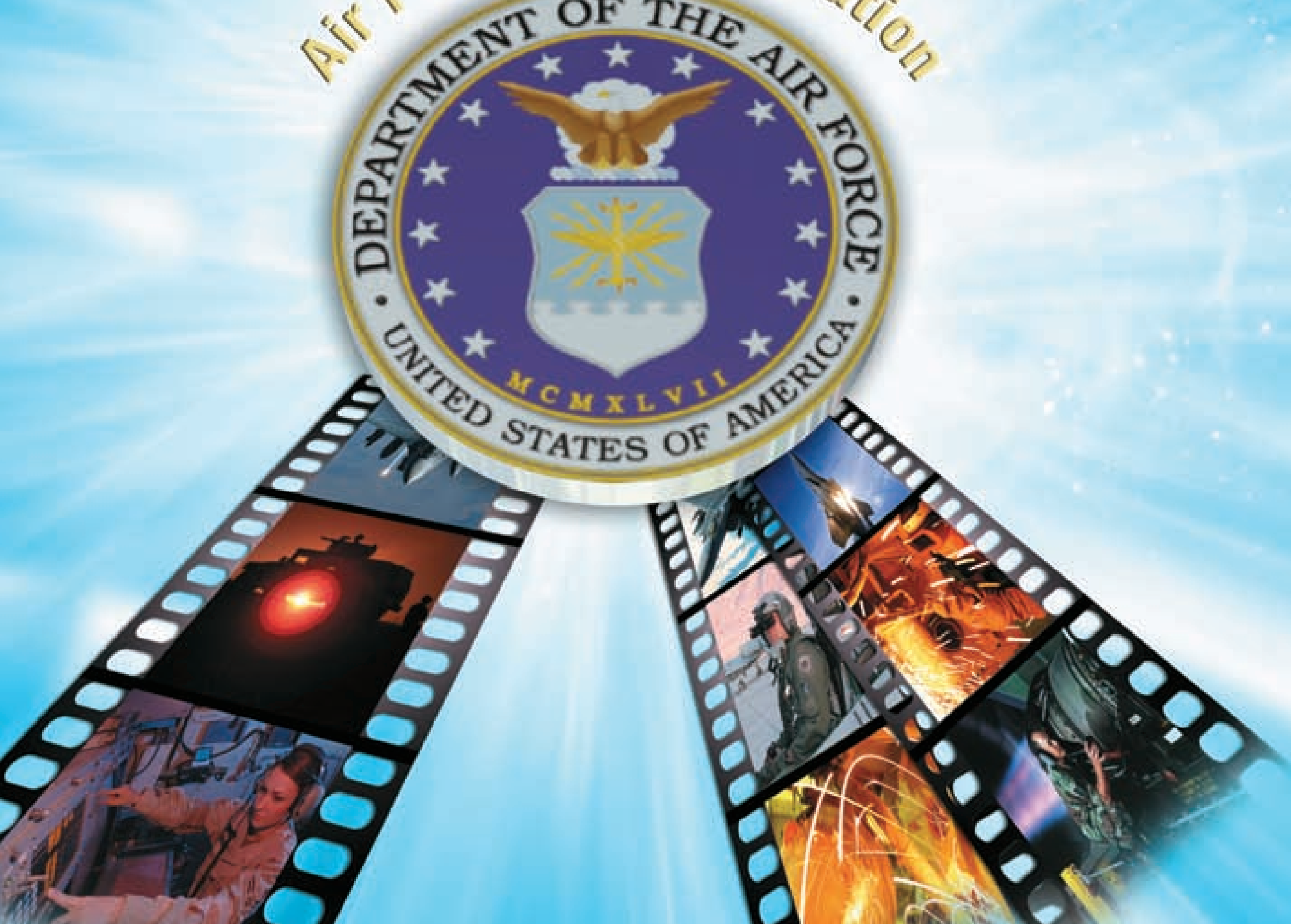
Defense Standardization Program

Journal

July/September 2005

Air Force Standardization



Inside

Standard Weapon Interfaces

GeoReach—The Air Force's New Web-Based Weapon

The Importance of XML to the Air Force Mission

Defense Standardization Program
Journal

Contents *July/September 2005*

Departments

Front cover: Some images courtesy the Department of Defense (U.S. Air Force).

Gregory E. Saunders
Director, Defense Standardization Program Office

Timothy P. Koczanski
Editor, Defense Standardization Program Journal

Defense Standardization Program Office
8725 John J. Kingman Road
Stop 6233
Fort Belvoir, VA 22060-6221

703-767-6870
Fax 703-767-6876

dsp.dla.mil

For a subscription to the *DSP Journal*, go to **dsp.dla.mil/newsletters/subscribe.asp**

The *Defense Standardization Program Journal* (ISSN 0897-0245) is published four times a year by the Defense Standardization Program Office (DSPO). Opinions represented here are those of the authors and may not represent official policy of the U.S. Department of Defense. Letters, articles, news items, photographs, and other submissions for the *DSP Journal* are welcomed and encouraged. Send all materials to Editor, *DSP Journal*, J-307, Defense Standardization Program Office, 8725 John J. Kingman Road, Stop 6233, Fort Belvoir, VA 22060-6221. DSPO is not responsible for unsolicited materials. Materials can be submitted digitally by the following means:

e-mail to DSP-Editor@dla.mil
floppy disk (Windows format) to *DSP Journal* at the above address.

DSPO reserves the right to modify or reject any submission as deemed appropriate.

In this issue of the *Defense Standardization Program Journal*, we will be focusing on the many standardization efforts and initiatives currently underway in the Air Force. Past issues have focused on Army and Navy efforts and, in an upcoming issue, the Defense Logistics Agency will be afforded the same opportunity. It is my pleasure now to turn over my column to Mr. Terry Jaggers, the Air Force Standardization Executive. I hope you enjoy reading about the good work being done by the Air Force and seeing how some of their standardization successes might apply to you.

Gregory E. Saunders
Director, Defense Standardization Program Office

Message from the Air Force Standardization Executive

By Terry J. Jaggers
Air Force Standardization Executive

As the Air Force Standardization Executive, I want to focus for a few minutes on the "big picture." We often get caught up in the details of developing and managing standards and need to remind ourselves of the importance of the Defense Standardization Program to the Air Force. Congress passed the Cataloging and Standardization Act in 1952. This act required that the Secretary of Defense "develop a single catalog system and related program of standardizing supplies for the Department of Defense." Congress went on to say, in Title 10, Section 2457, that we need "to standardize equipment, including weapons systems, ammunition, and fuel, procured for the use of the armed forces of the United States stationed in Europe under the North Atlantic Treaty or at least to make that equipment interoperable with equipment of other members of the North Atlantic Treaty Organization."

But the law does not drive the real reasons for standardization. Standards make key contributions to the Air Force mission. They are important not only to the sustainer and developer, but also to the warfighter. Standards are the key to enabling interoperability and can provide cost benefits in addition to making system development, maintenance, and logistics easier. In this special Air Force edition of the *Journal*, you will see from the articles that standards play an essential role across the Air Force.

The warfighter…

As seen in Joint Vision 2010 and the ensuing Joint Vision 2020, standards are essential to the warfighter. These documents provide the vision for how our Armed Forces are transforming themselves to be more responsive and agile against global threats in today's

Terry J. Jaggers
Air Force Standardization Executive

environment. Joint Vision 2010 provided the conceptual template for how our Armed Forces are to achieve new levels of effectiveness in joint warfighting. Joint Vision 2020 subsequently built upon and extends the conceptual template established by Joint Vision 2010 to guide the continuing transformation of America's Armed Forces.

Responding to lessons learned from recent operations and experimentation, Joint Vision 2020 sees that "expanding roles for multinational and interagency partners will require collaborative planning capabilities, technological compatibility/interoperability, and mechanisms for efficient information sharing." Joint Vision 2020 requires that our Armed Forces "be capable of operating with allies and coalition partners who may be technologically incompatible—especially at the tactical level." The overarching focus of transformation is full spectrum dominance—achieved through the interdependent application of dominant maneuver, precision engagement, focused logistics, and full dimensional protection. Standardization is an enabler not only for command and control interoperability among multinational organizations but also for focused logistics (for example, consumables and cross-servicing).

The developer and the sustainer…

Standards are essential to the developers and sustainers of our Air Force high-tech weapon systems. In addition to being an enabler for interoperability and focused logistics, standardization also helps reduce acquisition and sustainment costs. Standards discourage developers from continually "reinventing the wheel," but also may slow introduction of new technologies. As a result, our standardization program has shifted from reliance on detailed military specifications and standards to performance requirements using industry, interface, performance, and open system specifications and standards. This shift was achieved through specifications and standards reform over a period of time starting in the mid-1990s to where we are today. This approach allows us the opportunity to capture the benefits of standardization while, at the same time, makes it easier to introduce new technologies into our weapon systems. However, specifications and standards reform may have gone further than needed, and we are now implementing a more balanced approach where the key is to use the "right" standard—whether it is a performance or detailed standard or a non-government or military standard.

Where we are going with standards in the Air Force…

Today, our standardization program supports performance-based acquisition and spiral development to achieve capabilities needed by our Air Force. The program focuses on partnering with industry to develop and maintain standards, using standards for interoperability, maintaining needed military specifications and standards to document unique military materiel requirements, and maintaining a tool set of standards for use by our acquisition and logistics workforce and numerous other Air Force functional domains.

In today's environment of conflicts across the globe, I also see the need to strengthen our ability to conduct coalition warfare with our NATO and other allies. Joint Vision 2020 states that the "overall effectiveness of multinational operations is, therefore, dependent on interoperability between organizations, processes, and technologies." Some of this can be achieved through use of the international standardization agreements that identify needed interoperability and logistics interchangeability standards.

The rest of the story…

As you read through the articles on Air Force standardization in this edition of the *Journal*, you will see just some of the contributions that standardization makes to the mission of the Air Force. I sincerely hope you enjoy the articles. I thank the Defense Standardization Program Office for dedicating this edition of the *Journal* to the Air Force and thank the members of the *Journal* staff for their hard work in putting it together. I also thank the authors for taking the time to prepare the articles. Through them, you can see that Air Force standardization is working hard to meet its customers' needs.

The Electronic Systems Center and Information Technology Standards Council

By Richard Haycook

What if they gave a party, but nobody came? In most situations, this rhetorical question can be both funny and thought-provoking. But consider this fictional scenario:

> Zero-hour has arrived! A final assault on the city is about to start. The locked-and-loaded ground troops are massed, ready to move forward. The aircraft for command and control and close air support are on station, waiting for target information. Ships at sea have their cruise missiles programmed to launch. Covert operatives lurking in the city have gone undercover, abandoned their easily detectable communication devices, and anticipate linking up with friendly forces soon. All are waiting for the execution order to arrive from headquarters. Back at the Joint Theater Command Center, the general gives the order to proceed. The message is transmitted to the field, and—nothing happens!

Why did nothing happen? The joint command center sent the message in a format different from that used by the Army, Air Force, and Navy in the field. In fact, none of the formats were compatible. The lack of a common interoperable communications system caused this operation to fail. The element of surprise was lost, and possibly the pre-attack buildup was compromised to the enemy. And who knows what happened to those who were left in the city? So, the rhetorical question could now be: What if they planned an attack, but nobody came?

Achieving interoperability between joint and coalition forces requires establishing standards for designing and operating electronic platforms, devices, and services. With that basic common architecture, command and control elements can talk to each other with-

Establishing IT Infrastructure Standards

Establishing IT infrastructure standards entails promulgating formally documented information for developers, testers, operators, and users. The Air Force IT Standards Council accomplishes this with a standards profile—a solution space that is purposely constrained, but still satisfies a desired operational capability. The profile narrows all the possible solutions down to those conforming to certain technical or procedural dictates. Profiles ensure consistent behavior and implementation for all intended users.

To accomplish this, a standards profile must clearly articulate information (with varying degrees of detail) in four categories:

- Architecturally descriptive material rendered in the form of DoD architecture framework views (operations, system, and technical)
- Implementation-constraining direction regarding standardized products, if necessary, to satisfy corporate requirements such as common training, enterprise acquisition bulk-buy cost savings, security regulations, enhanced or assured integration and interoperability, and logistics maintainability
- Performance parameters to ensure consistent operation for warfighter or user mission applications, regardless of location
- Configuration parameters (if necessary) to ensure consistent implementation and concomitant operational (behavioral) responsiveness and capability.

out fear of something being lost in translation. The Air Force Electronic Systems Center (ESC) and Information Technology Standards Council (ISC) are working together to ensure that communication can occur.

Electronic Systems Center

The ESC, headquartered at Hanscom Air Force Base near Bedford, MA, manages development and acquisition of electronic Command and Control and Intelligence, Surveillance, and Reconnaissance (C2ISR) systems that gather and analyze information on potentially hostile elements, enabling commanders to make quick decisions and rapidly pass them on to their forces. ESC's mission is, in part, "to serve as the Center of Excellence for command and control and information systems to support the war fighter in war and peace," and to "provide full spectrum architectures, weapon systems management and technical cognizance throughout the life cycle of communications, intelligence, surveillance, reconnaissance, and information systems."[1]

ESC neither designs nor manufactures equipment; civilian contractors do. As systems acquisition managers, ESC translates the operational user's needs into systems to best meet those needs, solicits industry proposals, and selects contractors. Teams of professionals specializing in engineering science, business management, acquisition, and computers supervise the design, standards compliance, development, testing, production, and deployment of C2ISR systems.

Information Technology Standards Council

Establishing key IT standards is an important enabler for interoperability, and those standards are germane to the warfighter, operational support, and infrastructure systems. The Clinger-Cohen Act placed the responsibility for monitoring IT standards under each service agency's chief information officer (CIO).[2]

In a December 2003 memorandum to all major commands (MAJCOMs) and functional agencies, the chief of staff of the Air Force and the secretary of the Air Force directed the Air Force CIO to "lead the development of the Enterprise IT Services Strategy…to an enterprise-wide implementation of standard services with guaranteed performance characteristics. That strategy…will be developed with MAJCOM and Functional participation."[3] The memo contained a list of Air Force IT initiatives for FY04 and beyond. Specifically, it stated that the "AF CIO (with assistance from the MAJCOMs and Functional communities) will publish definitions, standards, timelines, and performance levels for IT Enterprise services."

The Air Force CIO, John Gilligan, tasked the Air Force chief architect, then Eric Skoog, to establish and chair the ISC. The council was charged with focusing on establishing standards, products, services, and other actions to guide and complement the AF enterprise IT-related mission. Mr. Skoog recommended that the ESC support the ISC as deputy chair, technical reviewer, and secretariat, because of the strength and depth of its role in systems engineering, architecture, and information technology.

As a collaborative effort between the AF CIO and the ESC Net Centric Operations/Integration Wing, the ISC held its initial meeting on August 20, 2004, under the chairmanship of Mr. Skoog. During that meeting, the council's basic concept, purpose, and organization were presented to members representing every MAJCOM and functional agency, U.S. Air Force Europe and Pacific, and Headquarters Air Staff.

In October 2004, the new chief architect, Jerry Friedman, assumed the role of council chairman. He continued the council's evolution by establishing procedures for designating standards that would be applicable to Air Force IT products and services. The council's primary purpose is to designate and apply a consistent set of IT standards, profiles (described below), and standardized. products for use by MAJCOMs, functional agencies, and all AF enterprise organizations that plan and acquire IT-supported operational capabilities.[4]

The AF CIO is particularly interested in supporting the Network Centric Solutions contract. The ISC fosters mainstream network-centric standards supported by industry products, and it supports the interoperability of both acquired systems and commodity products.[5] To accomplish that, the council does the following:

- It establishes profiles for IT products and services recommended for inclusion in the Air Force inventory, which are categorized as either an "IT platform" (hardware/software) or an "enterprise service" (software). A profile includes a description of how to achieve interoperability across other platforms and systems, documented test cases, behavioral performance, interface specifications, and provisioning information. All proposed IT platform products or enterprise service descriptions must include how they comply with the governing profiles.
- It requires proponents of proposed IT products and services to review and consider the established and emerging DoD, Air Force, and industry standards. Those standards have been adjudicated by the DoD IT Standards Committee, which registers them in the DoD IT Standards Repository (formerly the Joint Technical Architecture), or by the Defense Standardization Program Office (DSPO).

The ISC is organized into two major parts:

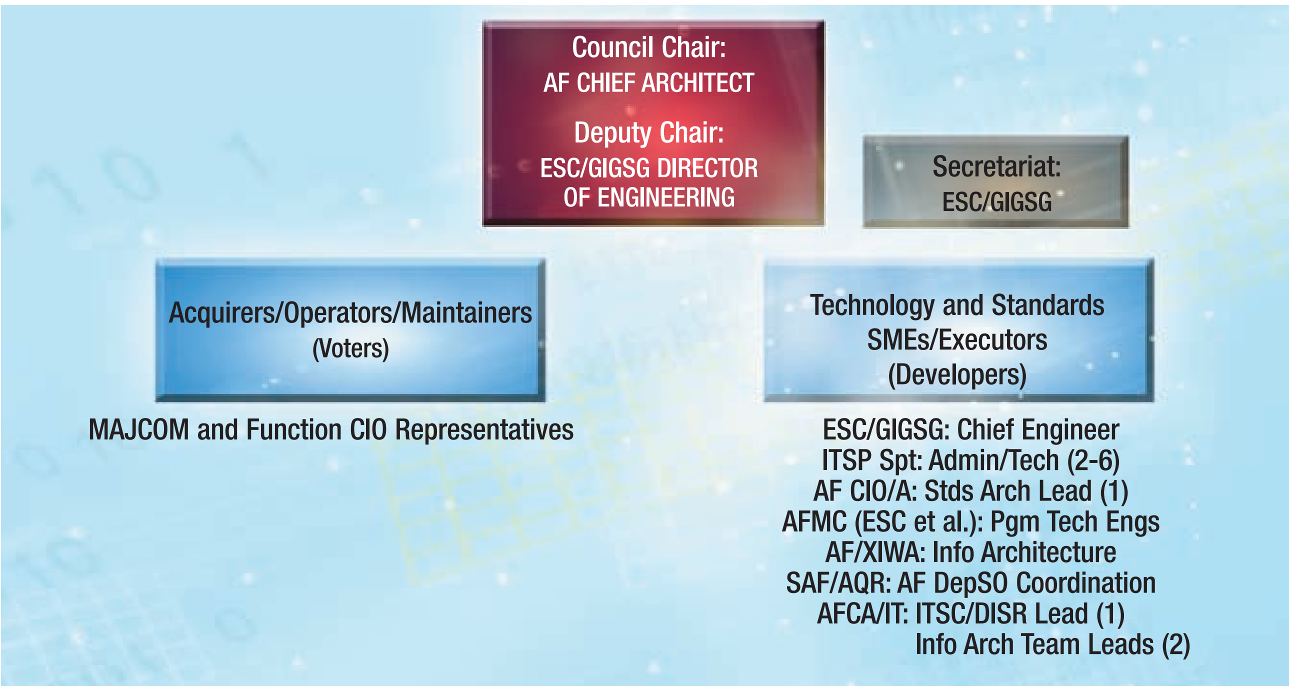
- The ISC chair and technical reviewers, who are located at the Air Force Chief Architect's Office at the Pentagon. The ESC Global Information Grid Systems Group is chartered to provide the ISC deputy chair, chief technologist, additional technical reviewers, and secretariat.

- A staff of developers, who support the council in complying with established directives, interfacing with other activities (such as the Air Force Infrastructure Architecture Council), and liaising with the other services and industry. This group consists of representatives from ESC, the Air Force Communications Agency (AFCA), the AF CIO's Chief Architect's Office (AF CAO), DSPO, and the Industry Advisory Council.

The general membership consists of action officers and the executive (voting) members. Each AF MAJCOM and functional agency participates at meetings through one or more action officers. They conduct the council's routine business and review and comment on proposals and other issues arising at each meeting. Each member command or agency also participates through an executive member, usually at the general officer or senior executive level, for matters requiring senior involvement or decision making.[6]

Figure 1 depicts the composition of the ISC, showing the heavy-lifting players (ESC, AFCA, MAJCOMs, commercial contractors, other AF organizations) that generate draft profiles from a template of required information. The AF IT Standards Council (led by the chief architect) adjudicates the draft profiles, coordinating and vetting them through the MAJCOMs or functional agencies that will be the major infrastructure users and maintainers of the stipulated capabilities.

FIGURE 1. Composition of AF IT Standards Council.



Note: AFCA/IT = Air Force Communications Agency Information Technology; AF CIO/A = Air Force Chief Information Officer/Chief Architect's Office; AFMC = Air Force Materiel Command; AF/XIWA = Air Force Information Architecture Division; ESC/GIGSG = ESC Global Information Grid Systems Group; ITSP = Information Technology Services Program; SAF/AQR = Secretary of the Air Force (Acquisition); and SME = subject matter expert.

Collaboration with Other Air Force Agencies

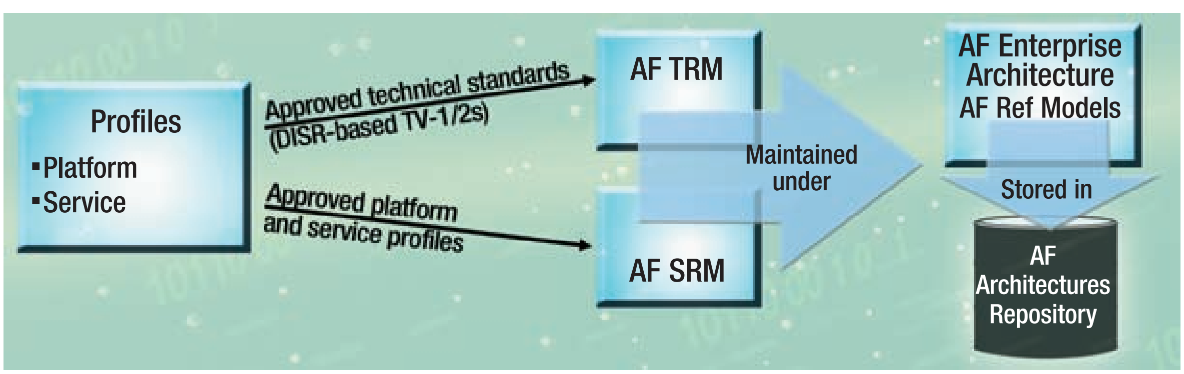
As previously stated, the ISC receives support from the MAJCOMs and functional agencies through coordination and voting activities. Another council that works with the ISC is the AF IT Commodity Council (ITCC) at Gunter Air Force Base, AL, operating under the purview of the Standards Systems Group, an ESC geographically separated unit. The ITCC makes bulk buys for the AF enterprise after a product or service receives approval as a standard.

After the ISC approves a product standard or profile, it forwards the information to the AF Enterprise Architecture Integration Council. The council is "the authoritative (AF) body responsible for ensuring the development and application of AF architectures across the entire enterprise."[7] Approved technical standards go into the AF Technical Reference Model (AF TRM). This web-accessible database, which AFCA maintains at Scott Air Force Base, IL, is an extension of the Office of Management and Budget/Department of Defense technical reference models. Approved platform and service profiles go into the AF Service Component Reference Model (AF SRM), another web-accessible database at Scott, which ESC and AFCA maintain. Figure 2 depicts the profile development process.

These two AF reference models (and three others that are not discussed here) are essential parts of the AF Enterprise Architecture (AF EA). As such, they contain architectural direction necessary to govern multiple developers and users of those common "infostructure" capabilities. The reference model information represents reusable components to facilitate integration and interoperability of separately developed and utilized AF architectural artifacts. In this case, the reuse is the (purposely constrained) implementation and usage details in the standards profile. That information governs consistent enterprise-wide development and use of the specified IT platforms and services.

The AF-EA is a visualization model representing the AF framework elements. It is maintained by the Air Staff Information Services Division and CIO for the entire AF

FIGURE 2. IT Profile Development.



community. Pointers in the AF-EA redirect a user from items in the AF reference model to the actual storage locations of the profiles in a web-accessible architecture repository.

Although the council is an AF CIO construct, its governance, end products, and impacts are the result of effective partnering and cooperation between AF Headquarters and ESC.

Contacting the AF IT Standards Council

The ISC maintains a website on the Air Force Knowledge Management Portal, which is accessible by portal account holders. Navigate to the Air Force CIO CAO website and click the link for the AF IT Standards Council. This site provides links to meeting minutes and presentations, the ISC charter and related documents, and other standards sites, including DSPO and the AF TRM and SRM.

Recent Reorganization and Council Status

On May 10, 2005, the Air Force Warfighting Integration, Air Force Communications Operations, and Air Force Chief Information Officer merged to form a new organization called Secretary Air Force, Office of Warfighting Integration and Chief Information Officer. Many of the functions described in this article as supporting the AF ISC, as well as the overall council structure, were affected by this action. At press time, the changes had not been officially finalized and are, therefore, not included here.

[1]U.S. Air Force Electronic Systems Center, "Our Mission," accessed online at http://esc.hanscom.af.mil/esc_info.asp.

