MITCHELL INSTITUTE FOR AIRPOWER STUDIES

WWW.AFA.ORG/MITCHELL

LAYERING ISR FORCES

By Michael W. Isherwood

Mitchell Paper 8

Brig. Gen. Billy Mitchell

On September 12, 1918 at St. Mihiel in France, Col. William Mitchell became the first person ever to command a major force of allied aircraft in a combined-arms operation. This battle was the debut of the US Army fighting under a single American commander on European soil. Under Mitchell's control, more than 1,100 allied aircraft worked in unison with ground forces in a broad offensive—one encompassing not only the advance of ground troops but also direct air attacks on enemy strategic targets, aircraft, communications, logistics, and forces beyond the front lines.

Mitchell was promoted to Brigadier General by order of Gen. John J. Pershing, commander of the American Expeditionary Force, in recognition of his command accomplishments during the St. Mihiel offensive and the subsequent Meuse-Argonne offensive.

After World War I, General Mitchell served in Washington and then became Commander, First Provisional Air Brigade, in 1921. That summer, he led joint Army and Navy demonstration attacks as bombs delivered from aircraft sank several captured German vessels, including the SS *Ostfriesland*.

His determination to speak the truth about airpower and its importance to America led to a court-martial trial in 1925. Mitchell was convicted and resigned from the service in February 1926.

Mitchell, through personal example and through his writing, inspired and encouraged a cadre of younger airmen. These included future General of the Air Force Henry H. Arnold, who led the two million-man Army Air Forces in World War II; Gen. Ira C. Eaker, who commanded the first bomber forces in Europe in 1942; and Gen. Carl A. Spaatz, who became the first Chief of Staff of the United States Air Force upon its charter of independence in 1947.

Mitchell died in 1936. One of the pallbearers at his funeral in Wisconsin was George Catlett Marshall, who was the chief ground-force planner for the St. Mihiel offensive.

ABOUT THE MITCHELL INSTITUTE: The General Billy Mitchell Institute for Airpower Studies, founded by the Air Force Association, seeks to honor the leadership of Brig. Gen. William Mitchell through timely and high-quality research and writing on airpower and its role in the security of this nation.

ABOUT THE AUTHOR: Michael W. Isherwood, a retired USAF colonel and fighter pilot, currently is Senior Analyst at the Northrop Grumman Analysis Center in Washington, D.C., where he provides in-depth analysis of military, technological, and political developments affecting national security. He concentrates on military air and space operational developments and their corresponding impact on the joint/combined warfighting team and Northrop's business sectors.

Published by Mitchell Institute Press

Design by Darcy Lewis

For inquiries: mitchellinstitute@afa.org

LAYERING ISR FORCES

Michael W. Isherwood

December 2011

Mitchell Paper 8

PREFACE

The official end to America's mission in Iraq in December 2011 left behind a new term in the art of airpower: ISR. The acronym for intelligence, surveillance, and reconnaissance had been in use before, often combined with command and control in various permutations. Operations in Iraq and Afghanistan transformed ISR from obscure jargon to headline material familiar to all who followed the progress of those wars.

The Pentagon's budget followed suit. ISR now stands out as a burgeoning mission area for aircraft modernization. "This emphasis may surprise or even alarm some who see the Air Force's mission being to 'fly and fight,'" warns Michael W. Isherwood in *Layering ISR Forces.*

Surveillance and reconnaissance are nothing new, of course. World War I observation biplanes carried their glass-plate cameras for taking pictures of enemy trenches and artillery. Commanders counting down to the invasion of Normandy in 1944 sent P-38s to buzz beach defenses and bring back close up photos of German defenses.

However, the level of surveillance and reconnaissance provided for Iraq and Afghanistan acquired a whole new level of operational significance.

Over the years, US military forces came to rely on a diverse, daily feed of airborne intelligences. Predator surveillance aircraft patrolled assigned patches of territory and piped back full motion video. Fighters contributed non-traditional ISR by slewing targeting sensors to monitor ground forces. Expanding stability operations added new layers such as high-altitude Global Hawks with a combination of sensors at 65,000 feet. E-8 JSTARS supplied radar pictures and ground moving target indicators.

ISR enabled the complex operations in Iraq and Afghanistan and other locations to be conducted across a wide swathe of territory with proportionately fewer ground forces. Here was a role for surveillance and reconnaissance on a scale not previously seen in warfare.

All that history is just the starting point, writes Isherwood in a new Mitchell Paper that provides a look ahead at how to improve ISR for future operations. Isherwood points out that intricate ISR is set to increase in value. “Today, force planners confront a wide range of scenarios, from sporadic attacks by guerrilla groups to hybrid conflict from a non-state or nation-state force all the way up to conventional, biological, or nuclear conflict with a modern military force,” Isherwood writes.

He is well acquainted with the fire and steel of airpower. As an A-10 pilot, Isherwood flew more than 25 combat missions in Operation Desert Storm in 1991. Later in his career he held command positions with USAF forces at Bagram Airfield in Afghanistan. He brings the experiences of the tactician and the commander to the challenge of connecting airborne ISR to operations on the ground.

The tactical overwatch that was so highly valued by a road convoy in Iraq or a foot patrol in Afghanistan is just one element of future ISR demands. Nor is it just the foot patrol relying on them today. Command centers, national intelligence analysts back in the United States—all sorts of users place different demands on ISR.

In this paper, Isherwood links the scenarios to operational concepts. The result is a clear message. US forces have to be extremely proficient at all aspects of ISR. As Isherwood details, success in future operations hinges on timely, astute combinations of ISR resources. Layering airborne ISR forces is especially intricate because of their different operational qualities and sensors.

Those in command of airpower at all levels have to rely more and more on ISR. In his memoirs of World War I, Billy Mitchell wrote of trips to Allied headquarters under Marshal Foch to look over the situation. French airmen there kept a briefing room of constantly updated aerial photoreconnaissance of the front lines. Mitchell liked to call it “Armengaud’s cinema” after the name of one of the French liaison officers. He often made special trips for pre-mission planning.

The same holds true today. Commanders parcel out their resources and make risk decisions based on information at hand.

One of Isherwood’s main points is that airmen can improve ISR by more effective layering of assets. Isherwood discusses the “critical six” disciplines which build full situation awareness. Starting with signals intelligence and continuing through the realm of cyberspace, airmen must demonstrate mastery in each and then blend it together to fit the needs of the joint force.

Of course, flying the missions does not produce full intelligence by itself. Processing and dissemination deliver the final product. Isherwood cites areas for improvement such as fielding semi-automated imagery processing technology. With careful planning, “the imagery analyst of the future could have access to all source intelligence data,” Isherwood says. Better solutions will allow imagery analysts to access all fully relevant information on a particular location.

Effective ISR also demands investment, according to Isherwood. “The layering of ISR assets is only possible when there is a sufficient quantity to employ the force,” he writes.

Judged by sheer buying power, ISR is a top Pentagon priority. Isherwood makes the case for deeper analysis of the heavy investment in ISR. Much of the fleet was acquired in great haste. Almost none of the acquisition was based on integrated analysis of techniques for layering ISR. Operations and budget constraints make it time to change all that and seek a much more thoughtful national investment roadmap for layering ISR.

Making the best use of ISR forces has been one of the most demanding tasks for airmen in Iraq and Afghanistan. But it will become even more imperative in the future and must be accomplished with greater finesse. After all, the goal is not just sortie generation or data collection. “The goal is intelligence—the “I” in ISR,” points out Isherwood.

Rebecca Grant, Director
Mitchell Institute for Airpower Studies
December 2011

LAYERING ISR FORCES

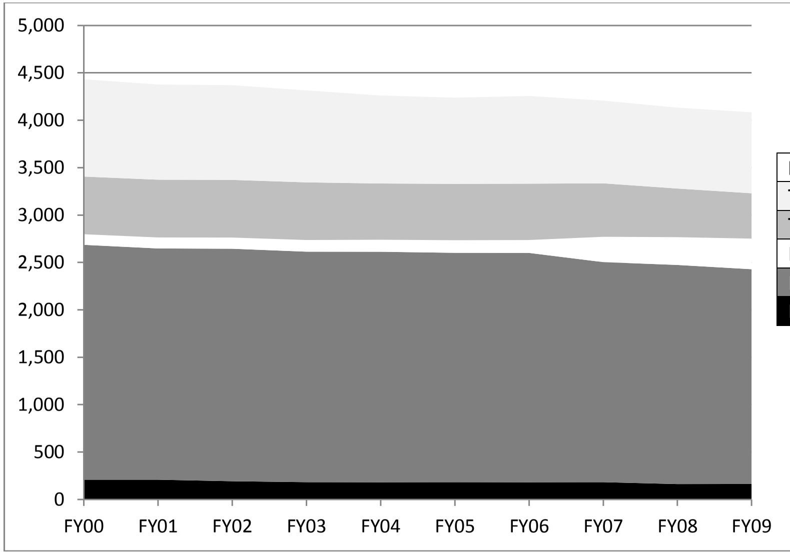
Intelligence, surveillance, and reconnaissance (ISR) may be growing into the pre-eminent mission of the United States Air Force.

In its 2010 ISR strategy, the Air Force reinforced this view. It recognized that the nation's adversaries are reacting to the US military's ability to hit anything almost anywhere. "Consequently," warned the study, "finding the enemy has moved to the forefront of USAF operations."[1]

In the past decade, the Air Force has increased investment in ISR aircraft many-fold, even as it has allowed its inventories of fighter, bomber, tanker, and transport aircraft to shrink. USAF's general force structure declined 11 percent, but ISR assets increased by nearly 300 percent.[2] Figure 1 (p. 8) depicts the trends in USAF force structure over the past decade.

