

Boeing and the company TrustComm, Inc., of Stafford, VA, are joining together to sell satellite bandwidth to both government and commercial users as a way of addressing the increasing demand for satellite communications capacity. TrustComm and Boeing, the latter of which is an authorized reseller of Inmarsat capacity, will sell bandwidth from Inmarsat's Global Xpress high-speed mobile broadband service.

"TrustComm becomes the first service provider for Boeing Commercial Satellite Services (BCSS)," says Jim Mitchell, VP of BCSS, "and TrustComm's access to certain government markets will augment our sales efforts." Through BCSS, Boeing works with owners of active satellite systems to market available bandwidth and to include hosted payloads on future spacecraft.

Navy submarine development contracts won by General Dynamics

General Dynamics Electric Boat won two contract modifications from the U.S. Navy for submarine work. Under the first contract Electric Boat engineers will provide advanced submarine research and development studies to support a range of technology areas such as manufacturability, survivability, maintainability, hydrodynamics, materials, and acoustics. Company experts will also perform research and development work in hull integrity, manning, performance, logistics, ship control, safety, and weapons handling. The award supports near-term Virginia-class technology insertion, core technologies, and future submarine concepts. This contract could potentially be worth about $710.6 million over five years.

For the second contract Electric Boat personnel will continue to develop the Common Missile Compartment for the U.S. Ohio replacement submarine. Electric Boat engineers will then procure missile tube long-lead-time material and design and manufacture hardware. This five-year, $1.85 billion contract calls for Electric Boat experts to conduct research and development work for the Navy's next-generation ballistic-missile submarine, which is expected to begin construction in 2021.

Boeing Maritime Surveillance Aircraft for search and rescue, security completes first flight

The Maritime Surveillance Aircraft (MSA) demonstrator from Boeing, designed for anti-piracy patrols, coastal and border security, and search and rescue, successfully completed its first flight. The four-hour test flight took place on February 28 by Boeing teammate Field Aviation, from the Toronto Pearson International Airport. The Bombardier Challenger 604 aircraft was used, and Field Aviation modified the structures and systems into the MSA configuration. The MSA configurations provide multi-mission surveillance capabilities on the aircraft.

Additional test flights are scheduled through April. Once these test flights are completed, the aircraft will be sent to a Seattle-based Boeing facility, where the MSA mission systems will be installed and tested.

Figure 4 | The Boeing Maritime Surveillance Aircraft (MSA) for coastal and border security and search and rescue missions successfully completed its first flight. Photo courtesy of Boeing.

Navy sonar minehunting contract won by Raytheon

Raytheon won a $35.5 million contract to deliver AN/AQS-20A minehunting sonar systems and equipment to the U.S. Navy. The system will be deployed from the Littoral Combat Ship (LCS), functioning as the variable depth sonar for the AN/WLD-1 Remote Minehunting System (RMS), where it will be towed undersea to scan the water in front, below, and to the sides of the vehicle to look for anti-shipping mines.

AN/AQS-20A makes use of sophisticated sonar, electro-optical sensors, and high-precision location data to create high-resolution images of mines and mine-like objects. The system detects, localizes, and identifies bottom, close-tethered, and volume mines, while the AN/ASQ-235 Airborne Mine Neutralization System (AMNS) reacquires and neutralizes those mines found by the AN/AQS-20A. AMNS is made up of a helicopter-based control console and a launch and handling system that is equipped with four unmanned Archerfish neutralizer vehicles that can destroy mines via remote control from the operator in the MH-60S helicopter.

Figure 5 | The Remote Minehunting System (RMS) and an AN/AQS-20 minehunting sonar (attached underneath) are brought aboard the Littoral Combat Ship (LCS) USS Independence. Photo courtesy of Raytheon and the U.S. Navy.

Navy training systems task order won by Northrop Grumman

Northrop Grumman will continue development and improvement of Navy combat systems trainers under a task order valued up to $33 million. Northrop Grumman won the order under the SeaPort-e indefinite delivery, indefinite quantity multiple award contract. Directed by the Naval Undersea Warfare Center (NUWC) Division Newport, Northrop Grumman engineers will provide designs, products, and prototypes for new and updated training systems that enable enhanced training realism and easy operation while also being more cost-effective. Northrop Grumman personnel will also provide system analysis and development, product assurance, technology refresh, and performance evaluation. These training capabilities will be utilized to prepare sailors for important operations such as sensor control, navigation, and weapons launching.

Initial operational capability announced for Air Force Sniper targeting pod

Air Force officials announced Initial Operational Capability (IOC) for the Sniper Advanced Targeting Pod-Sensor Enhancement (ATP-SE) that was developed by Lockheed Martin engineers. It has since deployed for support of combat operations in theater. Sniper ATP-SE enables U.S. Air Force strike fighter and bomber aircraft pilots to have advanced modes for non-traditional Intelligence, Surveillance, and Reconnaissance (ISR); expanded air-to-air and maritime capability; improved combat identification; and two-way data link communication.

The U.S. Air Force and Air National Guard will deploy Sniper ATP-SE on the A-10C, B-1, F-15E, and F-16 Blocks 30, 40, and 50, according to Lockheed Martin officials. The Sniper ATP-SE system also has Net-T capability, which provides a point-to-multipoint networking architecture. When used with other platforms, it enables operators and analysts to have access to real-time data that is beyond their line of sight. B-1 bombers at Dyess Air Force Base in Texas were the first operational platforms to fly with Sniper ATP-SE.

Triton UAS completes first major milestone; Northrop Grumman, U.S. Navy clear for flight

Northrop Grumman and the U.S. Navy have completed the first Triton Unmanned Aircraft System (UAS) milestone, and have cleared it to fly at various altitudes, speeds, and weights. The test team validated more than 568 test points during the program. During this effort, 13 flights were conducted, including several long-endurance flights at altitudes up to 59,950 feet.

Triton carries a variety of Intelligence, Surveillance, and Reconnaissance (ISR) sensor payloads, which enable military commanders to gather high-resolution imagery, provide airborne communications to military units, and also use radar to detect targets. The U.S. Navy plans to build 68 Triton UASs, which will be used with the manned P-8 Poseidon to conduct ISR missions across vast ocean and coastal regions.

Figure 6 | The Northrop Grumman Triton Unmanned Aircraft System (UAS) will be used by the U.S. Navy to conduct Intelligence, Surveillance, and Reconnaissance (ISR) missions. Photo courtesy of Northrop Grumman.

Unmanned underwater vehicles modernize U.S. Navy's sea-mine-hunting capabilities

Sally Cole, Senior Editor

The Navy is using Unmanned Underwater Vehicles like the Knifefish from Bluefin Robotics Corp.
(Photo courtesy of Bluefin Robotics Corp.)

Since the end of World War II, sea mines have damaged or sunk four times more U.S. Navy ships than all other types of attacks. In the future, advances in fully autonomous Unmanned Underwater Vehicles (UUVs) – equipped with embedded computing technology – will play a key role in sea-mine countermeasures.

Sea mines are deeply entrenched in the history of naval warfare, having played a significant role in every major conflict since the Civil War. So it's no surprise the U.S. Navy has made the use of Unmanned Underwater Vehicles (UUVs) for sea-mine countermeasures a top priority.

An increased proliferation of inexpensive lethal threats targeting individual warfighters and high-value assets – combined with continued advances in computing, power and energy, sensors, robotics, and position-guidance technologies – is driving the push by the U.S. Navy to augment expensive manned systems with less expensive, fully autonomous unmanned systems.

Mines come in a wide assortment of flavors and types. During World War II, for example, mine threats ranged from advanced acoustic and pressure-influence devices to magnetic mines and electrical-potential/antenna-fired weapons. The four primary types of mines include bottom or "proud" mines that target submarines or ships in shallow water; moored mines held in place by anchors; floating mines assembled in buoyant cases and anchored; or buoyant drifting mines carried by currents and tides.

A relatively inexpensive sea mine, perhaps on the order of $10,000, is capable of sinking a ship worth more than $1 billion. "Much like Improvised Explosive Device [IED] use in Afghanistan or Iraq, sea mines play a similar role in making it difficult for an opposing force to move around or occupy an area without worrying that an unseen quiet threat can blow you up," explains Frank Herr, head of the Office of Naval Research's Ocean Battlespace Sensing Department (ONR; Arlington, VA; www.onr.navy.mil).

Mines pose a huge challenge for the Navy, because this threat isn't coming solely from new mines being laid in the ocean. "Tens of thousands of mines left over from World War II are on the seafloor and, since that time, more have been laid every decade by various nations," notes Jeff Smith, chief operating officer for Bluefin Robotics Corp. (Quincy, MA; www.bluefinrobotics.com), a company that designs and builds UUVs – including the Knifefish.

Knifefish and its role in U.S. Navy mine countermeasures

Bluefin Robotics is working closely with General Dynamics Advanced Information Systems (Fairfax, VA; www.gd-ais.com), the primary contractor of the Surface Mine Countermeasure UUV program, to develop Knifefish and modernize the Navy's underwater mine-hunting capabilities.

Knifefish, a heavyweight-class specialized Bluefin-21 UUV, builds upon the low-frequency broadband acoustic payload

technology initially developed by the Naval Research Laboratory to deliver a significant detection capability to the warfighter.

"Knifefish is a critical part of the Navy's Littoral Combat Ship Mine Warfare mission package and will provide the fleet mine warfare commander and sailors with enhanced mine-hunting capability by addressing the Navy's need to reliably detect and identify 'proud' and buried mines in high-clutter environments," Smith says.