[2]Clinger-Cohen Act of 1996 (Information Technology Management Reform Act), 40 United States Code 1401(3).

[3]Memorandum of the Secretary of the Air Force and Chief of Staff of the Air Force, "Air Force Information Technology Initiatives," December 3, 2003.

[4]Eric Skoog, "Introductory Briefing," U.S. Air Force IT Standards Council Stand-Up Meeting, August 20, 2004.

[5]Eric Skoog, "Introductory Briefing."

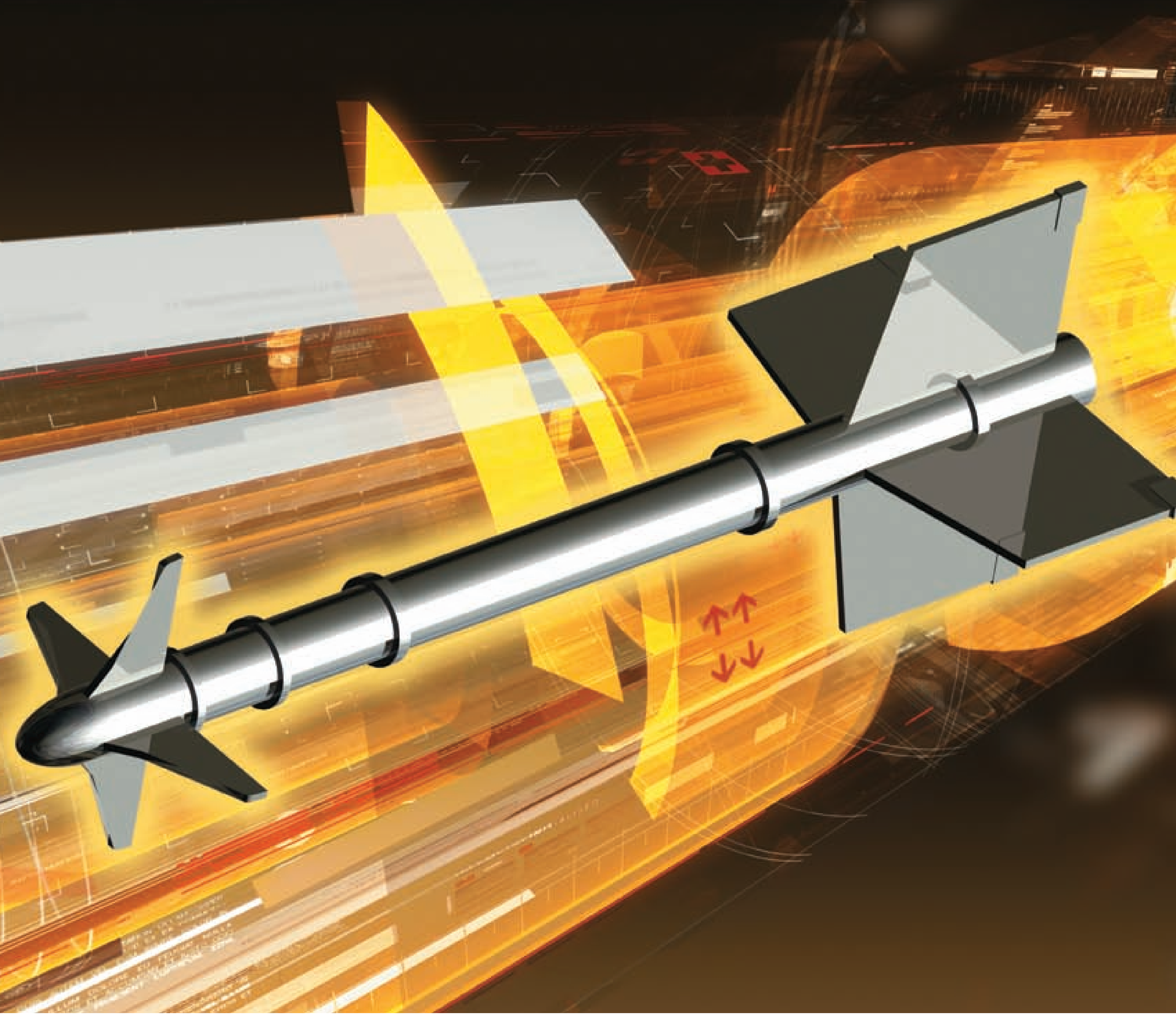
[6]These positions are subject to change as the ISC structure evolves.

[7]Eric Skoog, "Introductory Briefing."

About the Author

Richard Haycook has been employed at the MITRE Corporation since 1986. He initiated the reactivation of the ESC Defense Standards Program in 2000, through the ESC Office of Chief Engineer. In 2004, he was one of the original organizers of the AF IT Standards Council.

The author wishes to express his extreme gratitude to three colleagues who provided valuable insight and input: Dr. Louis Metzger, ESC Director of Engineering; Jerry Friedman, Air Force Chief Architect; and Eric Skoog, ESC Net-Centric Systems Wing Engineering Director.



Developing Standards to Integrate Weapons into the Global Information Grid

By Ron Taylor

> The joint force of 2020 will use superior information and knowledge to achieve decision superiority to support advanced C2 capability and to reach the full potential of dominant maneuver, precision engagement, full dimensional protection and focused logistics.... [T]he Global Information Grid will provide the network-centric environment to achieve this goal.
>
> —Joint Vision 2020

Communicating with in-flight weapons has been possible for many years with unitary (point-to-point) data links employing platform- or class-unique standards and protocols. Only in recent years, however, have the military services aggressively pursued the development and planned fielding of global, multiuser, joint-interoperable weapons that are truly "networked." The integration of munitions into the Global Information Grid—part of the network-centric warfare vision—offers the promise of significant enhancement of current operational capabilities. A network-enabled weapons capability facilitates battlespace awareness, from desired actions to direct effects on the battlefield, while providing the conduit for near-real-time feedback to decision makers.

The acquisition and warfighter communities commonly use various terms—such as "networked weapons," "weapons data link," and "network-enabled weapons"—to describe weapons that produce and consume information within a network construct. In the discussion that follows, we use those terms interchangeably.

Network-Enabled Weapons

Over the last several years, the Air Armament Summits conducted at Eglin Air Force Base, FL, have been a principal venue for the advocacy of network-enabled weapons. The 2003 summit highlighted network-enabled weapons as the single most cost-effective means available for enhancing *overall* armament capability against our most challenging targets. The gathering recommended modifying current inventories to exploit network-centric warfare via weapon in-flight tracking, retargeting to engage time-sensitive targets, and providing endgame information. The summit also considered future weapons that could loiter, search, identify, and (with an allowed level of autonomy) precisely engage targets and relay information back to the battle staff.

Those desired capabilities were later refined and introduced into the formal requirements process as the Tactical Data Link–Transformation Capabilities Development Document (TDL-T CDD). Although the U.S. Air Force was the principal author, close collaboration and contributions from the U.S. Navy resulted in a requirements document that reflects the TDL capabilities both services desire. These include updating a current target or redirecting the weapon to a different target, receiving weapon information (position and health/status) periodically throughout flight until just prior to impact, and aborting the weapon. Earlier this year, the Joint Requirements Oversight Council validated the capabilities documented in the TDL-T CDD, which are to be incorporated in the context of an evolutionary acquisition (spiral) approach.

Integrating Weapons into C2 Architectures

Although we have discussed the warfighter's desire for the increased operational utility that network-enabled weapons can provide, we have yet to describe exactly what network infrastructure these weapons will be accessing. Producers and consumers of information to…what? It turns out that the answer currently depends on the military service, with service-specific components such as the Air Force C2 ConstellationNet, the U.S. Navy FORCEnet, and the U.S. Army LandWarNet. These will eventually merge within the joint interoperable architectural framework of the Global Information Grid.

Because significant work remains in integrating network-enabled weapons into C2 architectures, the Weapons Data Link Network (WDLN) was proposed as an Advanced Concept Technology Demonstration (ACTD) candidate for FY05, sponsored by the U.S. Joint Forces Command. The demonstration has the following objectives:

- Develop standard architecture products for integrating weapons into networks as directed by Chairman of the Joint Chiefs of Staff Instruction 3170, "Joint Capabilities Integration and Development System" (March 12, 2004), using the DoD Architecture Framework (DODAF)
- Implement common terms, message formats, and definitions for developing a common networks interface to achieve the required capabilities
- Identify the modifications to C2 and aircraft infrastructure necessary to employ the WDLN capability
- Establish a baseline concept of employment for weapons' network communication
- Provide risk reduction for weapon system program offices
- Demonstrate the communications network using surrogate weapons.

The following organizations are participating in the WDLN ACTD:

- Air Armament Center, Capabilities Integration Directorate
- Air Armament Center, Air-to-Ground Munitions Systems Wing
- U.S. Joint Forces Command
- Headquarters, Air Combat Command
- Naval Air Systems Command
- Space and Naval Warfare Systems Command
- Electronic Systems Center Tactical Data Links and Gateways system program office
- Air Force Command and Control and Information, Surveillance and Reconnaissance Center
- Air Force Research Laboratory.

The specific Air Force and Navy weapon platforms of interest for the demonstration include the Small Diameter Bomb II (SDB II), the Joint Air-to-Surface Standoff Missile, the Joint Standoff Weapon, the Wind Corrected Munition Dispenser–Extended Range, and the Miniature Air-Launched Decoy–Jammer version. Though not directly affiliated at this time, airborne armament being developed by the U.S. Army to support LandWarNet will also come under consideration in the effort.

Developing DODAF Products

Products using the DoD Architecture Framework will help develop an interoperable network solution for weapons and provide a common, structured approach and product set usable across the weapons community. Development of DODAF products is progressing via analysis that encompasses the three Global Information Grid domains (terrestrial, airborne, and space).

Strike mission-based scenarios reflecting the approximate network environments of 2010 and 2020 represent the "as-is" and "to-be" architectures. The ACTD executive integrated project team chose 2010 to represent the as-is environment because it aligns with the current target for fielding the network-enabled SDB. II. The analysis (and the subsequent network-loading analysis that it supports) will examine specific weapons, but the resultant architectural products will apply to any weapon platform whose primary characteristics and capabilities resemble those of the specific weapon analyzed.

The Navy has demonstrated the broad utility of the DODAF products in its FORCEnet architecture as a powerful assessment tool for force-level planning and gap analysis. Seeking to leverage existing FORCEnet knowledge and products, the WDLN ACTD is working with SPAWAR Systems Center in Charleston, SC, to develop a common operational activity model (OV-5, in DODAF terms) that incorporates network-enabled weapons within the find-fix-track-target-engage-assess kill chain for engaging a time-sensitive target. This common activity model is viewed as a lynchpin for enhanced connectivity between the Air Force Constellation/ConstellationNet and Navy FORCEnet enterprise architectures.

The analysis is narrowed by other constraints, besides the selected time frames and operational environments. First, assuming that software-defined radios will be utilized to achieve network-enabled weapons capability, the choice of waveforms will be limited to those scheduled to be available from the Joint Tactical Radio System (JTRS) Program Technical Laboratory repository for the period of interest. Using these ensures alignment with the JTRS tenets of interoperability and reuse.

A second constraint is the desired preservation of current performance capability with limited weapon modifications. The words "desired" and "limited" are telling here—we may have to trade some current aspect of weapon performance to obtain the network-enabled capability we desire. Also, such tradeoffs could extend well beyond the weapons themselves; within this system of systems, other users may have to yield some of their network time to accommodate weapons access to the network. Certainly, our intent would be to recapture this forfeited capability downstream (through technological advances or other means), but until then, we may have to sacrifice something. For example, we simply might not be able to produce a capable but sufficiently small transceiver by a certain date. However, an assessment at the system level might reveal that we could incorporate the transceiver with a slight reduction in fuel capacity or warhead package. The WDLN ACTD will heavily rely on this type of tradeoff analysis to ensure the best overall capability in the selected parameters.

Common Networks Interface

Air-launched weapons receive information prior to launch via a physical interface with the aircraft. The aircraft umbilical feeds this information in the form of discrete data elements required for specific functions and activities. The capabilities desired for network-enabled weapons are essentially common across the current weapons of interest. With few exceptions, much of the information necessary for in-flight network-enabled weapons is the same as that currently passed via the umbilical.

However, even though commonality exists at the level of discrete data elements, little or no commonality exists in how the packaged information is required by and transferred to the various weapons. This flaw has proved extremely costly and cumbersome for the military services. Every time a new weapon is paired with a host platform, the host platform's software requires extensive changes. Although the WDLN ACTD will not address the umbilical issue—this is the objective of the concurrent Aeronautical Systems Center/Air Armament Center universal armament interface program—we must ensure that we do not create a similarly flawed environment when integrating weapons into the network arena. Thus, the ACTD objective is to develop a networks interface common across all weapons.

The process for creating the common networks interface for weapons is fairly straightforward. First, the organizations participating in the ACTD agreed on the functions to be supported, and established a common set (and definition) of Information Exchange Requirements (IERs). This process extensively used the TDL-T CDD and current weapon-specific capabilities documents, with a vision toward future network-enabled weapons. We then identified specific data elements to support the IERs, followed by mapping the data elements into existing MilStd message formats. This effort has exercised great care to make certain that the networks interface would leverage existing standards while being "waveform agnostic," ensuring both immediate and prolonged utility. Progress in developing a common networks interface for weapons has exceeded initial expectations, and the coming months should see an analysis of implementation alternatives.

On the Path

Enabling weapons to produce and consume information within a network will significantly increase our ability to engage time-sensitive targets while enhancing battlespace awareness. Activities such as the WDLN ACTD to develop class standards will ensure the thoughtful integration of weapons within C2 infostructures, to achieve the advantages desired by the joint warfighting community.

About the Author

Ron Taylor is a systems development engineer for the Capabilities Integration Directorate, Air Armament Center, at Eglin Air Force Base, FL. He is the lead systems engineer for the Weapons Data Link Network Advanced Concept Technology Demonstration, the joint-service pathfinder effort for network-enabled weapons.

The Evolution of a Standard

The STANAG 4607 NATO GMTI Format

By Clem H. ("Hamp") Huckins

A convoy of enemy tanks and trucks moves in the darkness along a roadway toward an assembly point or attack position. They think they are invisible to surveillance—but what they don't suspect is the presence of high-flying radar systems that can observe their every move.

The United States and the NATO nations have deployed a wide range of surveillance radar systems on fixed-wing, rotary-wing, and satellite platforms, all of which are highly capable of observing moving traffic from a stand-off distance or even from space. The Ground Moving Target Indicator (GMTI) data collected from these systems provide a wealth of information about the movement of those potential targets. However, the data from the radar system (also referred to as the sensor) must first be changed to a form appropriate for transmission to a system that can receive and use the data.

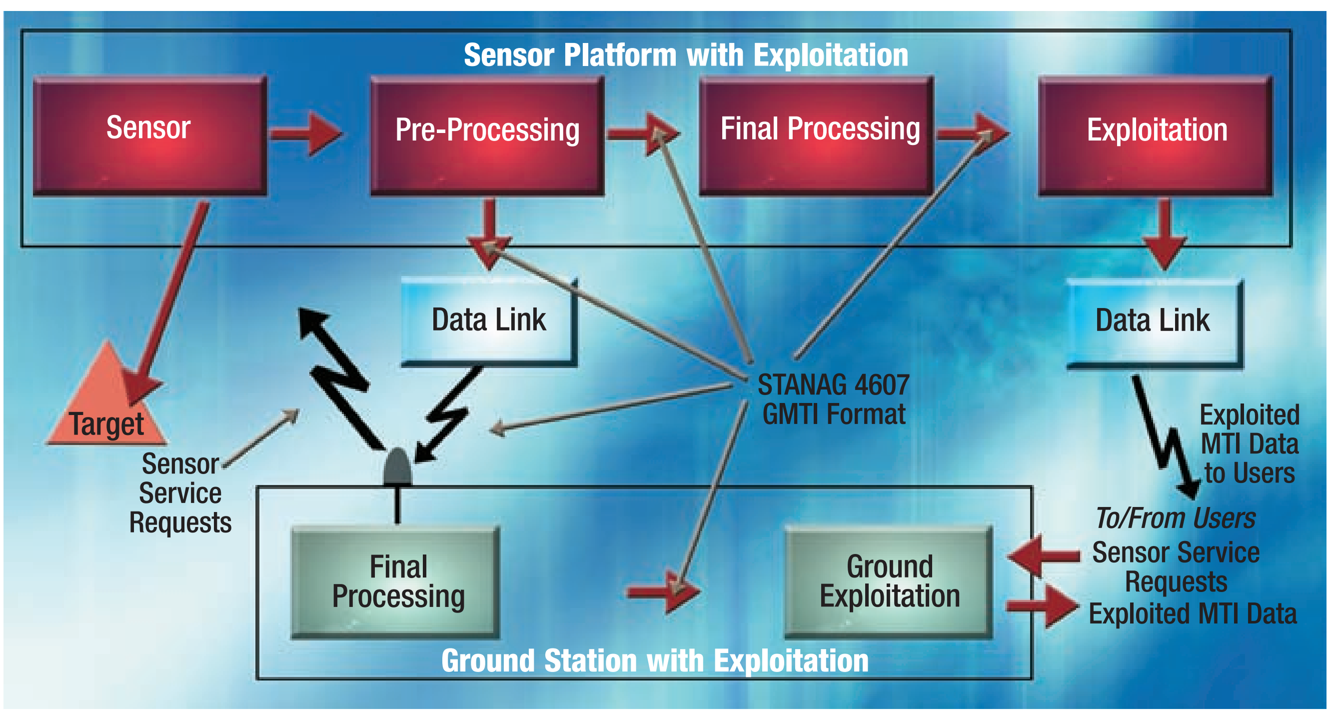
And that's where a standardization agreement (STANAG) comes in. STANAG 4607, the NATO Ground Moving Target Indicator Format, provides a format for sending GMTI data to systems that can extract usable information from the data. The format can be tailored to send very detailed GMTI data for activities such as targeting or to send less detailed data for applications such as situational awareness, as required by the warfighter.

"Exploitation" is the common name for the process of developing usable information ("exploited" or MTI data) from the GMTI data. The exploitation system may be on board the sensor platform, or it may be at a ground facility. Figure 1 portrays a sensor platform that includes an on-board exploitation system, as well as a data link to carry the standard-format GMTI data to a ground station and its exploitation system. The exploited data, used in conjunction with information from other sources such as synthetic aperture radar, video, and intelligence reports, provide significant inputs for creating an operational picture of the battlefield to support the warfighter.

Origins of the GMTI Format

STANAG 4607 originated in May 1999 at a meeting of U.S. Air Force military, government representatives,

FIGURE 1. Combined On-Board and Ground Exploitation of Targeting Data.



and contractors. Their goal was to establish an integrated product team (IPT) for developing a common MTI data format that would replace the multiple MTI message formats then in use. Arthur L. Money, Office of the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence), and Brigadier General David Nagy, Office of the Assistant Secretary of the Air Force (Acquisition) for Information Dominance, directed the development of a common MTI data format that will serve a user base extending to all services, the intelligence community, and coalition partners.

The initial product of the IPT, designated as the Common Ground Moving Data Indicator (CGMTI) Format, was designed from the ground up as a "universal" standard to meet the requirements of legacy and future U.S. radar systems for GMTI products.

NATO Enters the Picture

In April 2000, NATO Air Group 4 for Intelligence, Surveillance, and Reconnaissance (ISR), one of six air groups under the NATO Air Forces Armaments Group (NAFAG), established the NATO GMTI Technical Support Team.

The NAFAG is one of three armaments groups subordinate to the NATO Conference of National Armaments Directors (CNAD), the NATO organization at the secretary (or minister) of defense level where most work takes place to identify opportunities for collaboration in the research, development, and production of military equipment and weapon systems (including data formats and STANAGs). The CNAD, in turn, reports to the ambassadorial-level North Atlantic Council, the governing authority in NATO. Through its six subordinate groups and six working groups, the NAFAG is responsible for promoting cooperation and standardization in air armament via joint activities and information exchange. Air Group 4, as mentioned, is responsible for intelligence, surveillance, and reconnaissance. Its ISR Interoperability Working Group (ISRIWG) is responsible for developing STANAGs related to ISR.

The NATO Standardization Agency, set up by the North Atlantic Council, oversees the preparation work and overall administration of all STANAGs. It is responsible to the NATO Standardization Committee for coordinating issues among all fields of standardization. It sets out procedures, planning, and execution functions related to standardization for application throughout the alliance.

STANAG 4607 is one of several ISR standardization agreements called out under the NATO Intelligence, Surveillance, and Reconnaissance Interoperability Architecture (NIIA). The multi-volume Allied Engineering Documentation Publication 2 (AEDP-2) establishes the technical aspects of an architecture for interoperability among NATO nations' ISR systems. Other related standardization agreements called out in the NIIA include 4545, NATO Secondary Imagery Format; 7023, NATO Primary Imagery Format; and 4559, NATO Standard ISR Library Interface.

The GMTI Technical Support Team, which includes government representatives and contractors from several NATO nations, was directed by the ISRIWG to evaluate possible formats and existing procedures and standards, recommend a "way ahead" consistent with existing STANAGs and the NIIA, and prepare a new STANAG or an addendum to an existing STANAG. The work of the U.S. CGMTI IPT soon came to the attention of the GMTI Technical Support Team, which began to participate in CGMTI meetings and development of the CGMTI Format. This collaboration led to a transformation of the U.S.-centered CGMTI Format into the standard form for a NATO STANAG; the subsequent acceptance and designation of the standard by NATO as STANAG 4607, NATO GMTI Format; and the merging of the CGMTI IPT into the GMTI Technical Support Team.

The Method for Development of STANAG 4607

The present version of STANAG 4607 represents the culmination of 5 years of work by a dedicated technical team of GMTI experts. The technical group met periodically to develop technical details, then reported issues to a higher-level group, which typically included members of other STANAG support teams, for guidance and doctrine. During early development, it was also necessary to meet with representatives of the various program offices having a stakeholder interest in GMTI, to learn about their systems and requirements for GMTI data dissemination.

The basic method for developing the STANAG was to survey applicable legacy standards (such as the NATO Exploitation Format, the National Imagery Transmission Format, or NITF, and others); determine which data elements (including data fields, parameters, and values) were required for the new standard; and develop a clear, easy-to-implement standard based on those elements.

The starting point was to learn about the systems that could utilize a common MTI standard; the means for this was a series of briefings on the technical parameters of those systems. After a data call to accumulate standards for those systems, the next step was to analyze the standards for applicability, develop a straw man standard, and convene a technical working group to review it and determine the required parameters.

Due to the complex nature of the subject, it was convenient to establish three subgroups for particular subject areas: Coordinate Systems/Time Standards;

Anatomy of a STANAG

STANAG 4607 is primarily intended for data exchange between GMTI radar systems and their exploitation systems and to facilitate transmission, fusion, and display. The following are some of its technical features and characteristics:

- It provides a structured approach for various types of users (for example, low or high bandwidth) and an incremental fielding approach, depending on the user's particular data requirements.
- It can be used either as a standalone, embedded into other STANAGs (such as 4545, NATO Secondary Imagery Format, or 7023, NATO Primary Imagery Format), or disseminated in an XML version.
- It is a binary, message-oriented format for disseminating GMTI data, also referred to as radar "dots."
- It is organized into data packets, with each packet including a number of segments. Each segment carries a particular type of information, such as information pertaining to a radar dwell (the point where the radar beam strikes the earth), and the radar targets detected within that dwell.
- It currently includes segments for Mission, Dwell, High-Range Resolution, Job Definition, Free Text, Test and Status, Processing History, and Platform Location. Any of these can be selected as required by mission requirements and transmitted within a packet with other segments in any desired order.
- It also includes segments for Job Request and Job Acknowledge, which may be transmitted when there is a requirement to provide a request for sensor service or to acknowledge such a request.
- It provides a means in the Dwell segment for tailoring the transmitted information to the user's particular requirements or capabilities. For example, a user responsible for target attack would require significantly more information for a relatively small number of movers or targets, in comparison to a user who is interested only in situational awareness or knowing the general location of many potential movers.

High-Range Resolution (HRR), a form of radar target signature measurement; and Structure and Definitions. The subgroups for Coordinate Systems/Time Standards and HRR met separately and developed the parameters required for their specialty areas. The Structure and Definitions subgroup was the core group for the effort, with overall responsibility for editing the document and providing the final product. The Coordinate Systems/Time Standards and HRR subgroups were disbanded after finishing their work, and the burden for completing the STANAG fell to the Structure and Definitions subgroup, which then evolved into the GMTI Technical Support Team.

Each ISR STANAG is typically developed in parallel with an associated AEDP. AEDP-7, Implementation Guide for the NATO Ground Moving Target Indicator, provides detailed technical guidance on the implementation and testing of STANAG 4607. In addition to details of test, validation, and configuration management, the publication includes background information and an employment concept for the STANAG; descriptions of how STANAG 4607 relates to other ISR STANAGs; and technical details concerning data fields, data transmission considerations, coordinate-location systems, and other key parameters. It is essential to understanding and implementing STANAG 4607.