This shift in investment was no accident. Air Force intelligence leaders, in their ISR report, said that "knowledge—having always been key—is assuming precedence over kinetics as the prerequisite 'weapon of war.'"[3] Echoing this view are the senior commanders of Air Combat Command, US Air Forces in Europe, and Pacific Air Forces. In their 2010 "Combat Air Forces Master Plan," they declared: "Traditionally, the CAF was seen as solely aircraft engaging in combat to destroy the enemy. But today, the definition of the CAF is more than just fighters and bombers operating in the air."[4] The CAF leaders promised to "enhance joint battle space awareness and electronic warfare by improving Intelligence, Surveillance, and Reconnaissance (ISR) operations against irregular adversaries, and in contested and denied environments."

Much of the new ISR investment focuses on remotely piloted aircraft (RPA) such as the MQ-1 Predator, MQ-9 Reaper, and RQ-4 Global Hawk unmanned air vehicles. While many defense industry experts expect the fighter, bomber,



MDS	FY00	FY09	Change
Transport	1,026	854	- 17%
Tanker	608	478	-22%
ISR	112	323	+288%
Fighter	2,477	2,265	-9%
Bomber	208	163	-22%

Figure 1. Trends in USAF Force Structure Over the Past Decade

and mobility markets to remain relatively flat (or worse), they believe the RPA market will expand. Plans call for US spending on RPAs to double to $5 billion in 2016, with most of this funding used to enhance the vehicle's ISR capabilities.[5]

This emphasis may surprise or even alarm some who see the Air Force's mission being to "fly and fight." Yet the rationale becomes clear enough once one understands the anticipated operating environments and the challenge of collecting a full array needed to create that mosaic of situational awareness.

The United States Air Force—at war today and facing the need to ready itself for war tomorrow—must prepare for difficult operations across the entire spectrum of conflict. The current fights in Southwest Asia generate heavy demands on the service's counterinsurgency and counterterror capabilities. Yet USAF is a "full-service" force, and it must also be able to scale up rapidly for decisive operations against a nation-state with near parity in weapon systems and force structure.

This factor poses a particularly daunting challenge to USAF's ISR force. The Air Force's ISR units must generate information needed by commanders at strategic and theaters levels while also providing data to support precise force employment at tactical levels. In supporting current operations in Afghanistan and the greater Middle East, these ISR forces must provide accurate situational awareness; a hostile entity can rapidly emerge or shift from non-combatant to threatening status. Airborne ISR forces are ideally suited to collect data to inform terrestrial assets and to perform operations to build situational awareness. The same is true of conflict with a modern nation-state. Airborne ISR forces must rapidly find, fix, and track weapon systems and forces that may be concealed, mobile, agile, hardened, dispersed, or defended by air defense networks of unprecedented lethality and agility.

THE MUST-HAVE "MOSAIC"

Clearly, the US Air Force in the future will be challenged to complete the "find" element of the targeting cycle. This enormous and growing task now forces USAF planners to think anew about how to wring the most capability out of forces in hand and those likely to come on line in years ahead. It is for this reason that new attention now focuses on the emerging process of "layering" ISR forces to multiply their usefulness across the spectrum.

Simply put, the layering of airborne ISR sensors and interpretive capabilities can maximize the amount of information made available, generate the most accurate portrait of actions and intentions, and enhance the operational power of both the Air Force and Joint Force. No single intelligence discipline or sensor—imagery, signal intercept, moving target indicator, complex data (such as measurement and signature data), cyber, or human intelligence—is likely to provide all or most of the information needed by commanders and warfighters so they can accomplish their mission effectively or efficiently.

However, emerging techniques and technologies can blend together these distinct intelligence disciplines to produce a kind of "mosaic of information"—one that gives clarity and coherence to the operational environment. Given the anticipated complexity of future operational environments, the Air Force has little option but to invest in such emerging ISR capabilities. These are not luxuries or "nice to have" items.

Secretary of the Air Force Michael B. Donley, mindful of the need to strike the right balance, announced in early 2011 that he had directed a review of ISR airframes and force structure in order to better define Air Force needs.[6] In this, it is critical that force planners understand the importance of ISR layering. It will lead to the best possible mix of sensors, airframes, and exploitation technologies.

NEW OPERATIONAL ENVIRONMENT

Today, force planners confront a wide range of scenarios, from sporadic attacks by guerrilla groups to hybrid conflict from a non-state or nation-state force all the way up to conventional, biological, or nuclear conflict with a modern military force.

Low-Intensity War. Recent operations in Afghanistan highlight some aspects of the challenges faced by US forces at the low end of the conflict spectrum. Assassinations, beheadings, and intimidation actions are common. At the same time, belligerents can and do execute attacks on coalition outposts and forces. These attacks can feature units of 100 or more hostiles. US and NATO forces not only use small patrols but also employ air, infantry, and armor forces in ways resembling conventional warfare.[7] The most prevalent and lethal attacks in Afghanistan feature use of improvised explosive devices (IEDs). As shown in Figure 2 (p. 11), these attacks over the past three years have accounted for more than 50 percent of US casualties.[8]

Hybrid War. Non-state forces can pose dangers far in excess of those seen in Afghanistan, a fact confirmed in the 2006 war between Israel and Hezbollah. That war proved to be a hybrid of low- and mid-level capabilties. Essentially a guerrilla force, Hezbollah unleashed a barrage of rockets, mainly 122 mm

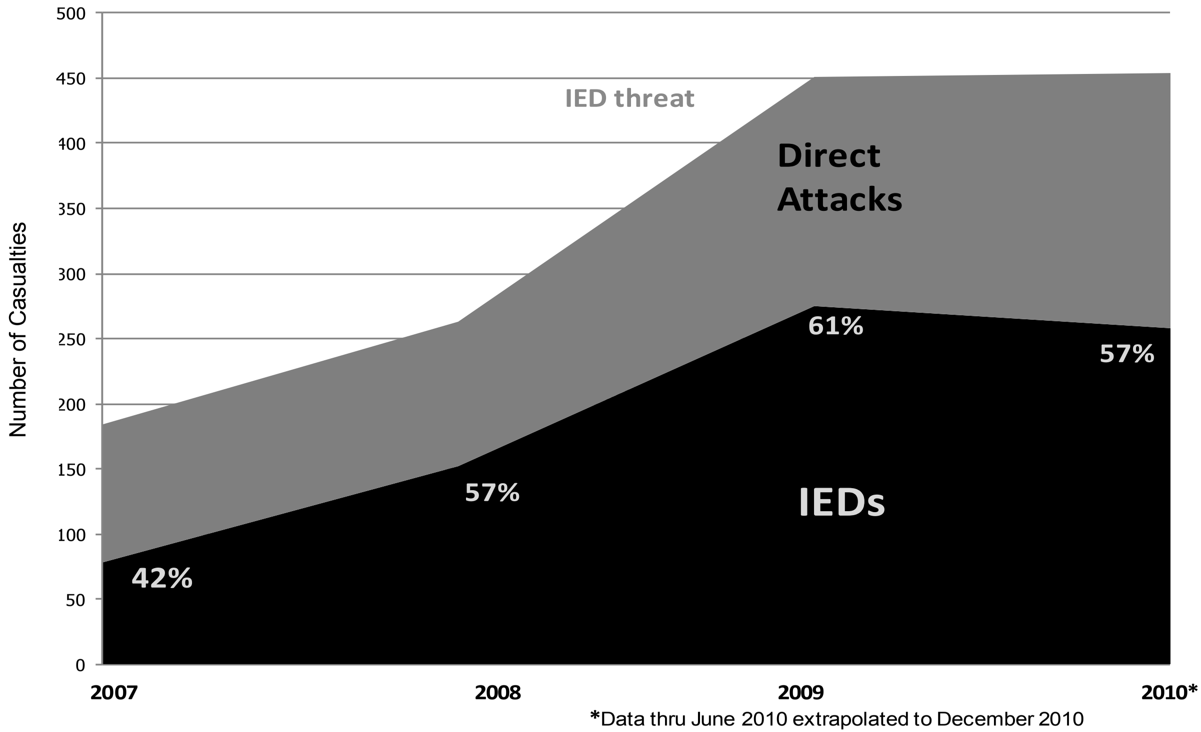


Figure 2. IED and Direct Attacks in Afghanistan: 2007–2010

Katyushas, with about 900 landing in urban areas and killing 53 civilians.[9] The Israeli Air Force was largely frustrated by the rocket force's mobility and deception tactics.[10] Moreover, Hezbollah employed sophisticated weapons such as the C-802 anti-ship cruise missile (requiring a tranporter-erector-launcher, radar, and a fire control launch vehicle) as well as remotely piloted aircraft with which Hezbollah conducted signals intelligence missions.[11]

High-Intensity War. Nation-states have increased the lethality and survivability of their military forces to challenge US access to air, water, and land environs. Modern threats include advanced surface-to-air missile systems such as the SA-10, SA-12, and soon the S-20, which can reach out to as much as 250 miles. The Russian T-50 fighter aircraft, with its stealth features, is far along in development and is destined for export. China's CSS-5 (DF-21) medium-range ballistic missile can reach out 1,000 miles or more and use maneuverable warheads.[12] Chinese submarines could challenge US warships in a way not seen since World War II.[13]

THE "FIVE WS"

In each case, adversaries will seek to deny US forces the power to find, fix, and track their forces. All use movement and relocation of assets to frustrate USAF targeting efforts.[14] Retired USAF Gen. Michael V. Hayden, who served as director of both the National Security Agency and the Central Intelligence Agency, once noted, "We're now in an age in which our primary adversary is easy to kill, he's just very hard to find."[15] Hayden's comment equally applies to low-intensity, hybrid, and high-intensity wars.