In terms of specs, a standard Bluefin-21 UUV is shaped like a torpedo, measures 21 inches in diameter and is 19 feet long (depending on its payload), weighs approximately 2,000 pounds, and is designed to operate to depths of 4,500 meters for 25 hours or more. Knifefish uses "a multitude of sensors to conduct its operations," Smith says. "The vehicle's main sensors include those typically found in UUVs, namely Inertial Navigation Systems (INS), Doppler-velocity logger, compasses, and sound-velocity sensors. Its payload is a low-frequency broadband synthetic aperture sonar for buried mine detection."

To communicate, UUVs send brief messages to satellites. "We've been using Iridium, an over-the-horizon communication link, which enables communication with these research vehicles in the middle of the ocean without airplanes or ships," says Herr. "But the Navy will use other communications channels for operations." (See Figure 1.)

Quite possibly one of the most important things to understand about UUVs is that these are not "drones." These are autonomous systems; they aren't remotely piloted. This fact makes their electronics and software extremely important. Knifefish is equipped with networking electronics, as well as communications, power-management, data-management, and storage electronics.

"Knifefish's subsystems are based on an open architecture developed by Bluefin and General Dynamics Advanced Information Systems during the last decade," explains Smith. "Its software uses a modular open systems architecture approach and is responsible for vehicle autonomy, mission planning and execution, payload data management, and other tasks."

Because Knifefish has a modular design, it enables the integration of alternate payloads capable of addressing other applications and missions. While Knifefish is designed to fulfill the Navy's requirements within the land-sea border known as the littoral zone, Bluefin has "variants of the Bluefin-21 tested for full ocean depth," Smith notes.

Knifefish will help the Navy to "reliably detect and identify volume, bottom, and buried mines in high-clutter

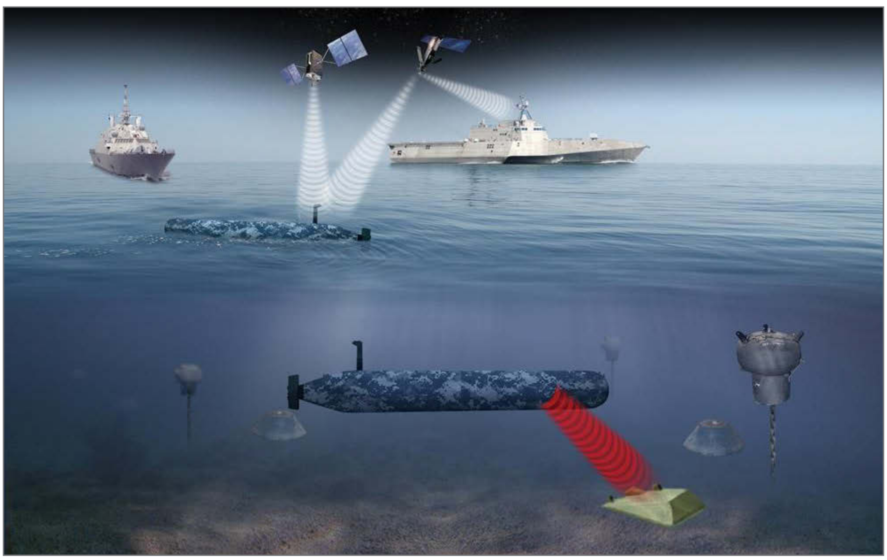

Figure 1 | Knifefish communicates by sending brief messages to satellites. Courtesy of Bluefin Robotics Corp.

environments," says Tom Mason, senior program manager for General Dynamics Advanced Information Systems. "As part of the Littoral Combat Ship Mine Countermeasure mission package, Knifefish acts as an offboard sensor while the host ship stays safely outside the minefield boundaries – enhancing situational awareness and significantly reducing risks to Navy personnel." (See Figure 2.)

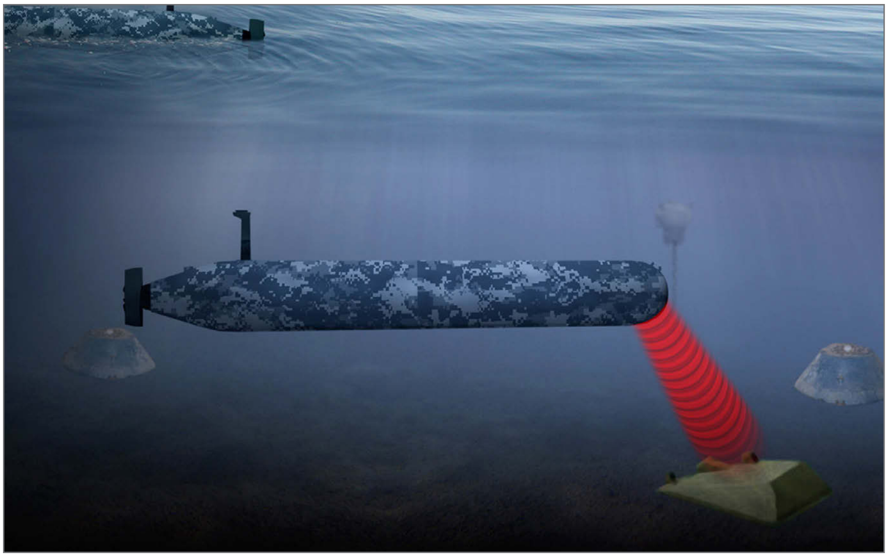

Figure 2 | Knifefish can detect and identify volume, bottom, and buried mines in high-clutter environments. Courtesy of Bluefin Robotics Corp.

Embedded computing and UUVs

UUVs like Knifefish are already quite advanced, but embedded computing can help take things to the next level. "Embedded computing will play a key role moving forward, because as computing continues to improve, these vehicles can become smarter," says Herr.

Three levels of computing must evolve in order to achieve significant advances:

"A reliable and capable autonomous vehicle first requires a stable and well-characterized control system – a computer to act as the brains of the vehicle so the vehicle can operate itself. Second, it needs to be able to understand features in its environment, with programs to detect items and classify them specifically compared to other things – and to recognize that it's not being spoofed to look like a mine – in an automated way," explains Herr. "Third, it requires a separate set of software

(Continued on page 30)

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to control the vehicle so that it reacts appropriately to the physical (ocean currents) or tactical (detected targets) environment that it senses in its vicinity. In this way, it can search, avoid, or follow in an automated manner."

Everything must become automated to avoid turning into "a big communications mess, with operators watching over the shoulder of a mission specialist, constantly asking 'Is this what you're looking for?' To avoid this, we need it all on that vehicle, because we don't have the communications bandwidth to get all of that information back to do real-time decision-making," Herr notes.

Behavior defines UUVs, in terms of avoiding obstacles and moving in response to sensors in an automated way. "The vehicle itself needs to be under control, the sensing needs to be under control and automated, and the behavior of the vehicle – the interaction between the sensing and control systems of the vehicle – needs to be in a specialized software," says Herr. "These three levels are what makes autonomy for these vehicles important and what it'll take to separate it from a remotely piloted system."

Open architectures

Clearly, one of the most vital components of a successful UUV program is its underlying architecture. "Designers and developers of UUV common-control systems must continue to evolve these solutions to be acceptable, flexible, and scalable to help agencies advance their missions," Mason points out.

General Dynamics Advanced Information Systems' unmanned mine countermeasure approach, which combines Commercial Off-The-Shelf (COTS) technologies and an open architecture, is driving innovation into the Navy's mission to decrease costs and increase operational efficiencies. "Our open architecture enables quick configuration for 'plug-and-play' integration to evolve to meet current and future mission needs," Mason adds.

The U.S. Navy's current vision for UUVs "includes using multiple heterogeneous unmanned systems collaborating to reduce mission timelines," says Smith. "A longer-term interest is to increase autonomy and energy for operational systems to effectively increase missions for greater persistence with less human intervention."

To this end, ONR is seeking proposals for innovative technology solutions to enable unmanned surface vehicles capable of carrying out three phases of mine hunting: detection/classification, identification, and neutralization, all in a single sortie to potentially be integrated into a future Littoral Combat Ship Mine Countermeasure mission package. For more information, visit 1.usa.gov/PM5a1O.

In the future, any technologies that can increase reliability for UUV components will be important, according to Herr, such as development of lower-power payloads and other systems designed to extend battery life. **MES**

Unmanned underwater vehicles aid in search and recovery missions

Unmanned Underwater Vehicles (UUVs) played a key role in the search and recovery of the wreckage of Air France Flight 447, an Airbus A33-200, which crashed and disappeared into the ocean on June 1, 2009, after encountering severe thunderstorms while en route to Paris from Rio de Janeiro.

