AEROSPACE & DEFENSE™ TECHNOLOGY

The Engineer's Guide to Design & Manufacturing Advances

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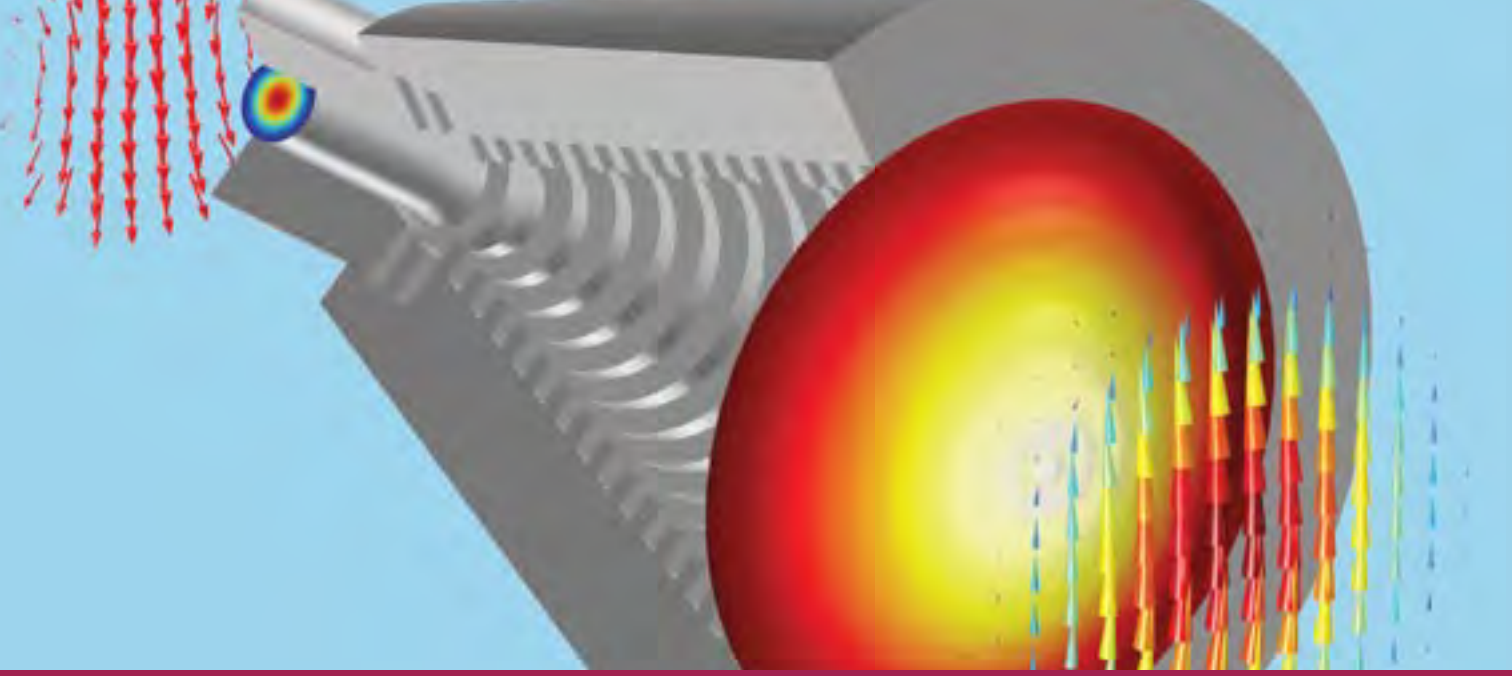

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Tech Briefs

Combustion Simulation Research

Emission levels, such as Nitrogen Oxide (NOx), are highly regulated by the International Civil Aviation Organization (ICAO). Emission reduction has been a key focus for the ICAO as they regularly tighten regulations. Combustion test and research facilities are now required to invest in furthering efforts toward emission reduction.

Facilities require flexible environments that can simulate the inside of an engine and accurately measure the emissions produced. A high degree of control is important in efforts to reduce the amount of Nitrogen Oxide (NOx) emissions based on the inlet air temperature of the combustor. This very sensitive ratio requires a high degree of accuracy to measure the composition of exhaust gases based on a set temperature and pressure equal to conditions produced during combustion. OSRAM flanged inline electric heaters will provide quick and accurate temperature control within 2° increments at high-temperature and pressure needed for today's combustion testing.

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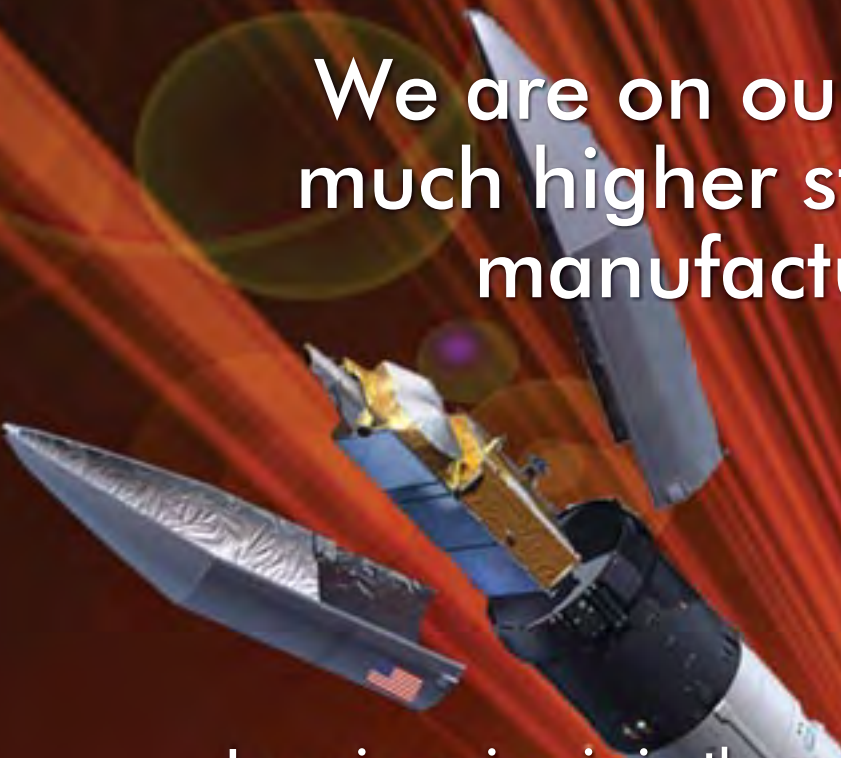

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The Royal Netherlands Air Force recently completed testing to receive certification to refuel F-35A fighter aircraft with their KDC-10 tanker. During the testing, the Dutch F-35A successfully connected in flight with a Dutch KDC-10 refueling aircraft and was refueled during the day, at dusk and at night above the skies of Edwards Air Force Base, California.

To learn more, read the applications brief on page 39.

(*U.S. Air Force photo by Christopher Okula*)

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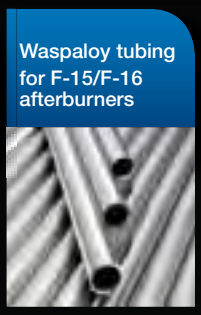
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Fuel, air and hydraulic lines

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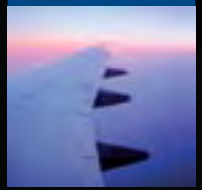
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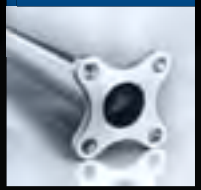
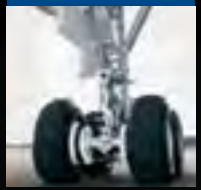

Flight surface actuation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Achieving Performance Advantages in Unmanned Systems

(U.S. Army photo by Staff Sgt. Tyffani L. Davis)

Unmanned Vehicle Systems (UVS) are reaching new levels of functionality and performance, and it's not just for air vehicles either. Ground and underwater UVS programs are all taking advantage of the higher-performance computing platforms that are using highly integrated, multicore processors; faster and larger DDR and flash memory; as well as integrated I/O. Additionally, remote I/O subsystems are being implemented to distribute the processing power closer to the sensors and use packetized message passing — with multiple levels of security (MLS) — back to a smaller central vehicle and mission management computer.

Traditional vehicle platforms had split the vehicle management computing functions (flight surfaces, engine and fuel controls, etc.) and mission management computers due to the overall expense of the computing hardware platforms and the costs to develop the software. Today, however, these hardware functions are being combined and then redistributed around the vehicle, significantly reducing size, weight, power, and cost (SWAP-C), due to the density and performance improvements in the underlying processing technology (Figure 1).

From Air to Sea: Expanded Applications

The available computing performance and SWAP-C optimized systems have caught the eye of DARPA and other research agencies, which are experimenting with using wireless in traditional "wire-only" defense and aerospace applications. Other areas of unmanned systems innovation include building upon existing vehicle platforms to extend the function of a single vehicle. For example, a fighter jet may have several UVS synced up to its inflight control center, extending its reach from one large aircraft to include several smaller units that act as a mini army, all working together and being controlled from one location. This effectively extends the amount of airspace one craft can cover (Figure 2).

Underwater is another vast area for military vehicles to monitor with a limited number of vehicles. Applying this same "mini-army" philosophy, one large carrier could manage several smaller submersed vehicles that can carry supplies to other sea craft or even stealthily gather intelligence and report the data back to the mothership.

Security Concerns

With the growing electronic density and enhanced communication profiles, UVS are offering a much more extended reach for military operations. But the data being transferred holds much larger security implications if it becomes compromised. So, in addition to mitigating size, weight, and power, many other critical design considerations are brought to the forefront. Data security and mission assurance, as well as signal integrity and reliability, are major focal points to implementing these new, more advanced unmanned systems.

Hacking, jamming/disrupting, or altering any wireless connection handling sensitive military information requires critical considerations, since compromised data can have a major impact on the outcome of the next engagement theater or battleground. So, where is the balance between security and performance, as more data is pumped into these systems and UVS growth continues?

Multicore Is Multi-Beneficial

Driving the higher densities of these computing systems are multicore processors. Their inherent ability to increase functionality and performance in

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Figure 1. Military intelligence requirements are growing in scope. Sophisticated UVS are providing a broader picture through enhanced processing abilities. (U.S. Army)

Figure 2. UVS help cover more areas for enhanced surveillance and security measures. (U.S. Army)

roughly the same real estate footprint makes them a natural progression in the evolution of integrated embedded computing. And in a UVS, space is at an especially high premium.

The advent of multicore processors from Intel and Freescale, combined with the use of multicore ARMs in nearly every smartphone, means multicore processors are here to stay. And integrating the memory crossbar switch and caches into the processor silicon eliminated the bottleneck of memory bandwidth limitations, removing it from the performance equation altogether.

Faster and larger memory has fueled more software developer creativity and more functional and capable systems. And underlying operating systems and improvements in portable software architectures have simultaneously advanced to finally start meeting the promises of true portability and application auto-level loading by supporting virtual memory, multi-user configurations, and multi-processing utilizing parallel execution of applications.

Applying this high-speed, multi-core technology from the enterprise to the PC has provided a wide and more diverse tool chain to enable a robust application development environment, which makes for faster, enhanced parallelism. The computing systems align better with one another, allowing for more complex computation to be effectively managed within the system. As data requirements continue to advance, throughput, as well as proper data handling, are critical tasks that must positively contribute to system reliability.

Of course, the application will always dictate the processing functionality to solve the initial design problem, and small form factors can carry with them lesser functionality in both performance and I/O. But the need for intensive, high-speed data, in real-time, in areas such as sensor fusion, melding and digital alignment of tactical area maps, camera vision, infrared, radar, or sonar, requires the shear processing horsepower to get the job done in the allotted time needed for the application.

Mitigating Design and Cost Challenges

Because they are growing in diversity and application, unmanned systems generally have a wide, varied mix of sometimes conflicting requirements. To best meet the needs of developers, system manufacturers need to take stock in what end users are looking for and apply these insights in R&D. Once collected, this critical information can be applied to next-gen products and systems designed to meet the majority of current needs and demands using more off-the-shelf products, which bring with them less costly customization.

Budgets are tight in just about every industry. In military and defense, system engineers need to maximize every dollar spent to position their systems with greater flexibility to expand capabilities with the latest technology at the highest TRL (Technology Readiness Level). This is what brings market leadership and value

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to their end-customers. And by tying together the hardware and software platforms, integrated mission systems' prognostics and automated diagnostics on unmanned systems open a whole new era of cost savings for the armed forces, potentially saving millions of dollars in maintenance and sustainment. Instead of forcing a system replacement into theater because a maintenance manual somewhere 5,000 miles away says "it's time for an engine or C4ISR pack change," vehicle and mission platforms can use their own intelligence to predict their own maintenance schedules.

Unmanned systems are no exception. In fact, they have even more demands placed on them. Removing the operator enables the vehicle to be far more condensed in size. But this means the electronics are expected to fit into tighter, more constrained areas, while providing even higher control and mission-critical functions.

Managing heat in these highly dense, highly integrated systems starts at the IC and works its way out to the external environment. The trick is to truly understand the subtle nuances presented by the vehicle platform to the embedded computer device. Designers need to be able to minimize the internal thermal impedances from the active devices out to the real world in the most cost-effective and least complicated ways (Figure 3).

Figure 3. Smaller footprints have equated to higher densities, compounding heat dissipation, which can be managed by smart system design.

System Security

By their nature, unmanned systems require wireless data to be transmitted from vehicle to control center, regardless of whether the system resides in the air, on the ground, or underwater. Because there is no physical operator onsite, the UVS needs to reliably communicate with the epicenter of the system. Military and defense environments handle extremely sensitive intelligence that, if intercepted, could compromise critical missions or provide classified information to improper recipients. And the DOD isn't the only entity concerned with protecting mission data.

System security is getting the same level of attention in the defense and aerospace markets as the commercial market, now that "nefarious other countries" are busy hacking into our government and contractor web sites and databases. RTOS providers (Wind River, GreenHills, Esterel, etc.) are providing multiple levels of security in their Ethernet stacks and processor core hypervisors to shut down any potential backdoor threats or malicious software embedded in JAVA scripts, etc. These heightened security profiles need to balance the transmission of the right information to the correct recipients from unmanned systems, without negatively impacting the specific application or intended mission results.

Looking to the Future

Increased usage of inter-processor communications, MLS, and data encryption will continue to rise quickly and efficiently, passing multiple gigabytes-per-second of data between local (onboard) nodes and nodes across board boundaries via high-speed copper, then optical pathways as the experience of implementing and using optical fiber gains momentum. And without stretching the imagination too far, cheaper multicore processors and larger volatile and non-volatile memory will be the norm for nearly all applications, with operating systems and apps taking advantage of the huge increases in capacity and parallelism. Prices of the processors and memory will drop quickly as demand increases almost exponentially across all markets — commercial/consumer, industrial, and defense.

Look at the figurative explosion of the self-stabilized toy drone market using the same internal semiconductor GPS receivers, accelerators, magnetometers, and MEMS (Micro-Electro-Mechanical Sensor) gyros as those used in today's smartphones. In just the past year alone, this trend has proven to be a viable predictor of the new smaller, lighter, and less expensive inertial navigation capabilities now available to the UAV/UAS defense contractor.