Another potential problem: cyber attacks. Some 140 foreign entities target the United States and its information networks.[16] USAF airborne resources such as the EC-130, EA-6, and EA-18G are critical to victory in this emerging theater.

US commanders assess their mission against the unknowns of their operating environments, and they often conceptualize their need for situational awareness by asking five questions about potential adversaries:

Who are they?
What will they do?
Where will they act?
When will the action occur?
Why are they acting?

US officials know that, to answer these "five Ws," the nation much collect an assortment of individual data points that build up the mosaic of information. The more individual pieces, the fuller and more accurate the picture becomes. A layering of ISR resources in an integrated, multi-disciplined manner provides the greatest opportunity to maximize the commander's and the joint team's situational awareness.

The goal is intelligence—the "I" in ISR. Building the requisite situational awareness begins with wide area surveillance—the "S" in ISR. WAS, as it is called, entails the scanning of a broad area for extended periods so as to detect an activity, location, or even a person. Surveillance seeks, by its nature, to distinguish such entities from their background. An air surveillance radar monitors a three dimensional volume of airspace and searches for aircraft moving through that airspace. After a target is detected, US reconnaissance—the "R" in ISR—strives to fix and track the particular asset or unit. The point is to allow precise employment of force.

THE CRITICAL SIX

Altogether, there are six main intelligence disciplines associated with building the situational awareness required for successive operations. They are the "layers."

Signals Intelligence (SIGINT). SIGINT, perhaps the most widely used ISR activity for WAS and reconnaissance purposes, is the collection of electronic intercepts or emissions. These comprise early warning, weather, target tracking radar signals or missile guidance signals. Analyzing the electronic signature for its radio frequency (RF), pulse length, and other characteristics can inform warfighters of the threat's operating parameters. At the same time, accurately characterizing the signal is important to knowing who is targeting a US unit, location, or aircraft.

SIGINT also includes intercepts of communications traffic such as radio or encrypted messages. Often, these intercepts are relatively short in duration, especially when person-to-person communication is involved. Communications intercepts may also be used to detect command and control activities such as direction of a remotely controlled device or aircraft.

Today, USAF's SIGINT force starts with the RC-135 Rivet Joint aircraft, which can precisely locate, record, and analyze much of what is being done in the electromagnetic spectrum. Outfitted with an assortment of signal processors, steerable antenna, and data links, the RC-135 can rapidly exploit and disseminate information when a hostile force emits in the electromagnetic spectrum—that is, turns on a radar, transmits a radio call, and such. Also operating SIGINT sensors is an array of other platforms—from the high-flying U-2 Dragon Lady and the MC-12 Project Liberty aircraft to the Reaper and Global Hawk RPAs with their unique versions of the airborne signals intelligence sensor.

After detecting a signal, SIGINT systems can extract the precise data necessary to exploit it. The signal's geographic location can be ascertained when the emission is tracked in azimuth. As the airborne platforms flies, the sensor establishes the signal location with greater accuracy. Rivet Joint can cross-cue other SIGINT aircraft, allowing for faster location via use of triangulation. At some point, the SIGINT platform cross-cues other ISR assets to identify the target. Multiple platforms can overcome the problem of covering an emitter hidden in hilly or mountainous terrain. In Afghanistan, for instance, terrain can obstruct a single SIGINT's sensor collection capability, but multiple platforms allow for faster geo-location resolution.

Moving Target Indicator (MTI) data. This represents the second WAS discipline. Today, the primary MTI techniques rely on pulse Doppler shifts of moving objects to detect and then track the target. MTI technology can be applied to air, maritime, and ground domains.

For broad air surveillance, USAF relies on the AN/APY-1/2 radar on its E-3 Airborne Warning and Control System (AWACS) aircraft. It reaches out beyond 200 miles and can monitor 125,000 square miles with every sweep of its beam. It can track the target at extended range, allowing weapons controllers and commanders to decide if, when, and where to engage. In this manner, AWACS functions as both a surveillance and reconnaissance asset. AWACS, however, isn't the only radar to provide air surveillance. Ground-based air surveillance radars, such as the TPS-77, complement AWACS coverage. Fighter aircraft are equipped with radars that can survey a smaller area and track targets within the radar's field of regard. The F-16's APG-68, F-15's APG-63, and the F-22's APG-77 are critical tools to enhance situational awareness of the air domain. The size of the target aircraft and its range from the radar determines how, when, and at what distance it is detected. Layering multiple radars in a "systems of system" approach ensures the optimum coverage.

MTI technology can be used to track moving targets on the surface. The APY-7 airborne ground surveillance radar on the Air Force's E-8 JSTARS aircraft monitors some 19,000 square miles of terrain, detecting and tracking vehicles as a joint USAF-Army program. Airborne ground surveillance radars face a demanding mission. While air-scanning radars monitor a comparatively clutter free domain, ground surveillance radars encounter obstructions; urban areas and hilly terrain often block the radar signal. In addition, the Earth's surface contains a significantly greater number of potential targets.

Just as in the air-to-air arena, the ground target's size and distance from the radar, plus its speed, dictates the range at which an airborne ground surveillance radar can detect and track it. Smaller targets may require focused radar energy to detect and track. Currently, the E-8 is the best at the WAS mission of detecting moving ground targets. During Operation Iraqi Freedom, it detected and tracked a hostile armor formation attempting to advance at night during a sandstorm to engage the US 3rd Infantry Division. Working with the Air Operations Center, the JSTARS aircrew guided fighter and bomber aircraft to the Iraqi armor, stopping the formation before it reached US forces.[17]

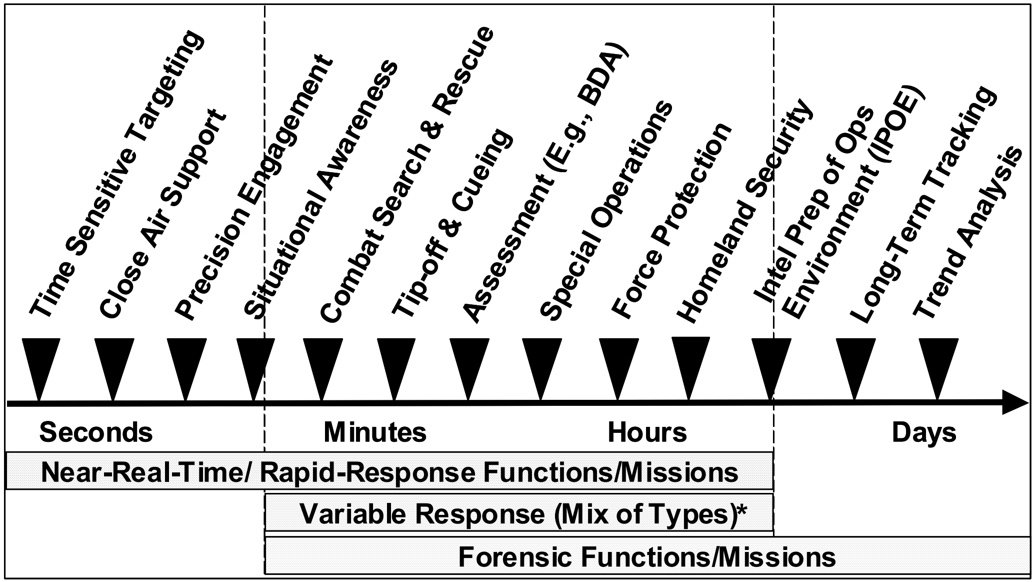
The MQ-1 Predator and MQ-9 Reaper carry the Lynx radar, which has a narrowly focused MTI mode. Reaching out to about 20 miles, it can concentrate its search along key terrain approaching an isolated forward operating base or border area.

The Navy's P-3 Orion's sensor suite has supported Marine Corps and Special Operations Force ground units. The P-3's Littoral Surveillance Radar System (LSRS) is a state-of-the-art active electronically scanned array (AESA) radar that provides a slightly larger search and detect area. According to one Navy official, LSRS can "track vehicles and items smaller than that."[18]

Global Hawk Block 40 will have an AESA, larger and more capable than the LSRS suite. Flying higher than the E-8 and P-3, the Block 40 can monitor more terrain in mountainous regions. With an AESA radar, it can detect and track mounted and dismounted forces while providing critical cueing of other ISR assets or providing direct warning to ground forces.[19] The Block 40 will increase the Air Force's capacity to provide WAS MTI support from two 24/7 orbits. MTI resources can help officials "rewind the tape" and re-construct a hostile action, helping locate enemy sanctuaries and movements. Commanders thus can build long-term situational awareness.[20] Figure 3 (p. 16) depicts the range of time in which MTI provides value to the warfighter.

SIGINT and MTI platforms support the warfighter with a blended WAS and precise reconnaissance technology. They also are invaluable to cross-cue other ISR disciplines. For instance, if a single full-motion video (FMV) asset is assigned a 40-mile-square area, it may find less than five percent of the mobile targets in the area. When coupled with SIGINT or MTI, the FMV platform may find up to 65 percent of the moving targets. If four Predators are in the same area, cross-cueing by WAS assets results in finding nearly 95 percent of all movers.[21]

Imagery Intelligence (IMINT). Predators and Reapers contribute precise reconnaissance, in the form of IMINT or full-motion video. IMINT represents the third ISR discipline. IMINT has been the readily understood type of airborne ISR, with the classic electro-optical (EO) picture of Soviet ballistic



* Operational situation dictates time requirement

Figure 3. Range of Time Value of MTI

missiles in Iraqi tanks on the Kuwait border. There are, however, other forms such as infrared (IR) or radar imagery.