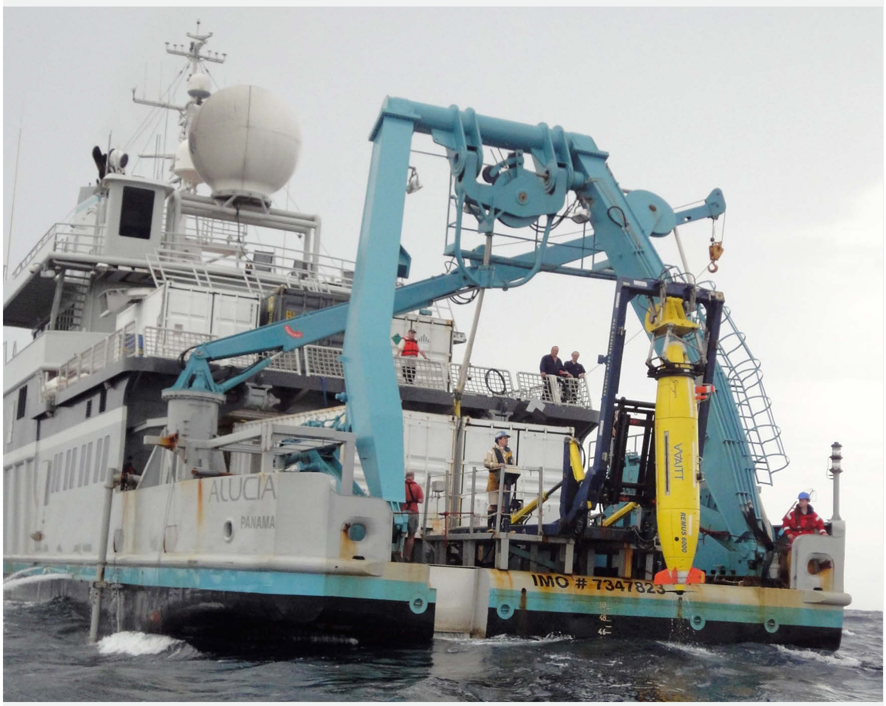
In April 2011, a search team led by Woods Hole Oceanographic Institution (WHOI; Falmouth, MA; www.whoi.edu), operating three REMUS 6000 autonomous underwater vehicles made by Hydroid (Pocasset, MA; www.hydroid.com), located the plane's wreckage and black boxes off the coast of Brazil. The discovery was made nearly 2.5 miles below the Atlantic Ocean's surface in topography similar to the Rocky Mountains, with intense peaks and valleys (see Figure 1).

Terrain-following algorithms allow the REMUS 6000 to climb and dive in steep terrain, while still collecting high-resolution bathymetric data. The REMUS 6000 was designed as part of a cooperative program involving the U.S. Naval Oceanographic Office, the Office of Naval Research, and WHOI in support of deep-water autonomous operations.

In the case of Air France Flight 447, the autonomous underwater vehicles' dual-frequency side-scan sonar and four-megapixel digital cameras located large pieces of the plane's wreckage, including parts of the aircraft's wings, engine, landing gear, and fuselage.

Years later, UUVs are once again being tapped to search for a missing plane: Malaysia Airlines' Flight MH370, which mysteriously disappeared and is presumed to have crashed into the southern Indian Ocean on March 8, 2014.

The Indian Ocean spans about 28.4 million square miles and its mid-ocean ridges, deep ocean trenches, strong winds, and currents make it a complex body of water to navigate and search, according to WHOI. At its deepest point, the Indian Ocean's Diamantina Trench is more than five miles deep. To aid this search effort, the U.S. Navy sent a Bluefin Robotics Corp. (Quincy, MA; www.bluefinrobotics.com) sonar-equipped Bluefin-21, capable of operating and locating wreckage at full ocean depth.



Sidebar Figure 1 | The REMUS 6000 in its launch and recovery system aboard the Alucia during the search for Air France Flight 447. Courtesy of Woods Hole Oceanographic Institution.

Electronic warfare suites such as those used by the French Rafale fighter aircraft, pictured here while refueling, are driven by FPGA-based signal processing solutions. U.S. Air Force photo by 1st Lt. Christopher Mesnard.

New electronic warfare architectures based on tight coupling of FPGA and CPU processing

By Thierry Wastiaux

Electronic Warfare (EW) system designers are taking advantage of the performance leaps in commercial technology, driven by high-volume commercial markets such as telecommunications and cloud computing. These components such as FPGAs combine speed, high connectivity, and low power consumption for signal-processing intensive EW platforms such as fighter aircraft and Unmanned Aerial Vehicles (UAVs).

The tremendous research and development push in recent years by the major FPGA designers has resulted in new technologies that revolutionize EW system architectures. These new FPGAs and A/D converters deliver the high sampling speed, high data rate connectivity, low power consumption, and parallel data processing power required by sophisticated EW platforms such as the French Dassault Rafale and UAVs on persistent surveillance missions.

FPGAs have thus become the best possible interface to sensors: Their capacity to perform powerful parallel algorithms makes them ideal for building all the filters and transforms that are essential to system performance. In EW systems that must seek for ever-fainter spectral features, FPGAs enable the implemention of polyphase filterbanks. This reduces the "spectral leakage" in the frequency response of the Discrete Fourier Transform (DFT) more efficiently than the classical windowing functions approach, and with less computational complexity.

Another important feature of modern FPGAs is their lower processing consumption compared to CPUs, DSPs, or GPUs. When working on integers, the FPGAs tend to be as much as 10 times more efficient in terms of Giga Operations (GOPs)/watt in comparison with CPUs or GPUs.[1] This ratio will only grow with each new generation of FPGA.

These FPGAs also feature enhanced connectivity. By implementing sophisticated analog designs, their transceivers have become extremely fast; in the case of Xilinx's GTZ technology, reaching 28 Gbps per lane, which enables high-speed chip-to-chip or backplane connections. Another of Xilinx's offerings, the Virtex-7 FPGA, can have an aggregate bidirectional transceiver bandwidth of as much as 2.7 Tbps. In order to benefit from these high-speed transceivers, strong multichannel Direct Memory Access (DMA) engines are implemented in FPGAs managed by software drivers run by the CPUs of the system. These DMA engines – part of the Reference Design delivered together with the FPGA modules – have become very fast tools to move data and samples between memories.

A/D converter designs are seeing similar leaps in capability. A single direct RF-sampling A/D converter can replace an entire Intermediate Frequency (IF) sampling or Zero Intermediate Frequency (ZIF) sampling radio signal path subsystem of mixers, LO synthesizers, amplifiers, filters, and ADCs. Such a configuration can drastically reduce the bill of materials cost and design time, while shrinking board size, weight, and power. In addition, their performance over a large range of input frequencies up to and beyond 2.7 GHz enables maximum frequency, bandwidth, and overall system programmability and flexibility in many applications, including radar, lidar, and Signals Intelligence (SIGINT). The JESD204B digital interface standard – ratified several years ago – allows moving from high pin count/low-speed parallel interfaces to low pin count/high-speed serial interfaces.

In combining the new technologies available on ADC and FPGAs, EW system architects can dramatically improve their data sample processing. The FPGA Mezzanine Card (FMC) VITA 57 standard, promoted by the VITA Group and the

FMC Marketing Alliance, enables high data throughput and very low latency response between an A/D converter or D/A converter FMC and the FPGA, simplification of the design, and the all-important ability to cost-efficiently retarget an FPGA carrier card design. Retargeting now requires simply swapping out the FMC module and adjusting the FPGA firmware. Moreover, thanks to the now well-established OpenVPX VITA 65 standard, all of these new technologies can be implemented on cards, ensuring the integrity of high-speed signals on systems backplanes.

The main point remaining to be solved: How to connect all these FPGA modules to the wideband network that sensors require to supply data to the users? Special middleware provides easy communication between FPGA modules, CPU modules, and the external networks of an EW system.

Only high-end CPU modules are able to run the high-level communication protocols and middleware that is necessary to get WAN connectivity. Consequently, it becomes essential to find ways to get the FPGA and CPU modules to communicate seamlessly.

The leading embedded CPU technology is the Intel 3rd or 4th generation Core i7 CPUs based on 32 or 22 nm microarchitectures. These CPUs contain integrated PCIe Gen 2/Gen 3 interfaces, allowing a per-lane maximum theoretical bandwidth as fast as 7.88 Gbps thanks to the reduced overhead allowed by the 128b/130b encoding. This configuration leads to a throughput of 31.5 Gbps on a PCIe x4 link.

The best way to get FPGA modules and CPU modules to communicate appears to be the proven PCIe protocol in its latest iteration. Figure 1 shows an example of a signal processing platform with communication between 6U OpenVPX FPGA modules and Intel dual-/quad-core dual processor cards.

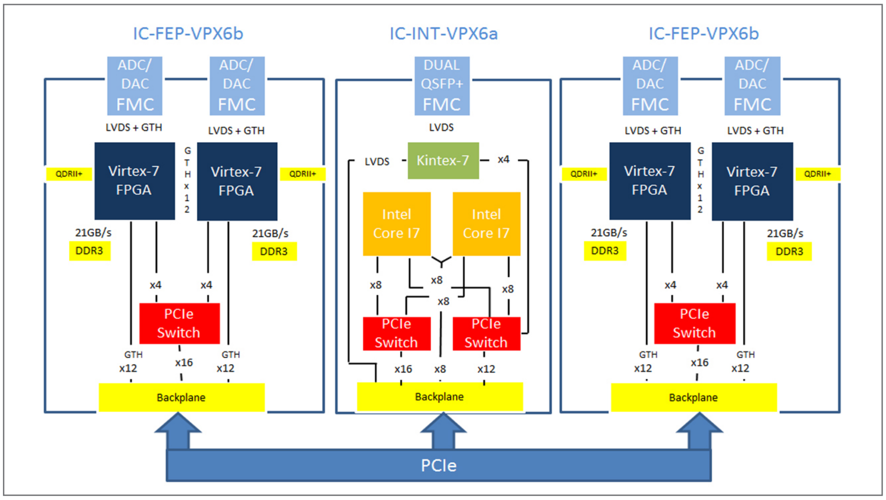


Figure 1 | Pictured is a signal processing platform architecture.

So how should seamless, high-speed communication between the FPGA modules and the CPU modules be organized? A good approach is a communication middleware package such as Multiware. A full set of software components provides a high-level abstraction in order to provide the designer with services such as Virtual Ethernet over PCIe, shared memory, message synchronization with DMA powered transfers, and transfer between FPGA modules and CPU modules or between different CPU modules.