As silicon and other semiconductor processing platform technologies continue to grow, evolve, and advance, their usage will become more commonplace in everyday life as well. And as the software operating systems and development tools also progress, applications will only be limited by the programmers' imagination, not the hardware platform underneath. These technology advances will be incorporated into cars, trucks, trains, and eventually flight-critical functions within aircraft, manned spacecraft, and UVS.

This article was written by Doug Patterson, Vice President, Military & Aerospace Sector, Aitech Defense Systems, Inc. (Chatsworth, CA). For more information, visit ***http://info.hotims.com/61066-500****.*

COTS Embedded Systems and Link Budgets

The days of proprietary embedded computing systems in military systems are numbered. Proprietary systems, with the attendant vendor lock-in, tend to be platform specific, increasing the development and long-term maintenance costs. New platform: new design. The military has realized that this is an untenable approach.

Electronics are increasingly more sophisticated, more prevalent, and more mission critical. The ideal approach is to create standards for open-architecture systems that leverage commercial off-the-shelf (COTS) technology and provide the flexible building blocks to meet a wide range of needs. Systems should be modular, allowing a module to be upgraded without requiring other modules to be replaced.

The U.S. Department of Defense's commitment to Modular Open System Architecture (MOSA) form the high-level approach seen in many current initiatives. The Army's VICTORY (Vehicle Integration for C4ISR/EW Interoperability) is developing standards for interoperability between Line Replaceable Units (LRUs) on combat vehicles. By defining intra-vehicle networking, VICTORY drives interoperability and drastically reduces component redundancy caused by "bolt-on" subsystems.

The concepts developed in VICTORY have been expanded in NAVAIR's HOST (Hardware Open Systems Technologies), SOSA (Sensors Open Systems Architecture), and SpaceVPX (VITA 78). All share the goals of MOSA in achieving flexible modularity, interoperability, and scalability. HOST, for example, defines a three-tiered system. Tier I provides the overall conceptual framework; Tier 2 defines the core hardware and software. Tier 3 is the component level where various suppliers can apply the secret sauce to differentiate their products, while maintaining compatibility at the module level. SOSA is similar to HOST, but focuses on the special needs of high-capacity imaging systems.

OpenVPX

The open-system architecture chosen for HOST, SOSA, and SpaceVPX are based on OpenVPX. VPX was originally defined in VITA 46 as a high-performance switched fabric backplane. VPX primarily defines a backplane/daughtercard architecture for high-speed digital signals and supports such protocols as VME, Serial RapidIO, PCI Express protocols, Ethernet, and InfiniBand protocols. The backplane system is based on the MULTIGIG RT 2 connector from TE Connectivity (TE).

To assure interoperability on an architectural level, OpenVPX (VITA 65) has been established as the governing standard defining profiles for various configurations at the chassis, backplane, slot, and module levels. To enhance the application flexibility, OpenVPX also recognizes the need to support optical and RF signals and power. A new series of standards has evolved, shown notionally in Figure 1, including VITA 42 (XMC mezzanine), 62 (power), 66 (optical), and 67 (RF). The ultimate goal is to create compatibility between products from different vendors, enabling open architecture, in addition to two-level maintenance and system upgrades, allowing users to swap out line-replaceable modules (LRMs) in the field.

MOSA standards basically define what's inside the box. They usually stop at the input/output (I/O) connector and do not consider box-to-box or box-to-sensor interconnections. These interconnections, however, are critical to achieving reliable system level perform-

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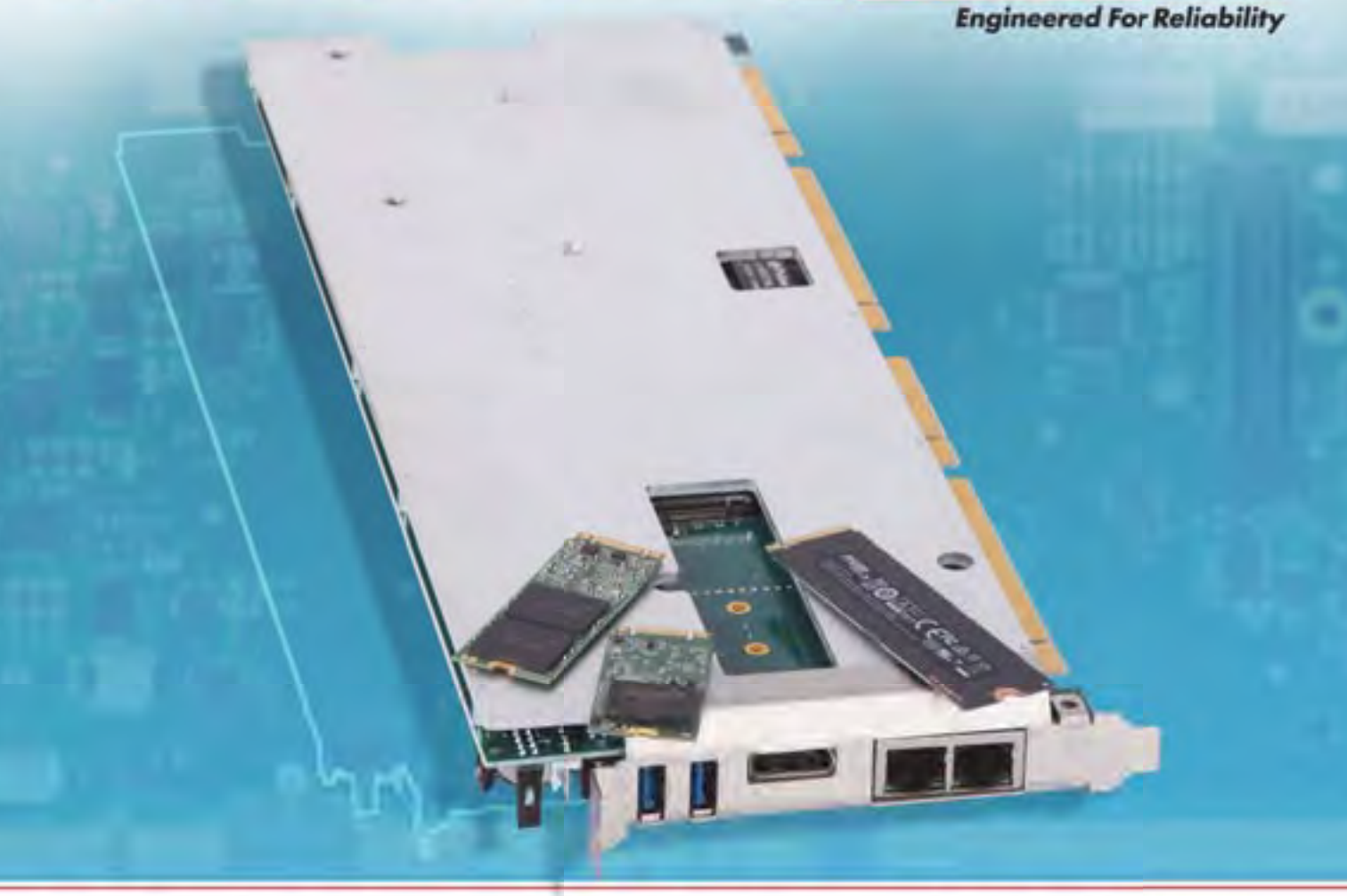

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ance. At issue is the link budget, which is critical to ensuring that the output of one system is delivered with sufficient signal integrity and power at the input of the receiving system. Too often, designers concentrate on the boxes and give scant attention to the I/O interconnections in series between the boxes until late in the design cycle. When the boxes are cabled together, if the chosen interconnect for the system is inefficient, the result is signal degradation and the signal's eye pattern being near fully closed once implemented.

Interconnections

As I/O speeds or bandwidth increase, so do the challenges of the interconnection cables. Both cables and connectors must be carefully evaluated. Many connectors and cables have both military and commercial counterparts. Some COTS connectors have been standardized in military specs. TE's CeeLok FAS-X connector, which was designed for 10-Gb/s Ethernet (Figure 2), arrived on the market as a COTS connector; the new MIL-DTL-32546 will give the soon-to-be-qualified connectors mil-spec standing. This example shows how the line between COTS and military is not clear cut.

To avoid late glitches in system operation, you should always consider the cabling as part of the system and not an afterthought. While embedded computers can be designed and tested by themselves, the interconnection design must also consider real-world application needs. Are there production breaks? How many? Each production break adds additional loss to the budget, which in turn will shorten the length of the box-to-box cabling distance.

Bandwidth is an important issue with copper cables. Attenuation increases with the signal frequency. A low-frequency control signal can travel further than a high-speed signal. High-speed signals may require a controlled-impedance interconnection to prevent reflections, reduce signal distortion, and maintain signal integrity. Highly concatenated cable runs can degrade performance if connectors and cables are not designed properly. A cable assembly that can handle 1 to 10 Gb/s signals in a homerun (no breaks) may not be up to the task if it needs to be divided into three or four small cables to accommodate production breaks.

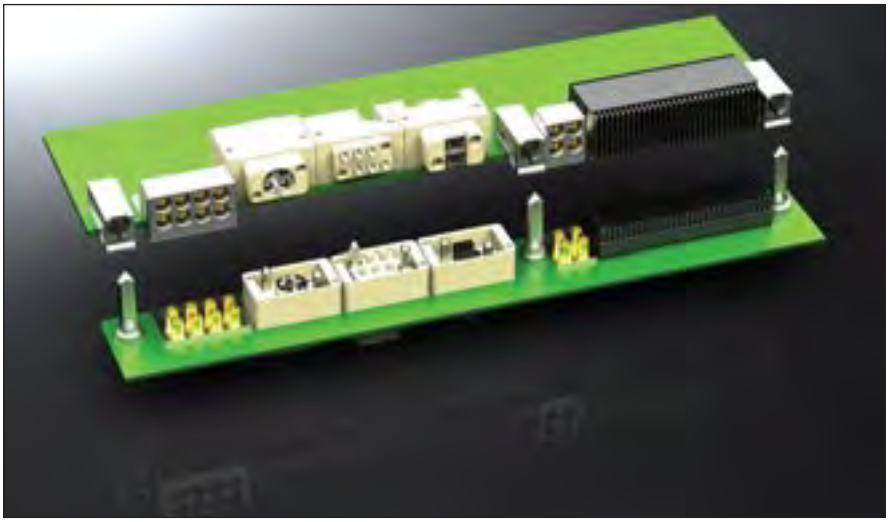

Figure 1. OpenVPX provides an open-architecture, COTS-based solution for high-performance embedded systems. (TE Connectivity)

Figure 2. The choice of cable and connectors can determine whether the link budget is met. (TE Connectivity)

The surrounding electromagnetic environment must also be considered. Are there noise sources nearby that can interfere? Electromagnetic interference (EMI) is combated with differential signals, cable shielding, and controlled impedance.

Additionally, the physical environment can also degrade performance and affect the link budget. Extreme temperatures, high levels of vibration, and mechanical stresses are important factors here. Such considerations affect the choice of both cables and connectors. And the choice of cable connector affects the I/O connector at the box. Don't expect to connect a shielded, controlled-impedance cable assembly to an unshielded, uncontrolled-impedance I/O connector and achieve optimum performance.

Figure 3 shows in simplified form the concept of link budgets. The choice of cable and connectors and the number of breaks in the link will determine whether the power at the receiver's end

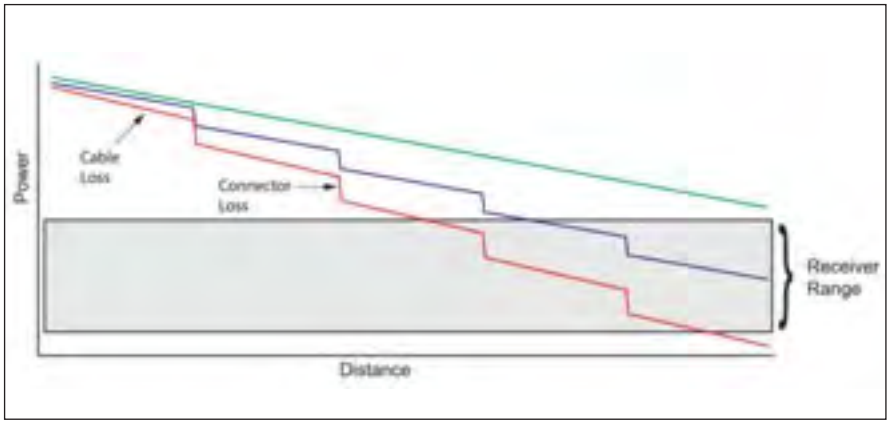

Figure 3. Link budgets should be an integral part of system design. (TE Connectivity)

is within the acceptable range. The blue line represents a link that works well. Lower-performance cable and connectors, as represented by the red line, may not deliver enough signal strength. As shown by the green line, it is also possible to overpower the receiver.

The Fiber Alternative

An alternative to copper cable is fiber-optic cable. Fibers are smaller and lighter than copper cables, especially shielded cables. This can be important in meeting SWaP goals. Optical fibers offer constant attenuation over the entire usable frequency range and are immune to EMI. Frequency-independent attenuation means that the transmission distance over fiber does not change with the signal speed. This can simplify link budgeting.

Optical connectors are important to link budgets, particularly at production breaks. Ceramic ferrule connectors, such as the ARINC 801, have a lower insertion loss than expanded beam connectors: typically 0.2 dB versus 0.7 dB. Each has its uses: ceramic ferrule for the lowest loss, expanded beam for exceptional resistance to vibration, dirt, and high duty cycles. As with the high-bandwidth solutions mentioned above, rugged optics require some forethought on the end use, environment, number of mating cycles, and similar factors. As an example with airborne fiber applications, there may be some add-on requirements related to smoke and toxicity that would be added to meet the FAR25 specification.

It's End to End That Counts

OpenVPX is perhaps the fastest-growing COTS solution for high-performance embedded computing systems in military and aerospace applications. It provides a rich ecosystem to support needs ranging from flight computers to sophisticated imaging systems. Standardized profiles can not only shorten design cycles, they promote interoperability and lessen the hassles of one-of-a-kind, vendor-lock solutions. The resulting economies of scale also promise lower costs at both the design and procurement stages.

But OpenVPX represents only a subsystem in the overall system. VPX boxes must be connected to sensors, actuators, and other computers. As the performance of computers continues to increase in speed and sophistication, the cabling system must be considered as part of the electrical design and not simply as an afterthought. There have been numerous cases where late in the design cycle snags develop in the system because power through the link has been improperly budgeted — or not budgeted at all. The added costs of redesign or more-costly-than-necessary solutions can be avoided by making sure that the link is part of the design from the beginning.

This article was written by Earle Olson, Business Development Manager, Global Aerospace Defense and Marine, TE Connectivity (Bensheim, Germany). For more information, visit ***http://info.hotims.com/61066-503****.*

Custom Designing Enclosures Using 3-D CAD Modeling

Due to the advancement of 3-D computer-aided design software, enclosure manufacturing is not what it used to be. Technology advances industry. The Wright Brothers' flyer, for example, is no match to the United States' newest F/A-22 stealth fighters. Nor should a standard enclosure be acceptable when 3-D CAD software makes custom work more affordable and easier than ever.

Since the mid-1980s, CAD programs have evolved to the point where they can handle 3-D modeling. The biggest benefit of 3-D CAD modeling software is that it gives engineers the ability to layer in a combination of architectural, engineering, and construction views along with the associated technical language into one single image. The software acts almost like a translator at the United Nations: It understands and combines multiple technical languages and then transfers them to a universal, three-dimensional image that is easy to comprehend.

