FIGHTERS EDITION

SPRING 2021

CONTACT!

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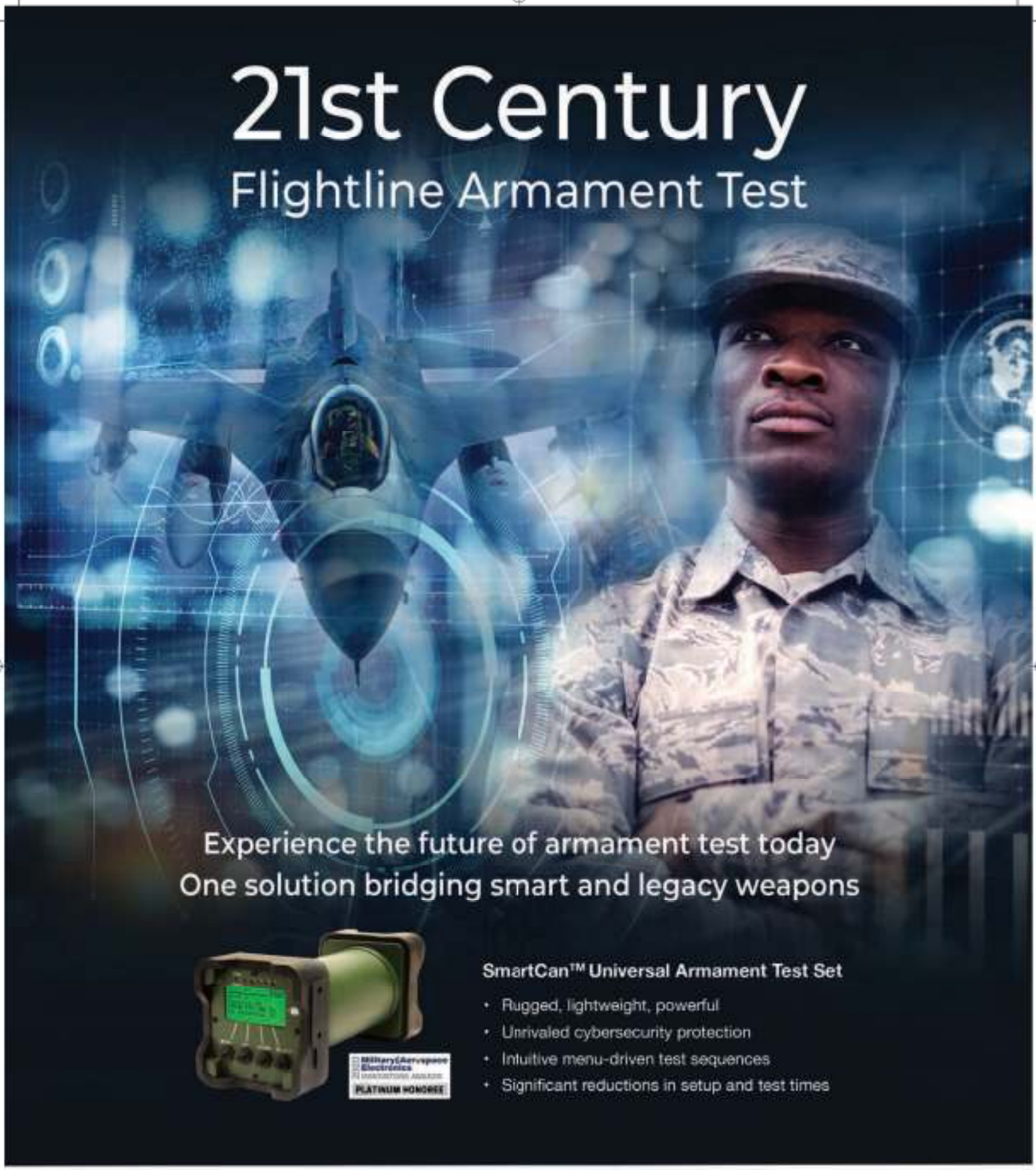

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Curtiss-Wright:

Upgrading Data Storage Capacity on Legacy Aircraft with Open Standards

Curtiss-Wright Defense Solutions is the world's leading supplier of rugged commercial-off-the-shelf (COTS) computer, networking and data storage solutions for defense and aerospace platforms. Our flexible subsystem designs can support legacy data buses, like MIL-STD-1553 and ARINC 429, making it fast, simple and cost-effective to replace aging aircraft systems with modern high-performance equipment. Even better, because our designs are based on the industry's favorite open standards, we can support your platform for many years to come. We solve semiconductor device obsolescence, technology roadmap, and lifecycle management problems every single day. That means we don't just provide your aircraft with a stop-gap solution. Instead, we deliver an open architecture path to ease technology insertion, so the performance of your systems can keep growing along with your demanding application requirements.

THE DATA STORAGE DILEMMA: CAPACITY AND SECURITY

One of the biggest problems facing system integrators today is the never-ending increase in data. From intelligence surveillance reconnaissance (ISR) sensors, video, and other proliferating sources, data just keeps growing. How do you store it and how do you keep it safe? Frequently, older data storage systems on legacy aircraft just aren't up to the job.

When defense and aerospace integrators need to upgrade their platform's data storage capabilities, or ensure their data is securely encrypted and safe from adversaries, they turn to Curtiss-Wright. Our range of high-performance open standards-based data storage systems can address even the most demanding ISR and EW application requirements.

MEET THE DTS1

The Data Transport System 1-Slot (DTS1), the embedded industry's first commercial off-the-shelf (COTS) data-at-rest (DAR) network attached storage (NAS) solution, stores up to 8 TB of data on a rugged Removable Memory Cartridge (RMC). The RMC, which is considered unclassified when in transport, is easily removed from one DTS1 and installed into another to provide seamless data transfer between one or more networks in separate locations (e.g. from ground to vehicle to ground), enabling quick data offloading. To protect that critical data, the DTS1 supports two layers of full disk encryption (FDE). Because it's received Common Criteria (CC) certification, the hardware and software FDE layers used in the DTS1 are listed on the United States NIAP Product Compliant List, NSA's CSfC Components List, the International Common Criteria Certified Products List, and the NATO Information Assurance Product Catalogue (NIAPC).

Selecting an approved data encryption solution device greatly reduces time, cost, and program risk. The DTS1 is deployed around the world today, storing and protecting classified data on ISR aircraft, helicopters, unmanned aerial vehicles (UAV), unmanned underwater vehicles (UUV), and unmanned ground vehicles (UGV).

INTRODUCING THE DTS3

With support for three RMCs, each storing up to six terabytes of data, the Data Transport System 3-Slot (DTS3) provides FIPS 140-2 certified AES-256 bit encryption for data-at-rest protection. Three storage cartridges means that mission, map, and maintenance data can all be stored on separate drives.

Find out what Curtiss-Wright can do for you. Upgrade to the upgrade experts!

CURTISS-WRIGHT

CURTISS-WRIGHT DEFENSE SOLUTIONS, a division of Curtiss-Wright Corporation, is recognized around the world as one of the most innovative designers and manufacturers of rugged and secure mission-critical solutions for the defense and aerospace industries.
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SmartCan™

A Test Set for the 21st Century Armament Maintainer

MARVIN TEST SOLUTIONS

The demand placed on armament maintainers in the 21st century continues to grow as weapons designers develop increasingly complex armament delivery systems incorporating advanced electronics and communications interfaces such as MIL-STD-1553 and MIL-STD-1760.

Fourth-generation aircraft have received numerous upgrades to their avionics and armament systems, including precision guided Smart weapons - now the munitions of choice for advanced militaries throughout the world. The ability to efficiently and effectively perform functional electronic testing on these complex optical guidance devices is necessary to ensure proper performance and safe operation. Yet, in many cases, maintainers are still required to use legacy test sets not capable of performing comprehensive armament system tests.

The F-16 is one example of the gap that exists between the advanced capabilities of its weapon systems and the inadequate flightline test equipment that is still in use for maintenance and sustainment. However, it is important to note that the armament test gap exists across all USAF fighter aircraft today.

NEXT GENERATION SOLUTION

In response to this capability gap in flightline test, Marvin Test Solutions (MTS) collaborated closely with maintainers to define, develop, and deploy the MTS-3060A SmartCan Universal O-Level Armament Test Set, the most advanced and cyber-secure flightline test set available. The SmartCan is capable of testing all Alternate Mission Equipment (AME), Normally Installed Equipment (NIE), and Aircraft Armament Equipment (AAE) including pylons, launchers, bomb racks, guns, and pods. Additionally, it can perform all pre-load and advance armament interface functional checkouts for both legacy and Smart weapons through weapons emulation, enabling common armament test and support for any known platform and any known Smart or legacy munition with advanced active test methodology.