This Multiware runs on the different Linux CPU modules and provides multiple kernel and user space services adapted to all user designs as shown in Figure 2:

- Virtual Ethernet to use Multiware as a network device
- I/O device to use Multiware as a character device
- Sysfs Linux virtual file-system to use Multiware through Sysfs directory entries and to create and access a shared memory or a pool frame
- Kernel functions to use Multiware from kernel modules

These services are based on a core layer with a set of sub-modules:

- Aperture manager, a Multiware component that allocates the system memory and configures Non-Transparent Bridging (NTB) to make the local aperture accessible from other remote PCIe domains
- IDC, a Multiware component that allows communication with the different RC domains
- Transfer layer in charge of executing the data copy with several kinds of copy engine

In addition to running this sophisticated communication middleware, the Intel CPU modules can manage classical functions such as storage through Serial ATA links or graphic displays through HDMI links.

All of these advantages are combined on OpenVPX-based devices that leverage

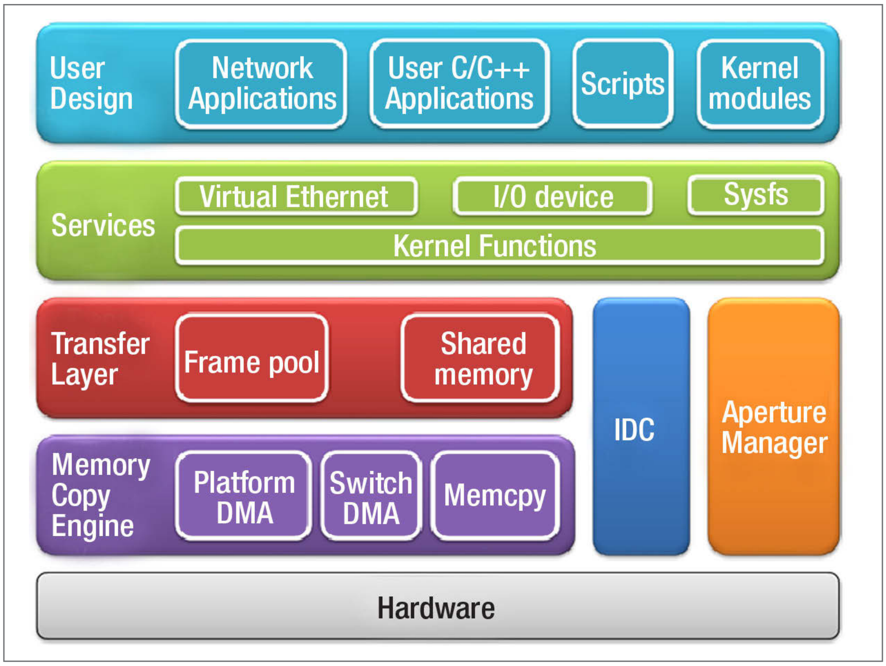


Figure 2 | Multiware architecture.

FPGAs. OpenVPX products, such as the IC-INT-VPX6a dual Intel core i7 CPU module from Interface Concept, are used in EW, radar, and other military signal processing applications. The Interface Concept device includes two independent PCIe switches and one Kintex-7 to connect 32 PCIe lanes on the backplane. This board can be combined with a dual FPGA card, like the company's IC-FEP-VPX6b, which has two XC7VX690T Virtex-7 FPGAs. **MES**

Thierry Wastiaux *is Senior Vice President of Sales at Interface Concept, a European manufacturer of electronic embedded systems for defense, aero, telecom, and industrial markets. He has 25 years of experience in the embedded systems and telecom market, having held positions in operations, business development, and executive management. Prior to Interface Concept, he was responsible for the operations of the Mobile Communication Group and the Wireless Transmission Business Unit at Alcatel-Lucent. He holds an M.Sc. from France's Ecole Polytechnique. Readers may contact him at twastiaux@interfaceconcept.com.*

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[1] National Science Foundation – Allen George, Herman Lam, and Greg Stitt – IEEE Magazine Computing in Science and Engineering – Jan/Feb 2011.

A U.S. Air Force MQ-1 Predator Unmanned Aerial Vehicle (UAV) assigned to the California Air National Guard's 163rd Reconnaissance Wing flies near the Southern California Logistics Airport in Victorville, CA. (U.S. Air Force photo by Tech. Sgt. Effrain Lopez.)

UAV ISR payloads demand lighter weight, faster processing

By Amanda Harvey, Assistant Editor

Several technology trends are driving advances in Intelligence, Surveillance, and Reconnaissance (ISR) payloads on Unmanned Aerial Vehicles (UAVs) – higher compute capacity, the growing use of VPX, and locating the processor closer to the sensor.

As Unmanned Aerial Vehicles (UAVs) assume a greater role in the Department of Defense's (DoD's) plans for the future, program managers are placing more emphasis on improving the payload technology they use to conduct Intelligence, Surveillance, and Reconnaissance (ISR) missions. To solve this challenge, industry is paying greater attention to the processor complex powering these systems, which must evolve in compute density and performance to execute the complex processing tasks required by the next generation of UAVs.

"There's a lot of interest in the ability to geo-locate and geo-register targets; elevated target recognitions; multi-modality fusion to increase the decision capacity so when you look at things like Synthetic Aperture Radar (SAR) systems combined with Electro-optical/Infrared (EO/IR) you get some benefit from fusing that capability to increase your decision capacity," says David French, Director of Business Development, Military and Aerospace at GE Intelligent Platforms in San Diego, CA (defense.ge-ip.com). "All of that can be relatively compute-intensive, so that's probably what is driving a lot of the payload designs today – evermore compute capacity."

"There are several technologies that make processing more attractive in the UAV," says Dennis Smith, Vice President of Engineering at Themis Computer in Fremont, CA (www.themis.com). "Primarily high core count, low-power CPUs, along with adjunct FPGAs or GPGPUs, allows for this to be realized close to the point of use. In the past, SIGINT has been a ground-based task because of the sheer volume, weight, and power needed to incorporate computing in the aircraft. The latest CPUs, with their high transistor count, have been able to deliver more processing cores, larger memory, and a host of general purpose I/O all in a single package."

FPGAs are not the only solution to this problem, as GPGPU technology continues to improve and is much more cost-effective than FPGAs. "Using an FPGA approach provides the highest performance and lowest latency," Smith continues. "However, there is a penalty in cost, flexibility, and power compared to a general purpose, software-driven approach. Some of the lost speed can be augmented through the use of large core count GPGPUs. If the application can tolerate increased latency and code complexity, using a GPGPU can provide a lot of value over a pure FPGA approach."

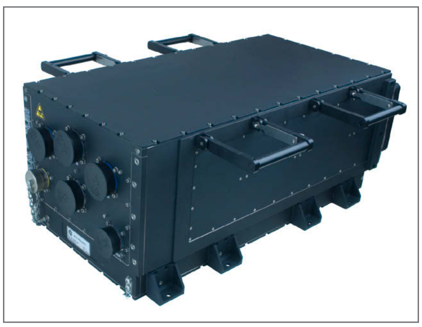


Figure 1 | The CRS 48.5 High Performance Embedded Computing (HPEC) rugged subsystem from GE Intelligent Platforms is used on unmanned platforms for airborne ISR fusion processing and exploitation.

"If you look at technology trends I think probably the most impactful has been the introduction of GPGPU processing," agrees French. "It really does offer a significant increase in the performance of ISR-type processing – if it's radar, EO/IR, or other payloads – and the fusing of that data in some cases. It's probably going to continue with higher core counts and more density, as we've seen GPUs' core count basically double every couple of years."

VPX architectures

Advances in processor technology have enabled performance gains in ISR payloads, but capability improvements and complexity also require a standardized system-level architecture to reduce cost and complexity, Smith says. Through the use of Open Architectures (OAs) such as VPX, application engineers and integrators are afforded an adaptable system that also allows compute resources to move closer to the sensors themselves, he continues.

"Delivering all of this capability at low cost requires a standards-based packaging and interconnect approach such as has been defined in the VITA 74 standard," says Smith."By dividing the processing task into multiple pluggable modules, the SIGINT problem can be easily segmented and optimized for a given application. Each of the module slots can be used to do pre-processing on the data stream before getting to the main processor for storage. The result is application flexibility," he continues.

"That's why a lot of ISR systems are going to 6U VPX, because you have to pre-process those signals," says Ray Alderman, Chairman of the Board for VITA, headquartered in Scottsdale, AZ (www.vita.com).

ISR payload design challenges

While advances in compute technology are enhancing ISR technology onboard UAV platforms, the unmanned vehicles face challenges in terms of Size, Weight, and Power (SWaP). Because of this, high-performance processing elements require hardware platforms that can support the additional size and heat that they generate, Alderman says.

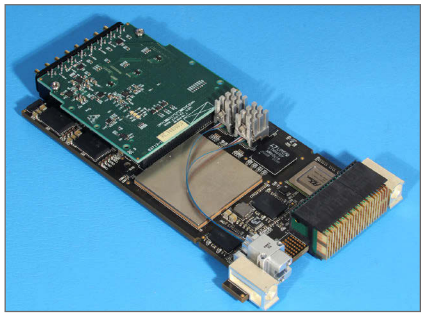


Figure 2 | The Pentek Model 5973 3U VPX Virtex-7 FMC carrier has an optical backplane interface for high-speed ISR applications.

"3U boards are [still] used a lot in UAVs, primarily for mission computers," he continues. "It just doesn't have the space to do the big GPGPUs and the memory arrays and all the I/O and high-speed interfaces. You can do some lower-end stuff on SIGINT and reconnaissance, and those guys are getting really good at packing their computing power on a 3U board. The more stuff you pack on a 3U board, your heat density goes up. There's this nasty relationship between computing power and power consumption and heat density."