While USAF operates only a few dozen WAS platforms, the service today can call on more than 250 aircraft yielding precise reconnaissance data. These include Reapers, U-2s, and MC-12s. The MQ-1 Predator and MQ-9 Reaper have the power to "stare" at one location to provide FMV. They have been dubbed the "unblinking eye" over a battlespace.[22] Other services deploy Hunter and Scan Eagle, RPAs that provide similar persistent recon for extended periods.

Radar is valued for its ability to "see" through clouds and into darkness to monitor a stationary target. Airborne ground surveillance MTI radars also provide synthetic aperture radar (SAR) imagery. Airborne ground surveillance radars also have attributes that make them valuable in specific scenarios. The radar return from a stationary mobile target can help define or classify the target type: wheeled, tracked, and so forth. In addition, select radars have the ability to provide complex imagery and detect changes in surface conditions, pinpointing disturbed earth that might signify emplacement of a roadside bomb.

Measurement and Signals Intelligence (MASINT). MASINT may be the least understood intelligence area, but it's also the area of greatest growth potential. DOD defines MASINT as "technically derived intelligence that detects, locates, tracks, identifies, and describes the specific signatures of fixed and dynamic target sources." It exploits radar, laser, optical, IR, acoustic, electro-magnetic, and atmospheric mediums to identify and characterize objects and targets. An air intelligence analyst who reviews AWACS radar data to determine speed, height, acceleration, and turn performance of a MiG fighter is conducting MASINT work. Another MASINT system is the Air Force's RC-135 COBRA BALL aircraft, which relies on extremely sensitive, long-range thermal sensors to capture information on nuclear and ballistic-missile testing.[23]

Previously, airborne ISR aircraft provided one type of intelligence. Today, they carry multiple sensors to provide data from as many disciplines as possible. The U-2, for example, has the RAS-1 (Remote Avionics System-1) for wide-area SIGINT, but it also carries the ASAR (Advanced SAR) radar sensor for all-weather radar imaging. The U-2 can also be outfitted with the SYERS 2 (Senior Year Electro-optical Reconnaissance System 2) sensor in place of the radar sensor, allowing it to collect across seven channels of visual and IR light. It performs multi-spectral imaging, a form of MASINT that is valued for its ability to detect changes in the environment, camouflaged equipment, water depth, and targets obscured by smoke or haze. The MC-12 has a tactical SIGINT sensor and an EO and IR sensor for clear weather, day-and-night

IMINT support. The MQ-9 has the MTS-B (Multi-spectral Targeting System-B) sensor package, which integrates an IR sensor, a color-monochrome daylight TV camera, and an image-intensified TV camera.

Cyber Intelligence (CYBINT). A fifth—and new—intelligence discipline is CYBINT. Airborne assets play a role in the conduct of CYBINT and larger cyber operations as a whole. USAF has a legacy of providing electronic countermeasures (ECM) and jamming, employing individual self-protection pods on aircraft. The EF-111 Raven electronic warfare and EC-130 Compass Call communications jamming platform are the past investments in what may now be viewed as CYBINT. Early ECM sought to identify and then fool hostile early-warning, target-tracking, and missile-guidance radars or supporting communications networks. To be effective, ECM had to perform many of the ISR disciplines—the system had to detect the RF signal and recognize its narrow frequency before the threat could be targeted. As electronic capabilities matured, warfighters could also monitor what was being transmitted or alter it, employing, for instance, a deception jamming technique emitted from an ECM pod.

Cyber operations require the same capabilities as kinetic air operations; CYBINT supports that action. In cyber operations, the warfighter must find, fix, track, target, engage, and assess in the cycle used to engage an armor force moving against a US position. CYBINT is needed to create and exploit vulnerabilities of all adversaries employing computers, networks, and associated telecommunications architectures, while minimizing US risk.

The proliferation of AESA radars—on traditional systems such as fighters and bombers—suggest there is a role for the air component to employ airborne assets for CYBINT and in support of cyber operations. Advanced radars on the F-15 and F-22 as well as the Global Hawk Block 40, can collect and exploit data over an extended range.[24] Some authorities suspect that in 2007, the Israeli Air Force used a combination of electronic attack and CYBINT to foil Syrian air defenses, allowing for non-stealthy fighter aircraft to attack Syria's nuclear site.[25] Thus, given the advanced technologies fielded and soon to be fielded within the air component's ISR fleet, CYBINT as an ISR discipline represents the newest area for consideration.

Human Intelligence (HUMINT). This is the oldest form of intelligence—human observation. This is not to suggest that aircrews will conduct HUMINT. It is important to include HUMINT because doing so will help the US avoid the tendency to separate HUMINT from USAF's technical capabilities.

Today, HUMINT has evolved. It is no longer the product of a Cold-War-type spy who collected specific data or a defector whose life story provided insight into a closed society. Now, HUMINT routinely includes data from debriefing combatants, reports on interactions with local leaders, businesses, and ordinary citizens. Operations in Iraq, Afghanistan, and other places have renewed the Joint Force's appreciation of HUMINT. The recently revised Army doctrine on counterinsurgency, FM 3-24, emphasizes that successful counterinsurgency operations require knowledge of the society and culture in which US forces are deployed. This includes knowing key groups and power brokers within that society—at the national and local level—and comprehending the dynamics between these bodies, their value system and motivations, how they communicate, and who their leaders are.[26]

The US Army has deployed "Human Terrain Teams" (HTT) designed to decipher and articulate to commanders the socio-cultural aspects of the battlespace. HTTs include a leader, one or two social scientists, analysts, and research assistants. Integrated into a brigade or battalion's operating area, the teams travel with patrols or interact independently with the population to build and adjust a vibrant picture of the peoples within that area over time.[27] HTT reports, debriefs of combatants, interactions with the local political, village, business leaders, and ordinary people contribute to the HUMINT discipline.

These six intelligence processes are the tools used by commanders to understand an operational environment and identify those forces, factors, or people who seek to prevent US forces from accomplishing their mission. Figure 4 (p. 20) shows a summary of the ISR disciplines and their potential abilities to detect and track threats, and which of the "five Ws" each ISR discipline may answer.

INTEL OPS IN MOTION: AN ILLUSTRATIVE CASE

Given USAF's admittedly large collection of expensive ISR assets, why would service leaders want to increase its inventory, especially at a time of great austerity? The answer comes from understanding the necessity to layer ISR resources to meet the challenge of the operational environment and from grasping how information gained from airborne ISR assets can be woven together to forge a more complete picture of the operating environment.

Each ISR discipline has strengths and limitations. The layering power is gained by employing different ISR disciplines in the same battlespace. This allows complementary disciplines to reduce gaps, provide additional information, and increase the likelihood of maximizing the value of information. Multiple SIGINT sensors can reduce the time required to pinpoint an RF emitter, for example. Commanders make decisions based on 100 percent of the available information. However, what they have in hand may

	Who		What		Where		When		Why		Assets
	WAS	**Recon**	**WAS**	**Recon**	**WAS**	**Recon**	**WAS**	**Recon**	**WAS**	**Recon**	
SIGINT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	RC-135, U-2, MC-12, Global Hawk
MTI			Yes	Yes	Yes	Yes	Yes	Yes			E-8, GH, MQ-1/9
IMINT				Yes		Yes		Yes			U-2, GH, MC-12, MQ-1/9
MASINT				Yes		Yes		Yes			Multiple
CYBINT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Multiple
HUMINT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Multiple

Figure 4. Building a Mosaic of Knowledge

amount to only 50 percent of the needed information. It appears that layered intelligence operations can reduce the gap between available and total information.

To see how, one need only ponder an illustrative scenario in which discrete ISR disciplines are portrayed with corresponding illustrative data points. This scenario portrays a brigade commander operating in the Khost province in Afghanistan, and the types of information he and his team may garner from various intelligence sources.[28]

Given the ground component's recent emphasis on HUMINT, this exercise begins by reviewing potential inputs US staffs might get from human sources within their area of operations.

Today's Army commanders often speak of the value of Human Terrain Teams and patrols that mix among the population. A number of veteran Army intelligence officers see HUMINT as vital to their campaigns. Based on the nature of their recent experience, these combat-seasoned officers stated that "useful intelligence is most often obtained through personal contact with the population. *This puts a disproportionate level of importance on HUMINT."* [Emphasis added][29]

Understanding the social, cultural, economic, historical, military, and political elements of a conflict is important to the success of any operation. However, HUMINT, like all intelligence disciplines, has limits. *First,* patrols, HTTs, and other such entities—however intent on mingling with the population—cannot be all places at all times. In Khost, the illustrative brigade commander has roughly 3,000 troops among a population of 148,000 people for a ratio of roughly one soldier per 48 people. In terms of terrain or population, the ground commander has insufficient forces to monitor and keep pace with all activities. What's more, some areas are simply off limits to US troops.

Second, people lie. The intricacies of the relationships between and within tribes, clans, sects, and factions mean some individuals are willing to exploit military counterinsurgency operations to eliminate a competitor. On more than one occasion, individuals have conspired to falsely suggest that a rival was secretly aligned with al Qaeda. In Figure 5 (p. 22), the information obtained from items #4, #5, #7, and #8 may be inaccurate or "fudged" for the perceived benefit of the source.

Third, relationships change. In Afghanistan, village leaders, seeking control of roads, trade routes, opium, and other resources, will align themselves with specific warlords or regional leaders to maximize their control and wealth. As time passes, local leaders may shift alliances to best preserve their control.