Ratification and Promulgation

By October 2002, the developing STANAG was substantially complete and ready to enter the ratification process. It was presented to the ISR Interoperability Working Group in November 2002, which approved it for submittal to Air Group 4. The Air Group endorsed the STANAG and submitted it to the NATO Standardization Agency, which prepared the ratification draft request dated March 2003 and submitted the document to the nations for their ratification.

Ratification is the procedure under which a NATO member nation formally accepts the content of a STANAG, either with or without reservation. A reservation is the stated qualification describing the part of a STANAG that the member nation will not implement or will implement with reservations. The member nation also has the right to state whether it intends to implement the STANAG.

When a sufficient number of member nations have stated their intention to adopt and implement the STANAG, it is considered ratified. That number will vary with the STANAG and its intended purpose. STANAG 4607 was considered ratified when seven of the 26 nations that would potentially use it agreed to ratify it. Three of those seven committed to immediate implementation, and the remaining four stated that they would not implement STANAG 4607 at this time but possibly in the future. Two other nations have stated informally their intention to ratify the document as soon as they complete their staffing.

After ratification, the next step is promulgation, which is simply an announcement by NATO that the STANAG has been approved. This occurs after the document has been translated into the two NATO languages (French and English) and approved in those forms. STANAG 4607 was promulgated in March 2005.

Successes

Early implementations of STANAG 4607 have been proven in several exercise and experimental venues. STANAG 4607-formatted data were successfully passed from multi-nation GMTI simulators to multi-nation exploitation systems in a distributed test-bed environment, within the Coalition Aerial Surveillance and Reconnaissance (CAESAR) project. That effort involves establishing interoperability between the GMTI and synthetic aperture radar assets of seven nations (Canada, France, Germany, Italy, Norway, the United Kingdom, and the United States). Tests and demonstrations were completed for both the binary (native) version of STANAG 4607 and an Extensible

Markup Language (XML) version based on it. The follow-on project to CAESAR, the Multi-Sensor Aerospace-Ground Joint ISR Interoperability Coalition (MAJIIC) project, will continue to use the binary and XML versions as the basis for GMTI dissemination.

Within the United States, the Air Force Research Laboratory funded a contractor demonstration of pre-recorded STANAG 4607 data embedded in a NITF 2.1/STANAG 4545 data stream. The XML version of STANAG 4607 was demonstrated in the Horizontal Fusion exercise Quantum Leap 2, also using "canned" GMTI data from U.S. and coalition platforms.

In addition, STANAG 4607 was identified as an "emerging" standard in an earlier edition of the Joint Technical Architecture (JTA), which identifies mandated and emerging standards that should be included in new system designs. Efforts are currently under way to identify STANAG 4607 as a "mandated" standard in the DoD Information Technology Standards Registry, the successor document to the JTA.

The Way Ahead

With the promulgation of STANAG 4607 in March 2005, it is now an accepted standard defining a format for transmitting GMTI radar detections, including GMTI target detections ("dots") and HRR data. However, that doesn't mean the work is over. As implementation and testing of the STANAG continue, there will be a need to correct minor errors and clarify some areas.

Also, the standard must be capable of growing and expanding to accommodate new requirements and new sensor platforms. Future versions of the STANAG, for example, could contain features such as track data, space-borne radar, MTI derived from motion imagery, and maritime mode radar. A driving concern, however, is that future versions must always remain backward-compatible with earlier ones.

To accommodate this future growth, the GMTI Technical Support Team, the experts who carried the STANAG from inception to promulgation, will be redesignated as the Custodial Support Team. The team, working in conjunction with the STANAG 4607 custodian, will be responsible for continued maintenance and configuration management during the lifetime of the STANAG.

Conclusion

So, where does that leave us with the enemy convoy moving in darkness? We have seen how its moving vehicles could be under observation from U.S. and NATO surveillance radar systems, as well as how the GMTI radar detections from those observations could be transmitted to exploitation systems and the exploited data used to support an operational picture of the battlefield. STANAG 4607 provides an unprecedented means of providing that information. It is the product of an intensive effort by a dedicated team of professionals and is expected to be used for many years to come. The bottom line is improved interoperability of joint and coalition forces for GMTI data, as well as enhanced support for the warfighter, especially in visualizing the battlefield.

About the Author

"Hamp" Huckins, a systems engineer for the MITRE Corporation, works in the Air Force Distributed Common Ground System program office at Hanscom Air Force Base, MA. He is the technical lead and chief editor of STANAG 4607. He chaired the Technical Interoperability Working Group for the CAESAR coalition project and now chairs the Technical Working Group for the MAJIIC coalition project. His special interest is in communications interoperability between coalition systems.

Standard Weapon Interfaces

The Path to a Universal Armament Interface

By Jim Byrd and Oren Edwards

A problem exists in the way new weapons are integrated onto U.S. Air Force aircraft. It can be illustrated by the following scenario:

> During operational testing of an F-16 software upgrade, a pilot notices an anomaly in the cockpit displays. The display symbology on the heads-up display, driven by aircraft flight software, indicates that a weapon is ready for launch release, and the pilot depresses the "pickle" button. Actual weapon launch, driven by critical inputs from the weapon, does not happen for another 2 seconds. Noting the operational impact to pilots in the field, the test pilot records the anomaly. Investigation reveals that a recent weapon software change generated a slight mismatch in launch parameters with the F-16. What the pilot can't understand is why a software fix won't be available to field for another 2 years.

With the advent of MIL-STD-1760 aircraft-to-store interfaces, we have largely eliminated the costs of hardware (wiring, connectors, and special interface circuits) for new store integration on aircraft. Now, software integration is the major cost and schedule constraint on store integration. Although MIL-STD-1760 does define data types, formats, and some common messages, much of the data interface definition is left up to the individual weapon programs. Optimizing weapon performance requires significant tailoring of each weapon's data interfaces.

The Universal Armament Interface (UAI) program explores and develops enabling technologies and system engineering approaches that will allow deployment of future precision-guided munitions without the need to revise aircraft software for each new weapon.

The Problem

A typical aircraft software revision involves two major iterations of the systems engineering process to provide the final integrated capability. The first iteration incorporates the majority of capabilities defined during the requirements process. The second allows for deficiency corrections, integration of subsystems delivered late in the development process, and development of capabilities that could not be accomplished in the first stage. The first iteration is typically a 4-year process, while the second usually takes 2 years, with a 1-year overlap. This leads to an overall time span of 5 years for software development and verification. Operational test and evaluation combined with deployment typically require an additional year, resulting in about a 6-year span from capability definition to fielding.

Two factors drive these long integration times. First, the weapon software must be sufficiently developed before starting aircraft integration. Second, there is only a limited window in the normal aircraft software update cycle for inserting new weapon integration requirements. Last-minute or out-of-cycle requirements are still possible, but only at highly increased cost and schedule impact, often needing money budgeted for other requirements.

This coupling between the aircraft and weapon software development cycles is illustrated in Figure 1. As the graph shows, weapon development is complete and ready for aircraft integration in year 4. However, it must wait for the next available requirements phase, now in version B.1. Since version B doesn't field until midway through year 9, the new weapon, completing flight test in year 5, must wait an additional 4 years before release to the field as a complete weapon system.

Figure 1 shows a simplified scenario. Often, in reality, the requirement is to integrate multiple weapons onto various existing and emerging aircraft, each with unique system upgrade cycles. The scenario in Figure 2 better represents typical weapons and aircraft acquisition and integration cycles. At a particular point in time, aircraft and weapons programs are at different stages of development, with weapon integration efforts coupled to the long aircraft software upgrade

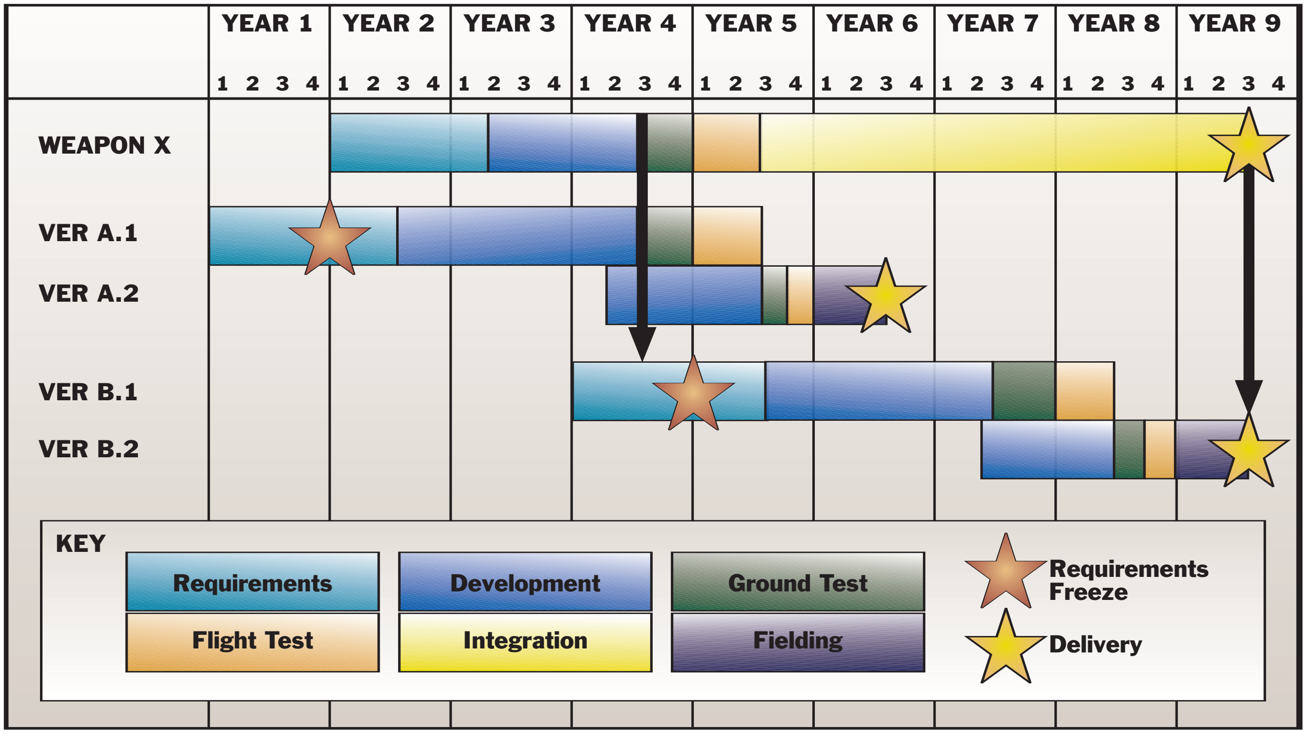


FIGURE 1. Typical "Coupled" Integration of a Single Weapon onto a Single Aircraft Platform.

cycles. In addition, out-of-cycle integration requirements, particularly in the case of Quick Reaction Capability efforts, often cause the weapon to be fielded with a limited capability.

The premise of the UAI program is that integrating full weapon capability across multiple platforms at reduced cost in a shorter time depends on the ability to "decouple" weapon integration efforts from the lengthy aircraft software upgrade cycles. UAI creates a common interface that, once implemented in weapon and aircraft software, removes the need to develop specific software for a new weapon-aircraft combination. This is a major shift from the current integration process that requires a completely new software interface each time a new weapon becomes available.

UAI Solution

Under UAI, weapons will no longer base their digital data interfaces on unique interface control documents (ICDs) for each aircraft-store combination. The new interface will incorporate a common mission planning (MPICD) and a platform-store ICD (PSICD) used with configuration data files to accommodate the unique features of each installation. This will decouple the installation of a new weapon from the long software upgrade cycle, allowing weapons to be integrated more quickly and at lower cost.

Figure 3 shows how UAI fits into the existing framework. It uses the existing MIL-STD-1760 connector with standard power, discrete signals, and MIL-STD-1553 data bus lines. Together, the two standards will govern the interface connection between aircraft and weapon.

Integrating the first smart weapons required developing completely new interfaces and writing them into aircraft flight software. The introduction of new weapon programs used existing ICDs as baselines to save time and effort, allowing maximum reuse of software code. As a result, many weapon ICDs have a large degree of commonality in their functional, electrical,

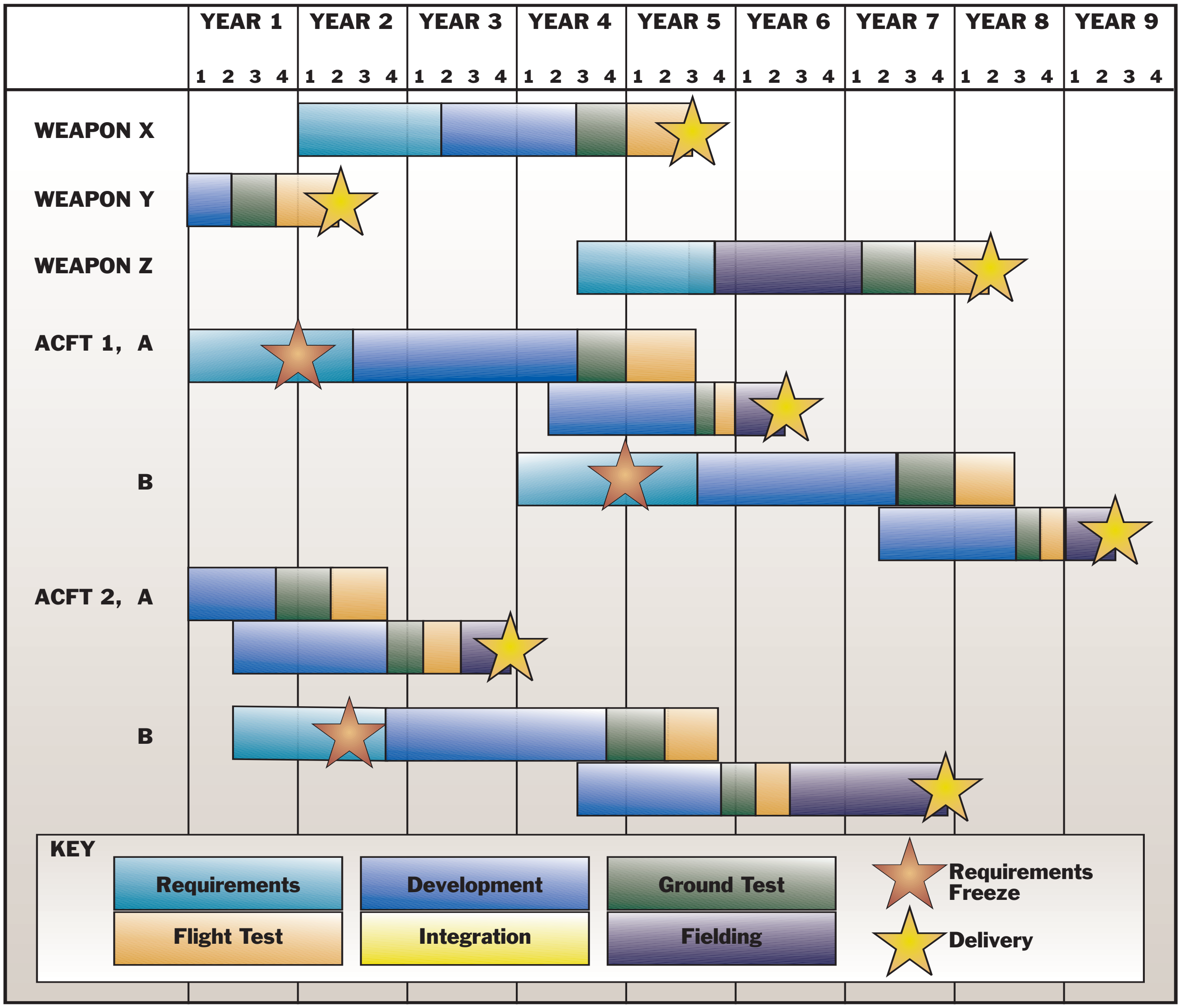


FIGURE 2. Realistic Integration of Multiple Weapons on Several Platforms.

and logical interfaces. The logical interfaces diverge mainly in areas dealing with mission-specific data, including targeting and fuzing options.

To minimize the impact of new weapons on aircraft, UAI will focus on four areas: the aircraft-to-store interface, definition of a configuration data set, mission planning interfaces, and common Launch Acceptability Region (LAR) algorithms.

AIRCRAFT-TO-STORE INTERFACE

UAI defines a PSICD that defines the requirements for the aircraft-to-store interface. This will build on the interface functional requirements and logical message definitions for all the weapon and aircraft programs that would benefit from UAI. It will also define provisions for emerging systems identified by the government to cover the next 10 years. The PSICD will include store functional interface definition of interface functions, including transfer alignment, global positioning system initialization, uploading of mission data, and others. Files containing configuration data will then tailor these functions.

DEFINITION OF THE CONFIGURATION DATA SET

The Configuration Data Set (CDS) will define or set parameters for a specific weapon when used on a specific airplane. The purpose of the CDS is to allow the CICD to be truly common. Because there is only one PSICD, data interfaces changing from weapon to weapon or aircraft to aircraft will need to be controlled by the CDS.

In general, the CDS will include four categories of data: weapon-specific data such as weapon ID, software version, mass properties, and launch parameters; aircraft ID and software version; aircraft display data; and unique aircraft-weapon message definition. With a CDS to configure flight software (similar to a hardware "driver" in desktop computers), weapon-specific data can be generated and updated completely independent of aircraft software upgrades.

MISSION PLANNING INTERFACES

The principal mission planning effort is creating an interface, defined in a new MPICD, which is common between store and aircraft Unique Planning Components (UPCs). As aircraft platforms migrate to the Joint Mission Planning System (JMPS) environment for planning specific missions, the interaction between store and aircraft UPCs will take place within the common JMPS framework. Since aircraft and weapon mission planning components are coupled very much the same way as with actual flight software, the MPICD defines a common interface among aircraft and weapon UPCs.

Also important is the transfer of mission data from the mission planning system through the aircraft to the weapon. Currently, mission data are passed via mass data transfer protocol defined by MIL-STD-1760. In this protocol, specific messages are used to define mission-specific data. When weapons don't use

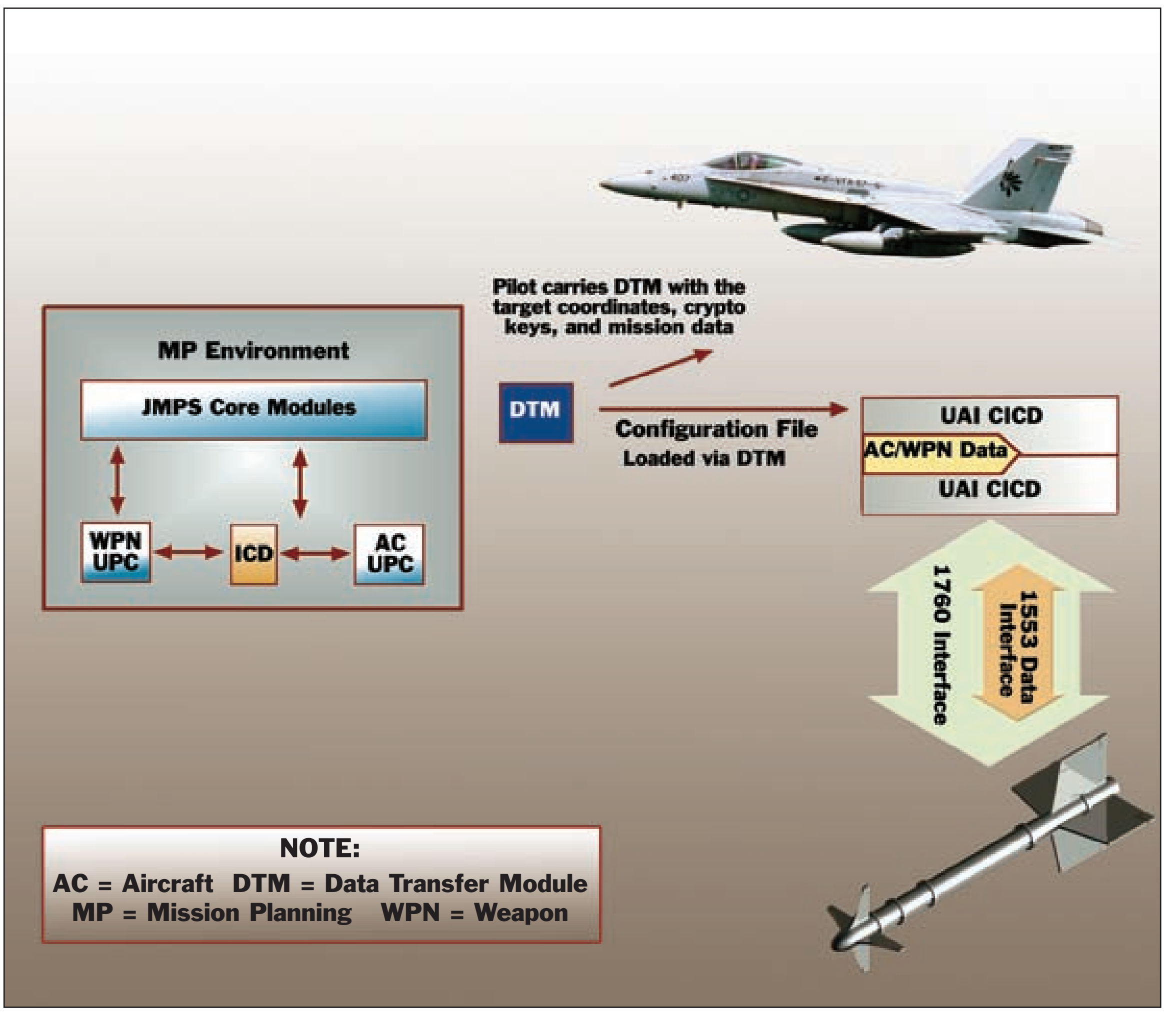


FIGURE 3. UAI Concept.

certain data—for example, weapons that don't require fusing parameters—the message containing blank data is still passed to the weapon, unnecessarily tying up communication bandwidth.

Because each weapon uses unique mission data, the decision was made not to define specific mission data message content. Instead, UAI will adopt the recently released MIL-STD-3014, DoD Interface Standard for Mission Data Exchange Format (MiDEF), to transfer mission data. Although MiDEF files are transferred to the weapon using the existing mass data transfer protocol, aircraft-to-weapon interfaces do not need to define the content of mission data files, only how to break them into standard size messages.

ALGORITHMS FOR THE COMMON LAUNCH ACCEPTABILITY REGION

Individual weapon programs have unique common LARs based on mathematical models of the weapon's flight characteristics. The store manufacturer develops the algorithms to compute these LARs and incorporates them into the weapon software.

Independent of this effort, the aircraft manufacturer also develops LAR algorithms for the same weapon, which the aircraft software uses to provide in-flight cues to the aircrews. The separate manufacturers may develop their products using proprietary business information, so the LAR algorithms could even stem from different (although similar) mathematical models. Issues arise when updates to the "fly-out" models are released, requiring revisions to both aircraft and weapon flight software (raising again the "coupling" issue).

UAI will define standard coefficient-based algorithms for use in UAI-compliant aircraft and weapons. The store-specific configuration data file, loaded during mission planning, will load the appropriate coefficients for the algorithm used.

Implementation

The current UAI development effort only defines the interface. It is important to note that aircraft and weapons will then become UAI-compliant in their next scheduled software upgrades. Although incorporating a new interface carries a significant initial cost, as opposed to modifying an existing one from a previous effort, this will be a one-time effort. Other aspects of integration are still required, including physical integration, as well as testing separation and flight characteristics, but the major software effort and schedule driver should be eliminated.

UAI will define a common interface that can be installed once and used for a series of aircraft-weapon configurations, resulting in new schedule flexibility for upgrades, illustrated in Figure 4. Using the same example shown in Figure 1, this flexibility allows insertion of a new weapon into the first aircraft software upgrade, resulting in a fielded weapon capability 3 years sooner than is currently possible.

The New Standard

The UAI CICD will be the standard that aircraft and weapons must comply with to ensure compatibility. Publishing it as a MilStd will immediately establish it as the companion to MIL-STD-1760 and make it available to all programs that want to participate in the future of air-to-ground warfare. The other products of UAI will probably not result in published standards, but will just as surely become part of the system.

The UAI contract has been under way since January 2005. Leveraging results from a 12-month risk reduction phase, the current effort will result in a baseline standard by December 2005.