Alderman says incorporating GPGPUs with their increased memory and horsepower is a must on larger UAVs that are switching to 6U VPX. "When you have a lot of processing and pre-processing to do, you have to go to 6U," he adds.

"Because the latest high-performance signal processing devices, like FPGAs and GPUs, can consume significant power, two big challenges are managing cooling and developing adaptive techniques for power reduction," says Rodger Hosking, Vice President of Pentek, Inc. in Upper Saddle River, NJ (www.pentek.com).

"Thermal efficiency is actually becoming one of the more critical items just because of the limited capacity to cool and the level of computational parts they require at the same time,"

says GE's French. "A lot of people don't think about the packaging and the cooling of it, but that's actually becoming a limiting factor in some cases – when we're delivering platforms that have this compute capacity, and the system being weight-sensitive. Just a few extra pounds saved can mean several minutes longer for an ISR platform to stay on station, for instance, or extend the range of a platform, which is very important. Because these are UAVs, they're very sensitive to weight. SWaP is a constant refrain; it's never going to stop."

> "While advances in compute technology are enhancing ISR technology onboard UAV platforms, the unmanned vehicles face challenges in terms of Size, Weight, and Power (SWaP). Because of this, high-performance processing elements require hardware platforms that can support the additional size and heat that they generate."

Future ISR payload tech on UAVs
For the foreseeable future, most ISR payload upgrades will occur in UAVs already in existence. However, even with budget cuts industry insiders still see growth in smaller UAV platforms.

"Most of the growth will be in the small to medium size platforms, primarily because of cost, but also due to the resources required to operate and support the UAV platform. Small and medium size UAVs can find their way into a larger array of applications than the large platforms," Smith says. Hosking also foresees increased autonomous capabilities for surveillance missions on the smaller UAVs, which therefore reduces direct human control and leads to cost reductions.

Due to the continued Department of Defense (DoD) budget cuts, French thinks most of the innovation will occur on platforms that are already in existence, with continued improvement to ISR payloads. Although there is interest in reducing weight of payloads for smaller UAVs, larger UAVs (Group 4 and 5) will most likely drive innovation in ISR payloads, French continues.

"Whenever something is proven on a larger payload, there's an immediate interest in reducing its size and capabilities. Affordability is going to be a limiting factor, and I think that's going to drive things like open architecture and commonality across platforms," French adds. **MES**

Sense and avoid technology on UAVs

As Unmanned Aerial Vehicle (UAV) use expands beyond defense applications into civilian airspace, sense and avoid technology will be as critical to platform performance as Intelligence, Surveillance, and Reconnaissance (ISR) payloads are to military persistent surveillance missions. Federal Aviation Administration (FAA) officials are working to integrate UAVs into national airspace, but they will never share the friendly skies with civilian aircraft without the capability to detect and avoid crashing into those passenger jets.

"The sensor suite, that needs to be able to see and avoid both cooperative and non-cooperative targets, is more complex than the ISR payloads themselves in many cases, and there's a lot of interest in keeping those segregated," says David French, Director of Business Development, Military and Aerospace, GE Intelligent Platforms (defense.ge-ip.com). "Just to fly around autonomously, [the aircraft] must have a relatively sophisticated payload similar to an ISR payload, so that might include radar and Electro-optical/Infrared (EO/IR). There is as much computational requirements on that side than there is on the ISR payload side."

As opposed to ISR payloads, sense and avoid technologies are required to be certified via DO-178 and DO-254 to support national airspace integration. The main reason for sense and avoid technology implemented in unmanned vehicles is for the safety of other aircraft in the national airspace. "Hence, the pilots are saying you can't have UAVs flying around blind and expect me to keep an eye out for them," says George Romanski, President and CEO of Verocel, Inc. (www.verocel.com) "They also have to keep an eye out for me."

Development of sense and avoid technology and other unmanned technology may get a boost from the private sector, as major commercial players have recently taken an interest in the business opportunities that UAVs present, French says.

"The commercial market is pretty interesting – Amazon talked about the drone delivery services; Facebook is looking into buying Titan Aerospace* (they make a high-altitude unmanned aircraft) and the purpose of that is going to be communication relay or routing over areas not covered by other means like cell towers and landlines," French says. "I think it's going to be very interesting to see what happens in the commercial market, particularly now that the FAA has announced their six test sites for further integration of UAVs into the national airspace. Commercial platforms are not necessarily ISR-centric, but I think you're going to see some interesting innovation in that market, and probably with commercial money behind it as well."

**Editor's Note: Google acquired Titan Aerospace on April 14, 2014.*

Unmanned Product Spotlights

Next-generation UAVs require high-performance end-to-end connectivity

By Gregory Powers

As the sophistication and capabilities of Unmanned Aerial Vehicles (UAVs) continue to evolve, engineers need to pay greater attention to end-to-end connectivity to avoid performance bottlenecks.

The MQ-9 Reaper – a UAV produced by General Atomics Aeronautical Systems, Inc., and used by the U.S. military for long-duration reconnaissance – sits on the flightline. Photo courtesy of TE Connectivity.

Many UAVs are long-endurance platforms capable of sustained flight measured in days, remaining aloft for long periods to perform surveillance and strike missions. In their surveillance role, UAVs may carry multiple cameras and sensors to deal with a variety of frequencies, from visible light to infrared and thermal. In addition to the spectral challenges in these environments, another important factor must be the creation of cameras that overcome low resolution and narrow fields of view.

The ARGUS imaging system, for example, can spot a six-inch object within a 10-square-mile radius from 20,000 feet in the air. The ARGUS system uses 368 cameras and can capture, process, and download one million terabytes of data per day. Because this system combines images from multiple cameras and performs other signal processing tasks, it requires fast embedded computers and sophisticated software. Because of the enormous amount of data generated by the sensors, an additional system challenge is separating the wheat from the chaff, so to speak, via onboard processing so that only critical data is transmitted to satellites or ground stations. Even if the ARGUS system can process one million terabytes a day, the larger Intelligence, Surveillance, and Reconnaissance (ISR) infrastructure can't handle such loads, even with hefty data compression.

More bandwidth inside, between boxes

All of this means the need for more bandwidth, not only inside the box, but also in box-to-box interconnections. One goal in system design is to create a transparent infrastructure, giving integrators the ability to achieve a location-independent architecture. Location independence enables subsystems to be placed at optimal locations throughout the UAV.

Open architectures remain an important factor, given their advantages of easier reconfiguration, ability to be upgraded, and the larger base of suppliers. Similarly,

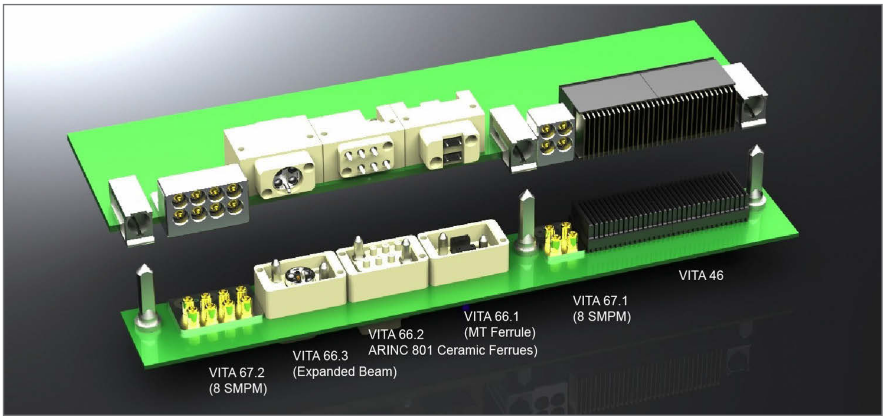
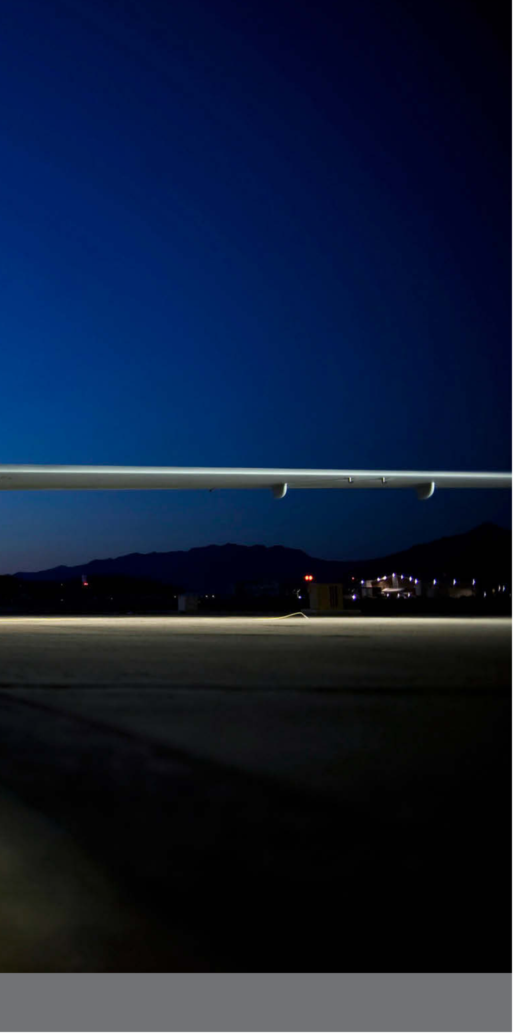


Figure 1 | The VPX system has evolved into a rich and varied ecosystem.



both in the overall network and in local data buses, industry-standard high-speed protocols – such as Ethernet, FireWire, or Fibre Channel – provide transparent physical layers for data transport.