Currently deployed in over 12 countries, and in use by the USAF System Integration Lab as a Smart weapons emulator for JDAM and AMRAAM, the SmartCan has repeatedly demonstrated significant reductions in training, field setup and test times, and sustainment.

WHEN WARFIGHTERS TALK, WE LISTEN

Armament maintainers have a clear understanding of the capability gap that exists with current flightline test sets and are a valuable resource when gathering data to develop next-generation solutions to these challenges.

MTS' collaboration with maintainers from organizations across the globe continues to drive innovation and improvements to the SmartCan, which is already the most advanced flightline armament test set available. We focus on understanding the challenges that maintainers face, and we strive to deliver solutions that are designed to make testing easy for the maintainer.

Here are some of the most recent SmartCan capability enhancements that resulted from MTS working closely with armament maintainers on the flightline:

Advance flightline test set additives

With the need to utilize numerous test sets, some of which are extremely large, expensive, and time consuming, to accomplish armament testing on a single aircraft SmartCan advancements have been taken. Cables and procedures, such as the F-15E

conformal fuel tank (CFT), have been added to accomplish functions which are currently accomplished by the -198 test set. This improvement to the SmartCan now allows an F-15E to be tested on the flightline by a single test set vs two test sets.

Test results at the speed of operations

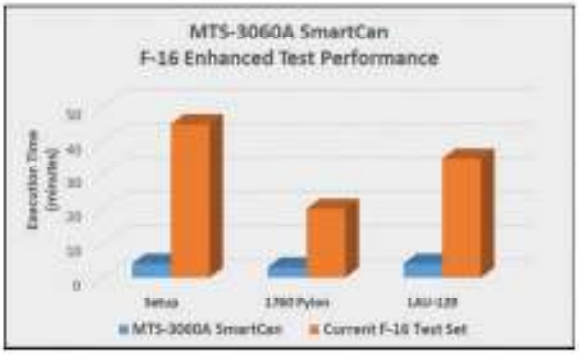
What if you learned it takes nearly three hours to complete one F-16 armament scheduled functional check accounting for more than 30,000 man hours annually? Now what if I told you this could be slashed to just 7,000 hours? Capitalizing on modern technology, over 35 test and measurement channels, and using active testing methods, SmartCan now makes this possible. Munitions stations which currently take 30-40 minutes to test, can be accomplished in roughly 5 minutes with the same level of test being accomplished.

Streamlined logistics, one test set, ALL aircraft

Unlike other flightline test sets, the SmartCan is capable of performing all pre-load and functional checkouts for both legacy and Smart weapons through active weapons emulation. This ensures SmartCan is a true common armament test set capable of supporting any known platform and any known Smart or legacy munition in any country. Future states exist where any US or NATO aircraft could land at any base and have a functional test accomplished by the base without waiting on a support package of equipment.

TRANSFORMING TROUBLESHOOTING AND TEST

The SmartCan increases test efficiency when every hour counts. Munitions stations tests, which currently take 30-40 minutes, can be completed in roughly 5 minutes with the same level of test being accomplished. Troubleshooting faults can now take minutes vs hours or days, ultimately allowing units to put more aircraft into the fight.



Active emulation allows the maintainer on the ground to duplicate what the pilot experiences in flight. Faults can now be identified in minutes, greatly accelerating debug and repair times over existing test systems. Scenarios for testing latency, intermittent or digital faults can be created and by testing single or multiple weapons stations simultaneously resembling the actual munition loads, thus fully testing the aircraft's digital interface and performance.

STREAMLINING LOGISTICS

As a universal tester, the SmartCan supports multiple types of aircraft and weapon systems. One customer was able to replace six flightline test sets used on two fighters with one SmartCan, simplifying logistics and reducing training requirements. One SmartCan could in fact support all DoD aircraft, and still have ample memory for future expansion.

ENABLING PREDICTIVE MAINTENANCE

The 21st century warfighter will undoubtedly benefit from many recent technological advances, but artificial intelligence (AI) arguably has the potential to be the most significant. The SmartCan, paired with powerful AI software, could become the premier predictive maintenance O-level test set, putting tomorrow's problems in the maintainer's hands today. Maintainers who employ this solution would no longer be held hostage to conducting reactive maintenance, or replace parts which may still be serviceable, based on only maintenance historical records analysis. Instead, they would be able to incorporate actual soon-to-fail components into their normal work flow, thus controlling the maintenance cycle and fixing pending failures before they happen.

CONCLUSION

Armament test is challenging and incredibly daunting when aircraft and munitions advance faster than their associated test equipment. Innovative solutions such as the MTS-3060A SmartCan have the potential to advance weapons and maintenance test into the digital era, revolutionizing the way units prepare and execute combat missions in the 21st century, and providing next generation long-term support to our warfighters.

ABOUT THE AUTHOR

Senior Master Sergeant (Ret.) Adam Wells is the Warfighter Support Solutions Manager for Marvin Test Solutions (MTS). He joined MTS in 2018 after retiring from the United States Air Force with 20 years of active duty service as an Armament Systems Specialist.

Adam's expertise extends to a number of aircraft platforms including the F-16, F-15C/D/E, F-22 and HH-60. He has extensive knowledge in conventional / nuclear munitions and operation, electrical testing and troubleshooting, intermediate and operational level of repair, training program creation and management, and strategic planning.

Curtiss-Wright:

Modernizing Legacy Aircraft Mission Computing with Open Standards

CURTISS-WRIGHT DEFENSE SOLUTIONS is the world's leading supplier of rugged commercial-off-the-shelf (COTS) computer, networking and data storage solutions for defense and aerospace platforms. Our flexible subsystem designs can support legacy data busses, like MIL-STD-1553 and ARINC 429, making it fast, simple and cost-effective to replace aging aircraft systems with modern high performance equipment. Even better, because our designs are based on the industry's favorite open standards, we can support your platform for many years to come. We solve semiconductor device obsolescence, technology roadmap, and lifecycle management problems every single day. That means we don't just provide your aircraft with a stop-gap solution. Instead, we deliver an open architecture path to ease technology insertion, so the performance of your systems can keep growing along with your demanding application requirements.

Intel Xeon-based Parvus DuraCOR 8043

1553 Mini-PCIe (photo courtesy of DDC)

NVIDIA Jetson-based Parvus DuraCOR 312

Our fully tested, field-proven solutions deliver far more performance than the out-of-date equipment they replace, often while requiring less space and weight, enabling you to reduce size, weight, power, and cost (SWaP-C) or add even more functionality to the aircraft. Even better, for our international customers, many of our products are ITAR-free.

When military and aerospace systems integrators have unique technical and platform I/O interface requirements, making it difficult to find a suitable COTS computing solution that meets 100% of their requirements, Curtiss-Wright offers Modified COTS (MCOTS) application engineering services for Small Form Factor (SFF) rugged mission systems. MCOTS can help integrators meet their cost, schedule, quality, and technical requirements, while reducing risk and traditional NRE fees.

A REAL-WORLD EXAMPLE: AN MCOTS MISSION COMPUTER

Seeking an exportable (non-ITAR) and SWaP-optimized solution to upgrade the mission computer on a fleet of maritime patrol and surveillance aircraft in Western Europe, a system integrator chose Curtiss-Wright's Parvus® line of small form factor (SFF) mission system solutions, which are classified for commercial export under U.S. Export Administration Regulations (EAR).

They selected an MCOTS variant of our Parvus DuraCOR® 8043, pre-integrated with the required interface cards. The DuraCOR 8043 is a rugged, modular, COTS-mission computer based on a quad-core (8-thread) Intel® Xeon® processor with multiple Mini PCIe® card slots and a stacking PCIe/104™ bus architecture. Pre-qualified for demanding MIL-STD-810 environmental and MIL-STD-461/DO-160 EMC compliance, the DuraCOR 8043 boasts a fanless and wide temperature design. In addition, the unit features industrial temperature-grade components, EMI filtering, and an isolated DO-160/MIL-STD-1275/704 power supply that protects against voltage transients. Since it's based on an Intel architecture, the system runs Linux and Windows® seamlessly. To meet avionics data bus requirements, our team of application engineers integrated MIL-STD-1553 and ARINC 429 cards from Data Device Corp (DDC), a trusted I/O card supplier. To extend digital I/O (DIO) capabilities of the DuraCOR 8043 system, we also installed an mPCIe-DIO-24S card from ACCES I/O Products, another proven and responsive supplier.

Find out what Curtiss-Wright can do for you. Upgrade to the upgrade experts!