Before 3-D CAD existed, the manufacturing process was lopsided and usually a one-way street. Enclosure manufacturers, for example, might offer a large number of standard cases that would come in a variety of sizes, materials, styles, and configurations. Customers would choose the one that best fit their product. With 3-D CAD modeling, an engineer can customize the 3-D CAD model to fit his or her end-user specifications and return it to a manufacturer with the exact design needed for a product with sensitive internal components. The process works the same, whether the customer is an engineer designing an enclosure for the aerospace and avionics industry or whether the customer is a product designer building a critical enclosure for the medical industry. The customer first identifies a standard enclosure on a manufacturer's website. Built-in search filters can allow the engineer/customer to narrow his or her selection to the enclosure that best suits the product.

By allowing a customer to download from an extensive library of 3-D CAD drawings, a manufacturer can provide a customer with a quick and easy layout of needed components. A customer can then modify the design to fit his or her needs and email it back to the manufacturer. The end result is that the manufacturer can provide a quicker turnaround and can create a product that is built to a customer's exact specifications. Downloadable 3-D CAD models have effectively eradicated the one-size-fits-all solution.

The CAD data that is downloaded from an enclosure manufacturer's website can be developed from "standard" enclosure drawings. When an engineer or designer selects a specific size case, the software will pull the proper components together and generate an assembly that the customer can then download in their choice of formats, such as STEP, IGES, etc. The downloaded model has no parametric intelligence but can be manipulated by the 3-D CAD program that it is imported into.

In the example that follows, the components are dimensionally correct, but some non-critical details, such as ventilation patterns, are shown as shallow cut squares to speed up creation and downloads.

The process to download an enclosure model is straightforward, but engineers need to know what file type works best for their CAD system. A STEP file is the most commonly used and typically works well for most CAD systems. An enclosure manufacturer's website can allow customers to select the enclosures section and choose the type of enclosure that best fits their needs. For this example, the DII-52-4-16RM Black enclosure will be selected and downloaded in a STEP format.

1. Select the View Catalog button for the Enclosures.

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2. Select the Enclosure type, which is DII.

3. Choose the height, width, depth, color, and mounting. In this example, the enclosure has a height of 5.25 inches, a width of 17 inches, and a depth of 16 inches. And the enclosure is rack mounted. The DII-4-16RM Black enclosure will be displayed as the results are narrowed.

Height = 5.250
Width = 17.000
Depth = 16.000
Rack Mount

4. Click on the View Item button.

5. Choose a CAD format and click the "Download CAD button." The 3-D CAD Model can be viewed, and the spec sheet can be downloaded from this page as well.

6. Sign in as a returning user with an e-mail address or click to create a new sign-in profile. Once a customer signs in, the system will prompt the customer to drag and drop into his or her CAD system or download a CAD model. Users should download the CAD model and unzip the file, which will be ready to import into the CAD system.

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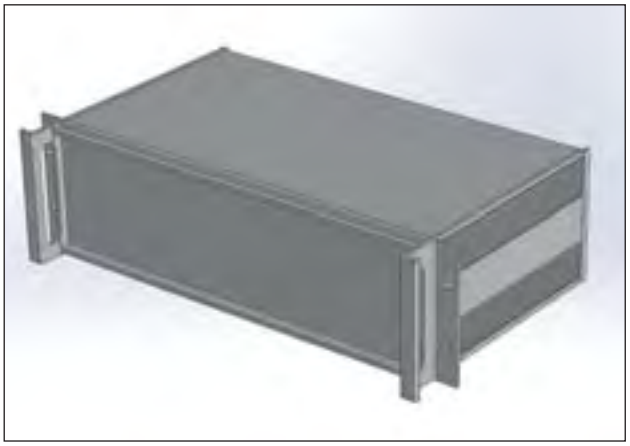
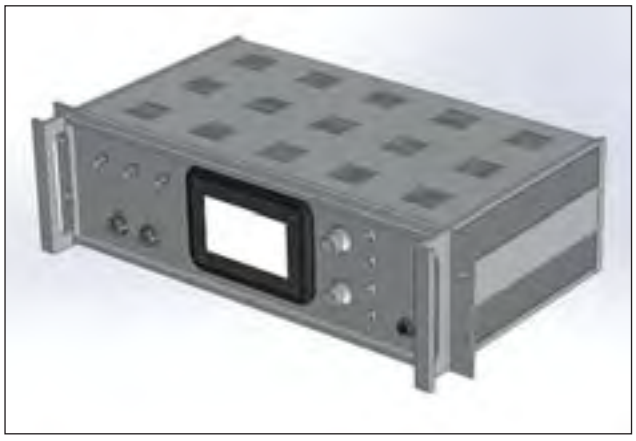
7. The following image shows the DII-52-4-16RM_Black.STEP file that has been translated with Solid Edge and can now be modified as necessary with CAD tools.

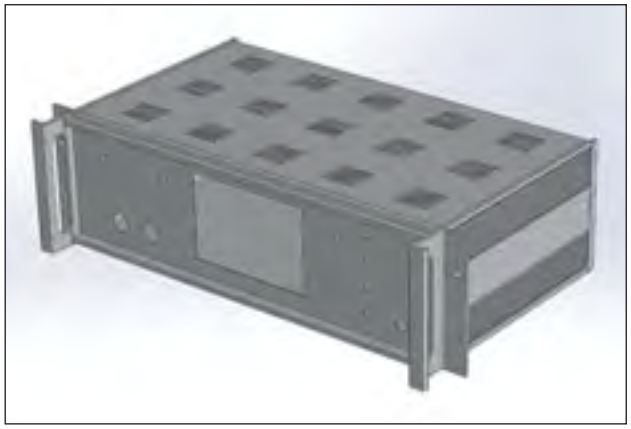


8. The designer can import the components into the assembly and accurately position them. Then, the geometry can be extracted from the components and used to create the panel cutouts for jacks, connectors, interface ports, power entry modules, fans, LCD/LED displays, internal chassis, etc. Ventilation can also be added to the panels as needed.

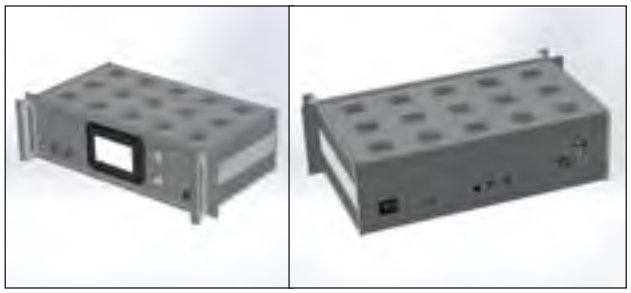
Manufacturers can customize an enclosure according to the customer's specifications, adding inserts (e.g., studs, standoffs, blind studs, captive nuts, spring latches, rivets, and right-angle standoffs, etc.) to a case in order to mount electronics or hardware. OEMs may want holes punched into their enclosure in order to mount internal components or allow for venting, and those punches and holes often need to be in a variety of sizes and shapes. When it comes time to produce the enclosure, a manufacturer with dedicated CNC fabrication equipment can create virtually any shape a customer requires. The machining process can be used for holes, vents, corner radius, cutouts, counter boring, and other customized processes that can all be specified far ahead of time in the 3-D CAD design process.



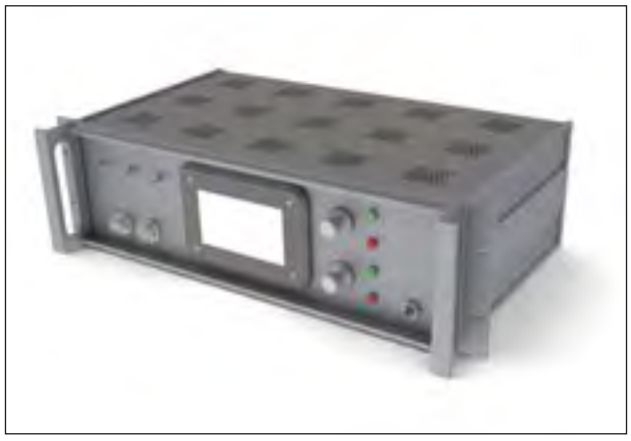
9. For this image, the cutouts and ventilation have been added to the enclosure panels, and the electronic components have been hidden. The modified assembly model or individual panels can be exported in a STEP or Parasolid format along with the pertinent drawings in a .dwg, .dxf, or .pdf format that specifies finish, hardware, silk screening, and other qualities and emailed to the manufacturer, who can then process and quote the order.



10. The following images show the front and back of the enclosure with the panel modifications and electrical components.



11. Rendering tools can be used to create presentations and advertisements of the modified enclosure.



Total Customization

Throughout the process, the user controls everything, from specifying customized front and rear panels to outlining where every hole and punch should go and what size they should be. In the design process, a user can even specify a finish. Enclosures can be finished with an undercoat and topcoat to provide a durable finish. Enclosures can even be customized with a company or product name or logo or some other artwork.

The ability to download 3-D CAD models for customization has been developed to accommodate virtually all engineering software, making it extremely user-friendly. Most enclosures in a downloadable catalog would be designed with desktop and rack-mount applications in mind, making an enclosure that is 19 inches wide by 15 ¾ inches high and 30 inches deep a rather large enclosure. But it is possible to design custom enclosures above and beyond the OEM selections. For example, a manufacturer can customize smaller enclosures with carrying handles, rubber feet, or design them to mount into a larger panel with optional plastic bezel and panel mount jacks.

This 3-D CAD functionality can be applied and utilized across any industry using enclosures. In some industries, shielding is necessary to protect a product by limiting interference (EMI) into or out of an enclosure. This is particularly important for products that include highly sensitive components inside the enclosure or for enclosures that will be placed near other sensitive equipment.

Digital Testing

Engineers also can digitally test 3-D CAD models and compare them with other parts or components. This capability can ensure proper fitting and alignment quality control checks before any manufacturing has to be started. Full-service manufacturers can couple 3-D CAD tools with talented design and engineering teams to support customers' needs.

Developing a downloadable, 3-D CAD solution has advanced the manufacturing process to the next level. 3-D CAD is now a mainstream tool that puts customization in the hands of the customer and provides product designers with the best options to meet their specific housing requirements and create a custom enclosure solution while remaining within budget. This solution speeds up the configuration process and allows customers to get to market much faster with their products.

This article was written by Ken Tumblison, President, Buckeye Shapeform (Columbus, OH). For more information, visit ***http://info.hotims.com/61066-501****.*

Fiber Optic Multi-Sensing Platforms

Enabling Innovation Across Aerospace Organizations

Eventually, technology advances to the point where solutions that have been "good enough" for decades are no longer "good enough" for the innovations of today. The philosophy of "good enough" is widely applied when developing a new product or solution. Businesses have to make decisions about what new technology features will receive the most attention to keep projects within scope and completed on time.

This philosophy has a downside when applied to testing and monitoring. For decades, point sensing solutions like strain gauges and thermocouples have been "good enough" for testing aircraft durability, however, the mindset of "good enough" often blocks innovation. It is not uncommon for researchers to find that they have innovated beyond their ability to test with legacy technologies.

Sometimes it takes a significant, expensive failure to admit that this is a human issue and not a technology issue. New, robust sensing technologies that can monitor beyond the scope of point sensors are necessary to enable the next generation of aircraft designs. Fiber optic multi-sensing platforms available today are capable of obtaining spatially continuous data and varying degrees of multi-sensing capabilities that will accelerate advances in aircraft design and lifecycle management.

Multi-Sensing Platforms Defined

Back in 2003, NASA experienced the downside to "good enough" sensing solutions firsthand when the Helios aircraft broke up over the Pacific Ocean. Thankfully, it was an unmanned vehicle so no one was injured. Unfortunately, millions of dollars of investment literally sank before their eyes. This spurred the team at NASA Armstrong (formerly NASA Dryden) to develop a sensing technology capable of keeping pace with their innovations. They realized that breakthroughs they made in developing a fiber optic sensing platform had vast applications and benefits across multiple industries due to its ability to obtain real-time, spatially continuous information of multiple parameters. The foundation they laid enabled the technology to be developed into a commercially available platform to help organizations across industries drive their innovations forward.

Multi-sensing platforms, simply put, are sensor technologies that can monitor multiple parameters (strain, temperature, deflection, etc.) simultaneously and are robust enough that they can be deployed in multiple applications across an organization and utilized throughout the product lifecycle. It's not just about being able to monitor different parameters using the same data acquisition hardware. More than that, a multi-sensing platform can consolidate sensing technology so the same hardware, with minor changes in application techniques and sensor packaging, can adapt to cover multiple testing and monitoring needs of an organization. To do this, the sensing system must obtain data in real time and obtain spatially continuous information. Point sensors can miss events that occur between critical points, leaving blank spaces in the picture painted by the data. These features allow multi-sensing platforms to be deployed in lifecycle monitoring applications from design validation to providing feedback for flight control systems.

Sensing Technologies Today

Data acquisition hardware can collect data from strain gauges, thermocouples, and other point sensors simultaneously, but these systems fall short of the definition of a multi-sensing platform in a number of ways. First, they are well suited for periodic tests but are not designed for long-term monitoring. Additionally, they only obtain points of information. While it is possible to get thousands of data points on a test article from strain gauges, the wiring and acquisition hardware necessary makes the task cumbersome and expensive due to extensive time and expertise requirements for installation. This limits the extent to which engineers can test and monitor their innovations.

Other technologies are capable of obtaining distributed measurements such as digital image correlation, which has numerous benefits in laboratory settings due to its ability to comprehensively measure such things as full-field material deformation. However, its spatial coverage is minimal, and it cannot

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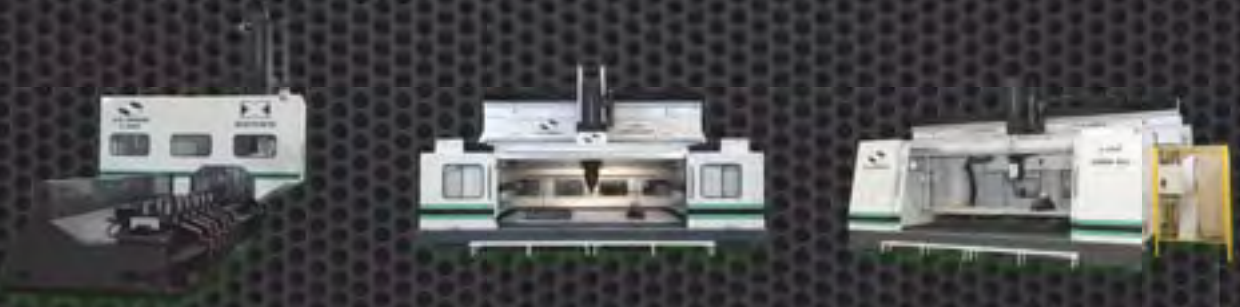

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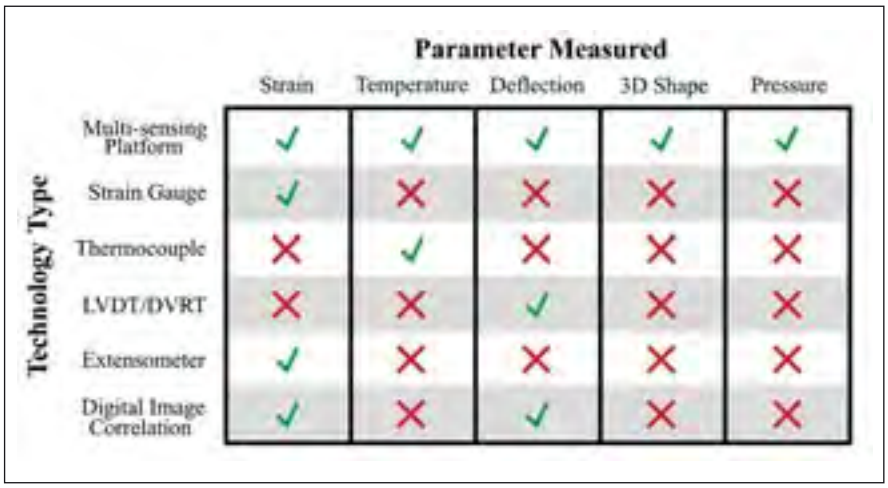


Technology Comparison

be readily applied outside of a laboratory environment. This technology will continue to gain traction in some settings. However, it is not well suited, nor designed, for environments outside the laboratory and can be cumbersome to implement.