VPX is the prevalent standard for embedded high-performance computing, with a data rate that can exceed 6.25 Gbps. The VPX ecosystem is rich, evolving to provide designers with an array of choices for single-ended and differential signals, mezzanine, power, optical, and RF connectivity. As VPX has evolved, new standards have been created to meet the widest range of interconnection needs. Figure 1 shows a notional configuration of signal, RF, and optical possibilities on a single card edge.

VPX connectors are robust and well suited for UAV applications, with the ecosystem continuing to evolve. As an example, the recently released MULTIGIG RT 2-R (VITA 46-compatible) connector from TE Connectivity exceeds the original VPX environment of VITA 47, meeting the far more rigorous environmental requirements of the VITA 72 study group. With designer expectations for mechanical ruggedness largely met, system architects are now focusing more than ever on signal integrity. As mainstream protocols continue to move to higher data rates, VPX equipment is being characterized in parallel, paving the way for even greater functionality.

Even with the success of VPX, some designers need to operate outside of standards due to a variety of packaging or application needs. Designers who want to move beyond the standards have a variety of capable interconnect solutions available to them.

Input/output and SWaP

To avoid performance bottlenecks, I/O connections need to keep pace with processors so that data is moved around quickly and efficiently. What's more, the number of interconnections is also increasing. Designers today have more choice in small circular connectors (see Figure 2) that combine space and weight savings with the high-speed performance needed to meet growing data processing needs.

Figure 2 | Small circular connectors support the high speeds needed for end-to-end connectivity.

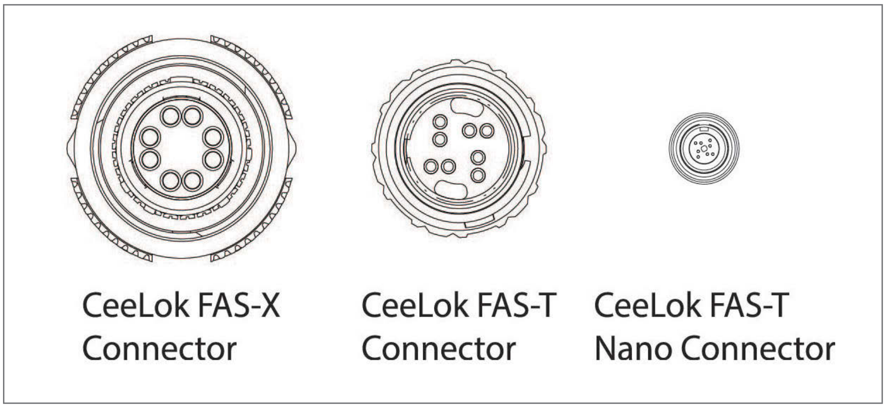


Figure 3 | The 10 Gbps CeeLok connector families from TE Connectivity come in multiple size and performance configurations.

As I/O speeds increase, issues of signal integrity and power budgeting create new challenges. Simply put, high-speed signals are harder to manage than low-speed signals. The higher the interconnection speed, the more difficult it is to manage return loss, insertion loss, crosstalk, and similar factors that can degrade signals. While an ideal cabling system would have no intermediate connections between boxes, the real-world need for production breaks and modularity necessitates connectors in the path.

A poorly designed connector will appear as a significant impedance discontinuity. The impact of the discontinuity is frequency-dependent (return loss and crosstalk increase with frequency), meaning that high-speed I/O connectors must be more carefully designed. Attenuation in the cable and insertion loss in the connector are also frequency-dependent, making power budgets more challenging at high speeds.

Size, Weight, and Power (SWaP) issues remain pivotal to providing persistent surveillance, a better fuel-to-weight ratio, and the potential for smaller UAVs. While smaller, lighter connectors help meet SWaP goals, miniaturization cannot come at the expense of signal integrity or robust ruggedness. Even though nanominiature and microminiature connectors already exist, these were not designed for high-speed signals.

To address this gap in fast copper connectivity, TE Connectivity introduced three families of their CeeLok product line. CeeLok FAS-X connectors maintain shield continuity through the connector and thus can be concatenated multiple times without degrading performance. The connector is somewhat larger than the other two discussed here, but maintains signal integrity, while still offering field reparability. The connectors support a single 10 GbE channel in a size 11 shell or four channels in a size 25 shell. The devices are smaller, with an eight-position connector in a size 8 shell. The connector's T-shaped contact pattern provides noise cancellation and decoupling to minimize crosstalk and increase signal integrity. The backshell is integrated into the plug body to help provide low profile, low cost, low weight strain relief, and EMI protection. The connector is field terminable and repairable.

CeeLok FAS-T Nano connectors use the same T-shaped contact pattern in a nanominiature size; plugs are only 0.3 inch in diameter, with a choice of push-on or threaded coupling. Unlike the larger devices, the nano version is factory wired rather than field terminable. The connectors are based on the NANONICS nanominiature connectors, but with an insert designed for high speeds.

Even as high data rate copper-based connectivity is evolving, fiber-optic transmission is finding increased use. Creating location-independent architectures means that different subsystems must not be constrained by cabling distances. Optical fibers have three primary advantages:

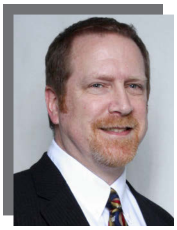
- **Long transmission distances:** Multimode fiber can easily carry today's data rates in UAVs. With single-mode fibers, bandwidth is virtually unlimited with respect to the distances encountered in a UAV. Bandwidth therefore disappears as an interconnection issue.
- **Noise immunity:** Optical fibers do not create EMI; nor are they susceptible to EMI. Issues like shielding, critical to maintaining signal integrity in copper interconnects, are eliminated.
- **Small size and light weight:** Fiber-optic cables are smaller and lighter than copper cables, making significant contributions to the minimization of SWaP.

Fiber optics has also made strides in easier use, ruggedness, and choice. The VITA 66 standard, for example, offers a choice of ceramic ferrules for the highest level of optical performance, noncontacting expanded beam termini for increased ruggedness, and MT ferrules for high fiber counts. The same options are available for a variety of military-style circular and rectangular connectors.

Bandwidth evolving into the future

UAV systems will most certainly need more bandwidth to deal with more sophisticated sensors, ever-faster and more capable silicon, and more sophisticated computer architectures and software. Network backbones are already migrating from 1 Gbps Ethernet to 10 Gbps, with 40 and 100 Gbps waiting in the wings. Efforts to streamline designs to create a common hardware set are also gaining ground. For example, designing interconnects to be compatible with a range of physical layer impedances – such as Fibre Channel, IEEE 1394, eSATA, and the like – will not only simplify system design but also reduce the number and types of cables and connectors that must be stocked. Increased compatibility will enhance the idea of modularity and easy plug-and-play connectivity.

While designers, in the end, will look for standardized high-performance systems and components, they still have choices when it comes to performance-based alternatives. Today's performance-based system may well become tomorrow's new standard. **MES**



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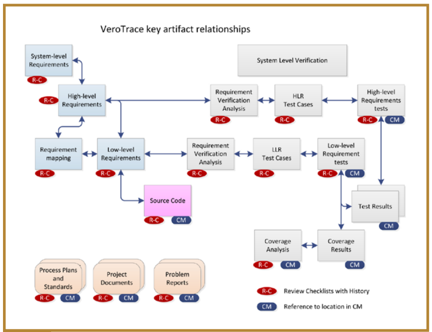


Verifying safety critical software systems

Verocel experts developed a commercial version of their VeroTrace tool, which is an advanced lifecycle management environment that develops, verifies, and certifies multiple software systems. The new commercial version has an enhanced architecture, an Eclipse IDE, and other capabilities so that software developers can now automate the many tasks and processes required for their own large-scale, advanced software development and verification efforts.

It provides traceability, review, and workflow tracking. It has been used to provide safety and security projects and certification evidence to meet the DO-178B/C avionics software standards, EN 50128 for rail certification, and IEC 61508 for the industrial sector.

The tool monitors development and certification lifecycle artifacts and their relationships and authorization statuses, whether they are held in the VeroTrace repository or external Configuration Management (CM) systems. VeroTrace can be installed as a distributed environment so users can access and share data across multiple sites. It also provides built-in integrated documentation management and problem tracking capabilities. VeroTrace does more than generate reports showing how interlinked dependents of a changed item are affected by a change – it guides a reviewer to examine the single artifact that has changed and only those other artifacts that are directly dependent on it, potentially saving large amounts of time in the process.

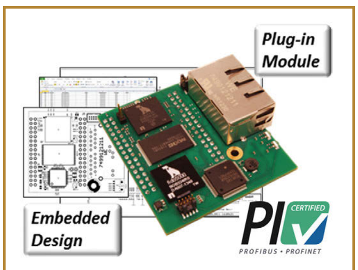
Verocel, Inc. | www.verocel.com | www.mil-embedded.com/p9917282

Armament test set has new simulation and test capabilities

Marvin Test Solutions made new enhancements to its MTS-3060 SmartCan, a universal O-level aircraft armament test set designed for legacy aircraft such as the F-16 that use smart (MIL-STD-1553 and -1760) weapons. Maintainers using the enhanced system can now test the complete functionality of the AIM-120 interface by emulating missiles. Currently, Armament Circuits Preload Test Sets (ACPTS) require additional, big-box test equipment to fully and accurately verify that sophisticated armament and munitions systems are fully mission-capable, and in some cases, this combination cannot even meet testing requirements. Therefore, maintainers need new testing capabilities to support today's smart weapons, including interfaces such as AIM-120.