CURTISS-WRIGHT

CURTISS-WRIGHT DEFENSE SOLUTIONS, a division of Curtiss-Wright Corporation, is recognized around the world as one of the most innovative designers and manufacturers of rugged and secure mission-critical solutions for the defense and aerospace industries.
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LETTER FROM THE PUBLISHER

MODERNIZING IS THE ISSUE

For some time now, a debate has been ongoing, at both the Pentagon and throughout industry, weighing the benefits of upgrading existing fighter aircraft against the advantages of scrapping them altogether and just buying new. With the F-35 expected to cost nearly a trillion dollars during its lifetime, taking a fresh look at modernization is timely.

What are the current thoughts about modernizing fighter aircraft? What are the best practices out there in the field? And who are the suppliers that operators and maintainers should look to for innovations? This edition of *CONTACT! Fighters* addresses the modernization discussion head on.

Since we have expanded the publication to include coverage of not only Lockheed Martin but also Boeing platforms, it is fitting that two of our feature articles concern upgrades and modernization efforts related to Boeing fighters. Our investigation of the F-15EX — with its beefed-up airframe, fly-by-wire flight controls, better radar, upgraded EW suite, and faster computers — qualifies this aircraft as "almost new" from the ground up. Is it worth it? You be the judge.

Additionally, we take a look at the Block III upgrades to the F-18 Super Hornet. New radar, new recorders, and fuel tanks are only part of the story. What does this equipment look like? Does it add value to the aircraft? Available software for reverse engineering and data sharing as a weapons system are some of the innovations developed for modernization that make their way into new production aircraft — and as upgrades into legacy models.

To complete our coverage, this issue's "Movers & Shakers" interview is with Mark Sears, Vice President of Fighter & Strike Product Support at Boeing Global Services. It is fascinating to consider Mark's opinion on the most important part of a large organization (the people), as well as his unique insight into the future of defense aviation sustainment and forthcoming transformative advancements.

Finally, cutting edge technology is previewed in the "Technical Briefings" section at the front of the magazine. Here is your opportunity to see how companies are producing equipment that results in greater performance and added reliability.

CONTACT! magazines are designed to address issues related to various defense aviation platforms. For more information, please refer to our details on page 46. Of course, feel free to reach out to us with your thoughts about this issue and suggestions for future publications.

Richard Greenwald
Publisher

TECHNICAL BRIEFINGS

The F-15EX
NEW/OLD FIGHTER

By Tracy Martin

Replacing the F-15C/D models, and bridging an operational gap between F-22 and F-35, the Boeing F-15EX will have a multirole configuration.
(Image courtesy of The Boeing Company and Ron Bookout.)

It has been U.S. Air Force policy since 2004 not to buy "new-old" fighters and instead concentrate on fifth-generation technology for new purchases. Despite this, the Air Force requested eight new F-15 Eagle aircraft — now designated as the F-15EX — with plans to purchase up to 144, thus initiating the first "4.5" generation fighter program in over 20 years.

In December 2020, Congress signed off on an appropriations bill to acquire the aircraft. However, the request for $1.1 billion for eight fighters was scaled back to just two F15EXs. These aircraft are scheduled for delivery to Eglin Air Force Base, in Florida, this year.

WHY A "NEW/OLD" FIGHTER?

In 2018, Defense Secretary James Mattis took the advice of the Pentagon in deciding that an updated fourth-generation fighter could provide additional operational capabilities when combined with Lockheed Martin's F-35A, the U.S. Air Force's preferred fifth-generation platform. In July 2020, the Life Cycle Management Center (AFLCMCM), at Wright-Patterson Air Force Base in Ohio, awarded a sole-source, indefinite delivery contract to Boeing to refresh the F-15C/D fleet and to upgrade F-15Es via the F-15EX program. In addition, a sole-source contract has been awarded to General Electric Aviation, which will provide F110 engines to meet F-15EX requirements.

This approach supports battle strategy envisioned on conventional battlefields of the future: F-22 and F-35 fifth-generation fighters will rid the sky of foes. Once that takes place, a flying "utility van" is required to deliver bombs and missiles to scorch the earth. Thus, the role of the F-15EX is to bridge the gap between the fifth-generation aircraft by adding more fire power.

Any way you slice it, the F-15EX is still a fourth-generation fighter and no stealthier than the F-15 Eagle (F-15E) when it was debuted in the 1970s. Modifications to the F-15E in the late 1980s included the ability to deliver ordnance to ground targets, earning the fighter a multirole designation inherited

This artist rendering illustrates what the F-15EX will look like in flight. (Image courtesy of The Boeing Company.)

Major General David Krumm (Image courtesy U.S.Air Force.)

by the F-15EX. Yet due to its detectability by modern air defense systems, this variant will be regulated to operating mostly outside enemy airspace until fifth-generation fighters can clear threats.

The last American purchase of an F-15 in 2001 was not the end of production, as Boeing continued to promote and develop the aircraft with updated technology for its foreign military customers. Israel, Japan, Qatar, Saudi Arabia, Singapore, and South Korea all have versions of the F-15 in their inventories and with good reason — the F-15 has never lost in combat against other fighters.

To meet air superiority requirements in 2004, the U.S. Air Force had planned to use the F-22 Raptor to replace its aging F-15C/D fleet. But it only received 186 out of 381 Raptors, leaving 200 F-15C/D aircraft (with low flight hours) slated to backfill this requirement. In a 2015 reality check, Air Force officials determined that it is no longer cost-effective to repair the F-15C/Ds, as these legacy fighters require constant airframe inspections to ensure they literally will not fall apart in operation. With F-15Cs aging out in 2028, the F-15EX will shore up the fleet.

The F-15EX program brings with it more advanced pilot and operational training, as a new flight simulator will be used. Good news is that the changes needed to upgrade existing simulators from the C/D or E configurations are relatively minor and will not require a large investment. In addition, the effort involved in integrating the EX into the U.S. Defense Department's wargaming simulations should be minimal.

According to Major General David

This artist rendering illustrates what the F-15EX will look like in flight.
(Image courtesy of The Boeing Company.)

Krumm, the U.S. Air Force's Director of Strategic Plans and Requirements, the investment in the F-15X also is a wise move because there can be up to 90 percent commonality between systems in C and EX variants related to the use of aerospace ground equipment for support.

This commonality also provides savings in that it should take less than 6 months for an active unit to transition to the F-15EX— it usually takes around 18 months. For the U.S. Air National Guard, it usually takes up to 3 years to become fully operational. Krumm goes on to say, "If you average that out, Active and Guard, each time we do that, we save about 2 years of readiness, and that's important for us."

BELLS & WHISTLES

The $80 million price tag for the F-15EX will include a stronger airframe, advanced flight control systems (fly-by-wire), advanced radar, two new weapon stations, new electronic warfare suite, conformal fuel tanks, and a hyper-fast computer. In addition, the fighter will not be speed-limited, as the current F-15s are, due to aging airframes. Instead, it will be able to reach its design capability of Mach 2.5. All-in-all, around 30 percent of the F-15EX will be unique to U.S. versions; other countries flying F-15Es will be operating with older technology.

The F-15EX has a 28-percent larger payload capacity than the F-15E and two more weapons stations that add loadout flexibility. Initially, the U.S. Air Force is expected to use the F-15EX in an air-to-air role substituting for the F-15C, as it can carry twelve AIM-9 or AIM-120 missiles, while the F-15C can only carry eight.

The new Eagles will be protected by the Eagle Passive Active Warning Survivability System (EPAWSS), a new electronic warfare suite. Because the system is classified, only some high-level capabilities are known — it can detect, locate, identify, and electronically engage various threat

systems. EPAWSS will be installed on the first two F-15EXs to be delivered to Eglin Air Force base, providing EPAWSS testing capacity.

Also included will be the Suite 9 common operational flight program, a series of new hardware and software releases providing advanced capabilities, as well as a Multifunctional Information Distribution System/Joint Tactical Radio System software-programmable radio. The new fighter also will feature the Joint Helmet Mounted Cueing System (JHMCS), a modular helmet display, mounted on a HGU 55/P helmet shell, that can accommodate day or night environments. This highly accurate magnetic tracking system provides pilots with full situational awareness. JHMCS is currently operational on the F-15, F-16, and F/A-18 fighters.

Pratyush Kumar, President, Boeing India Vice President, Boeing International (Image courtesy of The Boeing Company)

Boeing Vice President and F-15 Program Manager Pratyush (Prat) Kumar stated in November 2020, "The F-15EX is being built with modern technologies and with the idea that it will frequently be upgraded." He noted that the fighter will have open mission systems and architecture, enabling it to rapidly test and incorporate future technologies.