UAI will apply to multiple aircraft and weapon types, each developed and manufactured by competing contractors. Therefore, it is extremely important

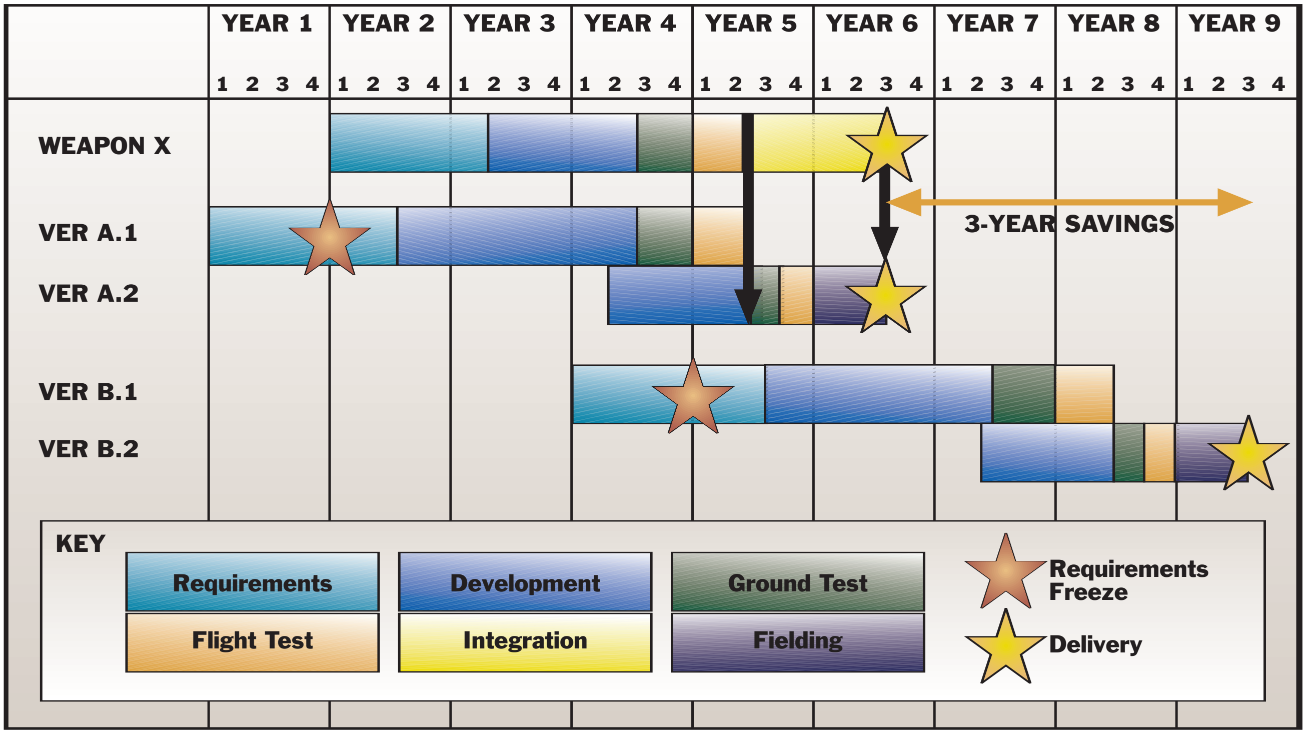


FIGURE 4. Example of "Decoupled" Weapons and Software Development Cycles.

that UAI have total buy-in by these companies. The traditional prime-subcontractor relationship was rearranged and replaced with a consortium of four independent contractual arrangements to make this buy-in possible. The industry consortium—consisting of Boeing, Lockheed-Martin, Northrop Grumman, and Raytheon—has its own team structure, with leadership roles in the project teams allocated equally across the contractors. Teams primarily consist of the same aircraft and weapon contractor engineers who will be tasked with implementation once the interface is developed.

Because the entire industry consortium is responsible for developing the interface components, the contractors have an increased incentive for cooperation and synergy, ultimately resulting in a higher quality product for the Air Force and its users. Currently, the F-15E program is seen as the first user; it will decide whether the standard can be scheduled in the current software upgrade.

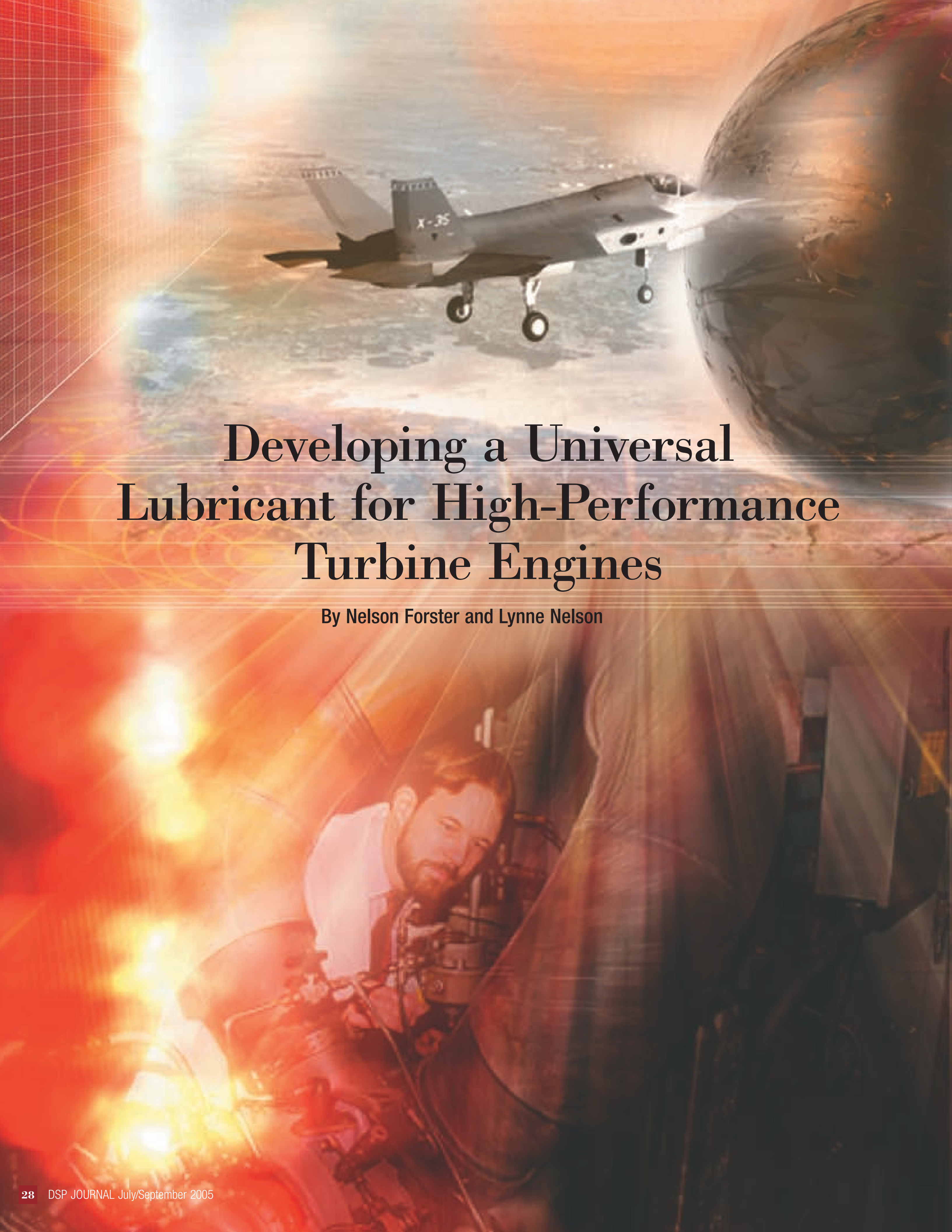
Conclusion

With the evolution of new weapons and aircraft, store integration is a cyclical process that will exist for as long as military aircraft fly. The UAI standard will eliminate the lengthy task of developing weapon-specific interface software that burdens present integration efforts, thereby allowing the warfighter to use new smart-weapon capabilities sooner and at lower cost.

About the Authors

Jim Byrd is an avionics systems technical expert for the U.S. Air Force Aeronautical Systems Center, Engineering Directorate, at Wright-Patterson Air Force Base. He has over 30 years' experience in engineering for aircraft systems, specializing in control and display equipment for aircraft cockpits.

Oren Edwards is a systems integration engineer for the Aeronautical Systems Center at Wright-Patterson Air Force Base. He is currently assigned to the Agile Combat Support Systems Wing, Aging Aircraft Squadron, where he deals with armament integration issues, and is the lead engineer on the Universal Armament Interface program.



Developing a Universal Lubricant for High-Performance Turbine Engines

By Nelson Forster and Lynne Nelson

In October 2001, the U.S. Air Force initiated a new demonstrator engine program, the Versatile Affordable Advanced Turbine Engines (VAATE). A major focus of the first phase of the program is to shift Air Force Research Laboratory (AFRL) technology to support the Joint Strike Fighter (JSF), which will use such engines.

As part of this effort, the Mechanical Systems Branch (AFRL/PRTM) is coordinating the development of a high-performance turbine engine oil with state-of-the-art bearing materials. A secondary goal is to maximize commonality among the Air Force, U.S. Navy, NATO, and commercial engine fleet to achieve logistic synergies. The lubricant developed under the VAATE program will also become available to legacy systems through the standard oil qualification process.

Reexamining Requirements

In the spring of 2003, AFRL/PRTM initiated a study to ensure that the next-generation lubricant would fully meet the requirements of both JSF and legacy systems. One of the first steps was to reexamine the long-standing Air Force capability requirement for a cold-weather start at –60°F.

The branch prepared a white paper and solicited input from engine manufacturers, the Air Combat Command Systems Office, and the Aeronautical Systems Center Air Vehicle Subsystems Branch. At the same time, we reexamined the current low-temperature requirements in the specifications for the fuel, hydraulic fluid, and subsystems (such as auxiliary power units) that may depend on the engine lubricant. We also assessed cold-weather patterns at two bases in Alaska, Elmendorf and Eielson, and at Minot Air Force Base, ND.

We found that military performance specification MIL-PRF-83282D already states a –40°F requirement for hydraulic fluid, and JP-8 turbine fuel has a maximum allowable freeze point of –53°F. In climatic tests for legacy systems, the aircraft was both cold soaked and started at –60°F; however, beginning with climatic testing for the F/A-22, the aircraft was cold soaked to –60°F and then warmed to –40°F before starting the engines. In effect, our study indicated that the Air Force had already shifted to a de facto cold-start requirement of –40°F.

Furthermore, from the weather data, we found that Eielson and occasionally Minot get below –40°F, but weather protection exists for crews and equipment in these extreme conditions.

In view of these facts, we decided that a –40°F cold-start requirement for the lubricant was feasible. However, at least for the near future, we also decided to keep the existing Grade 3 and Grade 4 oils that meet the –60°F requirement as qualified products under MIL-PRF-7808L. This will allow a suitable transition period for developing the new oil and for assessing further whether cold-weather bases should continue to use the Grade 3 and Grade 4 oils. We also found that auxiliary power units, even in commercial aircraft, frequently use the lower viscosity oils. This was an additional reason to keep the Grade 3 or Grade 4 oil as an accepted, qualified product.

At the same time we reviewed cold-weather start requirements, we also sought to determine the optimum viscosity for turbine engines at both low and high temperatures while maximizing commonality with U.S. Navy, NATO, and commercial engines. Using these combined objectives, we found the optimum viscosity to be that of U.S. Navy specification MIL-PRF-23699F.

This oil is slightly more viscous than the qualified Air Force oils meeting the MIL-PRF-7808L specification. However, if the Air Force cold-weather start requirement can be relaxed to –40°F, then all Air Force legacy systems can use the MIL-PRF-23699F oil specification. Selecting the latter viscosity requirements could also produce important benefits for bearing life in high-performance engines, such as the F135 and F136 used in the JSF. This choice would also offer substantial logistic benefits, because essentially all commercial engines use the viscosity requirements of MIL-PRF-23699F.

Moving Forward

In 2004, we briefed the results of this study to our Navy counterparts at Patuxent River, MD. Both parties agreed to pursue a joint oil development program for VAATE that would lead to utilization in the JSF and transition to the field. For the first time, the Air Force and Navy are united in developing a joint turbine engine oil for the entire Department of Defense.

Over the past year, considerable effort has been invested in redefining other critical parameters for the oil, such as lubricity and elastomer compatibility, as well as thermal stability, oxidation, and corrosion testing procedures. The end product will be a much more comprehensive specification for today's engines that will also be fully compatible with legacy systems.

We are also devoting due consideration to ensuring that the military oil meets commercial engine requirements. Commonality between military and commercial requirements is highly desirable to encourage participation by engine manufacturers and oil companies, because the commercial market is an important aspect of their overall business.

We expect to complete requirements definition for the joint oil program and full coordination with the gas turbine engine community by the end of 2005. Testing of prototype oils that meet the initial draft requirements is already under way. The joint oil is scheduled to be demonstrated in both the F135 and F136 engines through the VAATE program in 2007 and 2009. We anticipate an approved military specification by 2009 that will encompass virtually all military gas turbine engines.

About the Authors

Nelson Forster, Ph.D., is the chief of the Mechanical Systems Branch, Propulsion Directorate, Air Force Research Laboratory. He is responsible for research and development in aircraft engine lubricants, bearings, seals, and drives for the Air Force.

Lynne Nelson oversees all turbine engine lubricant specifications for the Air Force. She is the coleader for the Mechanical Systems Branch in-house research and development program on the ultimate liquid lubricant system for large turbofan/turbojet engines.

Standardizing Software Production at the Warner Robins Air Logistics Center

By Thomas Christian Jr. and Millee Sapp

In October 1997, Warner Robins Air Logistics Center (WR-ALC) at Robins Air Force Base, GA, consolidated its four previously separate software organizations into one—the Software Engineering Division. The leadership of WR-ALC and of the consolidated division itself identified several strategic factors driving this consolidation:

- The changing Department of Defense marketplace and the need for both increased flexibility and standardization to spur streamlined, responsive operations
- Growing customer expectations
- Acquisition reform and partnerships
- Recent industry trends to wider use of commercial off-the-shelf products, as well as accelerated technology evolution
- New global opportunities coupled with a no-longer-guaranteed customer base.

The consolidated organizations had some experience with the Software Engineering Institute (SEI) Capability Maturity Model® (CMM®) for process improvement, but these activities had been performed separately.[1] The CMM has five stages providing a road map to guide organizations in improving their software capability. The leadership decided to initially target a Maturity Level 3 rating, requiring enterprise-wide process standardization. At the same time, the leadership realized that, to be optimally effective, it would need to create a clear, inspiring, action-based strategic plan for the new organization. This plan included the vision, mission, and the following six strategic business goals:

- Customer satisfaction—Be honest, responsive, and flexible in providing products and services that meet or exceed customer requirements
- Employee satisfaction—Provide and foster a work environment that promotes employee satisfaction
- Common organizational process—Establish a common organizational process that implements a consistent management discipline across business domains
- Communications—Promote open, multidirectional, and timely communication

- Business opportunities—Pursue new business opportunities and partnerships based on value to our customers and the Software Engineering Division
- Skills—Develop and maintain the skills base to satisfy requirements of current and future business domains.

Consolidating Software Processes

In order to implement the third goal, an initiative was established to consolidate the software processes of the original four organizations into a standard set of processes that the entire organization could use. The initiative identified three major domain processes:

- Test Program Set (TPS) Development
- TPS Maintenance and Modification
- Operational Flight Programs (OFP).

The Software Engineering Division immediately established an integrated Software Engineering Process Group (SEPG) and Quality Metrics Group (QMG) to begin building upon previous software process improvement experience and strengths brought together under the consolidation. With the assistance of SEI, the SEPG and QMG established a process architecture to adopt the best practices identified in the CMM. This architecture became the design document for the corporate and domain-level process documents that all projects in the organization would follow.

As these documents progressed, members of the workforce reviewed them and offered comments that were incorporated. The Software Steering Team, a group of senior managers within the organization, then approved the documents. Implementation plans established which projects in the organization would implement which portions of the new processes. In April 2000, SEI led a CMM-Based Appraisal for Internal Process Improvement. The results of the appraisal revealed that the Software Engineering Division had achieved a solid Maturity Level 3.

Integrating Capability Maturity Models

During this same time frame, WR-ALC became involved in the Capability Maturity Model Integration (CMMI®) project, a collaborative effort of the Office of the Secretary of Defense, the military services, other government organizations, SEI, and industry.[2] Its goal was to provide an integrated approach across multiple disciplines for improving processes, while reducing the redundancy, complexity, and cost of using separate and multiple CMMs. WR-ALC participated in a CMMI pilot appraisal that brought together projects involved in systems engineering, software engineering, and software acquisition.

In July 2001, the Software Engineering Division decided to transition from the software CMM to the CMMI. For the next 12 months, the SEPG performed a gap analysis to determine which areas of the organization's process architecture would need to change. The priority was to correct problems or make enhancements to process areas at Maturity Levels 2 and 3. The SEPG also began to identify the requirements for Maturity Levels 4 and 5.

In October 2002, the division became part of the newly established Maintenance Directorate (WR-ALC/MAS) and benefited immensely from the director's strong support for software process improvement. In December 2002, the division rolled out a revised software engineering process to the organization. Implementation plans once again spelled out when projects within the organization would implement these new processes.

From September through December 2003, four Standard CMMI Appraisal Method for Process Improvement (SCAMPI℠) Class B appraisals assessed the organization's readiness for a SCAMPI Class A appraisal.[3] During the Class B appraisals, team members from WR-ALC, Ogden ALC, and SEI reviewed more than 980 artifacts across seven projects and identified areas of risk in how the organization was implementing the practices identified in the CMMI. These appraisals led to action plans for addressing the risk areas and verification meetings between each of the projects and the SEPG to determine whether the organization was adequately addressing the findings.

In October 2004, SEI led a SCAMPI Class A appraisal with team members from WR-ALC, Ogden ALC, and SEI. Of the nine members, five were SEI-authorized lead appraisers. During its 2-week appraisal, the team interviewed 80 individuals within the organization and reviewed more than 1,100 documents. The appraisal revealed that the Software Engineering Division had achieved a CMMI Maturity Level 5.

What Made It Work

Achieving CMMI Maturity Level 5 would not have been possible without software processes standardized across the entire 715-person Software Engineering Division. In addition to the large number of software personnel, nearly 500 of whom are degreed electronics engineers and computer scientists, the division consists of eight differently focused branches. Each of these branches—an artifact of the 1997 consolidation of the software organizations supporting the directorates for avionics, electronics warfare, the F-15, and the Joint Surveillance Target Attack Radar System (JSTARS)—had different customers and their own individual cultures. Furthermore, two branches worked only in the TPS Development and TPS Maintenance and Modification domains, while five other branches worked only in the OFP domain. (The eighth branch contained the SEPG, QMG, and administrative support such as computer network, financial, and personnel specialists.) The key to standardizing processes across this diverse landscape was centralized direction and decentralized execution.

CENTRALIZED DIRECTION

The SEPG and QMG developed the organization's standard software processes, following a standard format. These documents spelled out in detail a description of each process activity, the reason for it, the entry criteria, its inputs and tasks, the exit criteria, measures of the activity, and any required tailoring. The division's unwavering commitment to excellence resulted in the following extensive, meticulous, detailed documents:

- Software Engineering Process
- Supplier Agreement Management Process
- Peer Review Process

- Training Program
- Process Documentation Standard
- Developing, Implementing, and Maintaining Organizational Processes
- Approved Life Cycles
- Software Process Improvement Infrastructure
- Quality Assurance Process
- Measurement Program
- Measurement Plan.

Nearly 2 inches thick, these standardization documents give organizational direction and policy, laying the foundation for software success.

DECENTRALIZED EXECUTION

The execution of division-wide organizational processes was decentralized by having functional experts from each branch document software processes at the domain or branch level. Following the same format—description, reason, entry criteria, inputs, tasks, exit criteria, measurement, and tailoring—these documents provide the standardization of software activities within a domain regardless of project size, complexity, customer, or priority. Documents within the TPS Development domain include the following:

- Project Management Manual
- Software Configuration Management Manual
- Software Engineering Process Guide
- Proposal for New Workload Best Practice Guide
- Project Planning Best Practice Guide
- Digital Best Practice Guide
- Analog/RF Best Practice Guide
- Hardware Best Practice Guide
- Documentation Best Practice Guide
- Product Acceptance Best Practice Guide.

Documents within the TPS Maintenance and Modification domain include the following:

- Management Manual
- Software Engineering Process
- Maintenance Best Practice Guide
- Modification Best Practice Guide
- Support Services Best Practice Guide
- Re-host Best Practice Guide
- Risk Management Plan
- Software Configuration Management Plan
- Software Quality Assurance Plan.

Owing to the unique focus of the branches in the OFP domain, each branch prepared its own process guide. Nonetheless, standardization opportunities abounded. For example, in the JSTARS branch, the public-private partnership between the Northrop Grumman Corporation and WR-ALC ensured that processes were standardized so that the software produced at the two different locations (Robins Air Force Base and Melbourne, FL) could be integrated readily. Elsewhere, the F-15 branch standardized its processes among its three customers—the Israeli Air Force, Royal Saudi Air Force, and U.S. Air Force—to benefit all three. All five OFP branches (avionics/airlift, electronic warfare, F-15, JSTARS, and Special Operations Forces/Combat Search and Rescue) standardized process guides in accordance with the division's organizational documents, which mandated adherence to these processes by all of the OFP branches, regardless of weapon system.

Value of Outcome

The overriding reason for the Software Engineering Division's emphasis on standardization of software process improvement—indeed, the reason for CMMI itself—is benefit to the customer. Over the years, much Department of Defense attention focused on software projects that went terribly awry. To overcome that trend, the Software Engineering Institute was founded as a federally funded research and development center at Carnegie Mellon University. Developing first the CMM and then, with industry, the CMMI, SEI has made a major contribution to the body of knowledge regarding software best practices.

The CMMI staged representation consists of Maturity Level 2: Managed, with 7 process areas; Maturity Level 3: Defined, with 14 process areas; Maturity Level 4: Quantitatively Managed, with 2 process areas; and Maturity Level 5: Optimized, with 2 process areas. Using this road map with the standardized processes described earlier, WR-ALC/MAS has now put in place all of the process improvement practices needed to enable us to produce the highest quality software.

This process standardization effort has eliminated late deliveries of software release during the past 6 months (from August 2004 to January 2005). This marked improvement has prompted the division to embrace a goal of 100 percent on-time delivery for FY05. Similar dramatic results were also achieved in defect reduction after implementing CMMI Maturity Level 5 process improvement practices, with no defects reported in fielded software during the same 6-month period.

[1]Capability Maturity Model and CMM are registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

[2]CMMI is registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

[3]SCAMPI is a service mark of Carnegie Mellon University.

About the Authors

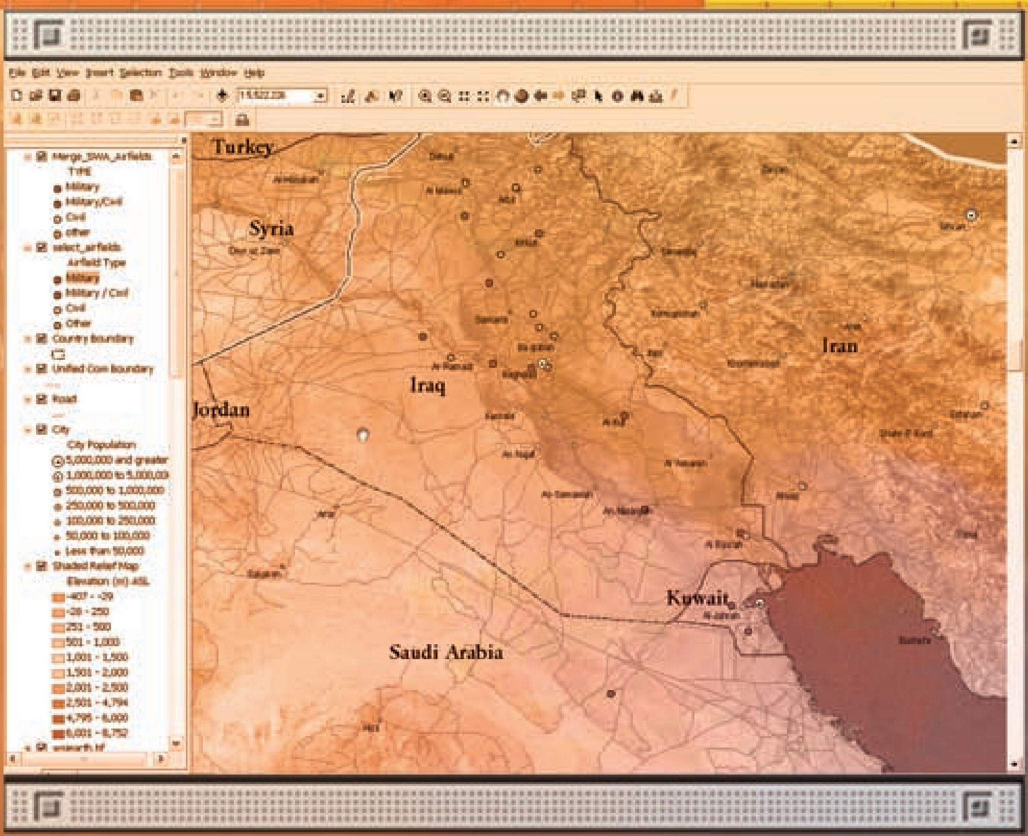
Thomas Christian, Ph.D., is chief of the Software Engineering Division in the Directorate of Maintenance at Warner Robins Air Logistics Center. He manages more than 700 software professionals supporting a variety of Air Force weapon systems. He is also the Standardization Executive for the Warner Robins Air Logistics Center.