HUMINT

Date	Time	Data	Geo-Location	Source	Item
1/6/2010	14:55 PM	Village shop owner shares Haqqani planning to embarrass US	33 18N/70 14E	Patrol	1
1/8/2010	12:05 PM	Villagers report local warlord now supports Haqqani with 25 fighters	33 23N/70 08E	HTT	2
1/8/2010	3:23 PM	Village leader reports night letters warning village to avoid coalition	33 19N/70 05E	Patrol	3
1/9/2010	9:00 AM	Detainee reports joining fighters to support family	33 21N/69 57E	Debrief	4
1/9/2010	2:45 PM	AA reports SS upset with coalition and will support Haqqani	33 27N/69 59E	Patrol	5
1/9/2010	9:45 PM	TF Gold raids suspect compound, detains 4 men, IED material	33 18 N/70 05E	TF Gold	6
1/9/2010	11:00 PM	Villager reports food shortages due to recent heavy snows	33 23N/70 07E	HTT	7
1/9/2010	11:45 PM	Detainee reports warlord will strike, retaliation of antidrug ops	33 18N/70 05E	TF Gold	8
1/10/2010	8:15 AM	Local jirga warns FOB Chapman commander tensions are higher	33 21N/69 57E	Patrol	9
1/10/2010	1:00 PM	Villager reports seeing 5 foreign fighters last night	33 18N/70 12E	Patrol	10
1/10/2010	3:45 PM	Local mosque has more traffic than normal	33 24N/70 08E	Patrol	11

Figure 5. Illustrative Human Intelligence Data

In such circumstances, it's more a "business" decision than an ideological one to support one side in a fight. Item #2 listed above mirrors a common reality that alliances reflect desired financial or political gains as much as ideological or religious motivations.

Nonetheless, a warfighter must take into account these limitations and take steps to maximize the value and accuracy of HUMINT data. Item #1—that the Afghan warlord Mawlawi Jalaluddin Haqqani seeks to embarrass the US with an attack—would cause a commander to want more information so he can ascertain as much of the "five Ws" as possible for information relative to this particular threat. Items #2, #4, #5, #6, #8, #9, #10, and #11 may or may not be completely connected with the general Haqqani threat. As such, the HUMINT information does help define "who" is acting (local warlord Haqqani) and "why," but there is no complete data on "what" will occur, "where" it will occur, or "when."

To expand the commander's available information, the air component's WAS technologies come into play. To continue the illustrative scenario, Figure 6 (p. 24) reflects select SIGINT data that might be collected and help clarify the Haqqani threat stream.

Airborne SIGINT collection has the power to range over significant distances and cover huge swaths of terrain. A U-2's RAS-1 sensor at 70,000 feet can monitor 330,000 square miles of Earth, collecting voice, radio, radar, and other emissions. When intercepting enemy command and control (C2) communications, US forces could uncover orders to units or personnel, upcoming activities, the status of those forces (shortfalls, readiness, limiting factors, locations, movement, etc.), and similar data points. Intercepts can also highlight not only activities occurring at that moment but also provide insight into future actions, such as plans to mount an attack at 2 a.m. An intercepted communication could answer each and every one of the five Ws on the Haqqani threat, but that rarely happens.

When one reviews SIGINT data presented in Figure 6, it appears that Haqqani's network is operational in the Khost area, but exactly where, with how many forces, and with what actual intention remains unknown. It is apparent that insurgent and other entities are monitoring US and coalition forces. Some of the communications traffic could be routine—such as requests for status reports. The statements on "night letters" from the Taliban may also be normal in this region. The intercept on the 9th at 4:57 p.m. indicating an absence of Taliban fighters may or may not be factual. Local commanders may wonder why the Taliban have departed, to where, and why—given the apparent heightened activities. Alternatively, commanders may think it is an attempt to divert coalition forces from operating in this area.

SIGINT

Date	Time	Data	Geo-Location	Source	Item
1/8/2010	5:18 PM	Haqqani lieutenant tells XX in Village X to start getting ready	33 16 20N/70 13 39E	MC-12	1
1/8/2010	7:57 AM	Village Y farmer complains of foreign fighters taking livestock	33 18 02N/69 53 18E	MC-12	2
1/9/2010	1:50 AM	UNK requests status report	33 19 50N /69 55 41E	U-2	3
1/9/2010	4:14 PM	UNK reports watching coalition forces from ridge	33 21 44N/70 06 24E	MC-12	4
1/9/2010	10:27 PM	PP tells DD to make the meeting tonight	33 22 17N/70 05 18E	MC-12	5
1/9/2010	10:26 PM	UNK tell ZZZ to be ready next 3 days	33 23 17N/69 50 45E	U-2	6
1/9/2010	4:57 PM	Villager B calls to say he's glad Taliban have not been around	33 04 47N/70 20 09E	MC-12	7
1/9/2010	8:36 AM	Haqqani operative tells GG to report on weapon status by tonight	33 18 41N/70 04 06E	U-2	8
1/9/2010	11:45 AM	UNK warns GG about coalition forces in area	33 21 29N/70 09 54E	U-2	9
1/10/2010	2:17 AM	TT wants to know what WW has seen tonight	33 21 08N /69 37 18E	U-2	10
1/10/2010	2:17 PM	UNK reports 4 coalition force vehicles moving on road	33 19 23N/69 48 42E	MC-12	11
1/10/2010	9:09 AM	UNK tells HH to be ready for the party tonight	33 17 32N/69 56 09E	U-2	12
1/10/2010	12:16 PM	FF, village leader, tells UNK that Taliban left 2 dozen night letters	33 14 27N/69 55 09E	U-2	13
1/10/2010	5:15 PM	UNK reports explosives in short supply	33 14 39N/69 17 17E	U-2	14
1/11/2010	12:32 AM	UNK tells XX to be ready in 2 hours	33 16 16N /69 59 18E	MC-12	15
1/11/2010	2:16 AM	XX reports ready	33 23 07N/69 56 15E	MC-12	16

Figure 6. Illustrative Signals Intelligence Data

At the same time, items #15 and #16 may cause heightened alertness on the part of the ground commander and his forces. The geographic location of #16 may well focus other assets, but it does not guarantee identification of Haqqani's target. Is the sender of this transmission located with all the forces? Are they dispersed along several avenues of attack? How many attackers are there? HUMINT item #2 suggests that there may be at least 25. Could there be more?

The overlay of a second WAS technology can fill in gaps in the SIGINT collection. If Haqqani and his supporters in fact will strike against US forces in the Khost region, they may or may not talk about all or parts of their plan, but they must walk or ride to converge on the intended target. MTI data, therefore, has a valued role in finding the hostile movement.

In the Khost scenario, Figure 7 (p. 26) reflects representative collection. In reality, each MTI mission provides a wide range of support. On a typical JSTARS mission in 2008, the aircrew responded to 92 separate taskings—ranging from overwatch of a ground unit to the monitoring a suspect compound and the coordination of air and ground forces in response to an insurgent attack. In the illustrative Khost scenario, items #1, #2, and #3 reflect highlights of this type of focused support. Items #8, #9, and #10, however, could show something of interest to the scenario—or not. Given the current state of dismounted radar tracking technology, the data is often displayed as "dots." Additional ISR resources are necessary to help identify who or what the "dots" are: people, horses, goats, or something else.

As MTI scans a wide area and zeros in on a specific area, cross-cueing IMINT resources may be a natural next step. In this case, IMINT reinforces the adage that a picture may be worth a thousand words, but it will not give insight into what an adversary is doing. Intelligence photos in July 1990 documented Iraqi armor forces were deploying to Kuwait's northern border. However, the imagery could not know whether these formations were going to cross the border. Based on their geographic location, analysts and commanders knew that a short-notice attack was feasible. However, they were at a loss to know whether the attack would come in an hour, day, week, or year. IMINT's value was limited to the exact moment the image was captured. IMINT told commanders "what" was present (tanks), "where" they were (geographic coordinates), and a limited "when" (at the moment of the image), but could not offer information on "who" (which tank battalion for example) or "why" they were there.

IMINT also is prey to deception. U-2 images taken over Cuba in 1962 suggested Moscow had deployed intermediate range missiles to that country. US military and political leaders reviewing the pictures believed they were

MTI

Date	Time	Data	Geo-Location	Source	Item
1/8/2010	2:15 AM	GMTI monitors multiple roads , suspect activities	33 21 29N/69 56 17E	P-3	1
1/8/2010	2:50 AM	DMTI monitors fields north of base, tracks suspects	33 22 01N/69 57 16E	P-3	2
1/9/2010	7:25 AM	Ambush area/vicinity monitored/blue forces tracked	33 17 55N/70 06 28E	E-8	3
1/9/2010	9:25 AM	Suspect compound monitored	33 18 22N/70 05 48E	E-8	4
1/9/2010	10:01 AM	Monitored road activity during convoy transit	33 21 15N/69 58 15E	E-8	5
1/9/2010	11:50 AM	Monitored suspect compound and vicinity	33 26 58N/ 69 58 16E	E-8	6
1/10/2010	4:50 AM	GMTI monitors road network for vehicles	33 19 45N/70 58 55E	E-8	7
1/10/2010	11:06 AM	DMTI detects a dozen tracks	33 13 50N/70 04 10E	P-3	8
1/10/2010	10:55 PM	DMTI detects 6 individuals near border	33 26 25N/70 14 56E	E-8	9
1/11/2010	2:33 AM	DMTI detects 40 tracks moving south	33 23 07N/69 56 15E	E-8	10