For example, the speed capabilities of the new fighter could help in the development and testing of hypersonic missile technology. As stated above, the new airframe is capable of reaching Mach 2.5. In theory, the aircraft could launch a hypersonic missile closer to the weapon's Mach 5 attack speed, allowing for a smaller, on-board rocket.

ENGINES

The General Electric Aviation F110 engine, first used in the 1980s, is slated for the F-15EX program. In fact, the GE F110 afterburning turbofan engine, producing 29,000 foot-pounds of thrust, currently is the only in-production powerplant certified to support the F-15EX. The U.S. Air Force awarded a $101.4 million contract to GE for nineteen GE-F110-129 engines. With all testing completed and fly-by-wire technology fully integrated, the GE F110 is considered a cost-effective choice for the F-15EX program.

General Electric's F110 engine is currently used to power more than half of U.S. Air Force F-16s and over 80 percent of its F-15E strike aircraft. GE has received all new F110 production engine orders for F-15s globally over the past 10 years. Currently, seventeen countries use the

Top Image:
The twin General Electric Aviation GE-F110-129 afterburning Turbofan engines, each producing 29,000 foot-pounds of thrust, can push the F-15EX to Mach 2.5. (Image courtesy GE.)

Image to right:
Because General Electric Aviation's GE-F110-129 engine is already in use by the U.S. Air Force, there are no up-front development and certifications costs for using this powerplant in the F15-EX. (Image courtesy GE.)

Image Far Right:
Mounted to a test bed, this General Electric Aviation GE-F110-129 engine is being put through its paces. (Image courtesy GE.)

engine for their fighters.

Prior to the F-15EX program, F-15 aircraft were powered by Pratt & Whitney engines. The U.S. Air Force also has opened the door for Pratt & Whitney to offer a competitive engine for the F-15EX production program, as long as the manufacturer certifies the engine at its own expense.

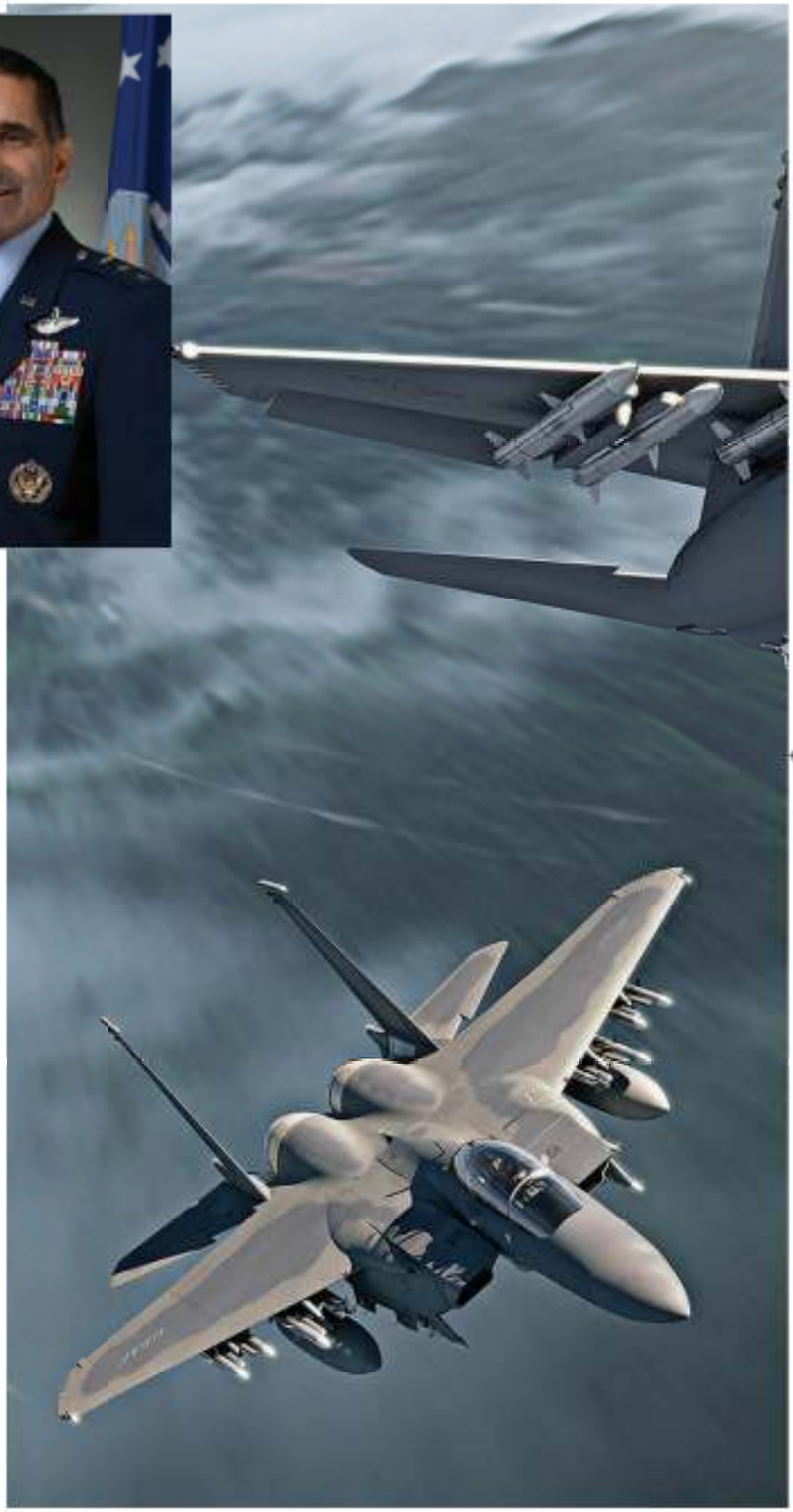
Lieutenant General David S. Nahom (Image courtesy of the U.S. Air Force.)

LOOKING INTO THE FUTURE

While the U.S. Air Force initially planned to purchase eight F-15EXs, with a far larger future buy, at the time of this publication, the fiscal 2020 National Defense Authorization Act and Congress had only approved two fighters. The remaining six could be purchased in the near future, but only after the Air Force submits a report on its acquisition strategy for the program. The cost for all eight would be $1.1 billion in the first year, including initial engineering, hardware and software design, parts production, and integration of subsystems.

According to Boeing, the out-the-door cost for one F-15EX is $80 million, about the same as the F-35A. But the cost per flight hour for the new Eagle, at $27,000, represents a savings over approximately $35,000 for flying an F-35A the same amount of time. The Pentagon's Cost Analysis and Program Evaluation group also has determined that the Air Force can update its fighter fleet of aging F-15C/D fighters more quickly with the F-15EX program. At the same time, funding for the F-15EX must not impact purchase and/or support of F-35 aircraft.

Decision-makers express a sense of urgency for moving ahead with the F-15EX program. According to Lieutenant General David S. Nahom, Deputy Chief of Staff for Plans and Programs, "The cost of sustaining the Eagle fleet and other old platforms is eating me alive. Older aircraft are handicapping the Air Force in multiple ways." Nahom went on to say, "Not only are they costing us too much money, but they're offering us too much risk, due to obsolete gear and age-related flight restrictions, and the Air Force must move out swiftly to bring on the F-15EX as quickly as we can to recapitalize F-15C/D units."



This Boeing illustration shows two F-15EX fighters armed with air-to-air missiles. (Image courtesy of The Boeing Company)

MODERNIZED SUPER HORNETS KEEP DELIVERING THEIR STING

There are plenty of upgrades in the Block III versions of the F/A-18E/F

By John Likakis

The F/A-18 Hornet ranks as one of the more successful designs of recent decades. First entering service in 1983 with the U.S. Marine Corps, and with the U.S. Navy the following year, the Hornet has distinguished itself in both war and peace. In fact, it proved successful in combat in nearly every military operation the United States has undertaken since the late 1980s. The Hornet also has been a success in the export market, with seven countries — Australia, Canada, Finland, Kuwait, Malaysia, Spain, and Switzerland — buying and/or building this model for their forces.

The first aircraft to carry the "Fighter/Attack" designation, the Hornet was the first to receive "F/A" before its design number. Intended from the outset to fulfill the roles of both a capable air-to-air fighter and a bomber/ground-support aircraft, the Hornet also was the first combat jet to be jokingly dubbed "a flying Swiss Army knife," as it ably performed different tasks. Despite doubts of industry skeptics, the F/A-18 has demonstrated it can handle both roles with aplomb.