Fiber optic sensing (FOS) technologies offer multiple advantages that other sensing technologies cannot. FOS technologies are also able to operate in temperatures ranging from -270°C to 900°C, depending on the technology, making them well suited for harsh environments. Historically fiber optic sensors have had mixed results when it comes to accuracy; however, systems today are equally or more accurate than legacy sensing technologies such as strain gauges and thermocouples. Perhaps the most significant advantage of FOS technologies is that some can obtain real-time distributed data and sense multiple parameters at the same time. In other words, there are fiber optic multi-sensing platforms currently available in the market today.

Where Multi-Sensing Platforms Provide Value

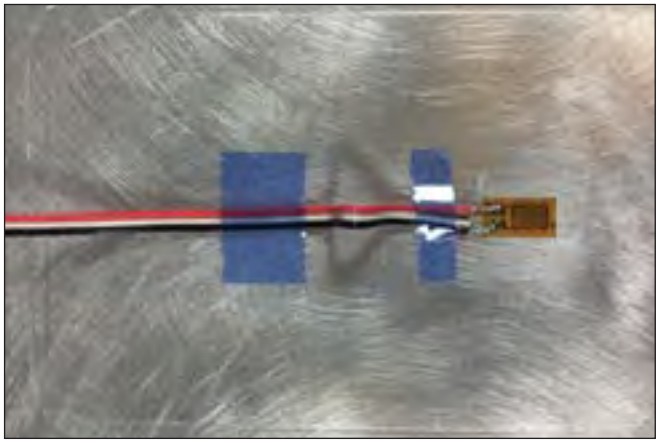
One example of how a fiber optic multi-sensing system provides value to aerospace organizations is the development and control of an adaptive trailing

edge at NASA Armstrong. In aircraft design today, an adaptive trailing edge is the next wave in aircraft innovations. Offering significant cost savings to the end user by enhancing aerodynamics and reducing fuel consumption, adaptive trailing edges are one of the most sought after innovations in the aircraft design community. Fiber optic multi-sensing systems can provide the data necessary to validate these designs and to enhance their performance by providing insights about the optimum wing shape for aerodynamic efficiency. For example, NASA Armstrong is able to monitor the load and deflection of one such design using FOS technology and continues to use it in flight-testing and operation as the primary feedback control mechanism.

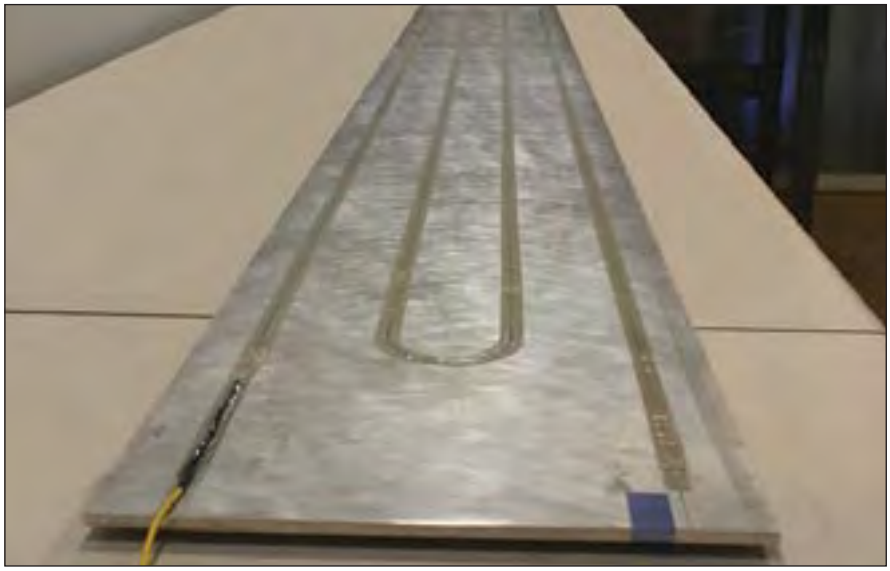
An industry challenge facing the aerospace industry is the development of advanced composite material manufacturing techniques. The benefits of composite materials in aircraft design are well understood; however, there is an industry-wide need to develop advanced manufacturing techniques that ensure quality and longevity.

As composite materials have been implemented into the design of aircraft and components, the demands for sensors have evolved. Strain gauges are limited in their ability to provide the data necessary for organizations to continue innovations in the manufacturing of composite components. For example, during the curing process, wrinkles can form within the thickness of a laminate, which can produce a hidden structural deficiency. As a point sensing solution, a strain gauge would not be able to capture residual strain from such a wrinkle unless it happened on or near the surface of the part.

On the other hand, fiber optic cables can be embedded in composites enabling a multi-sensing platform to collect spatially continuous strain data in real time. This information is necessary to understand the behavior of residual strain distributions after composite curing, and ultimately, to improve manufacturing techniques. Furthermore, a fiber optic multi-sensing platform can obtain temperature and deflection measurements at the same time, so a full picture of what is happening to the material, both spatially and environmentally, can be obtained.



Strain Gauge vs. Fiber. A test article instrumented with a strain gauge and fiber with approximately 50 sensors.



Fiber Installation. A test article instrumented with a distributed fiber optic sensor.

Multi-Sensing Platforms in the Near Future

Being able to understand how loads are distributed throughout a wing while monitoring the shape of the wing in real time is of enormous importance for future developments regarding aerodynamics. FOS platforms are currently being embedded in the wings of aircrafts to provide real-time data as part of a flight control feedback loop. Armed with this data, an aircraft can intelligently adapt the shape of its wing in order to optimize aerodynamics, reduce fuel consumption, and notify operators of required maintenance or failures. Over time, this adds significant value to the end user in terms of fuel savings, lifecycle management, and increased safety for passengers. In the future, many commercial aircraft will have this type of technology embedded in their design.

Another application of multi-sensing platforms in the near future is the development of smart aircraft in the Internet of Things (IoT). The aerospace industry will experience significant benefits from IoT technologies that enable predictive maintenance. If software is the brains of the IoT, sensors are the nervous system collecting continuous streams of data to be processed. Fiber optic multi-sensing platforms will be a critical component in the realization of predictive maintenance for the aerospace industry. For example, in addition to informing the flight control system, the embedded fiber optic multi-sensing system will be able to provide historical strain, shape, load distribution, and temperature data to a big data analytics platform. The analysis from the software will enable predictive maintenance on the aircraft throughout its lifecycle. The fiber optic multi-sensing technology needed to make this application a reality is available today. By implementing a multi-sensing platform, engineers can resolve multiple monitoring challenges with a single platform.

Replacing 'Good Enough' With 'Best'

While legacy sensing technologies such as strain gauges have been good enough for decades, the adoption of multi-sensing platforms will allow innovators in the aerospace industry to drive developments forward. By adopting a sensing technology that can consolidate multiple technologies into a single platform, aerospace organizations will be able to obtain the data they need across the lifecycle of their products in order to revolutionize aircraft design and provide value to their end user.

This article was written by Michael Heflin, CEO, Sensuron (Austin, TX). For more information, visit ***http://info.hotims.com/61066-403****.*

Figure 1. Wake turbulence forms two counter rotating vortices separated by a little less than the wingspan of the generating aircraft.

RECAT

Wake Turbulence Recategorization

Aviation safety is a fundamental concern for all stakeholders. The traveling public demands the highest safety standards, but also wants convenience and reliability at a low price with minimal environmental impacts. Taking account of these sometimes competing demands can be challenging.

A common cause of flight delay is the limited capacity of airport runways. One solution is to build more runways, but this understandably generates opposition from local people and often takes a lot of time. Another solution is to increase the capacity of existing runways. This is normally less costly and sometimes generates less local opposition.

To operate safely, aircraft must be separated from each other. The amount of separation required is determined by collision avoidance, wake turbulence, and other issues. Wake turbulence is generated when an aircraft generates lift (Figure 1). In general, heavier aircraft produce stronger wake turbulence and lighter aircraft are more vulnerable. If following aircraft are not sufficiently separated from the wake of the preceding aircraft, the turbulence could be sufficiently strong enough to result in violent aircraft accelerations. This is one reason why, for take-off and landing, all passengers and crew are seated and belted. In the worst case, wake turbulence could cause the encountering aircraft to lose control and crash. Wake separation standards and their associated procedures are designed to minimize the likelihood of this occurring.

Creating Standards

Historically, wake turbulence separation standards have been defined by a mixture of expert judgement and review of operational experience. This categorization was done by the International Civil Aviation Organization (ICAO) using three aircraft weight categories (Figure 2a). If subsequently the defined separations were found to be too small, perhaps by the review of wake incident reports, then increased separations were defined. A few years after the introduction of the Boeing 757 (a medium aircraft), the wake turbulence standards were modified to provide greater protection for light following aircraft (Figure 2b).

The initial wake strength of any aircraft can be calculated theoretically from aerodynamic principles. Once formed, the wake decays with time and is transported in space. The rate of decay depends mainly on the stability of the atmosphere and on the proximity of the wake to the ground. Wake is also transported laterally in the wind field and tends to sink vertically. However, it is very difficult to calculate absolute transport and decay rates theoretically, especially close to the ground, even with physics-based equations and supercomputing, with sufficient confidence to satisfy safety regulators.

In the mid-2000s, an innovative international project used wake measurements made by LIDAR (Light Detection and Ranging), which measures both the strength and the position of the wake turbulence from flying aircraft, and risk assessment methods to develop wake separation standards for the Airbus A380 within the context of existing separation standards defined by ICAO (Figure 2c). This successful work provided a framework for an objective, repeatable, and rational method of devising wake separation standards, and motivated international experts to consider if a wholesale redesign of the wake separation standards applied to all aircraft could deliver significant increases in runway capacity. The Wake Turbulence Recategorization Program (RECAT) was born.

NextGen

Under the FAA's NextGen initiative, RECAT is planned in three phases. RECAT I delivered a new six-category system in 2012. The categories are based primarily on weight: Super (A380), Heavy, B757, Large, Small+, and Small. This replaced the "3+1" historical ICAO system of Heavy, Medium, and Light, plus A380

Figure 2a. ICAO Wake Separation Matrix in 1980s (blank means no wake separation standard applies)

Leader\Follower	Heavy	Medium	Light
Heavy (e.g., Boeing 747)	4.0NM	5.0NM	6.0NM
Medium (e.g., Airbus A320)			4.0NM
Light			

Figure 2b. ICAO Wake Separation Matrix from 1995 after Boeing B757 Operational Experience

Leader\Follower	Heavy	Medium	Light
Heavy	4.0NM	5.0NM	6.0NM
Medium			5.0NM
Light			

Figure 2c. ICAO Wake Separation Matrix in 2008 after Introduction of Airbus A380

Leader\Follower	A380	Heavy	Medium	Light
Airbus A380		6.0NM	7.0NM	8.0NM
Heavy		4.0NM	5.0NM	6.0NM
Medium				5.0NM
Light				

Figure 2d. FAA RECAT I Wake Separation Matrix in 2012

Leader\Follower	CatA	CatB	CatC	CatD	CatE	CatF
CatA		5.0NM	6.0NM	7.0NM	7.0NM	8.0NM
CatB (Upper Heavy)		3.0NM	4.0NM	5.0NM	5.0NM	7.0NM
CatC (Lower Heavy)				3.5NM	3.5NM	6.0NM
CatD (Upper Medium)						4.0NM
CatE (Lower Medium)						
CatF (Light)						

Figure 2. Evolution of Wake Separation Minima.

(Figure 2d). This is currently being deployed at airports across the US, with 16 having implemented it since November 2012, including Memphis International Airport and JFK in New York. RECAT II, active today, will initially define static pairwise separations, to the nearest 0.1 nautical miles, for the most common aircraft at major airports. It provides a matrix of 10,000 pairs of aircraft separations, but the aim is to extend this to all aircraft when data becomes available. RECAT II can only be fully implemented with significant enhancement of air traffic controller support tools. However, it can be implemented as a six-category system similar to RECAT I, for example by bespoke local aircraft categorization such that capacity for the local airport traffic mix is maximized. In the future, RECAT III will deploy dynamic (weather dependent) pairwise separation standards between aircraft.

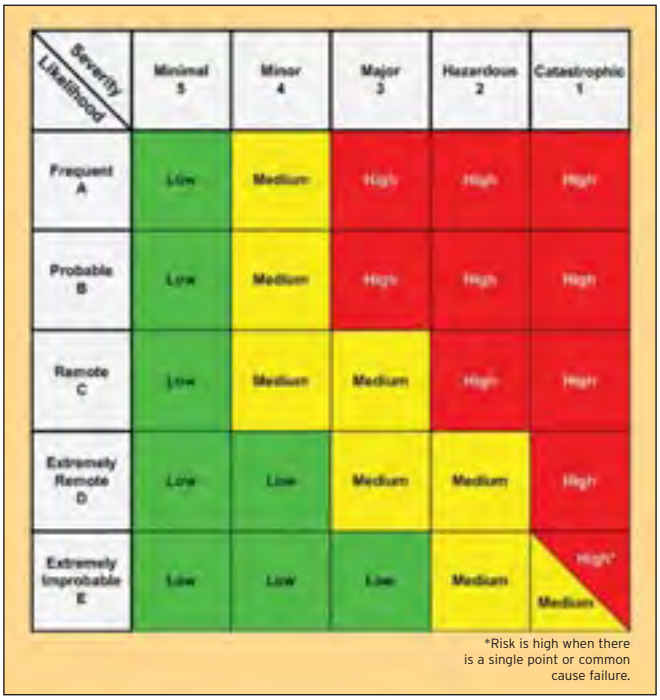


Figure 3. FAA Risk Matrix. Likelihood ranges from an event that is likely to happen once a week (A) to an event that is likely to happen less than once in 30 years (E). Severity ranges from minimal (5) through increasing levels of loss of control (4 to 2) to actual harm (1).

The goal of RECAT is to reduce wake separations while not increasing wake risk beyond that experienced by the most exposed aircraft pairs today. Risk is the combination of how likely an event is, such as a wake encounter, and the severity of the event should it occur. For wake encounters, there is a wide spectrum of event outcomes, from very severe, which might cause an aircraft crash, at very low likelihood, to mild turbulence, possibly sufficient to spill drinks, at much higher likelihoods. This variation needs to be correctly accounted for and balanced in the safety assessment. This can be done using the FAA risk matrix (Figure 3), or by using other risk assessment tools.