SmartCan can standardize and consolidate armament test equipment across 4th and 5th generation aircraft, including F-5, Hawk, TA/ FA-50, A-10, F-15, F-16, and F-18. It can fully emulate smart weapons such as JDAM during pre-load armament test. The system can also evaluate the functionality of the MIL-STD-1760 bus interface between the armament and aircraft. The hand-held, AA battery-operated flightline test set weighs under three pounds and can conduct full pre- and post-load operations as well as possessing pre- and post-flight audio and video channels for troubleshooting legacy systems such as AIM-9 and AGM-65.

Marvin Test Solutions, Inc. | www.marvintest.com | www.mil-embedded.com/p9917283



New interface supports PROFINET v2.3 IRT

Innovasic engineers released a new version of the company's RapID Platform Network Interface for PROFINET IRT and RT connectivity. The new interface supports PROFINET v2.3 and provides cycle times down to 250 µs. Cycle times down to 31.25 µs are supported on the same hardware platform as soon as PROFIBUS & PROFINET International releases the high performance profile. This version of the RapID Platform also has the company's PriorityChannel technology, which eliminates the detrimental effects of network traffic and loading.

The device comes as a module or embedded design with everything necessary to participate in a PROFINET IRT and RT network. The host processor connects with the Network Interface via a UART or 16-bit Parallel Interface. At the software layer, the host then connects to Innovasic's Unified Interface API so that other protocols may be used without changing host processor software. Since the Unified Interface is exactly the same across all versions of the RapID Platform, users that develop a PROFINET IRT or RT product may convert to any other supported Industrial Ethernet protocol. A web server included with the RapID platform enables users to change field device parameters through the use of a standard web browser.

Innovasic, Inc. | www.innovasic.com | www.mil-embedded.com/p9917285

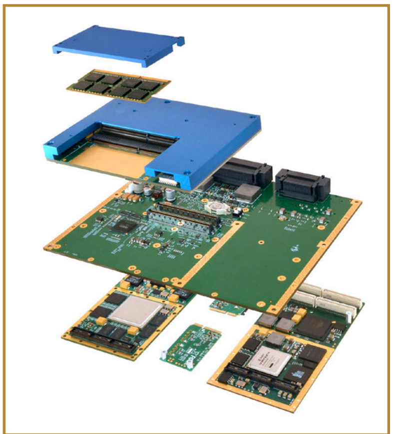
Rugged small computer

Designers at Small PC Computers developed a new iBrick rugged computer model called SC215ML that is an all-weather Intel i-series computer. The device's compact package is only 8" x 5" x 3" and weighs less than three pounds. It has a solid aluminum chassis married with a passive cooling system for high shock and vibration environments and extreme temperatures. The iBrick is targeted at military, oil and gas, public safety, transportation, utility, and industrial automation applications. Its heat pipe assembly, combined with a set of waterproof connectors and cables, seals it from dirt, dust, and water.

Standard configurations include a 4th generation Intel Mobile Core i3 processor and HD 4400 graphics engine. Basic I/O includes a RJ45 Ethernet port, an HDMI video port, and three USB ports. Extra Ethernet and USB ports are optional. The 4th generation Intel CPU has support for standard mobile SATA hard drives as well as upgrades to USB 3.0 ports. Configuration options include memory as much as 16 GB, solid-state flash drives with as much as 512G, RS232/RS422 serial ports, Wireless LAN, and Bluetooth. The unit also supports dual video options with a second HDMI or Thunderbolt port. An optional intelligent vehicle power supply is available.

Small PC Computers l www.smallpc.com l www.mil-embedded.com/p9916002

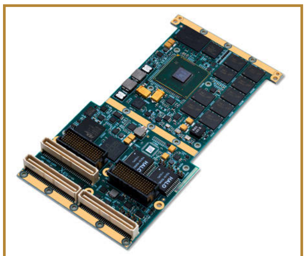
Rugged COM Express Type 6 carrier cards



Small form factor computing applications are the target for Acromag's new ACEX-4600 COM Express Type 6 carrier cards. The devices meet wide temperature operation and shock/vibration immunity and come in three models that can host a basic size COM Express module and have an option for one or two PMC/XMC modules for I/O or FPGA processing tasks. All models have two mini-PCIe slots. The ACEX-4605 model interfaces a basic Type 6 COM Express module and two mini-PCIe slots in a 125x165 mm footprint. The device's engineering design kit has a break-out board that routes all the I/O signals from the carrier's high-density connector to standard peripheral connectors. The ACEX-4610 is the same size but adds a PMC/XMC slot. Adding a second PMC/XMC slot, the ACEX-4620 is slightly larger with 200x165 mm Mini-ITX dimensions.

For ruggedization, thicker circuit boards resist flex while industrial-grade components enable operation from -40 °C to +85 °C. Front panels with military connectors and a power filter plug into the carrier card. Two gigabit LAN ports, a PCIe port, four USB ports, and two RS232/485 ports provide flexible network and serial communication options. The carriers also support as many as three DVI-I video ports and an audio in/out interface. A fused, onboard DC/DC converter accepts 10-32V DC input power.

Acromag l www.acromag.com l www.mil-embedded.com/p9917289



Low-power system-on-chip modules

Low-power, System-on-Chip (SoC) solutions are enabled by two new QorIQ-based modules from Extreme Engineering Solutions, Inc. (X-ES). The XPedite5970 and the XPedite6101 feature the Freescale QorIQ T2080 and T1042 devices. The XPedite5970 is a 3U OpenVPX REDI module running the T2080 processor, and XPedite6101 is a conduction-cooled XMC or PrPMC module using the T2081, T1042, or T1022 processor. The T2080 and T2081 processors offer eight virtual (four dual-threaded) e6500 cores and support an operating frequency of as much as 1.8 GHz. The T2081 processor provides the same performance as the T2080 in a smaller package and is pin-compatible with the T1042 and T1022 processors. The T1042 processor provides a lower-power alternative with four e5500 cores running as fast as 1.4 GHz. The T1022 provides the lowest-power option of the processors with two e5500 cores running as fast as 1.4 GHz.

The OpenVPX REDI XPedite5970 supports as much as 8 GB of DDR3 SDRAM and has multiple I/O options to the backplane, including 10 Gigabit Ethernet, Gen2 SRIO, and Gen3 PCIe. The XPedite6101 works with multiple processor configurations and as much as 8 GB of DDR3 ECC SDRAM. It supports multiple I/O options with a Gen2 PCI Express interface to P15, and dual Gigabit Ethernet, USB 2.0, and SATA 3.0 Gbps interfaces to P16.

Extreme Engineering Solutions, Inc. (X-ES) l www.xes-inc.com l www.mil-embedded.com/p9916942

Building Interoperability into Unmanned Aerial Systems

Global aerospace and defense avionics companies are continually challenged to deliver safe, secure, and reliable systems to satisfy complex mission critical requirements. The demand for increased situational awareness drives a greater array of intelligence, surveillance, and reconnaissance (ISR) platforms, which demands rapid insertion of new ISR payloads into unmanned surveillance vehicle mission systems. In order to provide these new capabilities, sensor payloads need to be based on open platforms that can consolidate intelligence from a multi-vendor array of sensors and systems. These consolidated systems require a higher level of connectivity, which, in turn, is forcing requirements for increased information security capabilities. Several technologies and standards are vital to addressing the changing needs and requirements of unmanned aerial systems (UAS).

Multi-core and Consolidation with IMA

There are clear advantages to moving from a federated systems architecture to an Integrated Modular Avionics (IMA) architecture. Commercial avionics designs have proven that avionics consolidation with ARINC 653 saves size, weight, power, and cost (SWaP-C), and enables rapid integration of software assets from multiple vendors on a single hardware compute platform. ARINC 653, and now FACE™, enables the reuse of legacy software assets with minimal change, and the ability to rapidly add in new capabilities as missions change.

Multi-core hardware naturally enables more functionality in ISR systems on UAS to be consolidated, with redundancy built in, and will provide the ability to future-proof the hardware so that additional capability can be added just by changing the software. Multi-core platforms make consolidation easier, but make safety and security more difficult; this challenge will be solved within the next two years by multiple vendors, and unmanned missions into controlled airspace will drive the investment to make this happen.

Autonomous Decision-Making

The intelligence of UAS will increase, enabling more autonomous decision-making based on their own data as well as data from other nearby vehicles and cloud assets. This decision-making will require increased on-board processing capability, which will further drive the move to multi-core hardware. This autonomy will also make unmanned missions more reliable – failures in providing mission data can be corrected by autonomously recruiting other assets to complete the decision structure and provide the operator with a reliable data stream and intelligence.

Consolidation of Standards

In order to make future platforms more capable, they must be based on open architectures and open standards, which drive both improved system interoperability and portability. Both the FACE Technical Standard and the UAS Control Segment (UCS) standard are creating open platforms for rapidly deploying new payload capabilities into both legacy and next-generation unmanned systems. Both FACE and UCS are built on existing standards like ARINC 653, ARINC 661, POSIX, STANAG 4586, and others that enable a wide range of applications to run on consolidated systems. This enables both commercial and military suppliers to create systems with components from different vendors, which drives down costs and helps ensure faster innovation and delivery of new capabilities.