One famous example featured a flight of Hornets on a bombing raid during the First Gulf War. Laden with four 2,000-pound bombs each, the F/A-18s took off from the aircraft carrier USS Saratoga. On their way to the target, the pilots were alerted to a pair of Iraqi MiG-21 fighters moving to intercept. Two of the F/A-18s engaged the MiGs, shooting down both Iraqi aircraft. From the first radio alert, the fight took all of 40 seconds. The Hornets, having fulfilled the "fighter" part of their F/A designation, went on to carry out the "attack" portion, completing the bombing mission.

As good as the F/A-18 Hornet is, it revealed some shortcomings. This led to development of the F/A-18 Super Hornet — more of a derivative than a variant of the original model. While the two airframes share the same design concept, the Super Hornet is about 25 percent larger than the Hornet, with larger wings, bigger engines, square engine inlets, and numerous other design differences. In many respects, it is an entirely different aircraft.

The Super Hornet entered production in the 1990s, slowly replacing the U.S. Navy's F-14 Tomcat swing-wing fighters. Since then, it has undergone several upgrade and improvement campaigns, with the latest being the Block III upgrades from Boeing.

THE CRITICAL BITS

From the earliest days of air combat, pilots have known that it is the threat you do not see that is most likely to kill you. In World War I, pilots communicated by hand signals — which worked fine if you happened to be looking at your wingman the instant he was trying to tell you about incoming fighters on your tail. In World War II, radios provided better communication, improving threat awareness, as long as pilots maintained radio discipline and did not talk over one another, which, in the heat and panic of combat, happened all too often. By the time Vietnam came along, radio transmissions were stronger and clearer, but issues with frequency congestion (everyone trying to talk at once) remained.

Fast forward to today, and frontline fighters are now a flying array of sensors. Most combat aircraft have multi-band radios to communicate with allied fighters and combat controllers, signals intercept receivers to eavesdrop on enemy communications, onboard radar to detect targets, radar warning systems to detect when the aircraft is being targeted, infrared targeting and tracking systems, and much more. With all this information available, data sharing ranks as a weapon system in itself.

Efficient data sharing in a combat environment can allow for amazing tactical innovations. For example, in a flight of four aircraft, only one pilot needs to use radar (the other three can see what that radar sees), reducing the flight's signal emissions and making it more difficult to detect. An orbiting air combat control craft, such as a Boeing E-3 Sentry or Grumman E-2 Hawkeye, can share its radar data, giving combat pilots access to a God's-eye situational view. Targeting data shared among fighters ensures no one target gets more than a single weapon fired at it, optimizing use of available ordnance.

A substantial part of the Super Hornet Block III upgrade effort is devoted to not just installing better avionics and weapons systems, but also ensuring that any new systems have robust interoperability within each aircraft's system architecture and that input and output data is sharable among friendly platforms. Therefore, as part of this key upgrade, a joint venture between Collins Aerospace and BAE Systems, called Data Link Solutions, worked with Viasat to develop the Digital Targeting Processor Network and the Tactical Targeting Network Technology. These systems allow Super Hornet pilots to share data in real time, both among themselves and with other combat assets.

RADAR LOOK, RADAR LISTEN

A casual glance at the world around us reveals how radically technology has changed since the F/A-18's debut nearly 40 years ago. On-board electronics, now commonly called "avionics," have not merely evolved in name since then. There has been a revolution in every aspect of these central systems.

One of the earliest upgrades for both regular and Super Hornets was replacing old radar units with modern active electronically scanned array (AESA) radar systems. Raytheon supplies the APG-79 for installation in the latest Super Hornets, and the APG-79(V)X is a simple upgrade for the earlier Hornets. (According to Raytheon, retrofitting with the new radar takes less than an hour and can be completed in the field.) Replacing previous APG-73 series units, these radars use computer-controlled "beam steering" to aim transmissions. With few moving parts, reliability is greatly improved, while performance is substantially increased.

With its AN/ALR-67(V)3 RWR (radar warning receiver) units, Raytheon supplies upgraded radar detection capabilities. More crucial than ever in the modern combat environment, detection also is more difficult than ever, because airwaves are so saturated with radio "noise" that can overwhelm older systems—especially as new uses are found for parts of the frequency spectrum that overlap some radars. Raytheon notes that the AN/ALR-67's "channelized" receiver enables it to detect and recognize even weak threat emitters in saturated electromagnetic environments. This not only provides pilots with earlier warning of potential threats, it also cuts down on false alarms from non-radar signals in or near the same frequency bands.

Related upgrades to Hornets and Super Hornets include improved radar jamming capabilities. The ALQ-214A(V)4/5 from L3Harris Technologies is part of the aircrafts' integrated defensive electronic countermeasures suite. Typical of many avionics upgrades, the ALQ-214 uses modular open systems architecture (MOSA), accommodating fast and flexible modification to deal with new or evolving threats. Plus, it is smaller, lighter, and more capable than the units it replaces. From the crew's perspective, the ALQ-214's autonomous operation means that it deals with threat it detects without the crew having to take action.

TANKS? NO TANKS

Jet fighters use lots of fuel, and the F/A-18 is no exception. Indeed, one of the aircraft's shortcomings is its short range. The answer to this problem has involved adding external drop tanks, carried on pylons on the wings or on the aircraft's centerline pylon. Drop tanks add to the available fuel, but they also add drag and weight. And a pylon holding a drop tank is not carrying a weapon.

One way around this is to design and install fuel tanks that wrap around and conform to the aircraft fuselage, virtually becoming part of it. Such conformal fuel tanks are installed on the F-15, and many other fighters use variations of this design. So why not develop a set of conformal tanks for the Super Hornet?

Boeing did just that. The tanks sit atop the fuselage and blend back to the twin tails. Engineering and flight testing showed the tanks added range but only increased drag significantly during trans-sonic flight; extra stresses imposed on the airframe in flight were found to be well within the Super Hornet's structural limits.

The U.S. Navy subsequently began acceptance-trial tests of aircraft with the conformal tanks installed. In January of this year, stories began to emerge that tests of the modified Super Hornets taking off from and landing on aircraft carriers revealed unspecified problems with the conformal tanks. While there has been much speculation about what those problems might be, the Navy is remaining tight-lipped about it for the time being.

While this may not bode well for the U.S. Navy's continued support of Super Hornet acquisitions, customers who do not operate off aircraft carriers (for example, Canada or Kuwait) may find upgraded Block III Super Hornets with conformal tanks an attractive option for their forces.

OLD BOXES, NEW BOXES

Upgrading systems on older aircraft can present interesting challenges. Many legacy airframes have avionics bays designed around what was state-of-the-art back then. Avionics upgrades, like L3 Harris's new module, generally are both more effective and more compact.

While that is a good thing, a reduction in the size of components proves problematic when it comes to retrofitting a new, smaller box into the comparatively cavernous space formerly occupied by a clunkier old-tech unit. Sensitive avionic systems cannot be left loose to rattle around, need to connect to the aircraft's existing wiring and systems, and like most electronics, have to be cooled. Interfacing with the avionics cooling system in a specific bay is not always easy, or, sometimes, even possible.

For operators of older platforms, including the F/A-18, Curtiss-Wright provides a range of components that bring modern avionics to many aging platforms without the need for extensive retrofit. In the case of the Hornet, Curtiss-Wright is providing new aircraft recorders to some legacy F/A-18 customers to replace the turn-of-the-century vintage units in F/A-18A and -B models.

According to Curtiss-Wright, "This aircraft recorder is pretty comprehensive, as it functions as an analog and digital video recorder system, maintenance data recorder, and mission planning system. It collects video from the heads-up display, multi-functional display, multipurpose horizontal situation display, cockpit audio, maintenance data, mission flight data, and mission planning data...Data is recorded continuously from these various sources on a solid-state disk, and some of the video is replaying simultaneously on a cockpit display." This system communicates using an efficient data bus and is controlled by an added mission computer.

For this and other such upgrade solutions, Curtiss-Wright says its systems have a form-and-fit factor that, in most cases, allows units to replace existing packages on a plug-'n'-play basis. As an example, data recording unit replacement packages can interface with existing aircraft systems, while adding new recording capabilities and bringing sophisticated data encryption to systems that have less secure, older-standard data protection protocols.

For any avionics upgrade, making sure the new box can talk to and work with on-board systems is crucial. After all, the best sensor package ever designed is just so much excess weight if it cannot transmit useful information to the crew and/or countermeasures systems. And trying to diagnose problems, one box at a time, can be a futile exercise, especially as systems grow more capable and complex.

To speed system integration and troubleshooting, Viavi Solutions offers the Xgig Secure System. It utilizes sixty-four time-synched ports to allow high-level viewing of overall system

OPTIONS FOR OLD PARTS

As mentioned, the "classic" Hornet and the Super Hornet are only superficially similar. With only the Super Hornet still in production, the original Hornet has become something of an orphan when it comes to major airframe components. There is no commonality between the two aircraft for such parts as wings, inlets, or even control surfaces.