Furthermore, under ICAO wake standards today, different aircraft types experience different levels of wake risk. It is more difficult to violently accelerate larger aircraft because of their greater mass, among other reasons. Thus smaller follower aircraft behind larger leader aircraft within a present-day ICAO weight category, which share a common wake separation minimum today, experience higher wake risk than other follower aircraft in the same weight category. RECAT makes use of this by reducing separations between some aircraft pairs to equalize the wake risk experienced by all aircraft pairs, while not increasing the wake risk for the most exposed aircraft pair today. This process is shown schematically in Figure 4. This strategy for demonstrating safety neatly avoids having to answer the difficult question: what level of absolute wake risk can be tolerated? The level of tolerable wake risk is decided by the highest level of wake

risk that is tolerated today. Of course, there are many complexities under this relatively simple, high-level methodology, but these have been addressed by the expertise and experience of the wake scientists, aerodynamicists, operational experts, and safety specialists working in the FAA RECAT team.

Feedback from operators has been uniformly positive. One RECAT user, UPS Airlines, commented that they have greatly benefited from the FAA RECAT initiative with increased throughput for both arrivals and departures. Since the implementation of RECAT, UPS has been able to schedule more aircraft in their peak operating hours. This has also led to better volume management with increased volume availability during critical time periods in the arrival and departure sequence.

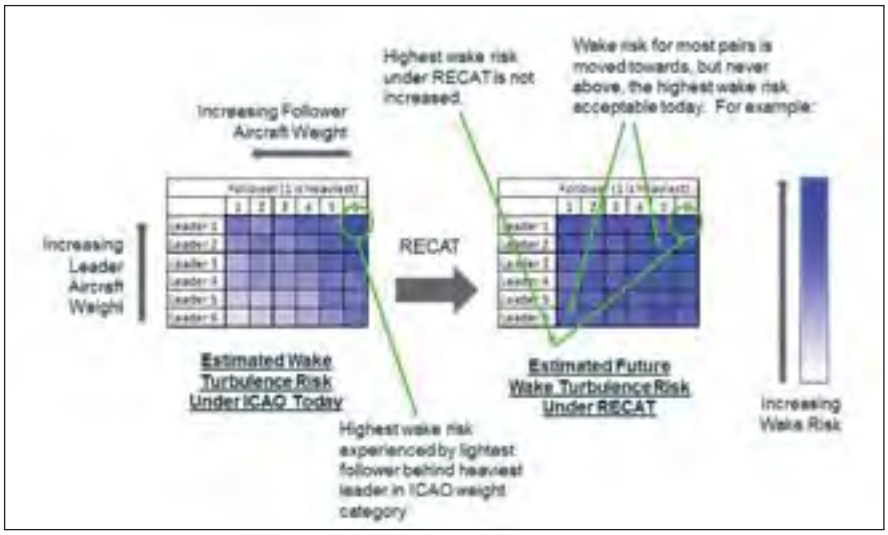


Figure 4. Schematic diagram to show wake turbulence risk today and how it changes after RECAT.

Following on after RECAT I, it is expected that there will be further operational benefits from RECAT II and RECAT III to be delivered in the next few years. Wake turbulence risk assessment will be fundamental to delivering these programs safely.

This article was written by Dr. Tim Fowler, Senior Principal Consultant, DNV GL (London, UK). For more information, visit ***http://info.hotims.com/61066-502****.*

A NEW CONCEPT FOR IMPROVING THE PERFORMANCE OF ELECTRICALLY SMALL ANTENNAS

Using advances in the areas of multi-mode, closely coupled miniaturized radiators and artificially engineered materials, ultra-broadband, highly efficient, electrically small antennas were developed for operation in military communications systems. A low-profile UWB antenna was developed that is composed of two electrically small loops coupled together in their near fields. Each loop has a three-dimensional surface with a bent diamond-arm shape. Half of each loop placed on top of an infinite conducting ground plane is used in the design. Each loop is loaded with a top hat to reduce the lowest frequency of operation of the antenna.

The antenna radiates like a vertically polarized monopole with omnidirectional, vertically polarized radiation patterns in the azimuth plane. The antenna demonstrates consistent radiation characteristics over a 4:1 frequency band. At its lowest frequency of operation, the antenna has an extremely low height of 0.033 λ_{min}, where λ_{min} is the free-space wavelength at the lowest frequency of operation of the antenna. Moreover, the antenna has lateral dimensions of 0.22 λ_{min} × 0.22 λ_{min} at the lowest frequency of operation.

While the antenna shown in Figure 1 is capable of delivering impressive performance levels, its bandwidth is limited to two octaves. To extend the bandwidth of this antenna, we examined the factors that limit its bandwidth. The bandwidth of this antenna is limited by the fact that its radiation patterns are deteriorated as frequency increases. This is due to the fact that as frequency increases, the radiation emanating from the different locations of the antenna has a larger phase difference between them. This way, the radiation emanating from the antenna adds constructively at some angles and destructively at others, resulting in deterioration of the radiation pattern of the structure from the desired omnidirectional patterns at higher frequencies.

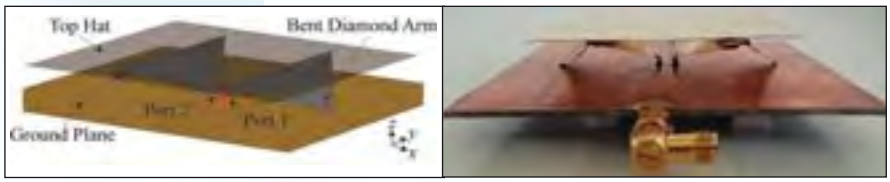


Figure 1. Topology (left) and photograph of a low-profile, ultra-wideband antenna.

To overcome this limitation and extend the bandwidth of the antenna, we proposed a new design of a wideband antenna that takes advantage of the previous antenna in a dual-antenna system. This significantly enhances the bandwidth over which the antenna can maintain its omnidirectionality. The topology and the photograph of a fabricated prototype of this modified antenna is shown in Figure 2. We demonstrated experimentally that this antenna can cover up to a decade of bandwidth with consistent, vertically polarized, omnidirectional patterns across the entire band. At its lowest frequency of operation, this antenna has electrical dimensions of 0.026 λ_{min} × 0.026 λ_{min} × 0.046 λ_{min}, where min is the wavelength at the lowest frequency of operation.

Small UWB Antenna Occupying a Cubic Volume

We also investigated the development of small, ultra-wideband antennas that efficiently occupy a cubic volume. The antenna developed is an electrically small, low-profile, ultra-wideband antenna with monopole-like radiation characteristics. Figure 3 shows the topology and the photograph of a fabricated prototype of this antenna. The antenna is composed of a monopole bowtie antenna reactively loaded with a cascaded system of top hats, two shorting arms, and a ring slot cut into the ground plane. The reactive loads are used to introduce two additional resonances close to each other and below the lowest resonant frequency of the bowtie. This results in a very compact, ultra-wideband antenna that utilizes the available volume inside the Chu's sphere rather efficiently. At the lowest frequency of operation, the proposed antenna has electrical dimensions of 0.085 λ_{min} × 0.19 λ_{min} × 0.19 λ_{min}, where min is the free-space wavelength. The antenna demonstrates a VSWR of 2.2:1, and consistent monopole-like, omnidirectional radiation patterns over a 5.5:1 bandwidth.

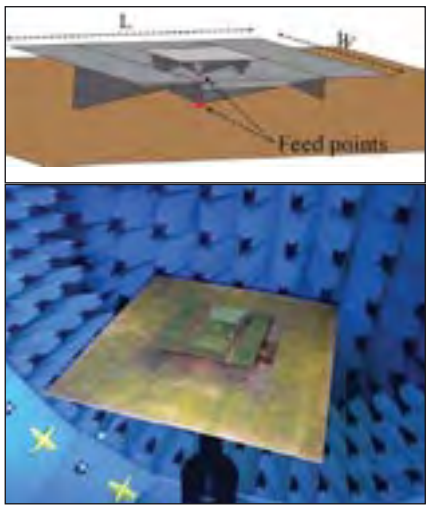
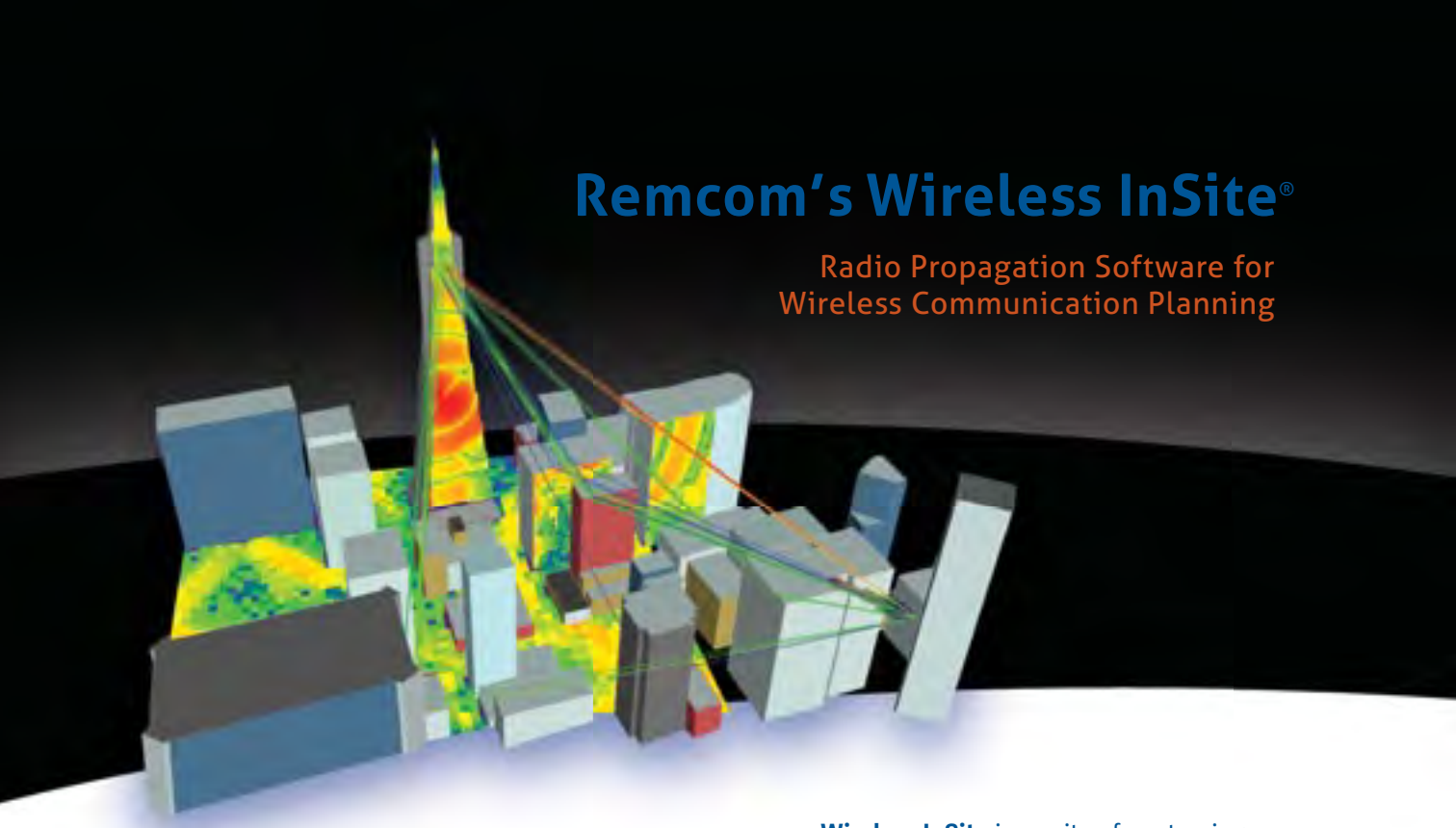


Figure 2. Topology (top) and photograph of the fabricated prototype of a low-profile, ultra-wideband antenna that is capable of providing a 10:1 bandwidth with vertically polarized, omnidirectional radiation patterns across its entire band of operation.



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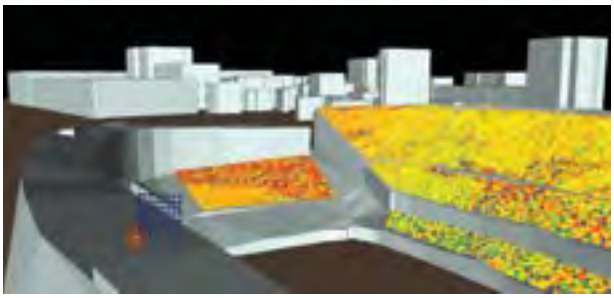

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Compact, Ultra-Wideband, Circularly Polarized Spiral Antenna

We developed a new technique for designing low-profile, compact spiral antennas with broadband circularly polarized (CP) responses. The antenna is backed by a ground plane and has unidirectional radiation patterns over its entire frequency band of operation. Figure 4 shows the topology and the photograph of the fabricated antenna. This antenna is a multilayer structure composed of a center-fed modified Archimedean spiral that exploits a novel loading structure, a ring-shaped absorber, and a feed network, which includes a 180° power splitter. The loading structure possesses both inductive and capacitive characteristics, which increase the equivalent electrical length of the antenna while maintaining its maximum dimensions. The Archimedean spiral is integrated into the multilayer dielectric structure along with its differential feed network. An optimized ring-shaped absorber is used on the periphery of the antenna to reduce the ground effects on the antenna performance.

The antenna developed in this part of the project occupies a volume that is 89% smaller than that occupied by a conventional ground-plane-backed Archimedean spiral antenna. At its lowest frequency of operation, the antenna has electrical dimensions of 0.21 λ_{min} × 0.21 λ_{min} × 0.09 λ_{min}, where λ_{min} is the free-space wavelength at the lowest frequency of operation (0.5 GHz). Over the frequency range from 0.5 to 1.4 GHz (2.8:1), the antenna has a VSWR of 2.4:1, and it has a CP radiation pattern with an axial ratio better than 1.2 dB. Within this frequency range, the antenna has minimum and maximum realized gain values of–5.0 dBiC and 3.1 dBiC, respectively.

RF Signature Reduction of Linearly and Circularly Polarized Antennas

We examined the design of low-observable antennas where the radar cross-section of the antenna is reduced by using a miniaturized-element frequency selective surface (MEFSS) and integrating it with a low-profile, wideband, circularly polarized or linearly polarized antenna.

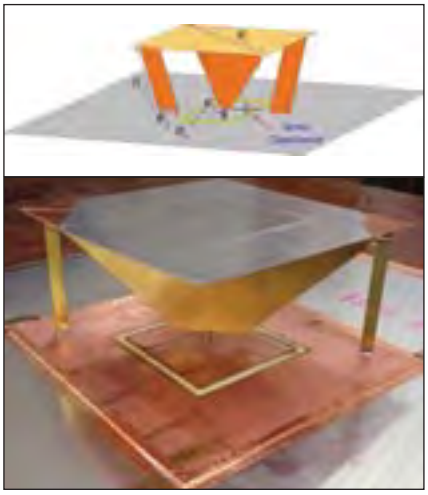


Figure 3. Topology (top) and photograph of the fabricated prototype of a compact, ultra-wideband antenna that efficiently utilizes the volume of a cuboid.

Figure 4. The miniaturized, ground-plane-backed, circularly polarized UWB antenna.