Millee Sapp is lead for the Software Engineering Process Group in the Software Engineering Division. She is a Software Engineering Institute SCAMPI℠–authorized lead appraiser and a member of the CMMI® Configuration Control Board.

GeoReach

The Air Force's New Web-Based Weapon

By Mark Cave and Lisa Litwin



The U.S. Air Force has added a new "blue intelligence" system to its arsenal: GeoReach. This tool is a geospatial information system (GIS) that gives base contingency planners a satellite view of potential overseas operating locations long before "boots hit the ground." For example, GeoReach has enabled Air Force personnel to evaluate sites in Iraq and Afghanistan, develop bed-down plans, and create aircraft parking plans weeks before the aircraft arrived. The system enables planners to tailor the material and equipment delivered to a contingency location, allowing quick delivery of bed-down assets and more efficient use of our large-frame aircraft.

The GeoBase Family

GeoReach is part of a larger program called GeoBase, consisting of four distinct efforts: Garrison GeoBase, Strategic GeoBase, GeoReach, and Expeditionary GeoBase. All adhere to the concept of producing a Common Installation Picture (CIP) for each installation, which standardizes the type of information available on a map and includes satellite imagery and georeferenced data. GeoReach allows a user to access a map for any installation and view the same type of data in the same format. The intent is to provide decision makers with "one installation, one map," incorporating the mapping requirements of each functional unit (civil engineering, security forces, communications, and so on) as "layers" on the map.

The goal of GeoBase is to give leaders decision-quality data. It provides a single installation map for visualizing assets and facilities, and it can be joined or integrated with other functional databases to create additional attributes on buildings, roads, and airfield surfaces. GeoBase is not intended to store all installation data in a single database, but to link existing databases to a common map.

Establishing GeoReach

In 1999, Pacific Air Forces Command (PACAF) faced several potential bed-down planning challenges in countries where advance access for site surveys would be difficult. PACAF had no prior site knowledge to optimize base site selection and little ability to plan aircraft parking, tent city layout, or utilities access. Its Civil Engineering directorate embarked on a program to "reach out and map" remote locations via satellite imagery, and GeoReach was the solution. The system was briefed at CORONA in fall 1999 and grew rapidly from there. The Air Combat Command (ACC) expanded the use of GeoReach for the Southwest Asia theater, and U.S. Air Forces Europe (USAFE) did the same for the European theater.

Since responding to the events of 9/11, GeoReach has enabled the warfighter and increased efficiency by supplying data and imagery to assist operations. It minimizes basing risk by allowing decision makers to assess multiple forward operating locations (FOLs), optimize basing decisions, and then coordinate deployment resources. The system allows planners to collect and maintain current data and imagery on 250 worldwide airfield surfaces and their infrastructure before crises occur.

The GeoReach Process

The GeoReach process has four steps: locate sites, collect data and imagery on those selected sites, assess the information, and enable decision makers and warfighters by conveying the information via secure website. When GeoReach is collecting data, the mission space is defined as the area confined to an installation's perimeter and its immediate vicinity (within less than 1 mile). The installation's perimeter, imagery, and other installation features make up the Common Installation Picture. CIP data displayed on maps meet standards recognized by all services as defined within the Joint Geospatial Data Standards.

LOCATE SITES

When contingency planning begins, decision makers identify potential sites that will best serve

FIGURE 1. Imagery and Data Are Compiled from All Available Resources. Pictured Is SrA Rebecca Cook, Minot Air Force Base, ND.

the mission. Command-generated operation plans and theater-wide site-selection priority lists are the key sources of information on candidate sites. (See the screen capture on page 37.)

COLLECT DATA AND IMAGERY

Once sites have been selected, the system compiles current imagery and related data from all available sources, both commercial and government.

When the imagery has been received, GeoReach data layers are created. (See Figure 1.) Depending on mission requirements, these data layers can consist of buildings, runways, elevation data, or specific features of concern to U.S. forces, such as stand-off distances for munitions storage. Using validated GeoReach data layers, Agile Combat Support planners compile logistics information to determine optimal locations for bed-down of personnel and material. These data layers support and enhance all aspects of deployment planning, including command and control, bed-down, and logistics.

ASSESS THE INFORMATION

Functional communities collaboratively assess the site using the validated data layers and develop an initial pre-bed-down planning solution. (See Figure 2.) Most of the time, the contingency response team assesses the imagery and data to fulfill the bed-down mission, because time and accessibility to the pre-bed-down site are unavailable. If that team has adequate time and the site is accessible, it deploys forward and uses mobile computing technologies to verify the existing information and ensure its validity. During the on-site assessment, the team collects additional information to enhance the accuracy, precision, and usefulness of the data layers and CIP. Data generated are part of the Air Force Expeditionary Site Survey Process, which allows immediate use of available information and permits GeoReach to evolve in proportion to the maturing CIP.

All data are transmitted from the FOL to rear areas to maintain mirror images of the CIP at forward and rear positions. The entire GeoReach collection and assessment process is performed before boots hit the ground, reducing the overall resource requirements for the mission.

ENABLE INFORMATION VIA SECURE WEBSITE

The last step of the GeoReach process is to use the latest unclassified commercial imagery of the FOL to create the CIP data layers. (See Figure 3.) The CIP is made available to planners and warfighters for detailed installation planning. Site information is conveyed by a secure map website, network, files provided on CD-ROM, or hard-copy maps. The goal is to provide planners, decision makers, and deploying forces with as much timely information as possible in an unclassified format.

GeoReach Successes

During Operation Iraqi Freedom and Operation Enduring Freedom, GeoReach proved to be a key enabler for the Air Expeditionary Forces "Open the Airbase" module. GeoReach allowed remote assessment of potential sites within Iraq for the Air Staff CHECKMATE planning cell. It was instrumental in providing that team with timely, decision-quality data by developing a weighted infrastructure evaluation and ranking of over 60 potential sites. Within 48 hours, two GeoReach personnel processed all available information and gave CHECKMATE planners the top five recommendations—all without boots hitting the ground. U.S. forces are still located at two of the five recommended bases.

Two applications that enable base bed-down planning are the Contingency Aircraft Parking Planner and the Base Engineering Survey Toolkit (GeoBEST). GeoReach supplied key data and displayed the results from these applications to follow-on civil engineering forces for bed-down plans of four Iraqi sites. A deployed civil engineering commander stated that GeoReach supplied "amazing detail without having put anyone in harm's way" and that it was an "outstanding 75 percent solution, a critical time-saver for my troops."

The bottom line is that GeoReach not only reduces the exposure of personnel to hostile conditions, it also allows critical information to be shared across the Air Force operational planning spectrum. Planners can review data and provide recommendations within days instead of weeks.

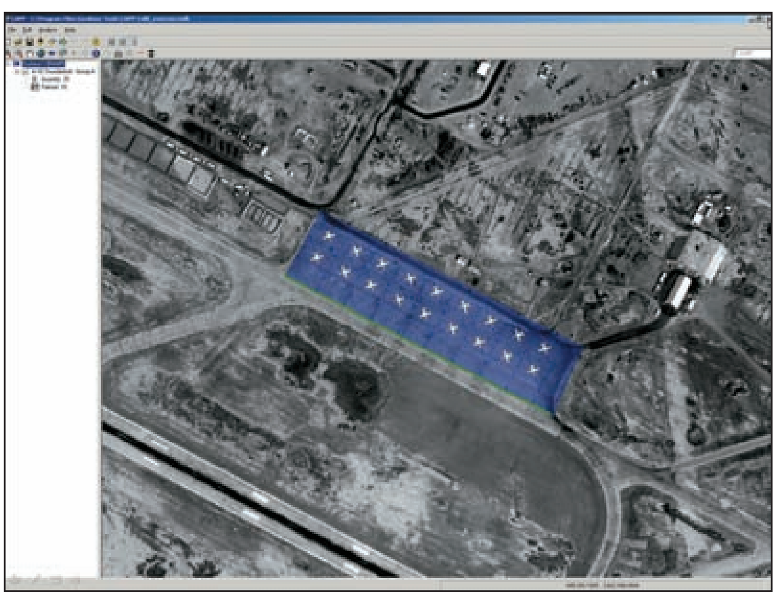


FIGURE 2. Planners Use the Contingency Aircraft Parking Planner Tool to Develop Parking Plans at Forward Operating Locations.

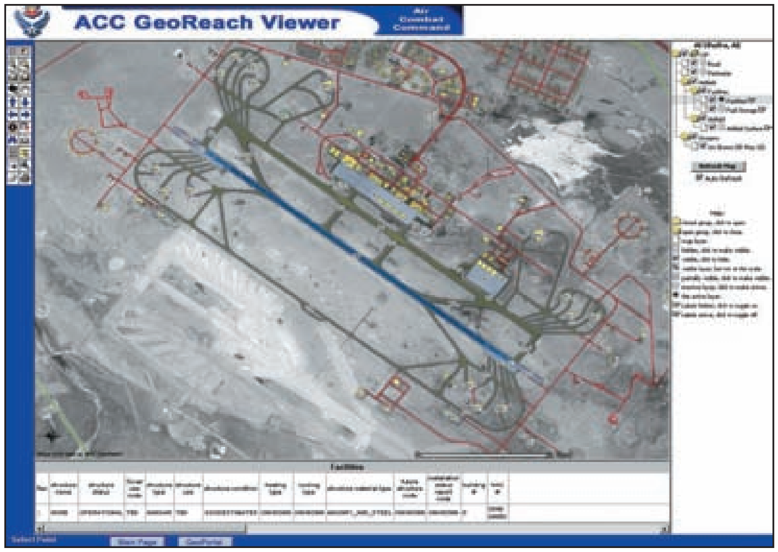


FIGURE 3. The GeoReach Web-Based Viewer Enables Airmen to View Forward Operating Locations.

Wider Application

GeoReach has enabled the standardization of Global Positioning System equipment and GIS software throughout the Air Force, allowing efficient equipment training, cross-functional usage, and expeditionary and garrison commonalities. This standardization allows airmen to move between major commands (MAJCOMs) with little or no learning curve for using the GeoReach program.

The system is fielded and being used by Headquarters Air Force, ACC, Air Mobility Command, Central Air Force, Central Command, PACAF, USAFE, and U.S. Transportation Command in support of Operation Iraqi Freedom, Operation Enduring Freedom, and Horn of Africa activities. Its secure map website accesses multiple standardized CIP databases shared and maintained by ACC, Air Force Special Operations Command, PACAF, and USAFE. GeoReach is a multi-MAJCOM initiative, which improves the economy of scale.

In view of GeoReach's recent successes and high visibility, multiple Department of Defense organizations that require similar capabilities are considering it for implementation. The system is scheduled to be the GIS interface for the Joint Expeditionary Planning Engineering System on Global Command and Control System–Joint and the Air Force Deliberate and Crisis Planning Execution System.

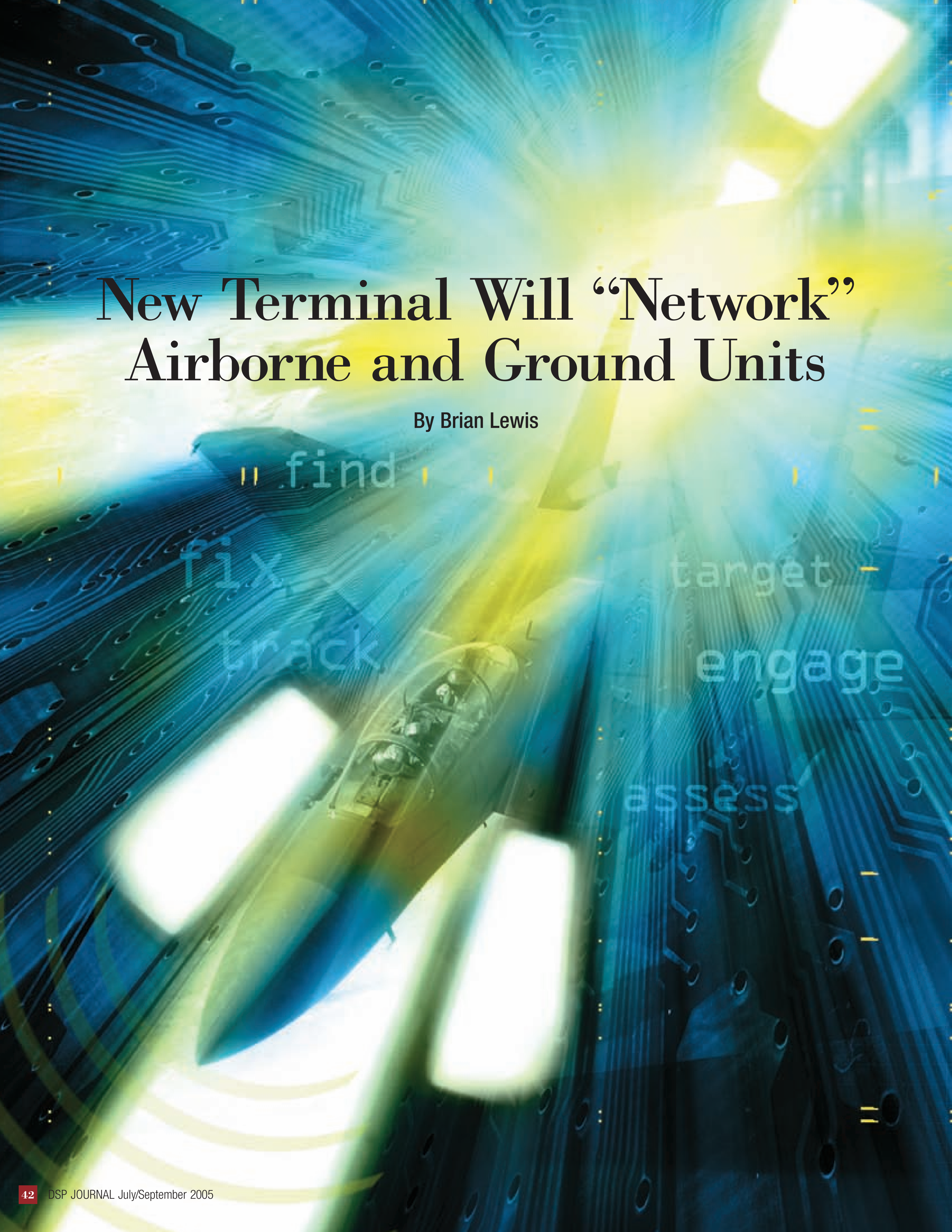
About the Authors

Mark Cave is the GeoReach technical program manager at the ACC Geo Integration Office, Langley Air Force Base, VA. He has worked there for 8 years supporting geospatial programs. He was instrumental in implementing the GeoReach capability in 2001.

Lisa Litwin is the business analyst director at the ACC Geo Integration Office. She has worked at ACC for over a year supporting geospatial programs. She has developed communication initiatives and coordinates training for the Garrison and Expeditionary GeoBase programs.

New Terminal Will "Network" Airborne and Ground Units

By Brian Lewis



In today's evolving battlespace environment, nothing is more critical to the precise execution of targets than the rapid exchange of information. At the same time, though, this information is becoming exponentially larger in file size and rapidly outpacing the capacity of our current radio frequency-based data links. The Multi-Platform Common Data Link (MP-CDL) terminal will address these issues for the warfighter.

The MP-CDL program is a concept and technology development program managed by the Aeronautical Systems Center's Reconnaissance System Program Office at Wright-Patterson Air Force Base, OH. Warfighter requirements and documentation were coordinated and developed within the Air Force Command and Control and Intelligence, Surveillance, and Reconnaissance Center (AFC2ISRC) and have been fully vetted through the Air Force and joint services communities, with the Joint Requirements Oversight Council granting approval in January 2004.

Compatibility with Multiple Waveforms

Although Common Data Link terminals contain the word "common," in actuality there is very little in common from one waveform to another. (A waveform is a unique modulation scheme applied to a signal in free space.) Over the years, numerous terminals have been developed using variations of the CDL waveform to meet specific mission demands. This has created a plethora of non-interoperable terminals throughout the joint community. To alleviate this situation, "the MP-CDL terminal will be the first truly common data link terminal, in that it will be the first terminal delivered that is backward-compatible with all current CDL waveforms," stated Major General Tommy Crawford, AFC2ISRC Commander.

The three primary waveforms in the MP-CDL terminal will be Standard CDL (Std-CDL), offering a line-of-sight (LoS) data rate of up to 274 Mbps; Advanced CDL (A-CDL), allowing an automatic air-to-air connection with improved anti-jam characteristics, also up to 274 Mbps; and the newly developed Networked CDL (N-CDL), offering a networking capability with up to 137 Mbps on the outbound link and 40 Mbps inbound to the hub. (See Figure 1.) The N-CDL waveform is the key to bringing our intelligence, surveillance, and reconnaissance platforms—such as the Joint Surveillance Target Attack Radar System (JSTARS), Rivet Joint, and Airborne Warning and Control System (AWACS)—into the network-centric arena.

The original concept was that the MP-CDL terminal would replace the JSTARS platform's aging Surveillance and Control Data Link—which carries far less than 1 Mbps—but it has grown beyond that purpose to meet other platform-specific requirements. JSTARS has a requirement to disseminate sensor data to Army ground stations in a networked environment. The MP-CDL terminal will meet Air Force and Army requirements in terms of data rate, timeliness, number of simultaneous users on the network, and schedule. JSTARS will benefit from the second high data rate LoS capability to satisfy mission requirements such as handover to a relieving aircraft; data exchange and fusion with other intelligence, surveillance, and reconnaissance platforms; or Unmanned Aerial Vehicle downlink or control.

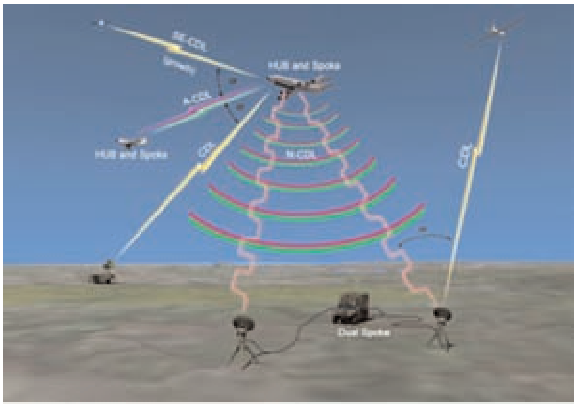


FIGURE 1. MP-CDL Will Enhance Interoperability and Situational Awareness.

The Path to the Network

The new terminal will be transformational, enabling the Command and Control Constellation and aircraft applications such as Network Centric Collaborative Targeting (NCCT). (See Figure 2.) It should be thought of as the physical "Internet" path, much like a cable modem you would use at home; an application like NCCT would use that path to obtain its objectives. (This is not to say that NCCT could not use another path, but this is one combination of many possible to achieve the desired outcome.)

MP-CDL terminals will be available in airborne and ground terminal variants. These will initially come with a two-channel capability, with growth potential for a third. The capabilities development document (CDD) directs the highest degree of commonality possible between airborne and ground terminal components, ensuring a leaner logistics line and reduction in overall costs.

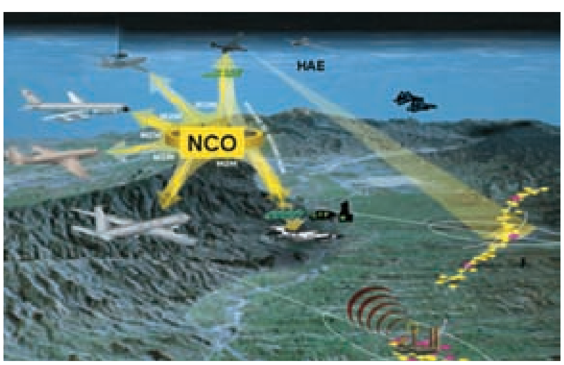


FIGURE 2. MP-CDL Will Enhance Network-Centric Operations.

Notes: HAE = High Altitude Endurance (e.g., Global Hawk); NCO = Network-Centric Operations; and M2M = Machine to Machine.

To further the terminal's interoperability, the CDD mandates compliance with the Joint Tactical Radio System (JTRS) Software Communications Architecture (SCA), use of programmable crypto devices, and implementation of the new Internet Protocol version 6 (IPv6) standards. This will ensure that new high data rate waveforms developed under the JTRS SCA standard will be easily ported onto the terminal and that the terminal will be able to process and route both IPv4 and IPv6 traffic, thus improving its position for both technology insertion and backward compatibility.

Related Upgrades in the Pipeline

In addition to JTRS SCA compliance, networking, and IPv6 compatibility, the MP-CDL program has several potential upgrades in the spiral development process. These include a high-capacity waveform to deliver 548 Mbps (and eventually 1.096 Gbps), and the Satellite Extension waveform for a beyond-LoS capability.

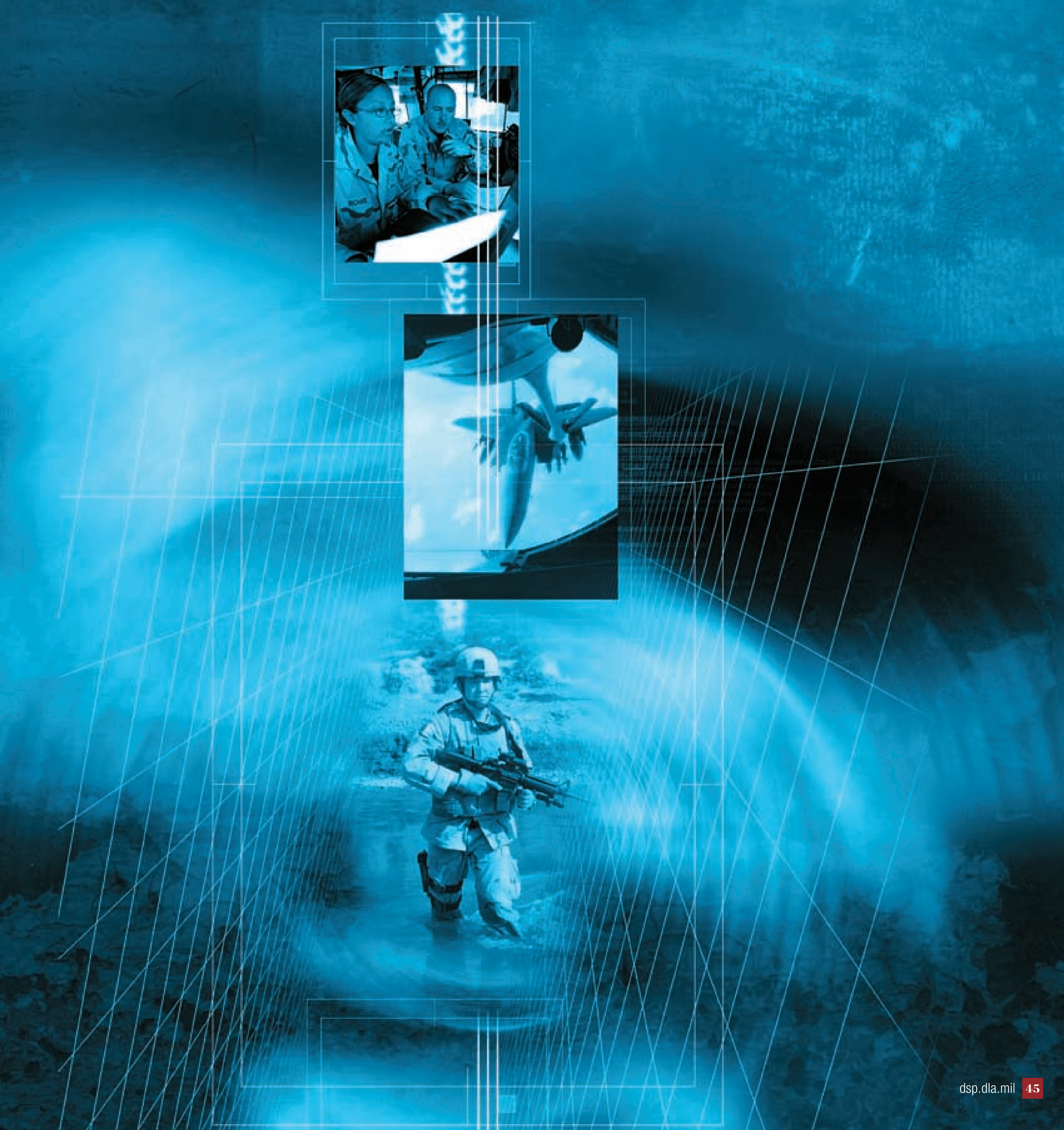
In summary, the ability to rapidly find, fix, track, target, engage, and assess time-sensitive targets requires a low-latency network for information sharing among sensors, decision makers, and shooters. MP-CDL will provide the backbone for such a theater-wide, high-bandwidth network. Clearly addressing his vision of MP-CDL's place in this network, Major General Crawford said, "The Networked Common Data Link waveform and the MP-CDL terminal are essential to bring our aircraft into the network-centric warfare arena."