Military boneyards can provide some replacement parts. But U.S. Navy and U.S. Marine Corps planners know that such supplies are inherently limited. As a result, many Hornet parts are being reverse-engineered so that they can be produced using new manufacturing techniques. Something like a main landing gear attach fitting that originally was a forged or machined part can now be replicated using 3D printing. This process requires a precise and often complex set of measurements of the part.

Enter Verisurf Metrology, a company that makes software designed to scan original components in exacting detail. The data gathered can be processed either to generate a CAD model for CNC machining or exported to STL format for additive manufacturing. It also can be used to compare a reverse-engineered copy to the original part to verify it meets the precise specifications.

performance. Analyzing issues with complex avionics architecture is much easier and can be done while preserving whole-system integrity. In the case of the F/A-18, Viavi's Xgig has become a valuable part of Raytheon's upgrades to the Hornet's avionics.

Another avionics improvement coming to the Super Hornets is the installation of a large touch-screen display on the instrument panel, replacing the old four-screen panel. Part of Boeing's Distributed Targeting Processor Network, the display will allow Super Hornet pilots to share information, including streaming video and tactical data.

AGING AIRFRAMES

Like all aircraft, Super Hornets face the problems of aging and timed-out airframes. The original F/A-18 Super Hornet has an airframe service life of just 6,000 hours. A set of modifications extends this to 7,500 hours, and added Block III upgrades for the Super Hornets will push service life out to 10,000 hours.

For older Hornets, such as the F/A-18 A, C, and D models flown by the U.S. Marine Corps, in-service airframe life management programs are extending the service life as well. The Marine Corps, in particular, instituted a program to replace their aircrafts' fuselage center barrel and other key components. Known as CBR+, this program resulted in early-model aircraft being approved for up to 8,000 hours in service. Further engineering and targeted maintenance and inspection programs may well get even these old warhorses flying out to 10,000 hours of airframe time.

Part of the Block III upgrades are improved stealth coatings to reduce the Super Hornet's radar signature. Stealth-coating technology goes back to World War II, when Germany tried to reduce the radar signature of its submarines by coating parts of U-boats in specialized rubber. While that did not work very well, stealth coating technology has since become a rapidly developing field. The newest coatings produce significant reductions in the Super Hornet's radar signature.

The bottom line is that modification, modernization, and constantly evolving maintenance practices will keep the Hornet and the Super Hornet from devolving into flying anachronisms. These aircraft will remain in service for decades to come, and a steady stream of upgrades will keep the Hornets delivering their sting.

An FA-18 Super Hornet at Boeing's Cecil Field location near Jacksonville, Florida. Boeing performs inspections and modifications on U.S. Navy Super Hornets before returning them to the fleet.

Image courtesy of The Boeing Company

In addition to periodic maintenance inspections and repairs, Boeing performs structural and electrical modifications at the company's Cecil Field facility in Jacksonville, Fl.

MOVERS & SHAKERS

INDUSTRY LEADER INSIGHTS – PAST, PRESENT, AND FUTURE

BY HANK HOGAN

SPOTLIGHT ON

MARK SEARS

VICE PRESIDENT, FIGHTER & STRIKE PRODUCT SUPPORT
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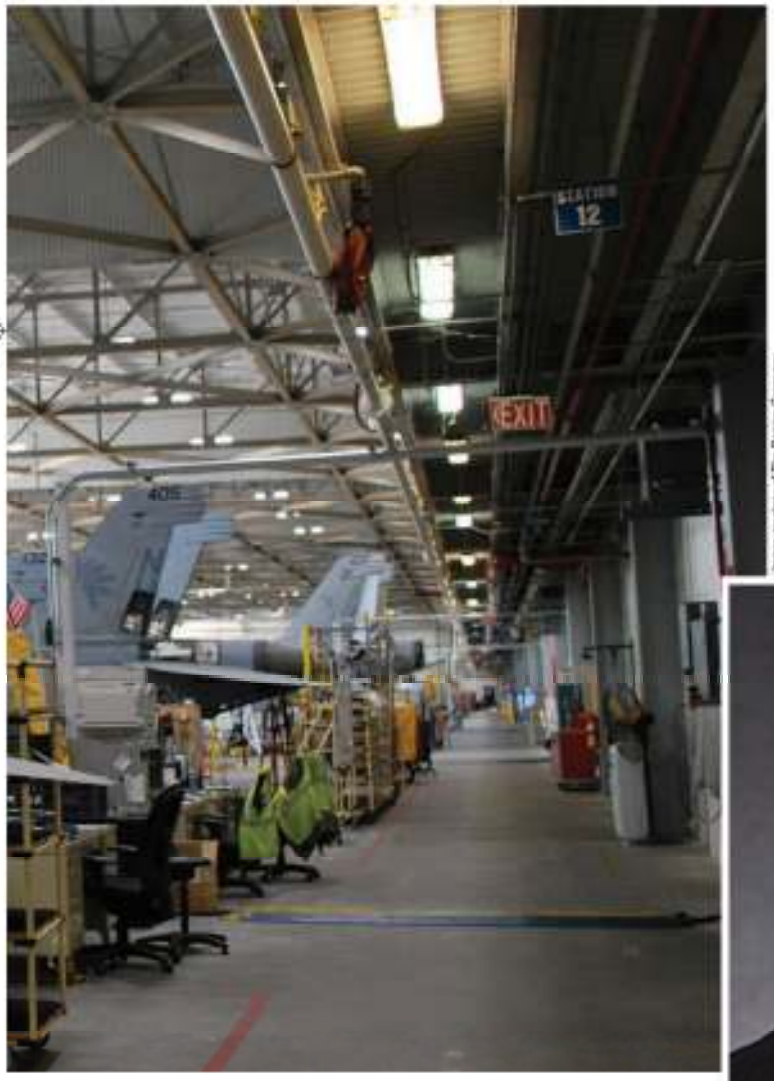


Image courtesy of The Boeing Company

The government side of Dallas-based Boeing Global Services supports warfighters across all military branches, both in the United States and around the world. Estimates in Forbes put Boeing Global Services' revenues in 2019 at $19 billion, with more than a third of that total coming from the U.S. government.

Part of those proceeds originate in the Fighter & Strike Product Support business, which provides innovative post-production training, analytics, sustainment, and modification services for the A-10 Thunderbolt, F-15 Eagle, and F/A-18 Hornet. Vice President Mark Sears states that while technology is transforming support of fighter aircraft in many ways, making it both easier and more efficient, the people who effectively utilize and act on that technology remain the key to aircraft availability and mission success.

Image courtesy of The Boeing Company

MARK SEARS
VICE PRESIDENT
FIGHTER & STRIKE PRODUCT SUPPORT
THE BOEING COMPANY

Sears recently discussed both current fighter support trends and ongoing developments. His lightly edited answers to questions follow.

Q: You have had a number of roles within Boeing. What are the most valuable lessons you have learned?

A: "Our business is really about people," Sears replies. "First and foremost are customer relationships. Whether it's developing intimacy with our customers' problem sets, so that we have better solutions to their needs, or developing trust through delivering on our commitments. That customer intimacy and customer relationship piece, the strength of that, can really help a program succeed."

"From a supplier perspective, the people and relationships are equally important, both to meet commitments and also to think through innovatively how we can provide solutions that bring the best of industry to the armed services."

"A third piece would be with our own Boeing teammates, leveraging the diversity they bring to form the best team. So much of our success depends on the relationships we form within these three groups."

Q: What are the most important trends or changes in the industry during your time in it?

A: "In the services business, especially, there's opportunity to constantly look for those efficiencies and gains in how do we do things better on fielded platforms. We're being looked upon to find those innovative solutions that can bring as good, if not better, performance — in the platform, availability, or readiness — for less."

"The old adage for this business is 30 percent of the cost is in development and production, and 70 percent is in sustainment." In this context, Sears says they consider: "How do we help control that overarching cost for our customer?"