Information Assurance

As ISR payloads become connected to intelligent systems of systems, they will need to prove that their end-to-end security remains intact over the life of the system. Using global standards such as Common Criteria, information assurance will provide security not only for the onboard sensor information, but also for transmission through public and private networks to the end users. Security must be present in all aspects of the system, from the UAS platform to the network controlling the UAS to the feed of intelligence to decision systems. For unmanned systems security must be built in, starting from the design architecture and including secure boot, secure operation, and secure power down. Foundation software, such as the system boot environment and the operating system, must be able to enable and support a foundation of security.

Intelligent Networks

With the tremendous amount of data generated by unmanned assets and the need to share this information in real-time and with multiple allies, intelligent multi-level secure (MLS) networks are needed. These networks must not only be smarter and faster, but also be built on open standards, be highly configurable, and have built-in flow analysis, security, and optimization for multi-core processors.

Summary

The payload of the future must be based on open, consolidated platforms that can easily accommodate multiple levels of safety and security. These platforms must be able to rapidly integrate applications from a wide range of systems, from ARINC 653 to FACE to Linux/POSIX. Systems that cannot enable this rapid multi-vendor integration will not be competitive in the next generation of advanced ISR systems in unmanned and autonomous vehicles.

Chip Downing *is the Senior Director for Aerospace and Defense at Wind River. He can be contacted at chip.downing@windriver.com.*

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E-CAST

Managing unmanned system software designs & requirements

Presented by IBM

The unmanned systems market is one the fastest growing segments of the military industry, and promises to have an even greater impact in the commercial world as the FAA begins to open its skies to drones. Embedded software designers of unmanned systems are faced with increasing pressure to deliver their more complex products faster than ever before, while managing new requirements and regulations along the supply chain. This webcast with industry experts details engineering solutions for unmanned systems software development through case studies with MBDA Missile Systems and the NASA JPL Mars Curiosity rover.

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OpenSystems Media works with industry leaders to develop and publish content that educates our readers.

Computer system design for critical applications

By Sealevel Systems, Inc.

"Industrial computer" is a widely used term that unfortunately can be quite ambiguous, often applied to computers that have little real advantage over commercial PCs but may outwardly appear "rugged." Before you select a vendor for your next industrial computer design, carefully consider the factors that affect system performance, reliability, and longevity. Paying special attention to heat management, component selection, testing, and other factors described in this white paper will greatly increase the success of your next project.

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BLOG

Reviewing DMSMS 2013: Collaboration brings new beginnings

By Kaye Porter, GDCA

Hurricane Isaac's interruption of Diminishing Manufacturing Sources and Material Shortages (DMSMS) 2012 and subsequent rescheduling instigated the pairing of DMSMS with the Defense Manufacturing Conference (DMC) for the 2013 event, located in Kissimmee, FL and hosted by the Navy. Bringing together these two complementary aspects of Department of Defense (DoD) operations created a unique opportunity for raising cross-disciplinary collaborations. Looking back, the pairing of DMSMS and DMC is a natural progression. The overlap of the two conferences provided a logical platform for discussion around balancing affordability and obsolescence risk amongst active defense programs: a threat currently facing every facet of the military's manufacturing and sustainment mission.

The proactive part

The general session's keynote speeches were well attended by both sides of the combined conference. They spurred dialogue between the DMC attendees that focused on introducing new manufacturing technology, and the DMSMS attendees responsible for supporting the implementations down the road. This convergence exposed the need for more understanding of how to realistically manage obsolescence issues in the face of manufacturing innovations.

Several presentations and conversations addressed how sustainment teams can be more proactive if they are integrated into the design phase. Bringing teams into the fold early on could enable more efficient management of the entire process, rather than having these teams wading through a wasteland of lifetime buys (LTBs) and end-of-life (EOL) solutions at the most volatile point in the supply chain. Managing the total life cycle with this type of approach offers more options to reduce cost and provide ongoing solutions for avoiding obsolescence and counterfeit risk.

Even with the silo environment of DoD programs, this could signal the possible beginning of a holistic approach to tackling military programs' sustainment issues. Maj. John Broadmeadow said that the development of future technologies depend on warfighters and manufacturing engineers collaborating in the initial development phase.

Additive manufacturing advances, also known as 3D printing, was also a hot topic as the technology has advanced enough to enable onsite manufacturing of parts a reality. This capability is projected to cut down manufacturing time and the need to ship critical parts to the warfighter, providing solutions for legacy mechanical parts that might not otherwise be supplied due to obsolescence issues.

Proactive obsolescence management still a challenge

The most recent update to the DMSMS SD-22, the playbook on defense program management of obsolescence, was introduced and discussed at the conference. Several sessions were dedicated to going through the updates and introducing newcomers to DMSMS. These conversations were of particular interest to us. The SD-22 represents the latest in obsolescence management; however, until there can be a larger move in the industry towards looking at program life cycles from a legacy sustainment perspective, the SD-22 still leaves programs unable to be truly proactive. Especially when tools for forecasting and the ability to accurately assess a program's life cycle remain largely tied to component availability rather than to need or affordability.

In the fight against counterfeits and the desire to secure ongoing component supplies, the need for resources to find EOLed parts took center stage. As the proliferation of counterfeits grows, industry resources seem to be mainly focused on tracking parts. Missing from the discussion was the reality that few tools are available to actually manage obsolescence from a proactive standpoint. The dominant approach still appears to be that the faster you can figure out what components are going EOL, the faster you can start a redesign and try to get it all together at once.

Standards and policies generated around counterfeit avoidance challenges require a long game strategy and need to have a legacy perspective to get solutions in place long before the supply chain becomes volatile due to obsolescence.

Military attendance

There was a noted and significant absence of military and government DMSMS and DMC attendees thanks to sequestration and defense budget cuts. Many long-time attendees noted the DMSMS side was down possibly as much as two thirds, resulting in industry members making up most of the audience – outside of key speakers. People were left wondering if a military presence at conferences is at risk of becoming obsolete – and if programs will suffer a disadvantage with organic teams missing access to critical information?

Conclusion

Because most of the attendees this year were from the private (industry) sector, perhaps there was less hesitancy to come together regarding the challenges in effective communication between siloed government agencies and their industry counterparts. With technological feats moving at lightning speed in today's global society, the comparatively slow adaption of government programs reduces the collaboration necessary between departments and branches to find truly proactive solutions. Frustration is at the forefront of some of the discussions and many attendees felt blocked in their efforts to marry newer technology and sustainment operations to create a holistic picture that supports the needs of the warfighters. While technology advances to the relentless march of Moore's Law, efforts to mitigate obsolescence have remained behind the curve. Industry and government instead need to be more proactive in this area.

Looking forward to DMSMS 2014, it is critical that the DoD engages more with industry on solutions to improve supply chain management. As a professional it is imperative to gather information to create a discussion space to identify the processes and standards that will make being proactive a reality – not just something we would like to accomplish someday.

CHARITY

Focus on Homes For Our Troops

Each month in this section the editorial staff of *Military Embedded Systems* will highlight 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 and to back that up, our parent company – OpenSystems Media – will make a donation to each charity we showcase on this page. This month we feature Homes For Our Troops, whose mission is "to build specially adapted homes for severely injured veterans across the nation to enable them to rebuild their lives."

It is a privately funded national non-profit, 501(c)(3) organization committed to helping combat veterans from all branches of the service who returned home with serious injuries since September 11, 2001. They help these warriors and their families by raising awareness, increasing community involvement, raising money, providing building materials and professional labor, and by coordinating the process to build a specially adapted home, according to the Homes For Our Troops website. These homes are provided at no cost to the veterans the charity serves, which removes the burden of a mortgage, so they can focus on their recovery, their family, and ultimately rebuilding their lives.

As of March 31, 2014, the organization has completed 164 homes for severely injured veterans, with 38 more home projects in progress, and all with only 9.2 percent of revenue spent on overhead since the inception of the charity. Most of the projects Homes For Our Troops takes on are the building of new homes. However, "in rare cases, especially in areas with very high land costs, it is more cost effective to buy an existing home and renovate it with all the special modifications needed as dictated by the particular disabilities and injuries of the veteran," according to the charity's website.

Homes For Our Troops estimates that with more than 50,000 injured service members to date, the need for their services will only increase in the future. For information on how to help, e-mail Homes For Our Troops at info@hfotusa.org, call 508-823-3300, visit their office at 6 Main Street, Taunton, MA, or check out their website at www.hfotusa.org. For fundraising information visit www.hfotusa.org/host-a-fundraiser.

E-CAST

Verifying the safety of avionics software for DO-178 certification

Presented by: MathWorks

Learn how to use Polyspace to meet DO-178 requirements, and achieve zero runtime errors in your most critical embedded software. Find out how engineers are using Polyspace static analysis tools to check for standards compliance, find difficult coding bugs, prove robustness, and meet DO-178 requirements. Using a unique formal-method approach called abstract interpretation, Polyspace verifies every possible execution of your code to find and prove runtime errors. Polyspace Code Prover proves that your software is safe from overflow, divide-by-zero, out-of-bounds array access, and other critical runtime errors. Along with Polyspace Bug Finder, you can check for MISRA compliance, identify programming errors, control flow, and data flow problems.

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WHITE PAPER

Mil/aero thermal management

By: GE Intelligent Platforms, Inc.

The latest generation of processors, GPUs, switch fabrics, and memory has placed more computing power into the hands of the designer. The improved performance has come with the challenge of higher power and higher power density for the designer to manage. The situation is exacerbated by the cramped, confined spaces in which increasing numbers of military/aerospace solutions are being deployed. These trends pose unique challenges for the COTS solutions provider. This white paper will discuss the thermal challenges, as well as explore the next generation thermal solutions available to maximize the performance for applications.

Read the white paper: http://mil-embedded.com/white-papers/white-milaero-thermal-management/

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