About the Author

Brian Lewis is the manager of the Intelligence, Surveillance, and Reconnaissance Operations Section of Northrop Grumman Information Technology TASC. He provides systems engineering and technical analysis at AFC2ISRC, Langley Air Force Base, VA, and is the technical manager of the Adaptive Joint C4ISR Node Advanced Concept Technology Demonstration. While serving in the Air Force, Mr. Lewis operated, analyzed, and maintained communications and data links between airborne command and control aircraft, other airborne platforms, and ground elements.

The Importance of XML to the Air Force Mission

By Sandra Swearingen



Just as Air Force fighter pilots need a common language to communicate, Air Force software systems need to adopt a common language to share both documents and data. The use of Extensible Markup Language (XML) technology will enable information to flow seamlessly between the elements of the chain of command to support warfighting operations.

What Is XML?

XML is a World Wide Web Consortium recommendation that is being used throughout the world to facilitate data sharing among diverse documents, databases, and software applications. XML is used as a method of labeling pieces of information so computer software can process that information. It is a subset of ISO Standard 8879, Standard Generalized Markup Language, a standard for defining and using document formats. Many Department of Defense (DoD) and industry organizations are now using XML to develop their own XML vocabularies to facilitate the sharing of information.

How Is the Air Force Using XML?

The use of XML in the Air Force is increasing every day. One of the first projects to implement XML was MIL-STD-6040, United States Message Text Formatting Program, which uses XML to improve the warfighter's ability to search, process, and exchange information. Since 1999, the Air Force Command and Control and Intelligence, Surveillance, and Reconnaissance Center has led the way in DoD making United States Message Text Format (USMTF) XML capable and, since 2003, in fielding USMTF with XML schema. Each USMTF baseline is now available in the DoD XML Registry. In recent years, the center has also been active in NATO, documenting the rules to make Allied Data Publication 3 (ADatP-3), NATO Message Text Formatting System, XML capable. It hopes to capitalize on its work in developing XML rules for messaging in NATO Standardization Agreement (STANAG) 5500, Change 4, NATO Message Text Formatting System, by applying them in future USMTF versions. ADatP-3 is the technical implementation of the formally agreed-upon STANAG document.

Joint Expeditionary Force Experiment 2004 demonstrated network-centric concepts of the Global CONOPS Synchronization initiative. The Air Mobility Command and Electronic Systems Center employed XML to move data machine-to-machine between multiple air and ground systems. This allowed collaboration among five main nodes: Mobility Air Force aircraft, the Tanker Airlift Control Center, the civil sector (Federal Aviation Administration), the Combined Air Operations Center, and Combat Air Force aircraft. Consequently, operators could react in near real time to disruptions in the battle plan for the theater. Not only was retargeting information sent to the bomber, but the tanker and bomber were dynamically resynchronized for an air refueling—all to meet global warfighting requirements.

On the support side, the Air Force selected XML-based electronic forms software from PureEdge Solutions, Inc. The new Information Management Tool provides Air Force users with digital signature capabilities. It encapsulates the electronic form and all related data, including attachments, into one document, and uses XML "tags" to make it easier to exchange information among different and legacy systems. This approach places the emphasis on the data, rather than on the rigid lines and boxes of traditional forms.

The Air Force Knowledge Now (AFKN) website and the Air Force Portal are also exchanging information via XML. The benefit of XML for this exchange is primarily to move away from proprietary data structures to a non-proprietary format that both systems understand. AFKN uses Microsoft web services technology that allows a Java server application, the Portal Enterprise Service Bus, to use the AFKN web service across the network and exchange XML data using Web Services Description Language and the Simple Object Access Protocol. (See Figure 1.)

Exchanging information between a Windows and a non-Windows operating system would typically be a major undertaking. However, because of the

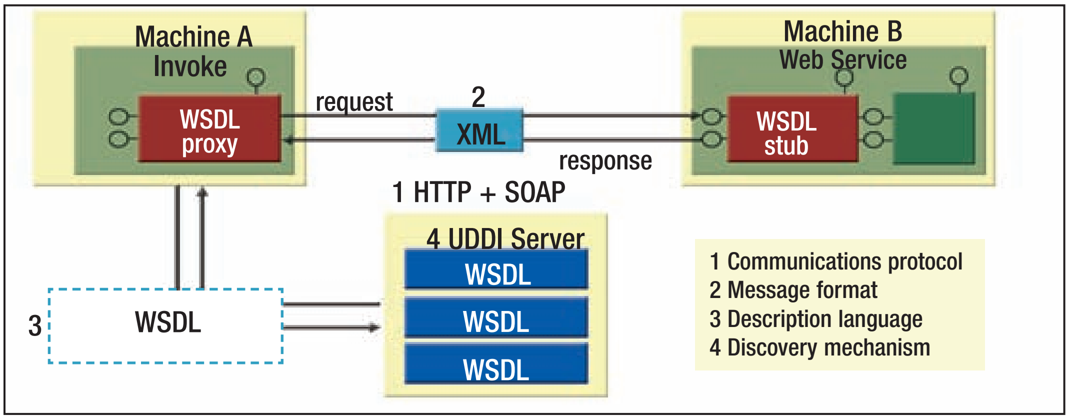


FIGURE 1. Machine-to-Machine Interface Using Web Services.

Note: HTTP = Hypertext Transfer Protocol; SOAP = Simple Object Access Protocol; UDDI = Universal Description, Discovery and Integration; and WSDL = Web Services Description Language.

web services technology and the ability to consume and transmit data using an agreed upon schema, these systems were able to exchange data in a fraction of the time and cost of typical data exchanges between disparate systems.

The Air Force Communications Agency has developed a prototype using XML-based messaging to demonstrate that the Enterprise Corporate Analysis–Time Saver (ECATS) web-centric information exchange application, currently used throughout the Air Force, could exchange information with other enterprise information management applications. The prototype used an XML message based on the Open Applications Group Integration Specification to exchange task information between ECATS and a workflow application.

The XML Way Ahead

Air Force program managers continue to take advantage of emerging XML technology by

- identifying and reusing existing efforts that have examined military processes and the information that needs to be exchanged to support these processes, then planning for the effective use of XML for information exchange;
- documenting and registering XML structures and tags according to the DoD XML registration process; and
- continuing to work with the Defense Information Systems Agency, other services, and civilian organizations to develop agreements on what information needs to be exchanged and the standard tags that will facilitate the exchange.

The Air Force has also been investigating the use of a binary variant of XML for satisfying information exchange requirements in tactical and bandwidth-constrained environments, in order to facilitate realization of the DoD Global Information Grid.

Increased use of XML by the Air Force and by DoD will greatly improve interoperability among systems, provide flexibility through vendor independence, facilitate information sharing, and better support our troops in the field who are using computers and personal digital assistants.

About the Author

Sandra Swearingen has more than 30 years of experience in computer technology. She represented the Defense Information Systems Agency at the World Wide Web Consortium's XML Query Language working group from 1999 to 2001. She currently is working on architecture standards at the Air Force Communications Agency.

The author wishes to thank the following people who contributed information for this article: Major Jean Schara and Major Janet Borden, Air Force Command and Control and Intelligence, Surveillance, and Reconnaissance Center; Roy Carlson, Air Force Communications Agency; Jessica Spencer-Gallucci and Lauren Gelfound, Air Force Departmental Publishing Office; Douglas Brook, Air Force Material Command; and Gregory Padula, Air Mobility Command.

The specification is now jointly owned by the U.S. Aerospace Industries Association and the AeroSpace and Defence Industries Association of Europe, by virtue of a memorandum of agreement signed February 13, 2003. ASD manages S1000D through the Technical Publications Management Group and its subordinate organization, the Electronic Publications Working Group. The United States participates on both groups through DoD and industry representatives.

Over the past 4 years, the U.S. participants have established an organization mirroring the international group that supports the standard. The U.S. S1000D Management Group, the U.S. Implementation Group, and their subgroups incorporate U.S. requirements, lessons learned, and knowledge into S1000D.

S1000D >>

Building Technical Manuals of the Future Now—With S1000D

By Steven Holloway and Bill Wendel

Do you want to be able to reuse the data in your technical manuals for other applications without re-authoring it? Do you want to stop printing and distributing paper? Do you want your users to be able to view their data electronically at the point of use? Do you want to distribute changes to your users online instead of through the Postal Service? Do you need to manage the data in your technical manual at a more discrete level than the document title? If so, the adoption of S1000D for Department of Defense (DoD) use may have significant implications for you and your data.

The technical manuals for U.S. weapon systems today are very similar to those used during the Vietnam War era, 30–40 years ago. They are mostly page oriented, are distributed on paper, and contain metadata collected only at the complete document level. Although some programs have made efforts to distribute and view data electronically, most have not been able to justify making major upgrades. This will be changing in the near future.

Evolution of S1000D

Since mid-2000, representatives from DoD and U.S. industry have been aggressively involved in an international activity that will lead to more effectively managed data for our warfighters. S1000D is an international technical data specification developed in 1984 for European military aircraft. Its initial purpose was to harmonize national and international specifications into a "western" specification based loosely on Air Transportation Association Specification 100. The result was a defined Common Source Database and markup rules to supply structure and format for page-oriented technical data.

S1000D evolved and improved over the years, but it started to change more dramatically as a result of the NATO Interoperability Roadmap in 2000. A task force concluded that interoperability between and within the allies would be more effective if one could leverage the positive features of S1000D, MIL-PRF-87269, MIL-HDBK-511, and Extensible Markup Language (XML). The task force decided to roll the best features of each of these specifications together into an improved S1000D:

- S1000D was valued because it offered an accepted approach to marking up and managing data so as to emphasize reuse, and it allowed for collection of metadata at a very granular level. Updates made it usable by land and sea systems, as well as aircraft.

- MIL-PRF-87269 was the premier standard for highly intelligent interactive technical data that could take S1000D beyond linear or page-oriented presentation.
- MIL-HDBK-511 defined "look-and-feel" guidelines for navigation and onscreen display of technical data.
- XML provided a markup standard that, unlike SGML, has been embraced by multiple industries and vendors and is supported by numerous robust commercial tools.

U.S. Participation

The desire to incorporate MIL-PRF-87269 and MIL-HDBK-511 brought much greater U.S. participation to the S1000D effort.

The specification is now jointly owned by the U.S. Aerospace Industries Association (AIA) and the AeroSpace and Defence Industries Association of Europe (ASD), by virtue of a memorandum of agreement (MOA) signed February 13, 2003. ASD manages S1000D through the Technical Publications Specification Management Group (TPSMG) and its subordinate organization, the Electronic Publications Working Group. The United States participates on both groups through DoD and industry representatives. (Figure 1 depicts the composition of the international S1000D organization.)

Over the past 4 years, the U.S. participants have established an organization mirroring the international group that supports the standard (see Figure 2). The U.S. S1000D Management Group (USSMG), the U.S. S1000D Implementation Group (USSIG), and their subgroups incorporate U.S. requirements, lessons learned, and knowledge into S1000D.

MANAGEMENT GROUP

The USSMG is responsible for determining U.S. requirements and achieving consensus among the military services relative to S1000D. It has five subproject groups with specific missions. The Land, Air, and Sea working groups ensure that S1000D can satisfy their

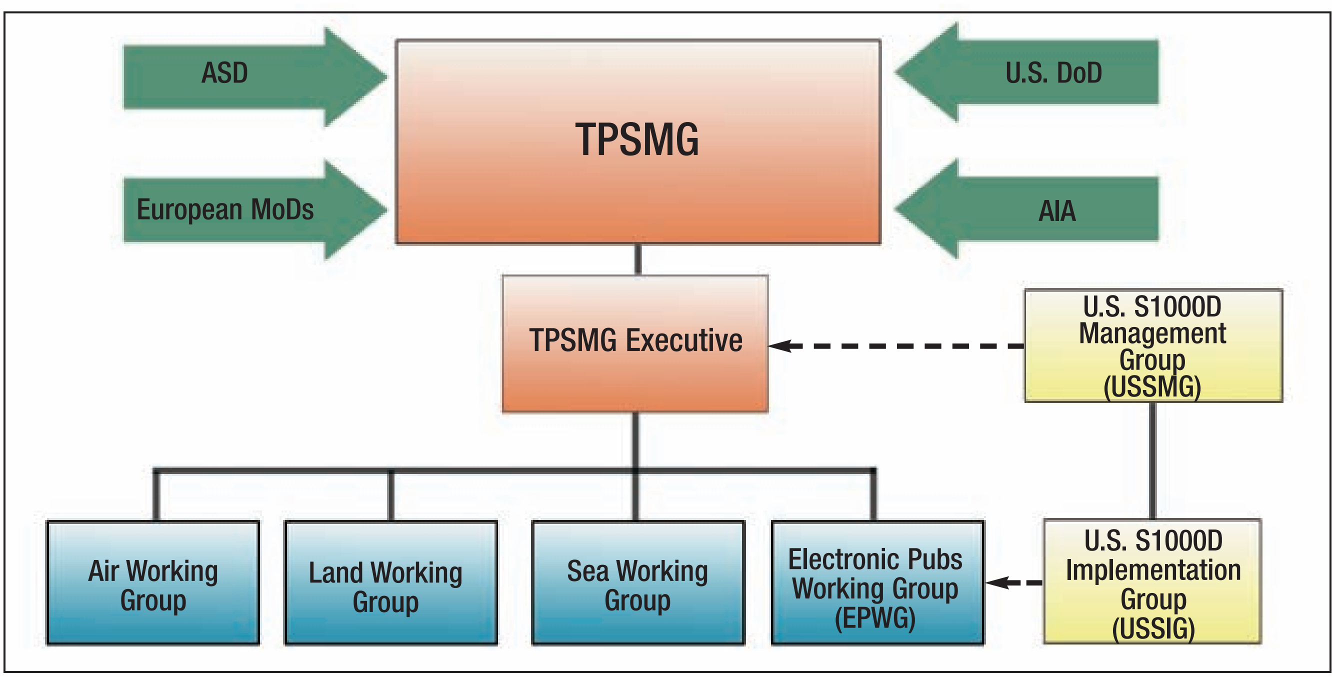


FIGURE 1. International S1000D Organization. Note: MoD = Ministry of Defense.

respective requirements. The Business Rules Working Group sees to it that S1000D captures the common DoD business rules so that it will apply consistently across U.S. systems, ensuring maximum interoperability. And the Acquisition Guidance Working Group is developing guidance for system program offices, so S1000D can be effectively placed on contracts.

IMPLEMENTATION GROUP

The USSIG is the technical arm of the U.S. efforts. It ensures that specification changes take place to implement the USSMG-determined requirements in S1000D. To accomplish this, it has established a number of subprojects focusing on objectives in specific technical disciplines (see Figure 3):

- The Non-Linear Subproject Group concentrates on adding and enhancing interactive capabilities. Many of the people working on this subproject have extensive backgrounds in MIL-PRF-87269. Much of their effort will bear fruit with the release of S1000D Issue 2.2 in May 2005.
- The Graphics Subproject Group is responsible for implementing changes related to U.S. requirements for graphics. Much of its work has centered on the upcoming World Wide Web Consortium's WebCGM 2.0 recommendation and on reusable graphics objects.
- The Training Subproject Group focuses on incorporating the advantages of the Advanced Distributed Learning/Sharable Content Object Reference Model. To that end, ASD and the DoD Joint Performance Assessment Laboratory signed an MOA in May 2004.
- The URI/URN Subproject Group registers "S1000D" as a Universal Uniform Resource Names Namespace with the Internet Assigned Numbers Authority, which will allow greater portability of data modules between programs.
- The Applicability and Effectivity Subproject Group implements requirements related to filtering the content of technical data for use with specific configurations of equipment or by specific user groups.

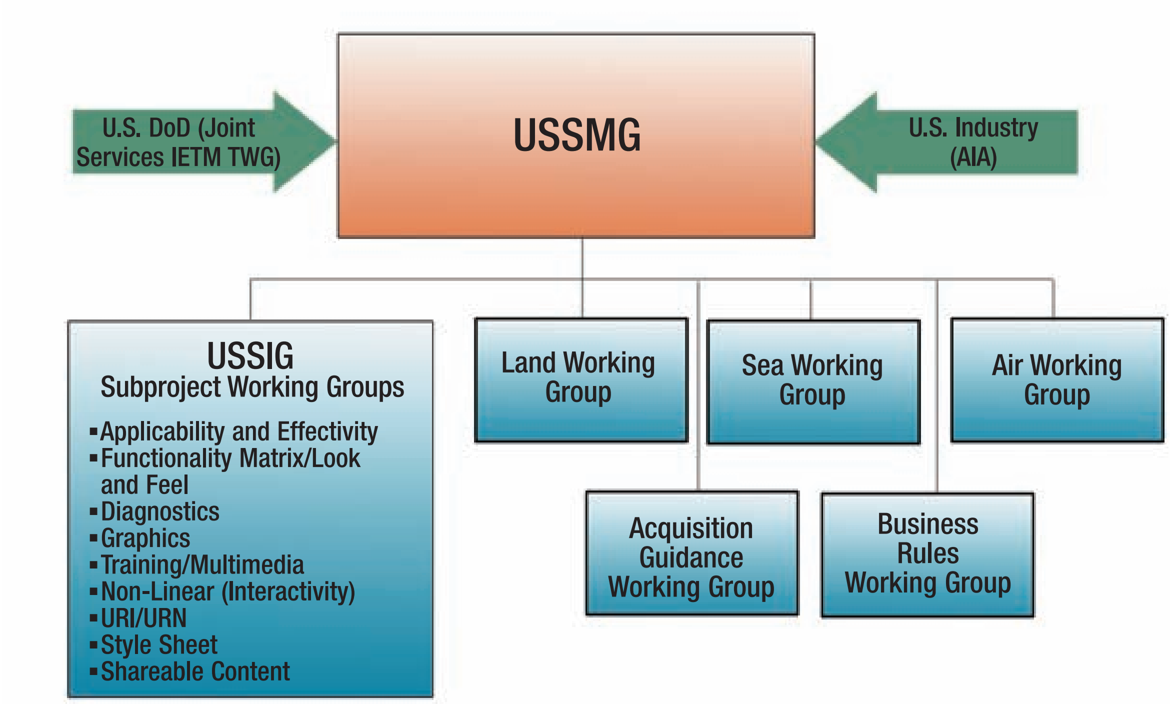


FIGURE 2. U.S. S1000D Organization.

- The Functionality Matrix/Look and Feel Subproject Group has the dual responsibility of maintaining the former AIA Functionality Matrix (now Chapter 6.4 of S1000D) and ensuring that the specification or DoD business rules comply with all U.S. requirements for look and feel. This effort is incorporating many of the lessons learned from MIL-HDBK-511.
- The Multimedia Subproject Group looks at ways to enhance technical data effectiveness with multimedia content. This subproject is closely tied to the efforts of the Training Subproject Group.
- The Style Sheet Subproject Group is responsible for establishing and maintaining a library of style sheets for displaying S1000D content on electronic devices.
- The Shareable Content Subproject Group is investigating ways to maximize data reuse by using shareable content objects.

The people supporting the U.S. efforts have made tremendous progress toward the goals of the NATO Interoperability Roadmap. These working groups consist of individuals from DoD and each of the services, as well as many industry partners. The latter include Boeing, Business Technologies and Solutions, Computer Sciences Corporation, Continental Data Graphics, Dimension4, General Dynamics, Lockheed-Martin, Northrop Grumman, PBM Associates, O'Neil and Associates, Raytheon, and others.

CURRENT AND EXPECTED BENEFITS

The benefits of S1000D are significant, but they are not always apparent to the end user. It is well established that digital information is an improvement over paper technical data in most situations. S1000D offers the same advantages, plus some added benefits for the military services. S1000D data can be managed at a much more granular level than traditional technical data, and the data are structured with well-

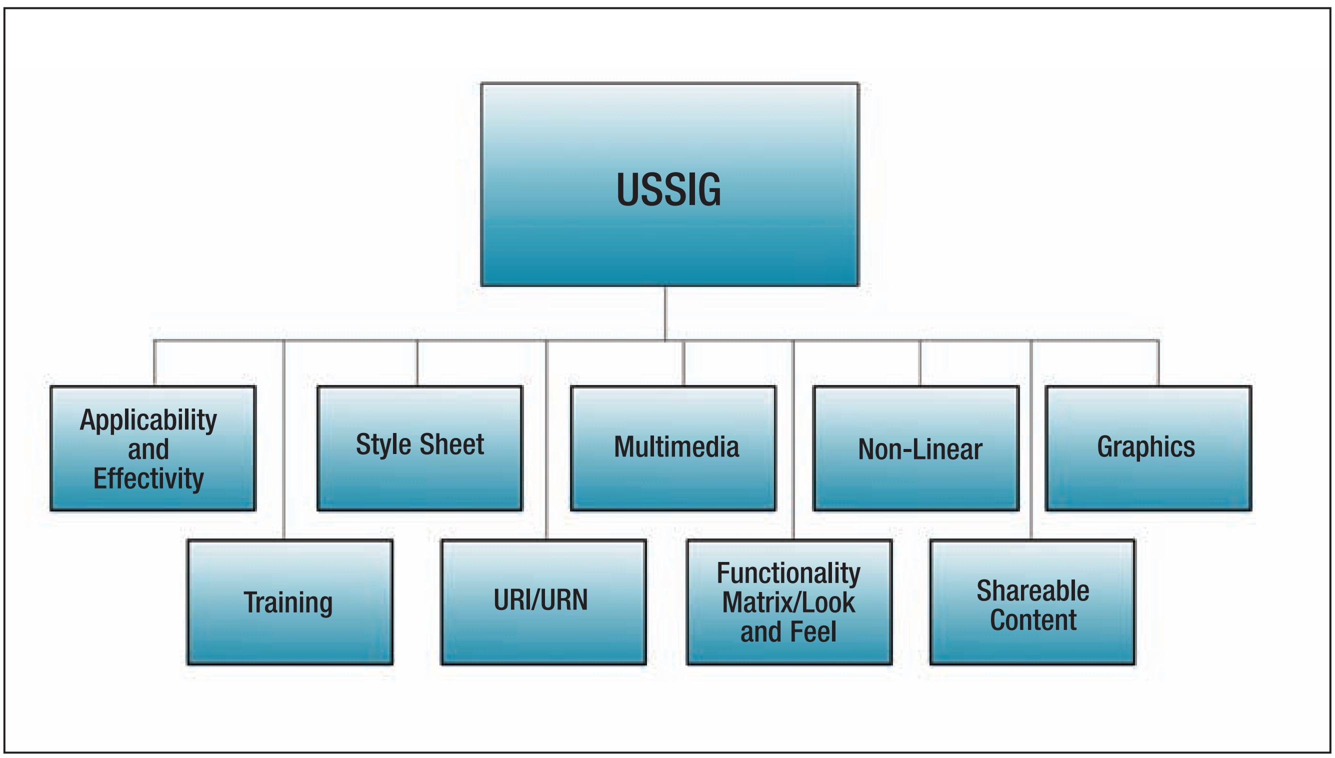


FIGURE 3. USSIG Subproject Groups.

defined metadata. These two factors enable greater data reuse than that previously accomplished. Taking very discrete portions of data and repurposing them for other uses is something one could only dream about with data built on the older technical manual specifications and standards.

S1000D has become a de facto standard overseas and is on track for the same status here. Its near-universal acceptance has fostered a wide variety of support tools and services competing in the marketplace, which drives down costs of development.

Even though expected savings will vary for each program, one can almost always expect reductions in the overall storage size of the data, compared with a linear digital file. Recent advancements in graphics reuse will improve this advantage even more. This benefit equates to more dollars for the things needed most.

The latest release of S1000D (Issue 2.2) can support interactive data and many other enhancements required by DoD and the services, but more work is needed to ensure that specifications continue to fulfill our requirements as they evolve with technology.

NEXT ON THE AGENDA

The next items that the USSMG and USSIG need to address center on acquisition guidance to ensure effective implementation of S1000D in the United States. This includes the development of common DoD and service business rules for implementing the standard and development of a data migration strategy for legacy systems. The business rules will provide guidance to program managers on how to apply the S1000D specification to new and legacy systems. The goal for the data migration strategy is to provide program managers guidance on how to convert to S1000D while minimizing financial hardships to the program. Training is also needed to effect a cultural change that supports the use and distribution of digital data via a net-centric environment. These cultural changes may be the hardest to accomplish.

In summary, the promise of S1000D is increased data reuse through better, more granular management information about the data, in a standardized format accepted by all services and many of our international partners. It will reduce the effort to sustain the information but, at the same time, increase data interoperability.