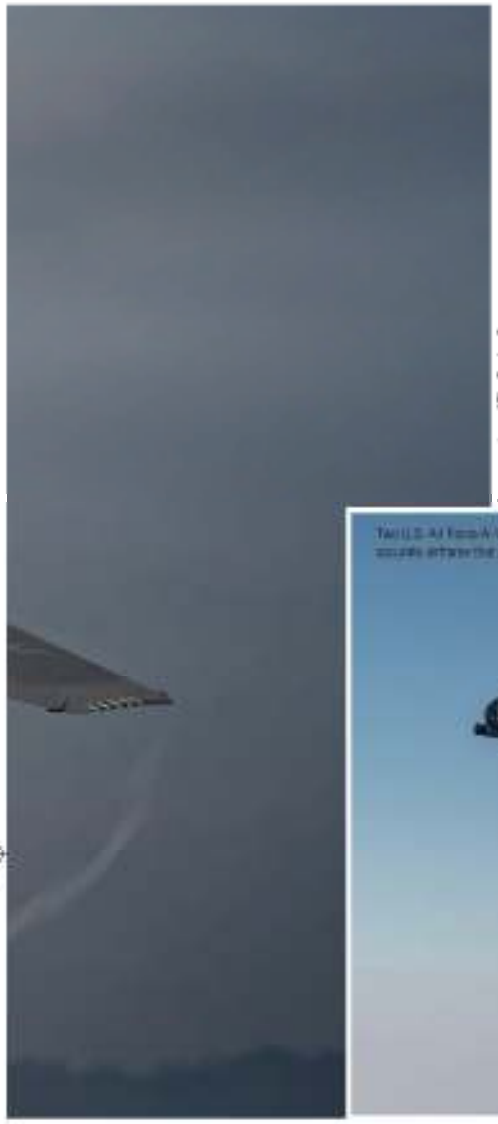
"The second trend is digital and the importance of digital toolsets that are coming. Whether it's the direct application to platforms and the insights they give us in helping with decision making and driving to efficient use of resources. Or whether it's the platform itself, in the supply chain or maintainers on the flight line."

"How can we use the information at hand to make better decisions?" he considers before finishing with a prediction. "I think we will see a major shift in how we think about sustainment for new platforms."

Q: Can you provide an example of how this might look or work?

A: "A digital twin exists today on some of the platforms. Having a digital model of the reality of what each individual airplane has experienced offers historical insight into what that airplane has been through — nonconformances, modifications, repairs on the flight line. All of that information together begins to give you, as a depot provider, insight about what you're about to face."

"As the techstack becomes more mature, as model-based systems engineering starts to proliferate into every platform, we will start to realize the other possibilities associated with the digital architecture that's there. How do we let that information flow not only into design, development, production, and testing, but how do we let it flow all the



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> "From a supplier perspective, the people and relationships are equally important, both to meet commitments and also to think through innovatively how we can provide solutions that bring the best of industry to the armed services."

Image courtesy of U.S. Air Force. Photo by Staff Sergeant Justin Parsons.

way to the post-production aspects, as we think about tech data or airplane health management or supply chain forecasting?"

For the last item, he explains, "You can take real-world data, bounce it against your model and predictions, and adjust your supply posture."

Q: Finally, where do you see things headed in your segment of the industry? What would you tell others to keep an eye on?

A: "Without a question, it's the digital advancements and transformation that is coming," he immediately responds. "I think that transformation is going to be huge over the next 5, 10, 15 years."

After this, Sears circles back to the importance of the people who implement and use such evolving technology, stressing that post-production sustainment must be done in close partnership with customers. He adds that this collaboration should start long before an aircraft is delivered and put into service to reap the maximum benefits and achieve the desired outcome.

"In that partnership, how do we develop concepts and solutions that are going to help customers achieve their objectives?" Sears says. "In the end, our number one objective is to make sure they're ready and that is through however we can best serve them."

Thus, through a combination of the people, relationships, and technology, Boeing Global Services plans to meet the sustainment challenge, even as platforms continue to evolve.

■

COMPANY HIGHLIGHTS

The companies listed on the following pages are suppliers of parts, components, systems and repairs for the fighter aircraft aftermarket. Firms indicated in **BOLD** type with their logo and description have been vetted by the publishers as bona-fide sources of supply and are the best in the business, providing quality equipment and services at a price that reflects true value for the purchaser. We suggest you contact these businesses for all your supply and repair needs, since they are dedicated to your satisfaction as customers. If they do not have the exact part or repair you require, they can act on your behalf to located a solution for you. For more information please contact Richard Greenwald at r.greenwald@abdonline.com

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The McDonnell Douglas (now Boeing) F-15 Eagle carrying an ASAT missile. (Courtesy of the U.S. National Archives and Records Administration.)

SHOOTING STAR

The F-15 Eagle, manufactured by McDonnell Douglas (part of The Boeing Company since the 1997 merger), has achieved an impressive record of kills in combat engagements around the globe. But its most unique shootdown was literally out of this world. In large part due to its speed and maneuverability, the F-15 was chosen to launch the first U.S. missile to destroy a satellite in orbit.

The target for the historic test of America's anti-satellite (ASAT) capabilities was the Solwind P78-1. This orbital observatory collected scientific data about the sun for 6.5 years, before its destruction by the Eagle-launched ASM-135 missile. The ASM-135 was created by the LTV Aerospace division of Ling-Temco-Vought and deployed solely on the F-15 Eagle.

By the time it was selected for the ASAT experiment, the P78-1 satellite had long surpassed expectations of its original mission, having achieved significant historical milestones of its own. Solwind was the first space-based device to discover a comet and the first to observe a "sungrazing" comet (one that passes extremely close to the sun).

Successfully destroying the satellite required split-second timing and expert flying by the pilot, U.S. Air Force Major Wilbert "Doug" Pearson. On September 13, 1985, timing the flight with P78-1's orbit overhead, Pearson directed his F-15A into a sharp climb high above the Pacific Ocean. At a reported altitude of 38,100 feet, he launched the missile, the F-15 essentially serving as its first launch stage. The ASM-135 traveled an estimated 345 miles on its upward trajectory, until it collided with Solwind, instantly breaking the satellite into a hash of debris.

The success of the experimental shootdown of an orbiting satellite by a fighter-based weapon system achieved its intended effect. It demonstrated the U.S. Air Force's ability to remove other nations' spy satellites from orbit, if and when that necessity should arise. In fact, the deterrent effect proved so effective that the F-15 Eagle ASAT program was wound down following the test and ended in 1988.

Sources: Jonathan Eberhart, "ASAT Target Was Working Research Satellite," *Science News*, September 28, 1985; Peter Grier, "The Flying Tomato Can," *Air Force Magazine*, February, 2009; NASA, *History of On-Orbit Satellite Fragmentations*, 14th ed., 2008.

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Close-up view of the Lockheed Martin F-22 Raptor.
(Courtesy of the U.S. National Archives and Records Administration.)

A RAPTOR BY ANY OTHER NAME

Given the reverence for history and rich institutional memory that has characterized the nation's aerospace firms, it is not surprising that designers of the Lockheed Martin F-22 Raptor initially dubbed their next-generation fighter the "Lightning II." The name recalls the legendary Lockheed P-38 Lightning, workhorse fighter of the U.S. Army Air Forces during World War II. The only American fighter to be produced in large numbers throughout the war, the P-38 became emblematic of the significant contribution Lockheed made to the war effort. While the name "Lightning" did not stick to the F-22, it also is not surprising that it became attached to the manufacturer's state-of-the-art F-35.

At one point, the fighter that ultimately emerged as the Raptor was renamed the "SuperStar," putting it in the rhetorical company of other well-known Lockheed fighters: the P-80 Shooting Star, F-94 Starfire, and F-104 Starfighter. The Raptor also briefly underwent a change in designation, when U.S. Air Force planners found themselves forced to defend the aircraft's continued development by asserting its versatility. The change from F-22 to F/A-22 highlighted its dual air and ground attack capabilities — as with the U.S. Navy's F/A-18 Hornet.

In a more creative moment, U.S. Air Force officials considered the name "Rapier." But it likely was decided too fanciful to associate a sophisticated new addition to the nation's air arsenal with the type of sword Zorro employed in his fictional adventures.

When the F-22 finally emerged in its lasting identity as the Raptor, the extended evolution of its name was generally submerged in a deceptively simple explanation. After all, the Raptor was designed to replace two previous U.S. Air Force fighters named for birds of prey: the F-15 Eagle and the F-16 Fighting Falcon.

Sources: Dennis R. Jenkins, *Lockheed Secret Projects: Inside the Skunk Works*, St. Paul: MBI Publishing, 2001; "Military Aircraft Names," Aerospaceweb.org; U.S. Air Force, "F-22 Raptor fact sheet" and "F-22A Raptor goes operational," December 15, 2005.

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The Lockheed Martin F-22 Raptor. (Courtesy of the U.S. National Archives and Records Administration.)

DEFINING THE FIFTH GENERATION

The lengthy development process that resulted in Lockheed Martin's F-22 Raptor featured all the twists and turns of an intricately plotted novel. Larger-than-life proponents and critics of the program clashed over everything from the project's overall cost to the specific numbers of aircraft procured and the efficacy of maintaining production to save jobs during a difficult economic period. In the midst of this debate, a frequently overlooked aspect of the Raptor's journey from blueprint to blue sky is the fact that opposing air forces of hostile or potentially hostile nations suffered their own lag in technological development in the late 1980s and 1990s.