Figure 7. Illustrative Moving Target Indicator Data

IMINT

Date	Time	Data	Geo-Location	Source	Item
1/8/2010	8:25 AM	Suspect house w/3 vehicles—same as 3 days prior	33 19 14N/ 69 58 07E	U-2	1
1/8/2010	11:17 AM	5 UNK with suspect weapons; hills west of FOB Chapman	33 20 45N/69 53 17E	GH	2
1/8/2010	2:09 PM	Road—possible IED location noted	33 17 30N/70 01 09E	GH	3
1/9/2010	7:22 PM	Ambush location imaged; 5 suspected hostiles observed	33 17 55 /70 06 28E	GH	4
1/9/2010	9:15 PM	Road monitored for IED activity—nothing observed	33 20 07N/69 58 32E	MQ-1	5
1/9/2010	10:20 PM	6 vehicles; 2 left at 8:29 PM; suspected Haqqani network house	33 16 20N/70 13 39E	MQ-1	6
1/9/2010	3:22 PM	Compound—7 trucks and 2 motorcycles	33 18 22N/70 05 48E	U-2	7
1/9/2010	4:15 PM	Suspected mines	33 21 17N /69 52 07E	GH	8
1/10/2010	3:57 AM	Compound—3 vehicles, outside fire	33 15 58N/69 59 17E	MC-12	9
1/10/2010	10:09 AM	5 UNK observed	33 18 41N/70 04 06E	GH	10
1/10/2010	11:30 AM	16 individuals monitored crossing border area	33 13 56N /70 04 18E	MQ-1	11
1/10/2010	4:52 PM	Compound—20 UNKs, 7 trucks	33 16 16N /69 59 18E	GH	12

Figure 8. Illustrative Imagery Intelligence Data

looking at actual missiles, however there was a risk the items were decoys. During Operation Allied Force in 1999, Serbian forces built and deployed mock tanks made of wood and tarpaulins.[30] Instances of such deception abound.

Figure 8 (p. 27) provides a cross-section of collected imagery in support of a ground commander's drive to understand his battlespace in more detail. Item #4 reflects the dynamic quality that the Air Force's ISR assets have achieved—responding to an emerging situation and distributing vital data to air and ground tactical centers. Items #1, #3, and #6 reflect routine building of the warfighters' situational awareness. Items #11 and #12, however, reflect the result of cross-cueing MTI to IMINT.

The recent increased demand for full-motion video reflects the fact that many consider it the easiest ISR data to interpret. For the imagery obtained by the SR-71 during the Cold War or from an RF-4 in Vietnam, analysts reviewed the photo after the aircraft had landed and distributed the information much later, if at all. With FMV, commanders and warfighters can observe, in real-time, what is occurring without interposition of a trained specialist. This ease of interpretation has led to a proliferation of FMV assets. It is the reason USAF is building toward 65 RPA orbits by 2013.[31]

In this illustrative scenario, a layering of ISR resources identified the threat, determined its size, and pinpointed the location of the source of the attack. HUMINT and SIGINT systems provided general warning of "who" (Haqqani) would act against US forces while SIGINT provided additional information on "when" the attack might occur (SIGINT item #15 and #16, when XX reported "ready"). HUMINT and SIGINT also may have identified an insurgent safe house north of a forward operating base. MTI data detected and then tracked the numbers of vehicles visiting this suspect site. Routine IMINT collection documented "what" vehicles were present (or not present) as well as "when." MTI assets focused FMV cameras to track suspected insurgents crossing the border from Pakistan, to the suspect compound, and alerted the commander when a large force approached the US outpost.

Individually, each intelligence discipline provided only some information. In concert, the layered ISR resources provided a fuller and more usable picture of who was acting, what they were doing, where, when, and why. Commanders didn't see only the tusks, trunk, tail, or legs of the animal. They saw the whole elephant.

Whether or when the commander engaged this force would, of course, depend on more than just ISR data. Also taken into account would be the rules of engagement, relative importance of many different possible tasks, and so forth. However, the top commander, alerted to the large force approaching his location, could posture the warfighting commander to best advantage.

INVESTMENT FOR THE FUTURE

The awareness gained from integrated, multi-source intelligence data is of supreme value. In actual operations, the creation of a coherent, seamless picture is not a routine event. Coalition forces in Afghanistan have suffered losses when they were surprised by a much larger insurgent force not detected in time by ISR forces. In 2008, 10 French paratroopers were killed in an ambush by 100 or more Taliban fighters.[32] Later that year, 45 US soldiers were suddenly engaged by more than 200 Taliban insurgents. The attack resulted in nine dead and 27 wounded Americans, prompting Sen. James Webb, a Virginia Democrat and Marine Corps combat commander in Vietnam, to seek an investigation into how a large US force could be so thoroughly surprised.[33] In October 2009, a pre-dawn raid by several hundred attackers at a forward operating base killed eight US and two Afghan troops.[34] IED casualties in the thousands suggest another gap in US powers to develop intel on IED activities and emplacements.

Many factors contribute to what may be termed an "intelligence failure." The simple shortage of ISR resources is one factor. The Air Force investment to expand ISR quantities and increase its ISR capacity will help solve that problem. The layering of ISR sensors is only possible when there is sufficient quantity to employ the force. Figure 9 (p. 30) reflects the planned USAF investment in key airborne ISR systems from 2010 to 2020. While the Air Force is pursuing select upgrades in manned ISR aircraft capabilities for the E-3, E-8, and RC-135, its increase in overall ISR capacity is coming from remotely piloted aircraft. Assessing the increased capacity can be viewed in two ways: orbits and area/time coverage.

By 2020, in terms of the two primary WAS assets—SIGINT and MTI—the Air Force investment in ISR capabilities will increase the WAS capacity from five to 12 SIGINT orbits and from two to 12 MTI orbits (see Figure 10 on p. 31). For SIGINT, this will allow an increase from 1.2 million square miles covered to more than 3.3 million square miles, while MTI area covered per radar field of view will increase from 33,000 square miles to 135,000 square miles. Increasing ISR inventories is vital to providing WAS support throughout the Joint Force.

Similar investments are underway to ensure adequate precise reconnaissance resources. The Air Force's anticipated inventory of MQ-1 Predators

ISR Types	E-8	U-2/ASARS	U-2/SYERS	RC-135	MQ-1	MQ-9	RQ-4/B30	RQ-4/B40
Wide Area Surveillance								
COMINT	N/A	331,000 nm2	331,000 nm2	164,000 nm2	N/A	118,000 nm2	303,000 nm2	N/A
ELINT	N/A	331,000 nm2	331,000 nm2	164,000 nm2	N/A	N/A	303,000 nm2	N/A
GMTI/Sweep	19,300 nm2	N/A	N/A	N/A	N/A	440	N/A	20,401 nm2
Reconnaissance								
EO/IR	N/A	N/A	38,700 nm2	N/A	18 hours	18 hours	40,000 nm2	N/A
SAR	175,781 nm2	11,500 nm2	N/A	N/A		9,000 nm2	40,000 nm2	308,800 nm2
Images/sorties		70	70				1,900	1,900
Capacity								
2010 Inventory	17	8	5	17	160	52	0	0
2010 Orbits	2	2	1	2	30	14	0	0
2020 Inventory	17	0	0	17	50	310	42	22
2020 Orbits	2	0	0	2	12	77	10	5
								nm2 = square nautical miles

Figure 9. Current and Future Air Force ISR Forces and Capabilities

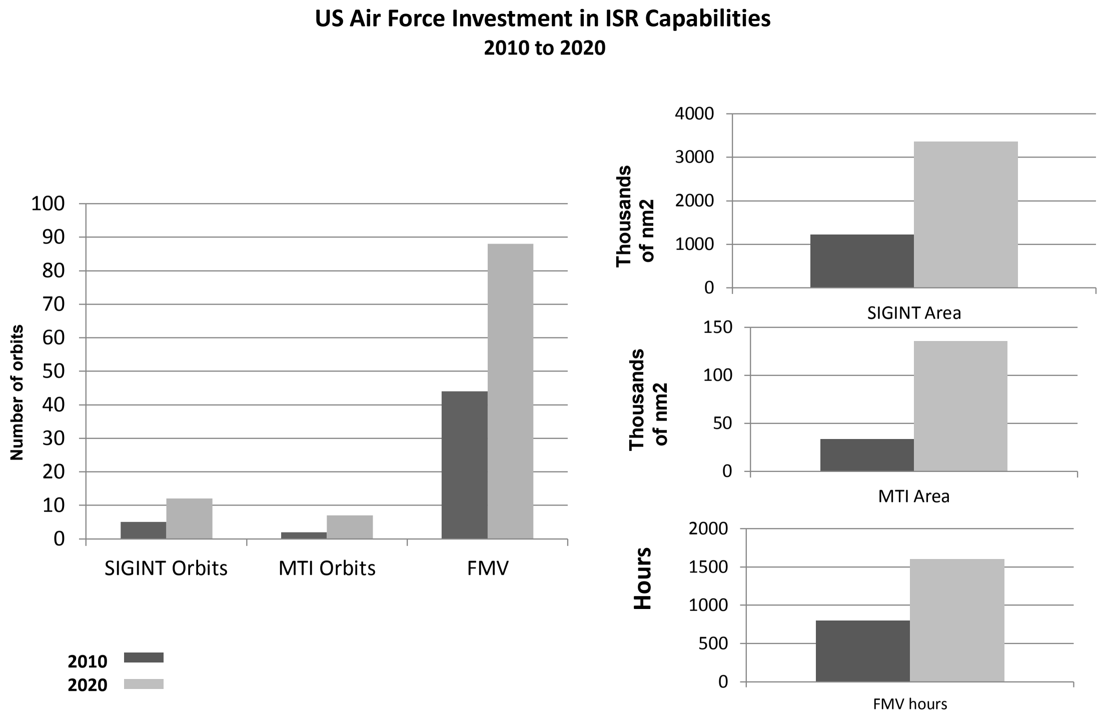


Figure 10. USAF Investment in Airborne ISR Capability

and MQ-9 Reapers in 2020 will allow it to operate 89 orbits, if desired or required. The amount of full-motion video time per day could double from 800 hours per day now to more than 1,600 hours per day.