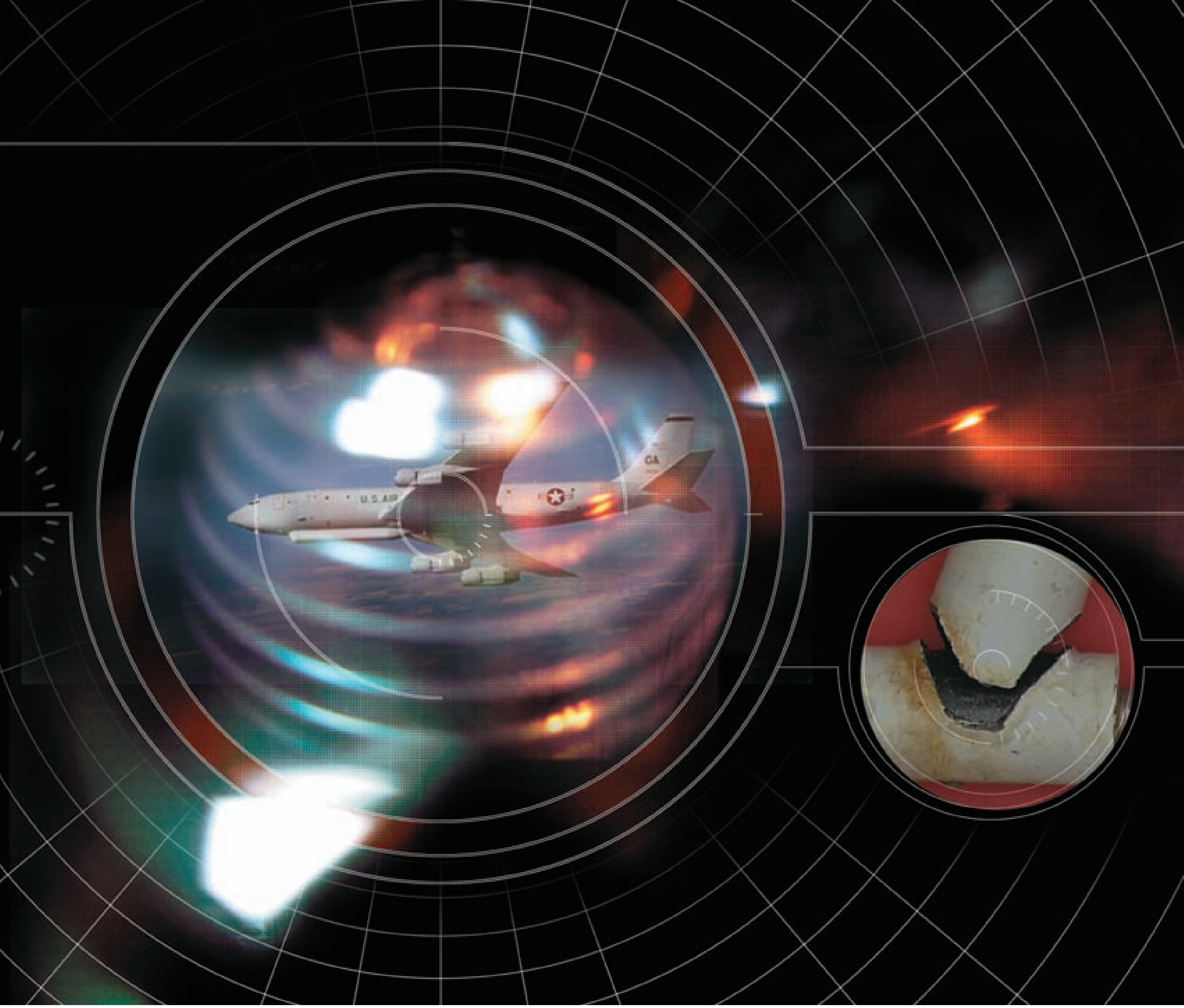
You can get more information about the U.S. groups that help maintain S1000D at https://peoc3sres.monmouth.army.mil/QuickPlace/us_epwg_tpsmg/Main.nsf/h_Toc/4df38292d748069d0525670800167212/?OpenDocument.

You can view and download the S1000D specification at www.S1000D.org.

About the Authors

Steven Holloway is the program manager responsible for Air Force technical manual specifications and standards. He is the DoD representative to the S1000D Technical Publications Specification Maintenance Group and the DoD co-chair of the U.S. S1000D Management Group.

Bill Wendel is a senior systems analyst at Wright-Patterson Air Force Base providing IETM consulting. He is a member of the Electronic Publications Working Group and secretary of the U.S. S1000D Implementation Group.



Acquisition Reform of Military Specifications and Standards

Losing the Aerospace Lessons Learned

By Donna Ballard and Larry Perkins

The primary role of specifications and standards is to standardize the process, material, application, and testing of an "acquisition product" to ensure that the end product achieves and maintains minimum attributes deemed essential to its service. These documents can be general industry specifications like American Society for Testing and Materials (ASTM) or Society of Automotive Engineers (SAE) standards, or they might be company-specific specifications developed by an individual manufacturer.

For example, automobile manufacturers, a profit-driven, highly competitive industry, typically specify steel to make the frames and bodies of cars. A company-specific specification will "guarantee" attributes such as corrosion resistance, paintability, formability, and weldability—characteristics needed to ensure adequate service. Design constraints such as strength, ductility, and toughness are also specified to some minimum value.

These manufacturers' standardization documents are akin to military standardization documents that are used for developing systems integral to our nation's defense. Military specifications and standards are based on years of lessons learned that were often expensive and sometimes lethal, and always imparted wisdom that saved time and money. However, when these specifications and standards were canceled, the lessons learned were lost. The loss of those lessons cost both time and money and can result in such inadequate performance that new programs are scaled back or canceled. Almost all of the examples presented in this paper could have been prevented by the judicious use of lessons learned.

Preserving (and Forgetting) Experience

One of the purposes of specifications, then, is to incorporate lessons learned. If the lessons are not documented and the "graybeards" retire or move on to other jobs, the corporate knowledge is lost. When a non-government standards body converts a specification to an industry standard, details might be removed because no one in the standards body knows the reason behind them. Canceling military specifications requires the responsible parties to understand their designs, materials, and processes thoroughly and completely, and to know when a substitution or replacement will have a beneficial, neutral, or detrimental effect on the system.

Since the 1800s, military specifications have offered the same advantage of documenting lessons learned from experience, albeit on a much larger scale than in industry. The organizations that prepared military specifications were the organizations that learned the lessons. Investigations of failed Department of Defense (DoD) assets generated the lessons learned that became the foundations for military specifications. Because the military had the advantage of evaluating every product that was manufactured by DoD contractors, these specifications reflected lessons from all defense manufacturers—not just one industry sector, as in the case of automotive steel. Moreover, because these specifications were coordinated with the DoD industry partners before issue or modification, they contained the wisdom of the entire acquisition infrastructure. Military specifications and standards were used to improve weapon systems by iterative application of lessons learned from the past. Thus, each new military system avoided the mistakes of the past.

Defense contractors eventually came to rely upon these specifications and standards instead of exploring and broadening sound engineering practices. This led to an inadequate infrastructure for applying the specifications and standards to systems. As a result, the documents came under fire as being out of date, unreasonable, and costly—criticisms that were, in some applications, correct.

In the early 1990s, military specifications were targeted as cost-drivers in system and component acquisition. In 1994, Secretary of Defense William J. Perry issued a policy letter declaring that military specifications should be used as a last resort, and only then with a waiver from the Milestone Decision Authority—a responsibility that, in the Air Force, typically falls to either the Assistant Secretary of the Air Force for Acquisition or the Under Secretary of Defense for Acquisition, Technology and Logistics.[1] Currently, the following is the preferred order of specification and standard use by DoD: non-government standards, federal specifications and standards, defense performance specifications and standards, and then defense detail specifications.

Although it is true that some specifications were redundant and therefore unnecessary, others contained the very parameters required to provide a reliable product that would perform effectively and consistently in a military environment. However, as the age of acquisition reform dawned, various specifications and standards were canceled without a full appreciation for the long-term impact of such decisions. In many cases, the superseding industry documents met only a portion of the requirements outlined in the original military specifications; in some cases, specifications were canceled with no superseding document, leaving industry scratching its head about where to turn next.

An advantage of military specifications and standards is that they can capture the lessons learned for an entire industry, military and commercial, without retribution. This is extremely valuable, because the government is able to sanitize the wisdom from the lessons learned—keeping the knowledge and filtering out blame—and incorporate it into a comprehensive military standard.

The examples that follow describe situations where a lack of lessons learned has caused significant headaches for U.S. Air Force systems.

Aircraft Bell Crank Weldment

The bell crank is the linkage that operates the main landing gear doors on aircraft. The bell crank assembly is a weldment made from AISI 4130 steel. If the crank fails, there is a 50 percent probability that the door will not open, forcing a wheels-up landing. A training aircraft used by the U.S. Air Force, the U.S. Navy, and the Canadian and Australian Air Forces experienced at least two wheels-up landings attributed to the failure of the bell crank. Failure analysis found that the welds were not typical of aerospace-quality welds (based on industry best practices, which are at times nebulous and undefined), and the failures were linked directly to weld defects.

The fix was to use the Procedure Qualification Record/Welding Procedure Specification approach from the now-canceled MIL-STD-2219, Fusion Welding for Aerospace Applications. New assemblies were prototyped, qualified, and productionized within 3 months using this approach—which is no longer required by the original equipment manufacturer's specification. All fielded assets were replaced with the properly qualified units, and failures ceased.

Gold-Plated Leads on Electronics

Using solders containing tin on electronic components with gold-plated leads can produce gold-tin intermetallics, compounds that drastically reduce ductility in the joint and can result in premature failure in service. When failures occurred in critical electronics for a large cargo aircraft program, gold-tin intermetallics were implicated. The now canceled military standard, MIL-STD-2000, Standard Requirements for Soldered Electrical and Electronic Assemblies, captured the lessons learned that (1) gold plating must be removed prior to soldering to prevent intermetallic formation and (2) design must be based on joint configuration (plated through-hole, surface mount, stress relief, and so on), gold plate thickness, criticality of use, and the solder process.

When the new industry standard for soldering, IPC J001, Requirements for Soldered Electrical and Electronic Assemblies, was published, it did not specifically require the removal of gold. (The current version includes information on gold removal but allows for eliminating the requirement if documented evidence indicates there are no embrittlement problems with the selected soldering process.) Consequently, the gold was not removed prior to soldering, which allowed for the intermetallic formation that led to solder embrittlement. Implementing the requirements in MIL-STD-2000 eliminated these embrittlement failures.

Lack of Specifications: Additive Manufacturing and Friction Stir Welding

In some cases, after cancellation of a military standard, the lack of industry specifications leaves a vacuum that inhibits the transfer of materials and processes to the field. For example, additive manufacturing processes use metallic powder or wire to add material to existing shapes to generate near-net-shape parts (Figure 1). The advantages of such processes are numerous: less material usage for expensive materials, manufacturing time savings, local mechanical property optimization, and production of hybrid structures that optimize the use of metallic materials on military systems. Currently, however, no specifications or standards, industry or commercial, address the performance requirements of these processes.

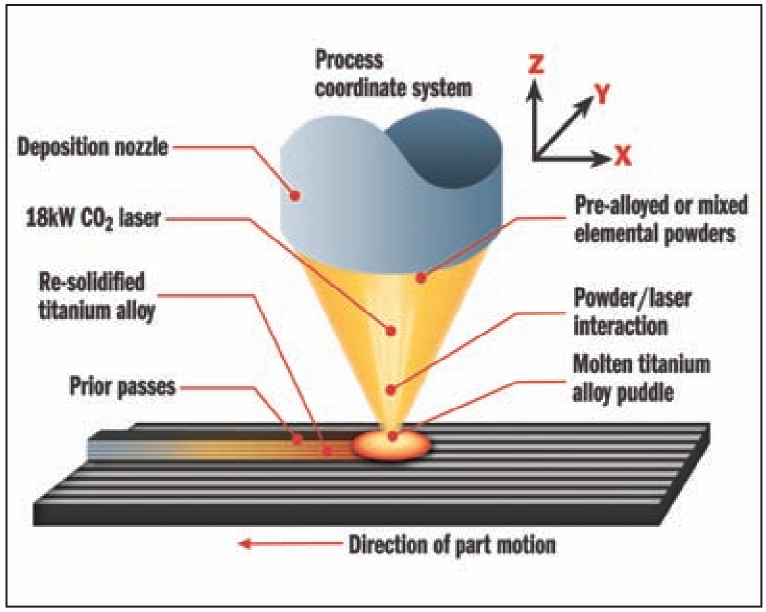


FIGURE 1. Laser Additive Manufacturing Process.

The principal hindrance to implementation has been the lack of a clear specification that could be used by designers to ensure the quality and consistency of production. Because additive manufacturing is akin to a welding process, standards like the canceled MIL-STD-2219 could be used as an early model to baseline the process and develop useful data for applications. (Although a canceled specification can still be used as guidance, there is nothing that would drive someone to use it.) Once the requirements from the military standard were utilized by industry and consistency demonstrated, several potential applications on U.S. Air Force aircraft are now being pursued and have a greater potential of being implemented because process and performance data are available to decision makers.

However, supposedly "equivalent" industry welding specifications like AWS D17, AMS 2680, or AMS 2681 do not have the depth to be utilized as a base document for this purpose. SAE issued a new additive manufacturing specification, but the Air Force deemed it inadequate for use in aerospace systems, because quality assurance and process control requirements were insufficient. Relying on these specifications for baseline development would leave gaps that are unacceptable for military aerospace applications and do not give system designers enough data to determine whether this process can be implemented.

Industry standards for friction stir welding (Figure 2) have suffered a similar fate, even though any number of canceled military standards could be used to help establish the requirements needed to field components welded with such a process.

Materials Selection

Yet another repercussion from canceling a military specification is the problem of selecting aluminum alloys that are prone to stress corrosion cracking (SCC) (Figure 3).

High-strength 7XXX alloys in the –T6 condition—solution heat treated, then artificially aged—offer the highest strength possible for aluminum alloys, making them the most likely candidate if a choice is made solely on the basis of strength. Alloys in the –T6 condition, however, have low SCC thresholds. The now canceled MIL-STD-1568, Materials and Processes for Corrosion Prevention and Control in Aerospace Weapons Systems, specifically advised against the use of this heat-treat condition without due consideration. Although this standard was converted to a military handbook, MIL-HDBK-1568, it cannot be specified as a requirement in new design and so it is not cited in many contracts.

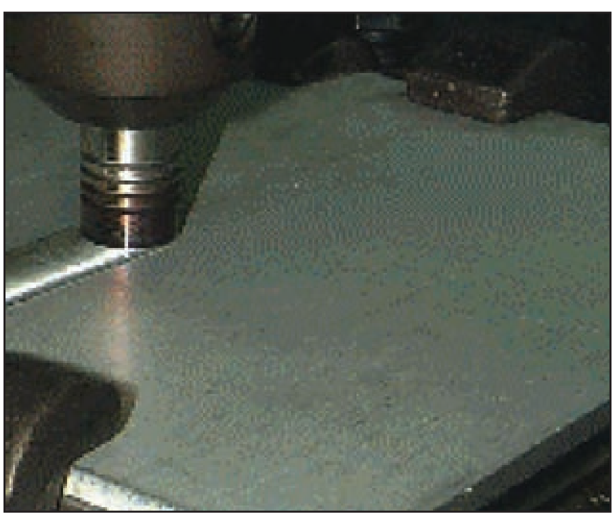


FIGURE 2. Friction Stir Welding Process on High-Strength Aluminum Alloy.

Unaware of this caution, designers choose alloys with the –T6 condition, and systems from ground support to aircraft structure are fielded. Then, when the SCC issue surfaces, the system maintainers are left with the expensive recurring cost to repair or retrofit these fielded parts or assemblies—even though MIL-STD-1568 had already addressed this issue clearly and succinctly. The standard was based on field experience and required a standard ASTM test method to identify aluminum alloys with an SCC threshold greater than 25,000 pounds per square inch. This ensured that premature field failures would not occur due to this well-documented problem.

Reinstating MIL-STD-2219

MIL-STD-2219, Fusion Welding for Aerospace Applications, was adopted by the SAE as AMS-STD-2219 in May 1999. Subsequently, the SAE contacted the Air Force to ask for engineering technical guidance on a portion of the standard. The SAE admitted that it did not have the expertise to answer technical inquiries about the document and requested that the Air Force reinstate the military standard. The industry document was canceled in September 2002, and the defense standard is in the process of being reinstated.

Conclusions

The primary goal of all engineering organizations should be to capture the wisdom behind the deci-

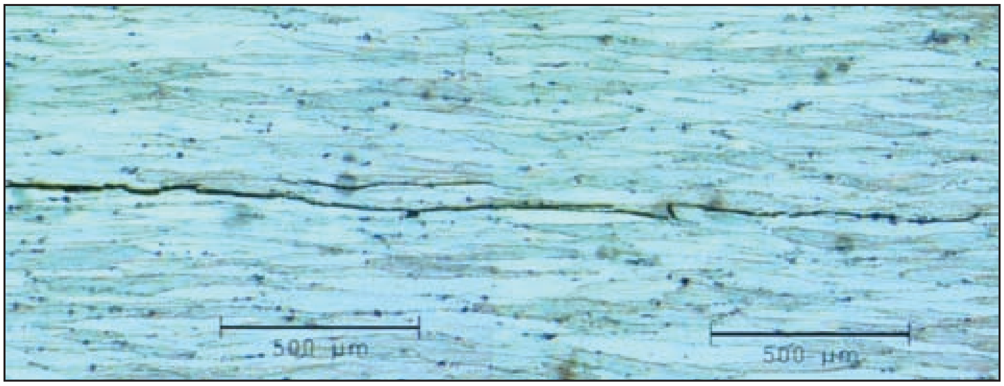


FIGURE 3. Stress Corrosion Cracking in 7075-T6 Aluminum Alloy (Magnification 50X).

sions made when any specification is written and to be able to access that history throughout the specification's life. It is imperative that new engineers have access to the wisdom behind the specifications, so explanations like "that's the way it's always been done" are replaced by "that specific requirement is in there because…." A standardized process for capturing lessons learned from specifications is needed.

Industry standards require the same maintenance as defense standardization documents. Their review and update cycles are similar, and they can become outdated if technology outpaces the review interval. Industry standards bodies sometimes lack the technical expertise to answer specific questions regarding defense specifications and standards that industry adopts. Defense and industry must partner to ensure confidence and integrity in the material provided to document users. Both industry and defense standards must be maintained as living, viable documents if they are to serve as true standardization instruments.

Defense specifications and standards are not an uncontrollable scourge. But developers and users of the documents must thoroughly review the defense specification or standard and the "equivalent" industry standards, and then do what makes sense. Establishing a formal industry and government technical panel to review specifications prior to cancellation would allow such comprehensive reviews and informed decisions.

Finally, and perhaps most important, specifications and standards—whether industry or defense—are a complement to, and not a replacement for, sound engineering practices.

[1]William J. Perry, Policy Memorandum: Specifications and Standards—A New Way of Doing Business, June 29, 1994.

About the Authors

Donna Ballard and Larry Perkins are engineers at the Air Force Research Laboratory, Materials and Manufacturing Directorate, Wright-Patterson Air Force Base, OH. Ms. Ballard focuses on evaluating corrosion of high-temperature superalloys and is responsible for corrosion-related programs for friction stir-welded assemblies, as well as non-chromated, environmentally friendly coatings and pretreatments.

Mr. Perkins is the senior technical advisor to the Metals, Ceramics and Nondestructive Evaluation Division. He has more than 20 years of experience with failure analysis and accident investigation and is currently working to streamline the transition of advanced materials and processes to meet Air Force needs.

The authors would like to thank Kumar Jata, Mary Kinsella, Tim Swigart, and Bob Ware for providing photographs.

The U.S. Air Force Role in International Military Standardization

By Chris Ptachik, Lt Col Addison Tower, Lt Col John Klatt, and Dennis Lynn

In today's global environment of coalition warfare, the U.S. Air Force is extensively involved in international military standardization (IMS) activities with multinational partners. The Air Force's objective in IMS is to enable the United States, its allies, and other friendly nations to operate effectively together in coalition warfare. This article offers an overview of U.S. and NATO policies, procedures, and doctrine guiding IMS activities; the scope of the Air Force's participation in those activities; and Air Force efforts to further interoperability through materiel IMS.

Guiding Policies, Procedures, and Doctrine

Department of Defense (DoD) and Chairman of the Joint Chiefs of Staff (CJCS) policies, procedures, and doctrine guide the Air Force role in IMS. DoD Directive 2010.6 provides policy and responsibilities for the military departments regarding attaining and maximizing materiel interoperability with allies and coalition partners, ensuring that interoperability is considered in the acquisition and sustainment of all systems that could be used in coalition operations, and providing representation at appropriate groups under NATO and other international forums.[1] CJCS Instruction 2700.01A provides guidance on achieving international military rationalization, standardization, and interoperability agreements with allies and other friendly nations, and assigns lead agency responsibilities to DoD components for U.S. representation in international forums.[2] DoD Manual 4120.24M provides guidance on U.S. participation in ratifying and implementing international standardization agreements (ISAs) intended for use in defense acquisitions.[3]

Air Force Participation in IMS Bodies

The Air Force bears lead agency responsibility for U.S. representation in four IMS bodies that produce military standardization agreements:

- NATO's Military Committee Air Standardization Board (MCASB), its four working groups, and their 17 panels
- Conference of National Armaments Directors (CNAD) NATO Air Force Armaments Group (NAFAG) and its six capability groups (CGs)
- NATO Pipeline Committee (NPC) and its three working groups
- Air and Space Interoperability Council (ASIC) and its 11 working parties (WPs).

The Air Force also participates as a member in 32 other IMS boards, groups, parties, and panels.

Air Force IMS activities produce documented agreements and information exchanges with members of participating nations that foster understanding and cooperation and lead to improved interoperability in future coalition operations. The agreements have different names in each IMS body, but generically are called international standardization agreements; they cover operational, materiel, terminology, and administrative areas that are important to achieving mission success through improved interoperability and reduced cost.

NATO

The NATO Standardization Agency sets out procedures, planning, and execution functions related to standardization for application throughout the alliance. It performs overall administration of all ISAs developed within NATO. NATO ISAs are designated as standardization agreements (STANAGs) and allied publications (APs).

The NATO Standardization Agency also supports four military committee standardization boards—Joint, Land, Maritime, and Air—each of which acts as a tasking authority for operational standardization, including doctrine, as delegated by the military committee. The boards are responsible for developing operational and procedural standardization among member nations within their areas of responsibility. Like other tasking authorities, they do this by generating applicable STANAGs and APs with the member nations and NATO military commands.

MILITARY COMMITTEE AIR STANDARDIZATION BOARD

The MCASB is delegated as a tasking authority and decision-making body. Its mission is to foster military *operational* standardization initiatives in the air domain with the aim of achieving interoperability of alliance and, where appropriate, other military forces, and to optimize the use of resources. It also addresses *materiel* standardization initiatives. It focuses on developing and promulgating STANAGs and APs that improve the interoperability of alliance air forces.

The MCASB meets 8 to 10 times per year to provide guidance and review results of its four working groups and 17 panels, which manage 237 active STANAGs and 50 in the study phase.[4] The U.S. representative to the MCASB is physically assigned to the U.S. military delegation to NATO in Brussels, Belgium, from the Air Force's International Standardization Office in the Pentagon.

The missions of the MCASB working groups and panels are summarized in Table 1, along with the U.S. Heads of Delegation (HoDs) organizations and the number of active and study-phase ISAs (both STANAGs and APs) they manage.[5]

TABLE 1. MCASB Working Groups and Panels.

WORKING GROUP AND PANEL	HoD ORGANIZATION	ACTIVE/ STUDY-PHASE ISAs	MISSION
Air Operations Working Group	AF Doctrine Center	16/3	Improve interoperability among warfighters to engage in tactical air operations using common doctrine and procedures.
Air Information Exchange Requirements Panel	AF Command and Control and Intelligence, Surveillance, and Reconnaissance Center	0/0	Develop and harmonize Information Exchange Requirement proposals relating to character-oriented ADatP-3 messages.
Joint Unmanned Aerial Vehicle (UAV) Panel	AF Doctrine Center	0/0	Develop standards for NATO joint UAV operational doctrine, tactics, techniques, and procedures that will enhance NATO UAV air power operations. Closely linked to CNAD NAFAG AG II on unmanned aerial vehicles.
Air Operations Services Working Group	HQ AF Civil Engineering Support Agency/Mechanical-Electrical Engineering Division	0/0	Improve the effectiveness of NATO forces by developing standardization and addressing interoperability with respect to airfield marking, lighting and infrastructure, air traffic services, and crash fire and rescue services.
Airfield Marking, Lighting and Infrastructure Panel	HQ AF Civil Engineering Support Agency/Mechanical-Electrical Engineering Division	13/3	Develop standards of airfield marking, lighting and Infrastructure. Address runway friction and braking conditions; aircraft classification numbers, pavement classification numbers, and pavement condition index surveys; airfield pavement technologies; and standard design criteria and airfield pavement rating systems.
Airfield Services Procedures Panel	HQ AF Civil Engineering Support Agency/Mechanical-Electrical Engineering Division	14/0	Develop standards of airfield services procedures. Monitor International Civil Aviation Organization's Procedures for Air Navigation Services–Aircraft Operations criteria changes, maintain Allied Publication AATCP-1, and develop additional military-specific criteria.