At its inception, the primary rationale for creating the best-in-class F-22 was to aggregate emerging technologies into a next-generation air superiority fighter, capable of controlling the skies in battlefield circumstances that seemed likely at the time and in the foreseeable future. Domestically, it was envisioned as a long-term replacement for the F-15 Eagle and F-16 Fighting Falcon, both having admirably filled the air superiority role in previous conflicts.

A more immediate case for the speedy, stealthy Raptor was to counter the emerging threat posed by Mikoyan MiG-29s and Sukhoi Su-27s — the latest, most sophisticated expressions of the Soviet Union's state-of-the-art fighter technology. But while the Raptor's development process unfolded, the collapse of the Soviet Union and the emergence of new threats in other regions drastically altered U.S. defense priorities and force deployments.

For the tasks of establishing and maintaining air superiority during the first Gulf War and in subsequent conflicts in Iraq and Afghanistan, as well as other engagements in recent times, the available F-15 and F-16 proved entirely well-suited. Initial plans for the U.S. Air Force to procure 750 F-22s were repeatedly adjusted, beginning with the Department of Defense's Major Aircraft Review of 1990 that reduced the acquisition to 648 aircraft. Further reductions were announced in 1997 and 2003. By the time the last F-22 was delivered to the U.S. Air Force in 2012, the total fleet numbered 187 operational aircraft and eight test vehicles.

In the long run and in sharp contrast to earlier concerns about the need for such an advanced aircraft, the emergence of fighters such as China's Chengdu J-20 and the Russian Air Force's Sukhoi Su-57 and similar ongoing efforts in other nations have validated the long-range vision embodied by the F-22 Raptor and Lockheed Martin's F-35 Lightning II. These U.S. fighters largely established and continue to define the "fifth generation" of fighter technology.

Sources: Julian E. Barnes, "Lockheed lobbies for F-22 production on job grounds," *Los Angeles Times*, February 11, 2009; Kevin Baron, "Gates outlines Air Force priorities and expectations," *Stars and Stripes*, September 18, 2009; August Cole, "Lawmakers Pressure Pentagon to Release Funds for Controversial F-22 Fighter Jet," *The Wall Street Journal*, November 5, 2009; Rebecca Grant, "Why The F-22 Is Vital Part 13," UPI, March 31, 2009; Fred Kaplan, "Aerial Combat: The Air Force tries to save a fighter plane that's never seen battle," Slate, February 24, 2009; Jim Wolf, "Pentagon OKs funds to preserve F-22 line," Reuters, November 12, 2008, and "Top general warns against ending F-22 fighter," Reuters, June 18, 2008.

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The McDonnell Douglas (now Boeing) F-15E Strike Eagle.
(Courtesy of the U.S. National Archives and Records Administration.)

LIKE PLINKING

As a derivative of the F-15 Eagle manufactured by McDonnell Douglas (part of The Boeing Company since 1997), the F-15E Strike Eagle was designed to add ground attack capabilities to the considerable air superiority expertise of the original F-15. But even the most prescient military planner could not have foreseen how blending air superiority and ground attack roles in generations of the same airframe would mirror a significant shift in how aircraft can be used to support ground forces.

At the time the F-15E was introduced, on September 15, 1989, the argument for how to use strike fighters was long established and largely settled. After the skies were cleared of enemy aircraft by air superiority fighters like the F-15, strike aircraft like the F-15E would be used to eliminate fixed, high-value installations deep in hostile territory.

As doctrine dictated, strike aircraft would traverse long distances with speed and stealth, careful to engage the enemy only from low or high altitudes, wary of the need to avoid the peril of increasingly sophisticated surface-to-air missile systems. But that was all before the rise of tank plinking.

Essentially defined as the tactical use of precision-guided munitions (PGM) against threats to ground forces, the practice of tank plinking was made a colorful colloquialism by U.S. Air Force pilots who first employed it during the 1990–1991 Gulf War. While reviewing videos of their missions against Iraqi ground forces, the pilots likened the accuracy with which their strikes eliminated tanks and other armored vehicles to their boyhood air rifle target shooting, recalling the distinctive "plinking" of a metal BB tearing through the shell of a tin can.

While the term has been discouraged by the military establishment since its inception, the concept it represents has proven a powerful combination since first use: new technology and altered tactics enabling aircraft like the Strike Eagle to "get in on the ground floor" of a new approach to aerial warfare.

Sources: Major Michael J. Bodner and Major William W. Brunner III, "Tank Plinking," *Air Force Magazine*, October 1993; Max Boot, "The New American Way of War," *Foreign Affairs*, July/August 2003.

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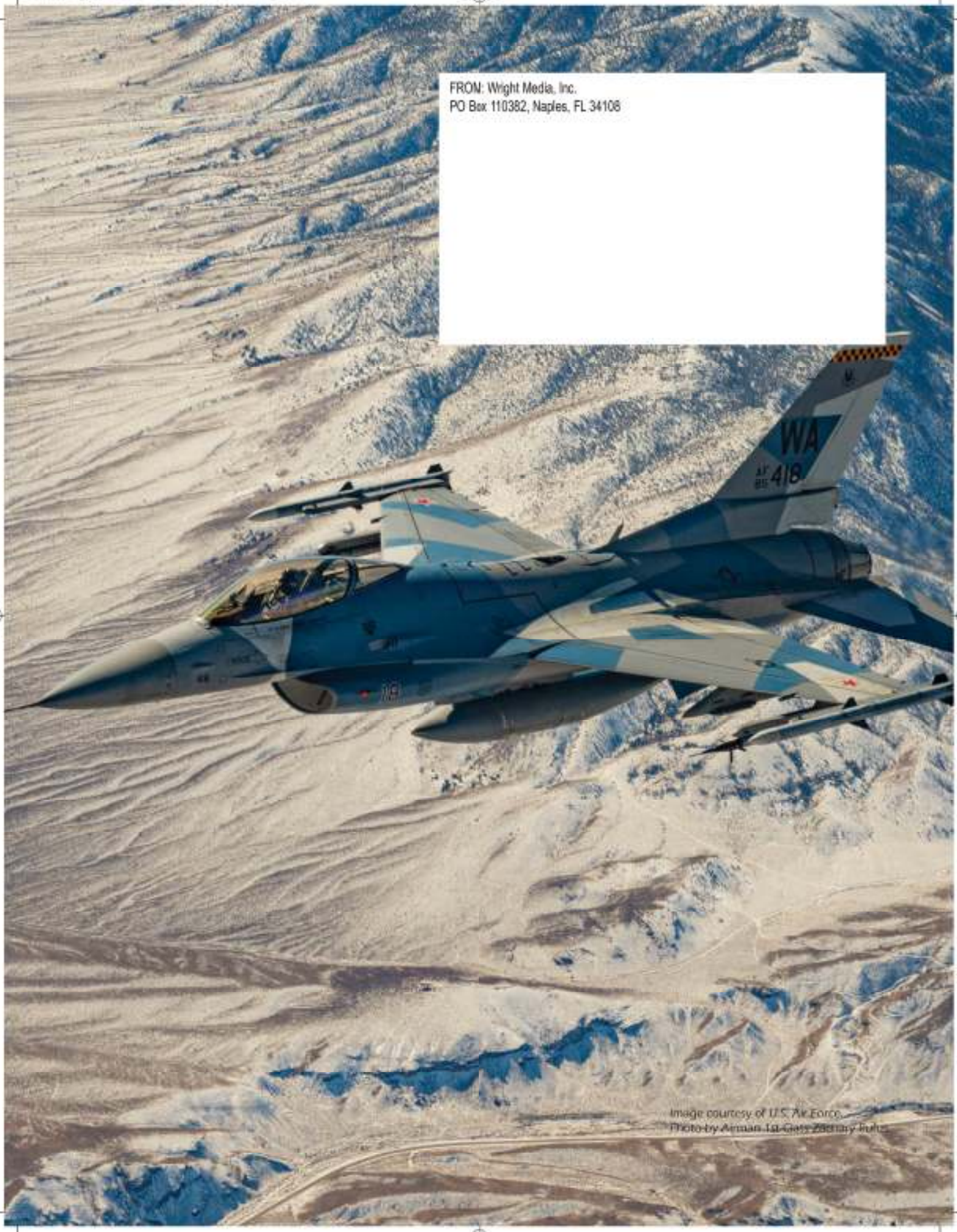
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