Increasing the overall capacity is only one element of how the Air Force will be able to improve the capability of its ISR force. USAF also has placed emphasis on improving the types and quality of the sensors.

Gorgon Stare is a sensor suite will expand the MQ-9's imagery collection by augmenting the FMV with 10 separate sensors monitoring the ground within a four-kilometer area. The sensors will be a mix of EO and IR sensors which can be melded into a single wide-area perspective, helping to overcome the "soda straw" perspective of a single Full-Motion Video camera. While the FMV camera takes 30 scenes per second, Gorgon Stare's sensors will collect two per second. The MQ-9 will give up its weapons load to accommodate Gorgon Stare's power requirements.[35]

Gorgon Stare is just one sensor investment the Air Force is making. The service has identified more than 270 ISR capability gaps as it looks to provide the full spectrum of ISR support to the warfighter. In the near term, these include better MTI sensors, mobile nuclear air sampling, and improved air surveillance for cruise missile defense.[36]

Research and development efforts have focused on improving multi-spectral imaging (MSI) up to the standard of hyper-spectral imaging (HIS). Similar to MSI, HSI captures images from the earth's surface across the continuous electromagnetic spectrum—creating more numbers of pictures and more accurate pictures. HSI technology relies upon hundreds of narrow wavelength bands to collect the reflected energy. Once collected, advanced algorithms can characterize the object, such as tank, artillery, fighting positions, and so forth. Military adversaries ranging from non-state belligerents to the militaries of nation-states appreciate that concealment is vital to the survival of their forces,[37] and HSI capabilities will be key to overcoming their camouflage, concealment, and deception efforts.

In addition to HSI sensors, improved radar technologies are in development. AESA radars today offer great capabilities; they include coherent change detection, target classification, and detection of small and slower moving objects. Radar sensors that allow the war fighter to "see" under thick foliage or to penetrate buildings will remove sanctuaries where adversaries can hide or shield their activities from US Forces.[38]

Survivability is an equally strong need. Air operations over Iraq and Afghanistan have occurred in a benign operating environment, allowing warfighters to employ aircraft with little risk. Fighter and attack aircraft can orbit for extended times over target areas. RPAs have helped to reduce the kill chain from hours to, in some cases, single-digit minutes.

Anticipating operations in contested and denied airspace requires the Air Force to field survivable ISR aircraft. This survivability may be gained from a combination of stealth, prompt electronic attack, and directed energy defenses. By adopting a tailless design and removing the cockpit, an RPA offers a lower signature to air defense radars.[39] The armed services seek to field new weapon systems that break down barriers between "attack" and "reconnaissance" missions. Armed Predator and Reapers were perhaps the first viable step in this direction. The F-22, with its advanced sensor suite, is viewed by some as the herald of a new era. As described in 2008 by Lt. Gen. David A. Deptula, then USAF's deputy chief of staff for ISR, the F-22 reinforces the fact that "every shooter is a sensor and every sensor a shooter."[40] The Defense Department described efforts in fielding the next generation bomber as focused on a "survivable, long range surveillance and strike aircraft."[41]

EXPLOITATION TOOLS

Increased inventory and new sensors will improve the warfighters' ability to better understand their battlespace only if the troops can digest the data and transform it into actual, usable knowledge. A growing deluge of information generated by modern ISR assets has prompted some military leadership to focus on better information management and exploitation. A commander of a major US Navy fleet has warned that "even the most experienced analysts" are no longer able to discriminate between actionable intelligence and "background." Deptula echoed this view in a 2010 interview, warning, "We're going to find ourselves, in the not-too-distant future, swimming in sensors and drowning in data."[42]

One solution might be to commit more manpower to the processing, exploitation, and dissemination task. This could well entail prohibitive cost. Currently, with 44 full-motion video Combat Air Patrols (CAPs) and one Global Hawk imagery CAP, the Air Force has committed to the task some 2,500 intelligence analysts, as opposed to only 1,300 ISR pilots and sensor operators. As Global Hawk matures, the Air Force will need to commit to each orbit nearly 400 intel analysts, up from under 200 today. As the FMV CAPs increase to 65, the Air Force will need to assign an additional 2,000 airmen to the exploitation task.[43]

To keep in bounds these new manpower requirements, a number of technology initiatives are underway. In late 2009, The Defense Advanced Research

Projects Agency challenged industry to offer computer software tools and algorithms that could be used in a post-mission forensic role to detect threat activities and indicators when collected from hours and days of streaming, wide area video. In an initiative DARPA called Persistent Stare Exploitation and Analysis System (PerSEAS), the agency sought to have technology that could synthesize multiple sensors that monitored wide area motion video in urban and rural terrain. PerSEAS effort sought to detect potential threat activities as they unfold, distinguishing potential hostile acts from a myriad of daily activities based on known hostile activities or patterns.[44]

As an example of how PerSEAS technology could work, the software tool would allow hours of video and EO/IR imagery collected over several square miles to be processed to find indicators of a possible car bomb. While there could be hundreds if not thousands of cars on the roads in this area, a potential hostile indicator could be the vehicle that stops and the driver immediately walks away. A situation where the driver exits the car to open the hood or starts changing a tire may warrant additional monitoring, but may not indicate an attack in the near term. As a semi-automated tool, PerSEAS technology would reduce the manpower required to monitor hours of video as well as synthesize multiple sources. Without such technological solutions, the Air Force must commit 19 imagery analysts per full-motion video stream.[45]

Other technologies are needed as well. One area for improvement is fielding semi-automated imagery processing technology. Since most imagery assets are tasked to gain “essential elements of information,” or EEIs, analysts review the imagery to fulfill that request. In on-going operations, often this request is to inform the ground forces what has changed at a certain location in terms of vehicles or people present or fires at a compound or a similar discrete target area. Today, when the analyst manually compares the latest image with previous imagery, he or she starts with looking for what has been requested (people or vehicles for instance), and then compares with earlier images. Technical solutions could allow the imagery to be highlighted with the desired information identified, reducing the time required. Follow-on software capabilities could allow for rapid comparison of the current image to previous images, further reducing the imagery analyst’s workload. As sensor data quality and software algorithms improve, the incidence of false alarms or missed targets will drop, further reducing the workload on the analysts.

Finally, the imagery analyst of the future could have access to all source intelligence data as they process the image to meet the war fighter’s request. Normally today, the imagery analyst looks only at the photo to answer the EEI; however, solutions could allow them to access SIGINT, MTI, MASINT, HUMINT, and similar data and overlay this data on the image, allowing the analyst full access to all potentially relevant information to a location. Thus, if a

SOF or Army unit needed to know what had occurred at a compound over the past 24 to 48 hours, the analysts could provide a full spectrum description.

Such technologies would allow the fusing of all ISR disciplines into that optimal mosaic of information that rapidly builds situational awareness for the warfighter. In the Khost illustrative example, the relevant information was laid out over a few pages. Often today, one ISR analyst does not have access to information from another discipline and does not have time to track it down.[46]

IN SUMMARY

Driven by political and fiscal constraints, the Air Force leadership is reducing force structure across the service in all areas, save the ISR area. A near tripling the size of the ISR inventory reflects the compelling need to field more systems capable of finding an elusive adversary, whether a guerrilla or forces of a belligerent peer state.

Increasing the quantity and quality of ISR forces will provide future commanders better airborne ISR resources as they seek to understand "who" will oppose them, "what" they might do, "where," "when," and "why" they will act.

END NOTES

1. “Lead Turning the Future: The Vision and Strategy for United States Air Force Intelligence, Surveillance and Reconnaissance” (Washington, DC: Department of the Air Force, Office of the Deputy Chief of Staff for Intelligence, Surveillance, and Reconnaissance, 19 July 2010), p. 11.

2. Col. James C. Ruehmund Jr., USAF (Ret.), and Christopher J. Bowie, “Arsenal of Airpower: USAF Aircraft Inventory 1950-2009” (Arlington, VA: Mitchell Institute for Airpower Studies, November 2010), Appendix B.

3. “Lead Turning the Future,” p. 1.

4. “Securing the High Ground: Agile Combat Airpower,” 2010 Combat Air Force Strategic Plan (Langley AFB, VA: Hq. Air Combat Command et al, September 2010), p. 2 and 6. (Accessed 12/14/11 via http://www.acc.af.mil/shared/media/document/AFD-100915-011.pdf)

5. Gene Fraser, Sector Vice President, Aerospace Engineering, Northrop Grumman Aerospace Systems, “The Future of Unmanned Systems” presentation at Farnborough Air Show, July 19, 2010.

6. Michael B. Donley, Secretary of the Air Force, speaking with reporters at the Air Force Association’s Air Warfare Symposium, Orlando, FL, Feb. 18, 2011. Reported in “ISR Review,” *Daily Report,* Feb. 18, 2011 (accessed via http://www.airforce-magazine.com/DRArchive/Pages/2011/February%202011/February%2018%20 2011/ISRReview.aspx).