We introduced a new technique for designing miniaturized-element frequency selective surfaces having bandpass responses and no spurious transmission windows over extremely large bandwidths. The proposed harmonic-suppressed MEFSSs consist of multiple metallic and dielectric layers. Each metallic layer is in the form of a two-dimensional arrangement of capacitive patches or an inductive wire grid with extremely sub-wavelength periods.

Harmonic-free operation in these structures is achieved by using multiple, closely spaced capacitive layers with overlapping unit cells to synthesize a single, effective capacitive layer with a larger capacitance value. This allows for reducing the unit cell size of a conventional MEFSS considerably and moving the natural resonant frequencies of its constituting elements to considerably higher frequencies. Consequently, the spurious transmission windows of such MEFSSs, which are caused by these higher-order harmonics, can be shifted to very high frequencies and an extremely broad frequency band free of any spurious transmission windows can be obtained. Using this technique, a number of MEFSSs with second-order bandpass responses were designed.

Integration of the Antennas with Harmonic Suppressed FSSs

The MEFSSs were also integrated with low-profile, linearly and circularly polarized antennas. Figure 5 shows a photograph of the linearly polarized antenna integrated with the MEFSS. The antenna radiates similar to a vertically polarized monopole, but is completely flush-mounted. The antenna also has omnidirectional radiation patterns in the azimuth plane. The antenna is cavity-backed and the frequency selective surface is completely integrated with the antenna within the cavity. The FSS is designed to be transparent in the frequency range where the antenna is expected to radiate. Outside of this frequency range, it presents a metallic ground plane where the FSS shields the antenna, at frequencies where the radar cross-section of the antenna may be high.

The radiation properties of the antenna were measured, and along the azimuth plane, the antenna showed a completely omnidirectional radiation pattern. The antenna has radiation patterns similar to those of a monopole antenna on top of a finite ground plane.

Wideband Antennas with Directional Radiation in the Azimuth Plane

A low-profile, compact, and wideband vertically polarized antenna was developed that demonstrated directional radiation characteristics in both the azimuth and the elevation planes of radiation. The antenna is composed of four bent-diamond-shaped half loops placed on a ground plane. A photograph of the fabricated prototype of this antenna is shown in Figure 6. The half loops are fed at their centers and short-circuited to the ground at their ends. Two of the half loops are fed in phase while the other two are fed with 180° phase difference generating omnidirectional and figure-eight-shaped radiation patterns, respectively. Coherent combination of these radiation patterns generates a cardioid-shaped directional pattern. A prototype of the antenna was fabricated and characterized. The antenna has electrical dimensions of 0.54 λ_{min} × 0.4 λ_{min} × 0.116 λ_{min} at its lowest frequency of operation, and operates over a 2:1 bandwidth.

Enhancement of the Bandwidth of HF Antennas

Many antennas working at the high-frequency (HF) band have significantly smaller dimensions than the operating wavelength, and thus suffer from narrow bandwidths. In many military applications, such HF antennas are mounted on relatively large metallic platforms. We studied how a platform-mounted antenna can be used to excite the natural resonant modes of the platform to increase the overall bandwidth of the system. This way, the platform acts as the main radiator, and the mounted antennas act primarily as the coupling mechanism between the antenna and the external circuit. We used the theory of characteristic modes to identify the appropriate platform modes and determine the efficient means of exciting them. This allows for significantly increasing the bandwidth of the antenna system compared to what is achievable using the mounted antennas in isolation.

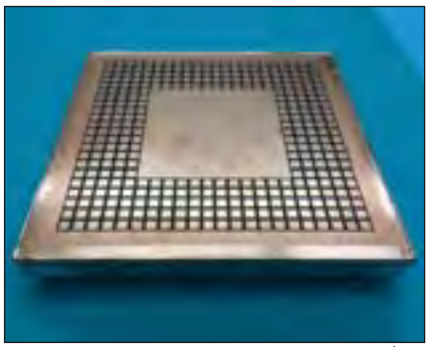


Figure 5. The fabricated integrated antenna/FSS prototype.

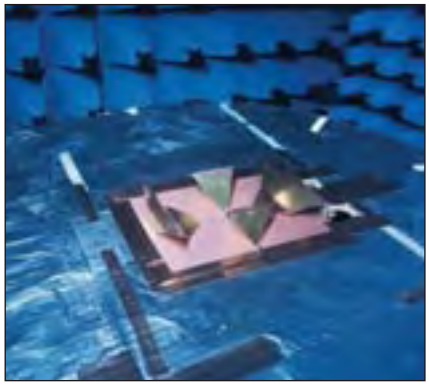


Figure 6. A low-profile, vertically polarized, wideband antenna with directional radiation patterns in the azimuth plane.

This approach was employed to successfully enhance the bandwidth of a horizontally polarized HF antenna system by as much as 10 times compared to a standalone antenna operating in free space. Scaled models of the proposed antennas were fabricated and experimentally characterized. Measurement results were observed to be in good agreement with the theoretically predicted results, and demonstrated the feasibility of using the proposed approach in designing bandwidth-enhanced platform-mounted HF antennas.

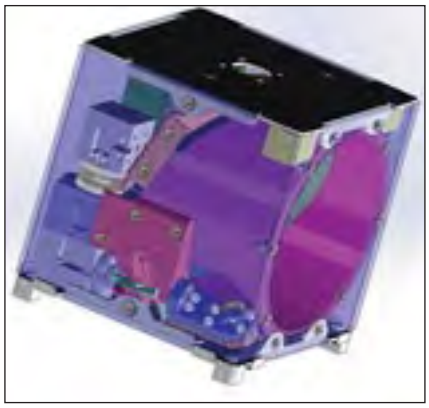
This article was written by Nader Behdad of the University of Wisconsin for the Office of Naval Research. For more information, contact the author at behdad@wisc.edu.

Microwave Radiometer for Advanced Nanosatellite Control Systems

Microwave radiometers measure temperature, water vapor, and cloud ice in the atmosphere, since oxygen and water vapor naturally emit signals in the microwave portion of the electromagnetic spectrum. These signals are measured at different heights and are used to make 3D images of hurricanes, tropical storms, and thunderstorms. The NanoRacks-Micro-sized Microwave Atmospheric Satellite (NanoRacks-MicroMAS) measures temperature from molecular oxygen. NanoRacks-MicroMAS is a small, low-cost CubeSat containing a miniaturized microwave scanner that paves the way for future constellations of similar satellites, gathering more detailed, more frequent images of severe weather that impacts people on Earth. NanoRacks CubeSats are delivered to the International Space Station (ISS) already integrated within a NanoRacks CubeSat Deployer (NRCSD).

The NanoRacks-MicroMAS is a dual-spinning 3U CubeSat equipped with a passive microwave spectrometer that operates nine channels near the 118.75-GHz oxygen absorption line. The focus of the first NanoRacks-MicroMAS mission is to observe convective thunderstorms, tropical cyclones, and hurricanes from a near-equatorial orbit. The payload housed in the "lower" 1U of the dual-spinning 3U CubeSat is mechanically rotated approximately once per second as the spacecraft orbits the Earth, resulting in a cross-track scanned beam with a full width at half-maximum (FWHM) beam width of 2.5 degrees, and an approximately 20-km-diameter footprint at nadir (directly below) incidence from a nominal altitude of 400 km.

Radiometric calibration is carried out using observations of cold space, the Earth's limb (edge of the planet), and an internal noise diode that is weakly coupled through the radio frequency (RF) front-end electronics. In addition to the dual-spinning CubeSat, a key technology development is the ultra-compact intermediate frequency processor module for channelization, detection, and analog to digital conversion. The payload antenna system and RF front-end electronics are highly integrated, miniaturized, and optimized for low-power operation. To support the spinning radiometer payload, the structures subsystem incorporates a brushless direct current (DC) zero-cogging motor, an optical encoder and disk, a slip ring, and a motor controller.



Rendering of a 118-GHz microwave radiometer from the NanoRacks-MicoMAS nanosatellite. (MIT Lincoln Laboratory)

The NanoRacks-MicroMAS nanosatellite with radiometer payload rendering. (MIT Lincoln Laboratory)

The Maryland Aerospace MAI-400 attitude determination and control system (ADCS) utilizes reaction wheels, magnetorquers (magnetic coils that are used to interact with the magnetic field of the Earth and apply specific torques to the satellites to prevent tumbling and stabilize the attitude), and infrared (IR) Earth horizon sensors, as well as Sun sensors, a magnetometer, and an inertial measurement unit (IMU). Radio communications are at ultra-high frequency (UHF) using the NASA Wallops Flight Facility ground station.

NanoRacks-MicroMAS uses a Pumpkin™ CubeSat Motherboard with a Microchip PIC24 microcontroller as the flight computer running Pumpkin's Salvo Real Time Operating System. Thermal management includes monitoring with thermistors (a resistor with a very large change in resistance as a function of temperature), heating, and passive cooling. Power is generated using four double-sided deployable 2U solar panels and with ultra triple junction (UTJ) solar cells, and an electrical power system (EPS) with 20 Wh lithium polymer batteries from Clyde Space.

The relatively low cost of CubeSat remote sensing to be demonstrated by NanoRacks-MicroMAS facilitates the deployment of a constellation of sensors, spaced equally around several orbit planes. Constellation simulations show that a dozen satellites could provide average global revisit times approaching 20 minutes, a revolutionary step forward for atmospheric sounding and precipitation science.

A small fleet of Micro-sized Microwave Atmospheric Satellites could yield high-resolution global temperature and water vapor profiles, as well as cloud microphysical and precipitation parameters. The NanoRacks-MicroMAS flight unit was developed by MIT Lincoln Laboratory, the MIT Space Systems Laboratory, the MIT Department of Earth and Planetary Sciences, and the University of Massachusetts-Amherst Department of Radio Astronomy.

High-resolution, fast imaging of Earth's atmosphere gives weather forecasters better information about hurricanes, tropical storms, and other severe weather. Improved observations aid weather forecasting and disaster-response preparations, as well as scientific research on the evolution of storm systems. NanoRacks-MicroMAS supports the development of more advanced nanosatellite control systems, which are used for a wide range of Earth-observing and communications applications.

For more information, visit ***www.nanoracks.com****.*

Secret Sharing Schemes and Advanced Encryption Standard

Using a simplified methodology to probe weaknesses in Shamir's Secret Sharing Scheme.

Naval Postgraduate School, Monterrey, California

There are many secret sharing schemes and variations available to hide and reconstruct the given secret. Shamir's Secret Sharing Scheme, making use of linear Lagrange interpolation on the dealer-generated polynomial, was used to reconstruct the secret from the stipulated threshold number of participants' shares. Such a scheme had been widely analyzed by mathematicians and computer scientists for potential weaknesses in the reconstruction of the secret by an external eavesdropper.

The objective of this research was to present a variation of Shamir's threshold secret sharing scheme by manipulating the dealer-generated polynomial into a simplified version such that any eavesdropper can reconstruct the secret by gaining two public shares, instead of the stipulated threshold level. The envisaged improvements would then be evaluated for any impact on side-channel effects on the Advanced Encryption Standards.

Existing and famous mathematical conjectures (including Pillai's conjecture, the Fermat-Catalan conjecture, and Hall's conjecture) were built upon to seek a potential weakness in the security of the current secret sharing scheme. Essentially, the analysis aimed to reduce the order of difficulty in reconstructing the secret. Assuming that the dealer-generated polynomial is monic, it is then deconstructed by applying a composite linear function in which two additional variables are introduced.

In general, assuming that the original form of the dealer-generated polynomial is $f(x) = a_0 + a_1x + a_2x^2 + \ldots + a_{k-1}x^{k-1}$, by composing it with the linear function $g(x) = x+\alpha$, the eventual form of the dealer-generated polynomial can be manipulated to be in the form of $f(x) = (x+\alpha)^k - b_0$, where both α and b_0 are the two newly introduced variables. The challenge then is reduced to finding the values of both α and b_0.

It was postulated that an eavesdropper would be able to recover the secret by simply obtaining two public shares, namely (x_1,y_1) and (x_2,y_2), from the multitude of available public shares, and this could be achieved by determining the numerical boundaries for the variable α. Specifically, all encompassing cases, without loss of generality, were considered to ensure that all possibilities were not neglected. The start state would be to take the difference between the two y-values that were easily obtained. From there on, it is just a matter of manipulating the inequalities to screen out the boundaries of α. Once the boundaries of α were found, then it would be trivial to try out the available choices for α, and subsequently b_0, and eventually the secret.

While this methodology does not allow for the absolute reconstruction of the secret as compared to Lagrange interpolation, it presents an alternate methodology for an eavesdropper to retrieve the secret using shares that are significantly less than the required threshold number. The boundaries reduced the possibilities of the secret value from a near-infinite number to a manageable cardinality size that could be derived through exhaustive means. The crux is that as long as two shares are gathered together, the value of α can be derived easily through exhaustive means. Once the value of α is found, then it remains trivial to determine b_0 through the equation $y_i = (x_i+\alpha)^k - b_0$, where (x_i,y_i) are known public shares. Subsequently, the secret is reconstructed to be f(0).

This work was done by Bing Yong Lim for the Naval Postgraduate School. ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Software category****. NPS-0001*

SIPHER: Scalable Implementation of Primitives for Homomorphic Encryption

Improving the efficiency and scalability of Fully Homomorphic Encryption (FHE).

Air Force Research Laboratory, Rome, NY

Prior to the Proceed program, the main challenges preventing practical demonstrations and use of Fully Homomorphic Encryption (FHE) were efficiency and scalability. At the start of the Program, the state-of-the-art FHE implementations were both inefficient and not scalable. Work in Scalable Implementation of Primitives for Homomorphic EncRyption (SIPHER) has brought FHE into the realm of practice, bringing several orders of magnitude runtime improvement, and resulting in FHE implementations that can be executed on single and multicore computers (including iPhones). Furthermore, implementation of an FHE hardware accelerator on a Virtex 7 Field Programmable Gate Array (FPGA) can speed up core FHE functions by over three orders of magnitude.

Previous FHE schemes were inefficient because the underlying algorithms and their implementations took too long to run at an appropriate level of assured security. Similarly, these

FHE schemes were not scalable because memory requirements for encrypting practical-length messages with a reasonable level of security exceed the abilities of highly parallel computation devices like FPGAs. These issues are driven by several factors:

- The very large keys required for an assured level of security and large expansion of unencrypted plaintext messages to encrypted ciphertext.
- The large computation depth needed for Bootstrapping/Recryption circuits (an efficiency bottleneck of FHE schemes).
- The lack of scalable and highly optimized implementations of basic modulus ring operations, which are building blocks used across many lattice FHE schemes.