WORKING GROUP AND PANEL	HoD ORGANIZATION	ACTIVE/ STUDY-PHASE ISAs	MISSION
Crash, Fire and Rescue Panel	HQ AF Civil Engineering Support Agency/Mechanical-Electrical Engineering Division	11/6	Develop standards and address interoperability of inter-service crash, fire-fighting and rescue. Covers training, special risks of hazards, weapons systems protection, fire engineering, life safety and fire prevention, force protection, emergency response to terrorism, hazardous material emergency response, technological advancements, and commercial technology.
Air Operations Support Working Group	Asst Sec of Defense/International Security Affairs/Def Prisoner of War/Missing Personnel Office	0/0	Improve the effectiveness of NATO forces by developing standardization and addressing interoperability with respect to air transport, air reconnaissance, search and rescue, and aeromedical services.
Air-To-Air Refueling Panel	HQ Air Mobility Command/Standardization and Evaluation Division	3/0	Develop standards that enhance effective air-to-air refueling employment and interoperability.
Aeromedical Panel	AF Medical Support Agency	24/7	Develop standards in aviation medicine, including aircrew flying time and rest periods, medical training for search and rescue/casualty evacuation personnel, medical equipment in aircraft, effects of high-G environment, flash blindness protection, effects of nuclear-biological-chemical agents, and protection for high-altitude parachuting operations.
Air Reconnaissance Panel	Asst Sec of AF/Acquisition/Reconnaissance Systems Division	22/3	Develop standards in multi-sensor imagery reconnaissance and related functions, including sensors, data transfer/processing, image interpretation/reporting, storage, storing, and requesting, tasking, and reporting. Closely linked to CNAD NAFAG AG IV.
Air Transport Panel	HQ Air Mobility Command/Standardization and Evaluation Division	33/3	Develop standards in fixed-wing air transport to improve the effectiveness of NATO forces in areas such as air drop operations, air landing operations, passenger/cargo handling, and air transport terms and definitions.
Flight Safety Panel	AF Chief of Safety, Safety Issues Division	12/0	Develop aviation safety standards, including aircraft flight safety, aviation-related ground safety, air weapons/range safety, aircraft accident/incident investigation and prevention, and safety requirements for flying and static displays.
Search and Rescue Panel	Asst Sec of Defense/International Security Affairs	5/3	Develop standards of search and rescue/combat search and rescue tactics, techniques, and procedures, including essential operational characteristics of survival and life-support equipment.
Air Technical Working Group	Naval Air Warfare Center Code AIR 4.3.5	0/0	Improve the effectiveness of NATO forces by developing standardization and addressing interoperability with respect to air armament, avionics systems, air electrical, aircraft gaseous systems, aircrew/aircraft integration, and aircraft servicing standard equipment.
Air Armament Panel	Asst Sec of AF/Acquisition/Fighter-Bomber Division	21/2	Develop interface standards in the area of air armaments, including aircraft conventional stores and associated equipment such as guns, ammunition, bombs, rockets, missiles, cartridges, pyrotechnics, fuses, and arming systems.
Air Electrical and Electromagnetic Considerations Panel	Aeronautical Systems Center/Avionics Engineering Division	16/4	Develop standards, publications, and operational handbooks, and exchange information on aircraft electrical and electromagnetic subjects.
Aircraft Displays and Aircrew Stations Panel	Aeronautical Systems Center/Flight Systems Division	27/6	Develop standards on aircraft displays and aircrew station design, including human engineering considerations such as visual, aural, and/or tactile displays/indicators and design criteria for aircraft, controls, selectors, and switches.
Aircraft Servicing and Standard Equipment Panel	Naval Air Warfare Center Code AIR 4.3.5	29/5	Develop interface standards for aircraft servicing and standard equipment to enhance aircraft cross-servicing and related support operations, including maintenance, replenishment, safety, and associated hazard-marking and aircraft-ground equipment.
Avionics Systems Panel	Asst Sec of AF/Acquisition/Combat Support and Joint Counter Air Division	17/1	Develop avionics systems standards, including avionics systems architecture, aircraft video systems, digital components in avionics systems, avionics software, and aircraft data transfer systems.
Aircraft Gaseous Systems Panel	Warner Robins Air Logistics Center/AF Petroleum Office	9/6	Develop standards for aircraft gaseous systems and equipment, including safety procedures associated with and quality/characteristics and labeling of breathing and technical gases used in aerospace systems. Also covers requirements of air and ground replenishment equipment for aircraft gaseous systems and connection features.

CONFERENCE OF NATIONAL ARMAMENTS DIRECTORS

CNAD sponsors most of the effort to identify opportunities for collaboration in research, development, and production of military equipment and weapon systems. Chaired by the NATO Secretary General, CNAD brings together the defense acquisition chiefs of all member nations, representatives from the military committees and strategic commands, the chairmen of its main groups, and other civil and military authorities with an interest in production logistics.

The CNAD substructure consists of many groups, subgroups, and working groups. Directly subordinate are the following:

- Main armaments groups covering land, sea, and air warfare: NATO Naval Armaments Group (AC/141); NATO Air Force Armaments Group (AC/224, NAFAG), discussed below; and NATO Army Armaments Group (AC/225).
- Main groups, which include the NATO Industrial Advisory Group and the Life Cycle Management Group (AC/327).
- Ad hoc groups dealing with special armaments projects, including the Alliance Ground Surveillance Steering Committee (AC/259) and Missile Defense Ad Hoc Group (AC/259).
- Cadre groups, which undertake activities of general interest to armaments cooperation. These activities are project-independent, of a tri-service nature, and often of direct interest to logisticians. They are the Group of National Directors on Codification (AC/135) and the NATO Ammunition Safety Group (AC/326).

The Air Force is the designated lead agency representing the United States on NAFAG. Through its six subordinate capability groups, NAFAG promotes cooperation and standardization in air armament via joint activities and information exchange. NAFAG develops relatively few STANAGs and APs. It currently manages nine active STANAGs and six in the study phase.[6] James Engle, the Air Force Deputy Assistant Secretary for Science, Technology and Engineering, is the current chairman.

Table 2 summarizes the missions of the NAFAG capability groups, along with their U.S. Capability Group Representative (CGR) organizations and the number of active and study-phase ISAs (both STANAGs and APs) that they manage.[7]

TABLE 2. NAFAG Capability Groups.

CAPABILITY GROUP	CGR ORGANIZATION	ACTIVE/ STUDY-PHASE ISAs	MISSION
Warfare Integration	Asst Sec of AF/Acquisition/ Air Dominance Division	0/0	Handle all command, control, communications and computers (C4) issues unique to air armaments. Determine phasing of data link integration in air forces and capabilities needed to support distributed operations. Determine airborne battle management improvements to support time-sensitive targeting. Interface with NATO Air Command and Control System to support integration of STANAGs across all CGs.
Effective Engagement	Asst Sec of AF/Acquisition/ Weapons Division	1/1	Assess and recommend procurement for hardened and deeply buried targets and counter-counter measures for guided weapons (e.g., GPS Anti-Jam, LGB). Review Suppression of Enemy Air Defenses lethal weapons (seeker technology). Determine and recommend common weapon interfaces.

CAPABILITY GROUP	CGR ORGANIZATION	ACTIVE/ STUDY-PHASE ISAs	MISSION
Air Survivability	Asst Sec of AF/Acquisition/ Fighter-Bomber Division	0/0	Address airborne applications of electronic warfare (EW) technology related to command and control (C2) warfare (military aspects of information warfare), EW support equipment, and assessment of EW effectiveness.
Information Superiority	Asst Sec of AF/Acquisition/ Airborne Reconnaissance Division	6/3	Covers all aspects (manned, unmanned) and all domains (space, air, land, and sea): Common imagery intelligence, electronic intelligence, communications intelligence, human intelligence report, and measurement and signatures formats to seamlessly share data between aircraft and ground stations. Common metadata to combine different data sources. Determine needs for wideband data links to support intelligence, surveillance, and intelligence gathering and dissemination.
Global Mobility	Asst Sec of AF/Acquisition/ C2 Platforms and ATC Systems Division	2/3	Special operations forces (SOF)-unique aspects for mobility platforms. Delivery and extraction of SOF personnel. Joint personnel recovery—combat search and rescue. Precision airdrop and equipment. Integration of mobile air traffic control systems in support of NATO Response Force deployment. Global air traffic management upgrades and common requirements.
Advanced Concepts	Asst Sec of AF/Acquisition/ Airborne Reconnaissance Division	0/0	Integration of UAVs in non-segregated airspace. Lead cross-CG tiger teams as directed by NAFAG. Liaison with Research and Technology Organization (RTO) to determine RTO-NAFAG science and technology studies and research to aid CG work; coordinate roadmaps across CGs with RTO.

The Air Force participates in and subscribes to ISAs developed by the other CNAD armament and cadre groups. Table 3 identifies those groups and the number of active ISAs (STANAGs and APs) to which the Air Force subscribes.

TABLE 3. Air Force Participation in Other CNAD Groups.

GROUP AND SUBGROUP	ACTIVE ISAs (AF SUBSCRIPTION)
Group of National Directors on Codification (AC/135)	2
NATO Army Armaments Group (AC/225)	
Surface to Surface Artillery (LG4)	4
Army Air Defense (LG5)	1
Joint Nuclear, Biological and Chemical (NBC) Defense (LG7)	5
Battlefield Engineering (LG9)	9
Battlefield Helicopters (LG10)	2
Soldier System Interoperability	3
NATO Naval Armaments Group (AC/141)	0
NATO Ammunition Safety Group (AC/326)	
Energetic Materials (SG-1)	23
Initiation Systems (SG-2)	7
Munitions Systems (SG-3)	16
Transport Logistics (SG-4)	1
Operational Ammunition Safety (SG-6)	18
Life Cycle Management Group (AC/327)	14

NATO PIPELINE COMMITTEE

The NPC (AC/112) is the main advisory body on consumer logistics relating to petroleum, and the Air Force is the designated lead agency. The NPC acts on behalf of the North Atlantic Council, in consultation with the NATO military authorities and other relevant bodies, on all matters relating to overall NATO interests in connection with military fuels, lubricants, and associated products and equipment, and in overseeing the NATO pipeline system.

The NPC consists of three working groups that manage 32 active STANAGs and 15 in the study phase. Working Group 1 handles special tasks and manages no STANAGs; NATO Fuels and Lubricants and its three service-related panels collectively have 17 active materiel STANAGs and 10 under study; and Petroleum Handling Equipment is handling 15 active materiel STANAGs and 5 under study. The Air Force Petroleum Office at Wright-Patterson Air Force Base provides the U.S. HoDs for the three working groups and the aviation-related panel.

OTHER NATO IMS BODIES

The Air Force participates in 32 other NATO boards, panels, or working groups led by the Army, Navy, defense agencies, or the Joint Chiefs of Staff. Table 4 identifies these groups and the number of their active ISAs (both STANAGs and APs) to which the Air Force subscribes.

TABLE 4. Air Force Participation in Activities with Non-Air Force Leads.

WORKING GROUP OR PANEL	ACTIVE ISAs (AF SUBSCRIPTION)
Land Standardization Board Working Groups	
Land Forces Ammunition Interchangeability	7
Artillery	2
Asset Tracking	5
Combat Service Support	11
Combat Engineer	9
Explosive Ordnance Disposal Interservice	7
Helicopter Interservice	6
Land Operations	17
NATO Range Safety	4
Maritime Standardization Board Working Groups	
Amphibious Operations	1
Helicopter Operations from Ships Other Than Aircraft Carriers	5
Maritime Logistics and Replenishment at Sea	7
Maritime Operations	25
Naval Mine Warfare	14
NATO Shipping	1
Radio and Radar Radiation Hazard	2
Submarine Escape and Rescue	3
Underwater Diving	3
Joint Standardization Board Working Groups	
Allied Joint Operations Doctrine	5

WORKING GROUP OR PANEL	ACTIVE ISAs (AF SUBSCRIPTION)
Environmental Protection	1
Information Exchange Requirement Harmonization	2
Interservice Geospatial	49
Joint Intelligence Interservice	9
General Medical	46
NBC Defense Operations	21
NBC Medical	14
Others (non-CNAD)	
Military Committee Meteorological Group	4
NATO Training Group	2
International Military Staff	4
NATO C3 Board	42
Senior NATO Logistician's Conference	6
NATO Maintenance and Supply Agency	3

Air and Space Interoperability Council

The Air Force also has lead agency responsibility as the U.S. representative on the ASIC and its 11 WPs. First formed in 1948 as the Air Standardization Coordinating Committee and redesignated ASIC in May 2005, the council is an active and productive international organization that works for the air forces of Australia, Canada, New Zealand, the United Kingdom, and the United States. With the name change came a new mission: "enhance air and space warfighting capability through joint and coalition interoperability—now and in the future." The organization will be going through additional changes in the coming year to add rigor to its tasking process and optimize its structure.

The ASIC works toward that objective by standardization of doctrine, operational procedures, materiel, and equipment. It also exchanges technical information and arranges the free loan of equipment between member nations for test and evaluation purposes. The results of these tests are usually distributed to all nations.

ASIC's primary products are air standards, advisory publications, and information publications:

- The working parties develop internationally agreed upon operational, materiel, and administrative air standards that are incorporated into each nation's appropriate document system.
- If a document is more of a guide to interoperability, they develop an advisory publication.
- Informational publications contain information for the prime purpose of exchange between members of a working party. It may be used to support further working party activity but is not of a nature that requires formal distribution as an advisory publication.

ASIC has published some 340 documents. Table 5 identifies the ASIC working parties and missions, the U.S. coordinating members' organization, and the number of active and study-phase air standards under their responsibility.

TABLE 5. ASIC Working Parties.

WORKING PARTY	COORDINATION MEMBER ORGANIZATION	ACTIVE/ STUDY-PHASE AIR STANDARDS	MISSION
WP 15—Aviation Fuels, Lubricants, Associated Products and Gases	Warner Robins Air Logistics Center/AF Petroleum Office	11/7	Develop agreements governing the quality of aviation fuels, lubricants, associated products, gases, and related equipment, from origin to point of issue, to meet agreed upon ASIC operational standardization requirements.
WP 20—Air Armament	Asst Sec of AF/Acquisition/ Fighter-Bomber Division	21/12	Develop standards for the characteristics, design requirements, testing, and installation of air armament to permit interoperability between member nations' air forces.
WP 25—Aerospace Engineering, Maintenance and Logistics	Naval Air Systems Command, AIR 4.3.5	29/16	Address the interoperability requirements of aircraft servicing, maintenance, engineering, and logistics support (excluding armament and petroleum-oil-lubricants requirements), including related environmental issues.
WP 44—Air Transport Systems	HQ Air Mobility Command/ Standardization and Evaluation Division	25/14	Address the coalition capability requirements of military airlift systems.
WP 45—Air Operations and Doctrine	AF Doctrine Center	21/10	Develop standards for doctrine, concepts, and procedures to enhance joint and combined air operations. Provide guidance to the other ASIC working parties.
WP 61—Aerospace Medicine, Life Support and Aircrew Systems	USAF School of Aerospace Medicine	70/31	Advance standardization in the fields of aerospace medicine, life support, and aircrew systems, in order to achieve and maintain relevant operational standardization requirements.
WP 70—Mission Avionics	Asst Sec of AF/Acquisition/ Combat Support and Joint Counter Air Division	10/5	Promote interoperability in the areas of airborne communications, identification, and navigation systems in order to achieve specified operational standardization requirements.
WP 80—Intelligence, Surveillance and Reconnaissance	Asst Sec of AF/Acquisition/ Airborne Reconnaissance Division	17/10	Obtain interoperability of the equipment and procedures used throughout the reconnaissance cycle in order to achieve and maintain specified relevant operational standardization requirements.
WP 84—Nuclear Biological and Chemical Defensive Measures	AF Civil Engineering Support Agency/Full Spectrum Threat Response Integration Division	10/15	Develop standards for member air forces to promote the interoperability of procedures, equipment, and operational training criteria in the field of nuclear, biological and chemical defense in military operations, jointly with the American, British, Canadian and Australian Armies (ABCA) as appropriate.
WP 90—Aeronautical Information, Airfield Facilities and Air Traffic Services	AF Flight Standards Agency/ Instrument Standards Division	19/14	Standardize coalition capability requirements in the fields of aeronautical information (flight information publications, aeronautical chart overprints, and digital data), airfield facilities, and air traffic services.
C4 Working Group	AF Doctrine Center	0/0	Address long-standing C4 interoperability deficiencies. (ASIC plans to make this a permanent working party.)

Other ASIC-Related IMS Bodies

In addition to its responsibilities on the ASIC, the Air Force International Standardization Office conducts liaison with several other bodies, all headquartered in the Washington, DC, area. These groups, together with the ASIC, call themselves the "Multifora," and their executive staffs meet three times a year. The groups send members to the others' meetings and share subject matter experts on projects of joint interest.

The five main bodies among these other IMS organizations are ABCA; the Australian, Canadian, New Zealand, United Kingdom, and United States Naval C4 Organization; the Combined Communications-Electronics Board; the Technical Cooperation Program; and the Multinational Interoperability Council.

Achieving Interoperability Through Materiel IMS

As mentioned previously, among the primary products from these IMS bodies are documented ISAs that the United States ratifies and that the services and defense agencies may subscribe to in order to achieve interoperability. Ratification of an ISA requires that each nation implement the agreement within its own document system. For the United States, the channels for implementing materiel ISAs are generally specifications and standards that can be placed on contract when the United States acquires new systems, modifies an existing system, or procures logistics provisions.

The Air Force is continuing an initiative, which it began in 1996 during acquisition reform, to review the implementation of ratified materiel ISAs to which the Air Force subscribes. This review is uncovering administrative and technical discrepancies that potentially affect compliance with the agreements. The discrepancies and recommended corrective actions are available at a web-accessible database within an access-controlled ISA Implementation Community of Practice at https://afkm.wpafb.af.mil/ASPs/CoP/EntryCoP.asp?Filter=OO-EN-IS-AI. This resource allows involved organizations and the implementing specification or standard preparing activities to review and coordinate corrective actions. It also enables the Air Force Departmental Standardization Office, in the Engineering and Technical Management Division, Deputy Assistant Secretary for Science, Technology and Engineering (SAF/AQRE), to track the actions to completion.

[1]DoD Directive 2010.6, Materiel Interoperability with Allies and Coalition Partners, November 10, 2004.

[2]Chairman of the Joint Chiefs of Staff Instruction 2700.01A, International Military Agreements for Rationalization, Standardization, and Interoperability (RSI) Between the United States, Its Allies, and Other Friendly Nations, December 17, 2001.

[3]DoD Manual 4120.24M, Defense Standardization Program (DSP) Policies and Procedures, March 2000.

[4]NATO Standardization Document Database (NSDD); data current as of February 1, 2005.

[5]NSDD.

[6]NSDD.

[7]NSDD.

About the Authors

Chris Ptachik is a retired Air Force colonel and a project manager for MTC Technologies, Inc., in Dayton, OH. He has provided subject matter expertise on international standardization agreements in systems engineering and acquisition to SAF/AQRE and the Directorate of Engineering and Technical Management, Headquarters, Air Force Materiel Command, since 1995. He currently leads a contractor team supporting the Air Force Departmental Standardization Office.

Lt Col Addison Tower is chief of the Air Force International Standardization Office and the U.S. Management Committee member for the Air and Space Interoperability Council. He is a bomber test pilot with 2,600 flying hours in 32 types of aircraft.

Lt Col John Klatt is the U.S. representative to the NATO Military Committee Air Standardization Board at NATO Headquarters in Brussels, Belgium.

Dennis Lynn is a NATO armaments officer assigned to the U.S. Mission at NATO Headquarters in Brussels, Belgium. During his 21-year career, he has supported each of the three services in their respective areas of international cooperation. He currently supports the U.S. delegations to the NATO Air Force Armaments Group and its recently reformed subordinate capability groups.

October 6, 2005, Washington, DC

2005 World Standards Day

The U.S. celebration of World Standards Day will take place on October 6, 2005, at the Ronald Reagan Building and International Trade Center in Washington, DC. This year's theme is "Improving Safety and Security through Standards." For more information about the 2005 World Standards Day celebration, exhibition, reception, and dinner, please go to http://www.ansi.org/meetings_events/wsw05/wsd05.aspx?menuid=8.

October 24–27, 2005, Birmingham, AL

DoD Maintenance Symposium and Exhibition

The DoD Maintenance Symposium and Exhibition will be held on October 24–27, 2005, at the Sheraton Birmingham Hotel and Birmingham-Jefferson Convention Complex. This year's theme is "Sustaining Weapon System Readiness Through Reliability, Cycle Time, and Continuous Process Improvements." This symposium brings together government and industry representatives to exchange ideas for improving maintenance practices and procedures via a technical program, presentations from senior-level speakers, and a dynamic exhibit. For more information, contact Nancy Eiben by telephone (724-722-8525) or e-mail (naneiben@sae.org).

Farewells

James Engle, U.S. Air Force, has been reassigned as the Deputy Director, Plans and Programs, Headquarters, Air Force Materiel Command, Wright-Patterson Air Force Base, OH. Previously, Mr. Engle served as the Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering in Washington, DC. In that position, Mr. Engle also served as the Air Force Standardization Executive. We wish him well in his new role.

Bill Heckman has retired from the Defense Supply Center Columbus (DSCC) after 32 years of federal service. As a manager/engineer, he provided his engineering expertise and leadership in the Lead Standardization Activity, the Specifications and Standards Program, and the Parts Management Program. Mr. Heckman received the 2002 Community Service Honor Award from the Federal Executive Association of Columbus and Central Ohio, an organization in which DSCC and other central Ohio federal agencies participate. We all wish him well in retirement.

Roselynne Ulm, of the U.S. Army's Institute of Heraldry, bids farewell after 12 years as a research analyst, quality assurance specialist, and specification writer. Her knowledge, dedication, and work ethic will be greatly missed. We wish her well in her new position as a design patent examiner at the U.S. Patent and Trademark Office.

Arrivals

Terry Jaggers has been reassigned as the Deputy Assistant Secretary for Science, Technology and Engineering, Office of the Assistant Secretary for Acquisition, U.S. Air Force. Mr. Jaggers will be responsible for the Air Force science and technology program and for engineering policy and guidance for Air Force system acquisitions. In this assignment, he will also serve as the Standardization Executive for the Air Force. We welcome Mr. Jaggers and wish him well in his new role.

Please welcome three new engineers to the Document Standardization Unit, which performs the specification preparing activity function at DSCC.

Ami Chase is assigned to the Interconnection Team. She will be responsible for standardization documents for electrical connectors and hardware items.

Cheri Rida is assigned to the Microelectronics Team. She will be responsible for standardization documents for microcircuits.

Yeasvina Afroz is assigned to the Electronics Components Team. She will be responsible for standardization documents for passive and electromechanical components.

Ken Thompson, of the U.S. Army Developmental Test Command, has recently been promoted to a new position as the standardization officer for national and international standards for environmental testing. Mr. Thompson brings more than 5 years of test method standardization and 16 years of laboratory vibration and climatic test experience to his new position. One of his major responsibilities will be to assume the role as the Army custodian of MIL-STD-810. He also will be responsible for participating in NATO standardization efforts and is a current member of the task group responsible for updating STANAG 4370 and all associated test methods.

Andrew Scott, the value engineering manager of the Subsistence Directorate at Defense Supply Center Philadelphia (DSCP) for the past 10 years, has been reassigned from the Quality Audit Branch, Operational Rations, to the Standardization and Technical Branch, Supplier Support Division at DSCP.

Margaret Bleau is a recent addition to the standardization community. She has joined the Defense Energy Support Center (DESC) from private industry and will perform the lead standardization activity function for several federal stock classes under 91GP, Fuels, Lubricants, Oils, and Waxes.

Yan Guo will be performing the preparing activity function for several federal stock classes under 91GP, Fuels, Lubricants, Oils, and Waxes. Her PA responsibilities will be in addition to her current responsibility as the program manager for fuel additives and research and development at DESC.

Passings

William Wallace passed away in March. Before he retired, he served as an engineer in the Navy for a number of years. He was very active in the reliability area and was instrumental in the development of MIL-STD-471 (now MIL-HDBK-471) for the DoD. He was a dear friend and colleague in the defense standardization community.

Upcoming Issues— Call for Contributors

We are always seeking articles that relate to our themes or other standardization topics. We invite anyone involved in standardization—government employees, military personnel, industry leaders, members of academia, and others—to submit proposed articles for use in the *DSP Journal*. Please let us know if you would like to contribute.

Following are our themes for upcoming issues:

Theme
International Standardization
DLA Standardization
Civil Agency Standardization
Joint Standardization Boards

If you have ideas for articles or want more information, contact Tim Koczanski, Editor, *DSP Journal*, J-307, Defense Standardization Program Office, 8725 John J. Kingman Road, Stop 6233, Fort Belvoir, VA 22060-6221 or e-mail DSP-Editor@dla.mil.

Our office reserves the right to modify or reject any submission as deemed appropriate. We will be glad to send out our editorial guidelines and work with any author to get his or her material shaped into an article.

DEFENSE STANDARDIZATION PROGRAM

MAKING SYSTEMS WORK TOGETHER