7. Maj. Trevor Cadieu, Canadian Forces, “Canadian Armour in Afghanistan,” *Canadian Army Journal,* Vol. 10.4, Winter 2008, p. 7. (Accessed 12/12/11 via http://www.army.forces.gc.ca/caj/documents/vol_10/iss_4/CAJ_vol10.4_03_e.pdf)

8. Walter Pincus, “IEDs Killing Fewer Troops in Afghanistan,” *Washington Post,* Sept. 25, 2010.

9. Stephen Biddle and Jeffrey A. Friedman, “The 2006 Lebanon Campaign and the Future of Warfare: Implications for Army and Defense Policy” (Carlisle, PA: Strategic Studies Institute, US Army War College, September 2008), p. 29-31.

10. Andrew H. Cordesman, “Preliminary ‘Lessons’ of the Israeli-Hezbollah War” (Washington, DC: Center for Strategic and International Studies, Sept. 11, 2006), p. 5. (Accessed 12/13/11 via http://csis.org/files/media/csis/pubs/060911_isr_hez_lessons.pdf)

11. Frank G. Hoffman, “Conflict in the 21st Century: The Rise of Hybrid Wars” (Arlington, VA: Potomac Institute for Policy Studies, December 2007), p. 37-38.

12. “Military and Security Developments Involving the People’s Republic of China 2011,” Annual Report to Congress, Office of the Secretary of Defense, released Aug. 24, 2011, p. 3.

13. Andrew F. Krepinevich, “Why Air Sea Battle” (Washington, DC: Center for Strategic

and Budgetary Assessments, 2010), p. 19-23.

14. Barry R. Schneider, "Counterforce Targeting Capabilities and Challenges," (Maxwell AFB, AL: USAF Counter Proliferation Center, Air University, August 2004), p. 14 and 35.

15. "A Conversation with Michael Hayden," Council on Foreign Relations, Sept. 7, 2007. (Accessed 12/09/11 via http://www.cfr.org/intelligence/conversation-michael-v-hayden-audio/p14158)

16. "Counter Cyber Intelligence," DefenseTech.org. (Accessed 12/09/11 via http://defensetech.org/2009/03/09/counter-cyber-intelligence)

17. John A. Tirpak, "The Blended Wing Goes to War," *Air Force* Magazine, October 2003, p. 26-27.

18. Keith Button, "Revealing Radar: US Navy Partially Lifts Shroud on Insurgent-tracking System," *C4ISR Journal,* Jan. 1, 2009. (Accessed 12/09/11 via http://www.c4isrjournal.com/story.php?F=3816224)

19. Rebecca Grant, "Issue Brief: New Global Hawk Undercuts Insurgents Advantages," Lexington Institute, Sept. 10, 2009. (Accessed 12/09/11 via http://www.lexingtoninstitute.org/new-global-hawk-undercuts-insurgent-advantages)

20. "Enabling Concept for Surface/Ground Moving Target Indicator Tasking, Collection, Processing, Exploitation, and Dissemination," Air Force ISR Agency, Geospatial Operations Branch, October 2008, p. 5.

21. Author interview with Randy Bithell, Northrop Grumman Aerospace Systems, July 2010.

22. "US Air Force Upgrades Intel Capabilities," United Press International, Sept. 1, 2006, quoting Gen. Bryan D. Brown, commander, US Special Operations Command. (Accessed 12/13/11 via http://www.upi.com/Business_News/Security-Industry/2006/09/01/US-Air-Force-upgrades-intel-capabilities/UPI-90791157144776/)

23. Zachary Lum, "The Measure of MASINT," *Journal of Electronic Defense,* August 1998, p. 43-48. (Accessed 12/13/11 via http://www.fas.org/irp/news/1998/08/MASINT.htm)

24. Geoff Fein, "New Sensors Are Force Multipliers," *Avionics Magazine,* May 1, 2007. (Accessed 12/14/11 via http://www.aviationtoday.com/av/issue/cover/10777.html)

25. David A. Fulghum, "Why Syria's Air Defenses Failed to Detect Israelis," Ares, a Defense Technology blog, Oct. 3, 2007. (Accessed 12/13/11 via http://www.aviationweek.com)

26. Lt. Col. Jonathan D. Thompson, US Army, "Human Terrain Team Operations in East Baghdad," *Military Review,* July-August 2010, p. 77.

27. Thompson, p. 78-80.

28. While an actual case study of an actual operation may be ideal, sensitive information that may compromise current or future operations warrants relying on a nominative scenario. The information reflects typical data the author observed while deployed to Afghanistan, 2005-2006. In addition, it should be noted that the volume of data from individual intelligence disciplines would be significantly greater each day and accumulated over time. For the ease of this scenario, total data points are reduced.

29. Maj. Dan Zeytoonian, US Army, et al, "Intelligent Design: COIN Operations Require Soldiers to Put a New Emphasis on Intelligence Collection and Analysis," *Special Warfare,* Vol. 19, Issue 3, May-June 2006, p. 23.

30. "And Now, the War Forecast," *The Economist,* online Sept. 15, 2005. (Accessed 12/09/11 via http://www.economist.com/node/4368226)

31. Maj. Gen. Alfred K. Flowers, USAF, Deputy Assistant Secretary for Budget, Fiscal Year 2011 Budget Overview briefing transcript, Feb. 1, 2010.

32. Amir Shah, "Taliban Kill 10 French Paratroopers, Raid American Base," Associated Press via *The New York Sun,* Aug. 19, 2008 (accessed 12/12/11 via http://www.nysun.com/foreign/10-french-soldiers-die-in-afghan-battle/84177/); Peter Allen, "Taliban Kill 10 French Paratroopers in Afghanistan Ambush," *The Telegraph,* Aug. 19, 2008 (accessed 12/12/11 via http://www.telegraph.co.uk/news/worldnews/asia/afghanistan/2585674/Taliban-kill-10-French-paratroopers-in-Afghanistan-ambush.html).

33. Sen. James Webb, letter to the DOD Acting Inspector General, July 9, 2009. (Accessed 12/14/11 via the *Washington Post* at http://www.washingtonpost.com/wp-srv/special/world/battle-of-wanat/correspondence/documents/6-Webb-DOD-IG-07-2009.pdf)

34. Robert H. Reid and Rahim Faiez, "8 Troops Killed in Afghanistan; Remote Outposts Attacked," Associated Press via the *Huffington Post,* Oct. 5, 2009 (accessed 12/12/11 via http://www.huffingtonpost.com/2009/10/04/8-troops-killed-in-afghan_n_308922.html); Stephanie Gaskell, "8 American Troops Killed in 'Complex Attack' on Afghanistan Outpost," *The New York Daily News,* Oct. 4, 2009 (accessed 12/12/11 via http://articles.nydailynews.com/2009-10-04/news/17934977_1_taliban-fighters-afghanistan-troops)

35. Richard Whittle, "Gorgon Stare Broadens UAV Surveillance," AviationWeek.com, Nov 3, 2010.

36. Edward Boyle, Hq. USAF, DCS for ISR, Plans & Integration Division, "Building for the Future: Air Force ISR Flight Plan Update" briefing, March 5, 2010.

37. Schneider, p. 14.

38. Schneider, p. 21.

39. Thomas P. Ehrhard and Robert O. Work, "Range, Persistence, Stealth, and Networking: The Case for a Carrier-Based Unmanned Combat Air System" (Washington, DC: CSBA, 2008), p. 214.

40. “Lead Turning the Future: The Vision and Strategy for United States Air Force Intelligence, Surveillance and Reconnaissance” (Washington, DC: Department of the Air Force, Office of the Deputy Chief of Staff for ISR, 4 July 2008), p. 15.

41.”Quadrennial Defense Review Report,” Department of Defense, February 2010, p. 33.

42. Stew Magnuson, “Military ‘Swimming in Sensors and Drowning in Data,’” *National Defense,* January 2010. (Accessed 12/14/11 via http://www.nationaldefensemagazine.org/archive/2010/January/Pages/Military%E2%80%98SwimmingInSensorsandDrowninginData%E2%80%99.aspx)

43. Col. James R. Gear Jr., Director, RPA Task Force, Hq. USAF, “Air Force RPA Way Ahead,” presentation at C4ISR Journal Conference, Oct 12, 2010.

44. DARPA-BAA-09-55 “Persistent Stare Exploitation and Analysis System (PerSEAS),” Defense Advanced Research Projects Agency, Information Processing Techniques Office, p. 4 and 6-7.

45. Eli Lake, “Drone Footage Overwhelms Analysts,” *Washington Times,* Nov. 9, 2010

46. Author interview with Imagery Analysts in the 548th ISR Group, Beale AFB, CA, Aug. 4, 2010.

About the Air Force Association

The Air Force Association, founded in 1946, exists to promote Air Force airpower.

The AFA mission is to promote a dominant United States Air Force and a strong national defense and to honor Airmen and our Air Force Heritage. To accomplish this, we:

EDUCATE the public about the critical need for unmatched aerospace power and a technically superior workforce to ensure US national security;

ADVOCATE for aerospace power and STEM education; and

SUPPORT the Total Air Force family and promote aerospace education.

AFA is a 501(c)(3) independent, nonpartisan, nonprofit educational organization, to which all donations are tax deductible. With your help we will be able to expand our programs and their impact. We need your support and ongoing financial commitment to realize our goals.

AFA disseminates information through *Air Force* Magazine, airforce-magazine.com, the General Billy Mitchell Institute for Airpower Studies, national conferences and symposia, and other forms of public outreach. Learn more about AFA by visiting us on the Web at www.afa.org.

1501 Lee Highway
Arlington VA 22209-1198
Tel: (703) 247-5800
Fax: (703) 247-5853

MITCHELL PAPER 8 LAYERING ISR FORCES DECEMBER 2011