These activities culminated in many orders of magnitude improvement for these bottlenecks. This revolutionary improvement was achieved by signifi-

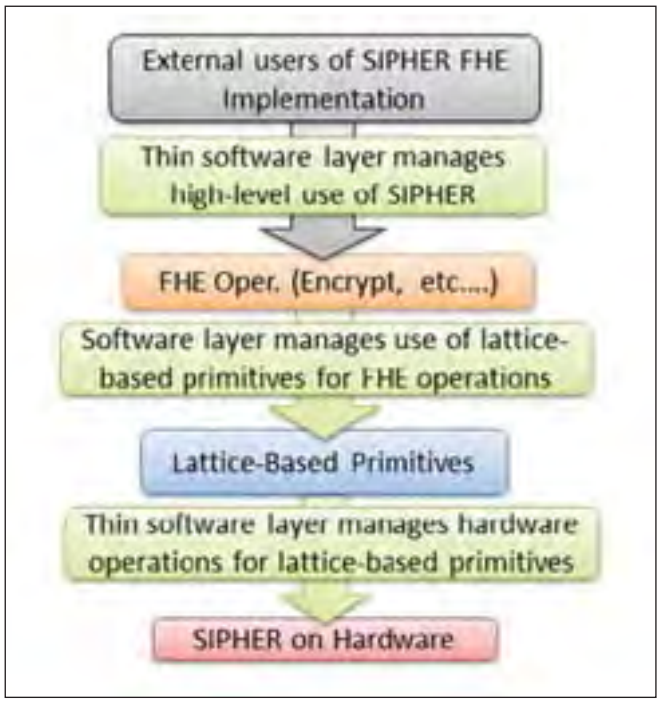
cantly advancing the state of the art in a number of independent focus areas:

- Multiple foundational improvements in the underlying FHE scheme for more efficient and scalable implementations of FHE operations. These improvements include a new approach to FHE Recryption, and the use of modulus and ring reduction to limit ciphertext expansion.
- Parallelizable, efficient algorithm design for scalable implementations of basic computational primitives at the core of lattice FHE schemes improving runtime of all FHE operations.
- Advanced code development approach for efficient and flexible embedded and FPGA implementations.

The accompanying Figure shows the layered SIPHER approach. Software interfaces are provided for optimized basic FHE operations. This lets users construct general applications computing on encrypted data. Core lattice-based primitives form the heart of the FHE implementations. This modular approach allows users to:

1) construct and experimentally modify multiple implementations of FHE operations and
2) easily deploy code on FPGA hardware to run the primitives on cost-effective, massively parallel hardware, providing 3 orders of magnitude improvement in basic FHE operation runtimes.

This work was done by David Cousins, Kurt Rohloff, Christopher Peikert, and Daniel Sumorok of Raytheon BBN Technologies for the Air Force Research Laboratory. ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Software category.*** *AFRL-0244*



Layered SIPHER approach

Using Mathematics to Make Computing on Encrypted Data Secure and Practical

Developing new algorithms to improve data security.

Air Force Research Laboratory, Rome, New York

In order to make computing on encrypted data more practical to use and more secure from attack, it is necessary to discover, develop, and understand the mathematics on which it is based and the mathematics that can be used to attack it.

The security of homomorphic encryption schemes is based on the presumed difficulty of mathematics problems about lattices. Discovering and fully exploring algorithms to solve these mathematical problems allow computing on encrypted data to be performed with confidence, knowing that its cryptographic security is based on sound mathematical foundations.

Hendrik Lenstra and Alice Silverberg discovered and developed algorithms to solve some lattices problems under suitable conditions, and investigated the mathematical foundations of these algorithms. A primary method of attack on homomorphic encryption schemes consists of lattice algorithms performed on ideal lattices, which are lattices with a certain type of algebraic structure. Any structure or symmetry is potentially susceptible to exploitation and attack. The work performed here gives algorithms for lattice problems for lattices that have symmetry. Recommendations are that the mathematical foundations of lattices with symmetry be further developed, in order to quantify the security of lattice-based cryptography, including especially the security of homomorphic encryption schemes.

In encryption schemes, one party encrypts a plaintext message to obtain a ciphertext. The other party decrypts the ciphertext to recover the plaintext. In Fully Homomorphic Encryption (FHE), parties that do not know the plaintext data can perform computations on it by performing computations on the corresponding ciphertexts.

The security of essentially all currently known FHE schemes is based on

the presumed difficulty of some lattice problem, such as finding an approximately shortest (non-zero) vector in a high dimensional lattice. The primary known attacks on FHE schemes are variants of the LLL lattice basis reduction algorithm, originally due to Lenstra, Lenstra, and Lovász.

A number of Fully Homomorphic Encryption schemes use ideal lattices rather than arbitrary lattices, including Gentry's first FHE scheme. Fully Homomorphic Encryption is performed more efficiently with ideal lattices than with general lattices. However, ideal lattices are very special lattices, with much structure ("symmetries") that has the potential to be exploited, and it might turn out to be the case that lattice attacks are easier for ideal lattices than for generic lattices.

Gentry and Szydlo introduced some powerful new ideas that combined in a clever way lattice basis reduction and number theory. They used these ideas to cryptanalyze NTRU (NTRUEncrypt Public Key Cryptosystem) Signatures. The recent interest in Fully Homomorphic Encryption and in the candidate multilinear maps of Garg-Gentry-Halevi have renewed the interest in the Gentry-Szydlo results.

The algorithm of Gentry and Szydlo can be viewed as a way to find an orthonormal basis (if one exists) for an ideal lattice. Determining whether a lattice has an orthonormal basis is in general a difficult algorithmic problem. The results of this research show that this problem is easier when the lattice has many symmetries. Lenstra and Silverberg construct a provably deterministic polynomial-time algorithm that decides whether a given lattice with sufficiently many symmetries has an orthonormal basis, and finds one if it does. More precisely, they give a deterministic polynomial-time algorithm that, given a finite abelian group G, an element u in G of order 2, and a G-lattice L, decides whether L and $Z\langle G\rangle$ are G-isomorphic, and if they are, exhibits a G-isomorphism. The Gentry-Szydlo algorithm is put into a mathematical framework, and shown as part of a general theory of "lattices with symmetry," shedding new light on the Gentry-Szydlo algorithm, and demonstrating that the ideas should be applicable to a range of questions in cryptography.

This work was done by Alice Silverberg and Hendrik Lenstra of the University of California, Irvine for the Air Force Research Laboratory. ***For more information, download the Technical Support Package (free white paper) at www.aerodefensetech.com/tsp under the Sofware category. AFRL-0243***

Gallium Nitride (GaN) Solid State Radar

Cobham Integrated Electronics Solutions
Exeter, NH
603-775-5200
www.cobham.com

Cobham and RFHIC Corporation (RFHIC) of Korea have established a strategic partnership to incorporate RFHIC's Gallium Nitride (GaN) technology into Cobham's next-generation RF products. Cobham and RFHIC will jointly develop GaN High Power Amplifier (HPA) modules that will be integrated into a prototype 175 KiloWatt (KW) solid state transmitter. Development activities will be executed by Cobham Integrated Electronics Solutions, a business unit of CAES, at its Exeter, New Hampshire site.

GaN-based Solid State Transmitter (SST) technology has a number of advantages over traditional systems. Radar transmitters using Vacuum Electronics Devices (VED) such as Klystrons, Traveling Wave Tubes (TWT), Magnetrons, and Crossed-Field Amplifiers (CFA) have high operational and sustainment (O&S) costs, require very high voltage power supplies, and the systems are not proven to have high reliability.

Compared to VEDs used in current transmitter designs, Cobham's SOLSTx technology offers a number of advantages such as a significant increase in Mean Time Between Critical Failure (MTBCF); graceful degradation (as opposed to single point of failure/instantaneous shutdown) in the event of hardware failure; significantly lower Phase Modulation (PM) noise levels resulting in higher Clutter Improvement Factor (CIF); and significantly lower out-of-band emission reducing the interference with adjacent radars and commercial communication signals. The new technology also offers reductions in size, weight, and power, meaning increased system efficiency; up to 10% higher duty cycle; and greater range of pulse widths (up to 100 μS).

Cobham has already successfully developed a 35KW prototype S-Band Solid State Transmitter for air traffic control and weather radar applications. RFHIC has a comprehensive product portfolio from discrete components to integrated high power amplifiers. The combined expertise of Cobham and RFHIC will enable further exploration of domestic and international civil and military radar applications for GaN-based solid state technologies. Additionally, the partnership between Cobham and RFHIC may help provide offset obligations between Korean Military and US Navy contracts.

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Helicopter DVE Solution

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Elbit Systems recently performed a series of successful demonstration flights using the BrightNite™ system, a solution that enables utility helicopters to successfully perform Degraded Visual Environment (DVE) missions in more than 90% of the nights. The goal of the flights was to demonstrate the systems' performance in DVE conditions, in moonless, pitch dark nights, in which flights are rarely executed. Dozens of pilots from a variety of Air Forces around the globe participated in the demo flights, which took place in Israel. Installed onboard an Airbus Twin-Star helicopter for the demo, the BrightNite system provided the pilots with night-piloting capabilities similar to and, in some cases, exceeding those of attack helicopters.

The BrightNite solution is comprised of non-gimbaled uncooled FLIR and highly sensitive Complementary Metal-Oxide Semiconductor (CMOS) sensors that present an ultra-

wide field of regard intuitive image to a display system which projects to the HDTS, Elbit System's most common ANVIS/HUD™ HMD with Line of Sight capabilities. The display is overlaid by a synthetic layer that follows the contours of the landscape and a third layer of 3D mission conformal symbology, which displays hazards, mission conformal symbology, and tactical data. Multiple crew-members can simultaneously scan the entire field of regard, using a single sensor and the synthetic world, enabling them to fly any night.

Low-flying aircraft are especially vulnerable to threats such as difficult terrain, enemy fire, and the intersection of utility wires in the flight path. Sorties must often be carried out in a Degraded Visual Environment, adding to the already heavy workload and leaving flight crews to rely on NVGs to accomplish their mission. Factors limiting the pilots' FOV include: complete darkness, poor weather conditions, brownouts, whiteouts, and sandstorms.

According to the U.S. Army Aviation, there is a problem with spatial disorientation while operating in degraded visual environments. Historically, approximately 20 percent of all Class A and B mishaps have been attributed directly to spatial disorientation or loss of situational awareness in DVE, but the issue remains far from solution.

Elbit Systems' BrightNite overcomes these visibility limitations and greatly improves situational awareness, mission effectiveness, and above all, flight safety in DVE. The system processes real-time panorama video, enhanced by a 3D conformal mission symbology concept, and transmits high-resolution video to the Helmet-Mounted Display (HMD). BrightNite utilizes unified location-based information culled from a wide FOV to display crystal clear images, in zero visibility and zero latency, enabling helicopters to successfully execute missions in more than 90% of the nights.

For Free Info Visit ***http://info.hotims.com/61066-575***

F-35A In-Flight Refueling System

Lockheed Martin Aeronautics Co.
Bethesda, MD
301-897-6000
www.lockheedmartin.com

The Royal Netherlands Air Force recently completed testing to receive certification to refuel F-35A fighter aircraft with their KDC-10 tanker. During the testing, the Dutch F-35A successfully connected in flight with a Dutch KDC-10 refueling aircraft and was refueled during the day, at dusk and at night above the skies of Edwards Air Force Base, California.

The Dutch KDC-10 is a tanker and transport aircraft which can rapidly deploy cargo and troops over long distances. Two Boeing DC-10-30s have undergone modification to become Royal Netherlands Air Force KDC-10s. In addition to refueling F-35As, the tanker is certified to refuel NATO aircraft equipped with a boom system. Air-to-air refueling enables aircraft to remain airborne longer, ex-

tending range and increasing the striking power of fighter aircraft.

Unlike aerial refueling technology currently used in the U.S. Air Force KC-10A, Dutch KDC-10s use the Remote Aerial Refueling Operation (RARO) system. It includes three-dimensional operator displays and controls located in the forward main deck of the aircraft, plus remote sensors that allow wing tip-to-wing tip viewing of the area aft of the tanker.

With the remote operating concept, the refueling crew member is located forward in the aircraft cabin and uses a closed-circuit video camera and monitoring system to view the air refueling operation. Additionally, the RARO system provides superb night vision, improved vision in poor weather conditions, and enhanced depth perception because of the camera's stereoscopic and infrared capabilities. RARO's refueling operators console is on a pallet, so it can be removed to provide added space on the main aircraft deck during cargo or passenger carrying missions. The consoles can also be installed in passenger-carrying DC-10-30s that are not equipped with the wide cargo door.

The F-35A variant, which is what the Dutch fly, uses a flying boom aerial refueling — the pilot flies in a tight formation with the tanker. An operator at the back of the tanker and the F-35 pilot work together to ensure the boom aligns with the aircraft and is inserted directly into the fuel tank opening. F-35Cs and Bs use the hose and drogue system.

Over the course of testing, the tanker pumped approximately 30,000 pounds of fuel to the Dutch F-35A. The certification was led by the 418th Flight Test Squadron of the 412th Test Wing at Edwards AFB and executed by RNLAF personnel and aircraft. The test was a requirement to enable the Dutch to transport their F-35s to the Netherlands.

In addition to the Dutch tanker, air-refueling aircraft from Italy, Australia, and the United States have been certified to refuel F-35s. The increased interoperability of next-generation F-35s being able to network and share information together as well as refuel from other countries' tankers will enhance coalition training and warfighting capabilities for the F-35 partnership.

For Free Info Visit ***http://info.hotims.com/61066-507***

Helicopter

Finmeccanica
Rome, Italy
+39 06 32473313
www.leonardocompany.com

The first AgustaWestland AW101 helicopter from Finmeccanica, designated the HH-101A "CAESAR," entered operational service with the Italian Air Force at Cervia Air Base earlier this year. A total of four HH-101A "CAESAR" helicopters, out of a total requirement of 15, have been delivered from the Finmeccanica Helicopter Division's assembly line in Yeovil (UK) to date, and will be used to perform personnel recovery and special forces missions. The HH-101As will also support search and rescue (SAR), medical evacuation (MEDEVAC), and slow mover intercept operations, countering small aircraft threats, to provide effective support to the Italian community.

The AW101 is one of the most advanced medium lift helicopters available today and is in service in a number of operational environments from the Arctic to the Antarctic. Depending on configuration, up to 30 troop seats or 12 stretchers can be hosted on board. Over 220 AW101 helicopters have been ordered to date by customers worldwide to perform a large number of roles, including personnel recovery, Special Forces operations, SAR, Combat SAR, utility, troop transport, Anti-Surface Warfare, Anti-Submarine Warfare, Airborne Early Warning, airborne mine countermeasures, and Heads of State/Government transport.

In the HH-101A configuration, the craft is able to accommodate up to five crew members plus twenty fully equipped troops, or six crew members plus eight troops for special operations, ensuring maximum mission flexibility. The helicopters also feature three M134 7.62-mm pintle mounted Gatling-type machine guns installed on right and left sides and on the rear ramp provided by Finmeccanica Defence Systems Division, armored cockpit seats, ballistic protection for machine gun operators, as well as for critical systems and an Integrated Electronic Warfare System.

Through its Airborne & Space Systems Divisions, Finmeccanica has supplied a number of sensors, communication, and self-protection systems, including radios, Identification Friend or Foe (IFF), crypto, Link 16, intercommunications system, Gabbiano radar system, Laser Warning Receiver (LWR), and a Missile Launch Detection System (MILDS). The HH-101A also features an air-to-air refueling kit for extended range operations.

To date, over 220 AW101s in various configurations have been ordered by customers worldwide, including Italy, UK, Japan, Canada, Portugal, Denmark, and Norway.

For Free Info Visit ***http://info.hotims.com/61066-581***

Radiation Tolerant 3-Phase Motor Drive

Data Device Corporation (DDC) (Bohemia, NY) introduced a new high-reliability, 3-phase radiation tolerant motor drive, providing 100k Rad Total Dose protection, and advanced circuit and logic protection to ensure fail-safe operation. The new compact PW-82336 3-phase motor drive hybrid utilizes a high-efficiency, radiation tolerant MOSFET output stage with 100 VDC rating to deliver 5A continuous current (10A peak current) to the motor.

Flexible I/O allows common design to be used across multiple application platforms with individual bridge returns and standard logic level inputs. Design eliminates shoot-through conditions with high and low-side input logic signals XOR's in each phase to prevent simultaneous turn on of in-line transistors. Internal logic controls (from +5 to +15 V) for the high and low-side gate drivers for each phase. 100 VDC rating with 5A continuous, 10A peak current capability.

For Free Info Visit http://info.hotims.com/61066-529

Lightning Protection Products

CDM Electronics (Turnersville, NJ) now stocks the full Times Microwave Systems' Times-Protect™ Series of surge and lightning protection products and accessories. These connectors meet or surpass all industrial, commercial, military and aerospace wireless communications standards for equipment and infrastructure with a frequency operating band from DC to 6 GHz.

The Times-Protect Series (LP-XXX) features a proprietary DC blocking technology to support optimum isolation in the event of multiple lightning strikes and subsequent power surges. Easy-to-install with Type N or 7/16 DIN interconnects, protectors are offered with an IP65- or IP67-rated shield that makes them suitable for outdoor as well as indoor use. Low PIM (Passive Intermodulation) versions for specialized applications are also provided. Parts are supplied in numerous configurations and mounting arrangements to maximize design flexibility in both new and retrofit applications.

For Free Info Visit http://info.hotims.com/61066-510

700 MHz - 6 GHz Benchtop Power Amplifiers

AR (Bothell, WA) now provides up to 350 watts of linear output power over the 0.7 to 6 GHz instantaneous frequency band in one benchtop amplifier housing when driven with a signal generator output of 0 dBm. Class A designs can be provided when linearity and ∞:1 output protection is required, or in Class AB configurations when lower cost and higher efficiency are needed with slight sacrifices in linearity and output VSWR protection. Units have a digital display and all amplifier control functions and status indications are available remotely in GPIB/IEEE-488 format, RS-232 hardwire and fiber optic, USB, and Ethernet. These instruments are used for EMC, wireless, or EW applications.

For Free Info Visit http://info.hotims.com/61066-513

Portable 3D Scanner

Hexagon Manufacturing Intelligence (North Kingstown, RI) has released the new Leica Absolute Scanner LAS-20-8, a portable laser scanner for large volume inspection applications such as automotive sheet metal, aerospace mold tools, large industrial castings and more. The lightweight, ergonomic LAS-20-8 is optimized for portable metrology applications requiring effective measurement volumes up to 196.85 ft. With an IP50 rating and a convenient battery power option, the scanner can be utilized almost anywhere on the factory floor or in the field.

The LAS-20-8 laser scanner integrates seamlessly with the Leica Absolute Tracker AT960, Leica T-Probe. The laser scanner uses the same software interface as Hexagon's ROMER Absolute Arm product line, enabling experienced operators to immediately apply their existing knowledge to system checks, compensation and certifications.

For Free Info Visit http://info.hotims.com/61066-511

Inertial Navigation System

Based on iXblue's (Natick, MA) unique Fiber Optic Gyroscope Technology, Phins C3, C5 & C7 are fully scalable inertial navigation systems with a similar architecture and interface. Available as an OEM version, the three products all include the same algorithm and software, which enables seamless reuse of the control system on any vehicles' sizes or types, via modern interfaces such as Ethernet, helping to reduce integration and non-recurring costs. With a MTBF up to 100,000 hours and with no need for preventive maintenance, the systems guarantee high levels of reliability and robustness. Phins C3, C5 & C7 are ITAR-free, dual-use systems and are all compatible with DELPH INS post-processing software to achieve ultimate survey accuracy.

For Free Info Visit http://info.hotims.com/61066-520

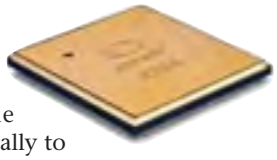
Radio Test Set

Astronics Corporation (East Aurora, NY), through its wholly-owned subsidiary Astronics Test Systems, has introduced a radio test solution for use in commercial aerospace, military, and civil security applications. The new CTS 6000 Series radio test set, incorporates nine test capabilities into a single tester with an easy-to-use, modern touchscreen interface for testing radio communications systems at the factory, at the depot or in the field.

Users can test tactical handsets, amplifiers, antennae and any other component of a radio system. General specifications include: 10.1" sunlight-readable display; 11.8" × 10" × 3.3" (300 mm × 255 mm × 85 mm) overall size; weight of less than 10.6 lbs. (4.8 kg); Windows 7; and a 128 GB solid state hard drive.

For Free Info Visit http://info.hotims.com/61066-522

Ptototyping FPGAs



Microsemi Corporation (Aliso Viejo, CA) has introduced the RTG4™ PROTO field programmable gate arrays (FPGAs) developed specifically to enable prototyping of space systems, enable lower cost prototyping and design validation activities for the latest radiation-tolerant high-speed FPGAs. The RTG4 PROTO FPGAs are also the only reprogrammable prototyping solution of their kind providing the same timing and power characteristics as space flight units.

Microsemi's new RTG4 PROTO FPGAs enable easy hardware timing verification, as well as power evaluation. As the devices use the same reprogrammable flash technology as flight units, they can be reprogrammed multiple times without being removed from the development board. The RTG4 PROTO FPGAs are electrically tested to ensure reliable performance over full military temperature ranges and are offered in non-hermetic, ceramic packages.

For Free Info Visit http://info.hotims.com/61066-526

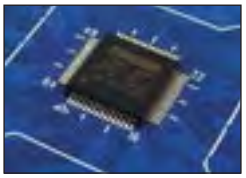
Fanless Embedded Computer

DFI Tech (Sacramento, CA) now offers a higher performance quad core processor in its rugged EC series fanless computing systems. The EC700-BT Fanless Embedded System from DFI Tech features an Intel® Atom™ E3845 quad core 1.91GHz processor and 4GB of DDR3L ECC on-board memory. The lightweight fanless system is rugged, conforming to MIL-STD-810F (514-5C-2) for vibration and can handle 15G half sine wave of shock for 11 ms in 3 axes.

The EC700 can be wall-mounted or VESA-mounted and supports expansion for 3 Mini PCIe, 1 mSATA storage, 1 SIM card, and 1 microSD. There is also I/O of 8-bit DIO, 4 serial ports, 5 USB, 2 WiFi antenna holes, 1 VGA, 1 HDMI, and 2 LAN.

For Free Info Visit http://info.hotims.com/61066-536

Disk Encryption Technology



Enova Technology Corp. (San Jose, CA) recently announced its 10th generation X-Wall MX+ hardware security solutions for Microsoft EHDD. The X-Wall MX+ has built-in TCG Opal 2.0 capability to effectively transform any number of standard SATA disk or SSD to an Opal 2.0 compliant drive.

When working in conjunction with another built-in IEEE1667 firmware, the X-Wall MX+ can transform any number or capacity of standard SATA disks or SSD's into an eDrive, wherein Microsoft BitLocker can manage and configure it, through the software interface of the IEEE1667 and Opal 2.0. In this application it can configured as either a boot drive, a data drive, or a portable drive using latest USB3.0/USB3.1 technology.

For Free Info Visit http://info.hotims.com/61066-537

ARINC 600 Network Server

MEN Micro Inc. (Blue Bell, PA) now offers a robust ARINC 600-compliant high speed network server for inflight communications. Pre-integrated and pre-qualified to DO160-G up to the operating system, the versatile MP70S enables aircraft to achieve new levels of inflight connectivity for wireless data transmission, entertainment and system maintenance applications. Using the latest Intel Core i7, quad-core 64-bit processor, the MP70S easily handles the high performance computing and networking requirements of modern avionics applications.

Based on CompactPCI Serial, the MP70S is a scalable system offering flexible I/O configuration and long-term availability. A carrier-grade, managed 16-port Ethernet switch ensures high availability, providing six ports internally and 10 via the ARINC 600 connector. Two USB 3.0 interfaces for fast, efficient data uploads and internal disk updates. Two hot-pluggable 2.5" SATA HDD/SSD shuttles, totaling 1.8 TB, and two SIM card slots are also accessible via the front panel. The robust system provides an interface for ARINC 429 and ARINC 717 as well as discrete I/O for connection to legacy aircraft equipment.

For Free Info Visit http://info.hotims.com/61066-514

ADS-B Compliant Transponder

ACSS (Phoenix, AZ), an L-3 and Thales Company, has developed an ADS-B transponder solution for legacy corporate aircraft, the NXT-700. This next-generation Mode S transponder will satisfy the DO-260B mandate for Automatic Dependent Surveillance-Broadcast (ADS-B) on many legacy aircraft models and will reduce owner/operator costs, as well as downtime, because it is a "one-quarter ATR short" form-fit installation.

L-3's NXT-700 ADS-B transponder is designed for use on the following legacy aircraft models: Beechcraft Hawker 125-400, 600 and 700; Beechcraft Hawker 400 SP/Beechjet, Early 400 Series; Gulfstream IIB, III and V; IAI Westwind 1124; Textron Aviation CitationJet, Ultra, V, VII and 550; Learjet 35, 35A, 36 and 36A; Dassault Aviation Falcon 10, 20, 50, 200, 900 and 900B; and Bombardier CL-6013A and 3R.

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Rate Indicator/Totalizer

The Hoffer (Elizabeth City, NC) HIT-4U Rate Indicator/Totalizer is being offered with additional options providing the user with enhanced functionality and flexibility in a compact enclosure. The choice of a NEMA 4X enclosure joins the explosion-proof enclosure options and is now available flow meter mounted or remote mounted on a 2" or smaller pipe. The NEMA 4X enclosure offers options for local Modbus access ports via USB port or hardwired access through strain relief for data log retrieval and configuration of the unit.

Additional user friendly features of the unit include 12-point linearization, dual set point alarm output configurable for rate or total and a wide range of engineering unit display icons. The HIT-4U is offered in battery or loop-power with a lithium battery backup to ensure continuous, reliable performance.

For Free Info Visit http://info.hotims.com/61066-534

Rugged Embedded System

Connect Tech (Guelph, Ontario) announces Rosie, its latest rugged embedded system, based on the NVIDIA® Jetson™ TX1. Housed in a compact enclosure with optional mounting brackets, Rosie features the NVIDIA Maxwell™ architecture with 236 CUDA cores delivering over 1 TeraFLOPs of performance with a 64-bit ARM A57 CPU.

Rosie's rugged system also provides USB, HDMI, 2x Gigabit Ethernet, WiFi, and Bluetooth capabilities. Designed to MIL-STD 810g and DO-160G for shock and vibration as well as IP67/68 ingress protection rating. Additional features include: 4GB LPDDR4 of memory; 16GB eMMC storage; 1x HDMI Type A display; 2x Gigabit Ethernet (10/100/1000) RJ-45s connectors; 1x RS-232 with Modem (TX/RX/RTS/CTS) serial connector; 4 x Parallel or CSI-2/MIPI Camera Sensor Inputs via Coaxial Input on SMA video inputs; 2x USB 2.0 Type A connectors; and IEEE 802.11 a/c 2x2 WiFi. Operating Temperature: -40°C to 85°C.

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Product Spotlight

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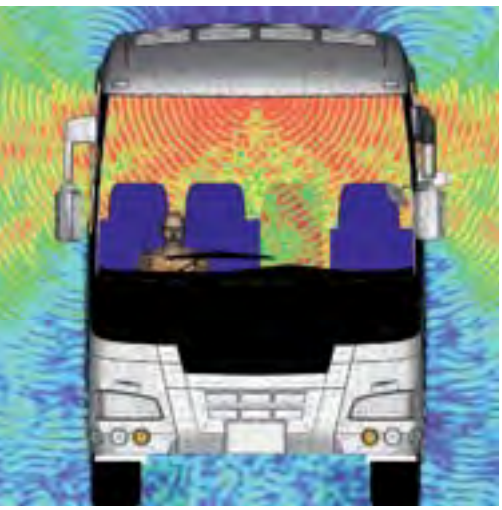
October 2016, Volume 1, Number 6

Make the Connection

Find the simple way through complex EM systems with CST STUDIO SUITE



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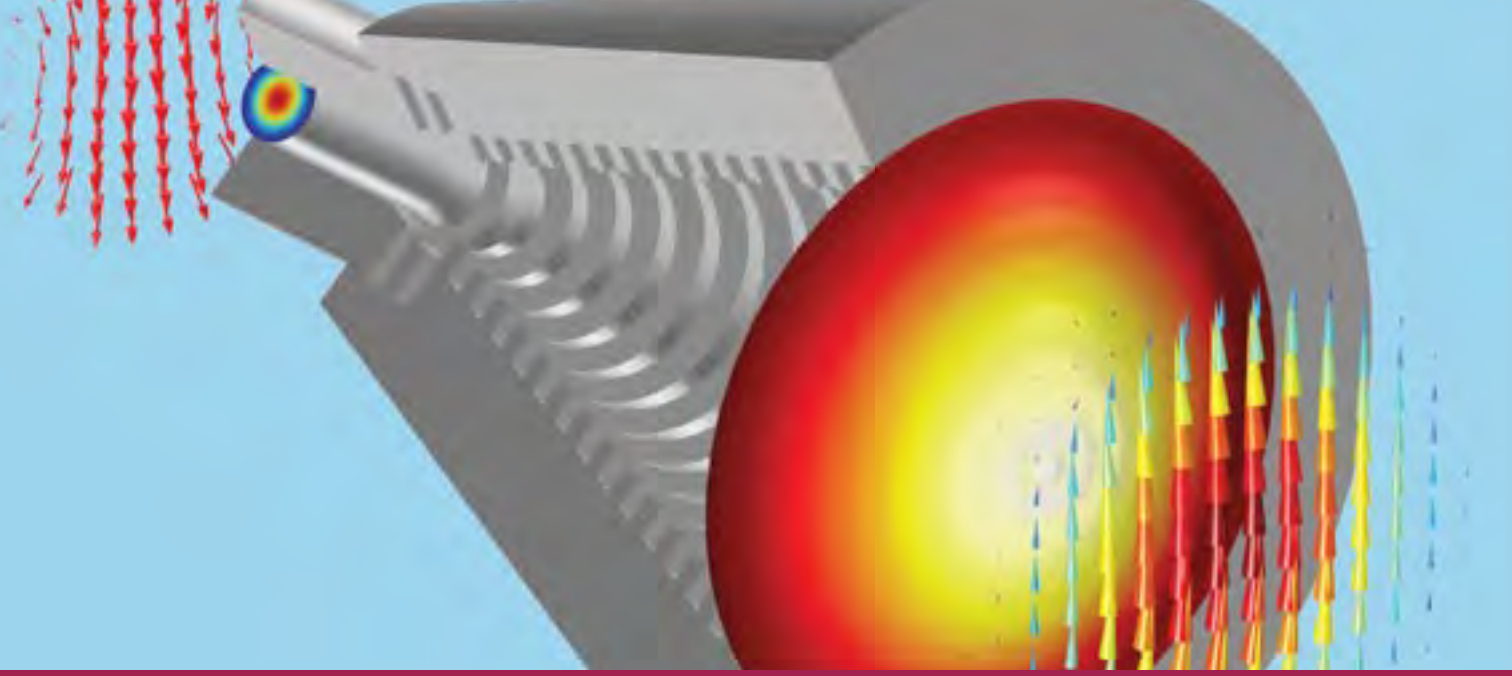

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