Joint Intelligence, Surveillance, and Reconnaissance in Contested Airspace

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Despite unprecedented success with intelligence, surveillance, and reconnaissance (ISR) networks put in place over Iraq and Afghanistan during the last decade, the joint force has yet to come to grips with the challenges and range of possible options to employ ISR platforms in contested airspace.[1] The Department of Defense ISR Task Force that supported innovations such as Project Liberty and the battlefield airborne communications node in countering insurgencies in Southwest Asia and the Middle East has not yet addressed either the new strategic concepts or the operational challenges inherent in an AirSea Battle in the Western Pacific or the Persian Gulf in an antiaccess/area-denial (A2/AD) environment.[2]

This article seeks to define the attributes of a family of airborne ISR systems required to operate in nonpermissive military environments. It assumes that despite solid progress in integrating ISR into uncontested airspace, these systems, for the most part, will not prove adequate in future contingencies in which the adversary contests the airspace over a vital region. To help expand the scope of options for ISR systems to operate effectively under these conditions, the article identifies operational factors in Iraq and Afghanistan that led to an integrated, joint ISR system of systems. In so doing, it becomes apparent that the force mix of platforms and sensors fielded to support these conflicts is unlikely to be the right system for an emerging security environment characterized by problematic access and the denial of key bases, ports, and lines of communication enabling power projection. When force planners analyze the plausible contingencies facing US armed forces in the future, they find that an ISR network designed for operation in permissive airspace will be quickly stretched to failure.

The article first reviews the ISR network that proved so successful in uncontested airspace in terms of platforms, sensors, and integration systems (command, control, communications, and computers used for processing data). It then examines the tasking declared in *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*, inferring from that document and follow-on joint guidance the requirements for a future ISR family of systems.[3] Finally, the article suggests a course of action through investment in ISR platforms, sensors, and system integration that might successfully underwrite this strategic guidance.

ISR in Uncontested Airspace: Platforms, Sensors, Integration

Airborne ISR assets deployed to Iraq and Afghanistan had the good fortune to operate in essentially uncontested airspace in support of counterinsurgency and counterterror operations. Much of that airborne ISR network consisted of unmanned aerial vehicles (UAV) because of their long dwell time, improved sensors, enhanced connectivity, and precision strike capability. By using more than a platform-centric approach, however, the United States successfully created a family of systems during these conflicts that integrated sensors and command and control (C2) systems to prosecute the wars against a mobile and clandestine foe.

The principal airborne ISR platforms employed in Iraq and Afghanistan were UAVs that evolved from use of the Predator drone during the North Atlantic Treaty Organization's air war over the Balkans in the late 1990s. Although the Predator brought newfound capability in its ability to persist over an area of interest and relay video to the air component commander, "it couldn't . . . deliver target-quality mensurated coordinates or designate targets for other aircraft to strike."[4] Furthermore, the Predator may have brought with it the second-order consequence of gluing too many humans in the chain of command to the video screen, forming long lines of intelligence analysts waiting for their opportunity to watch the real-time show from the battlefield and, as a result, slowing decision making. For example, the attack on Abu Musab al-Zarqawi, the al-Qaeda leader in Iraq, was said to have taken 600 hours of Predator time and thousands of hours of analyst time to facilitate a strike executed in a matter of minutes. Nevertheless, Predator ushered in a new era in situational awareness (SA) and inspired a revolution in coupling ISR with strike when it and its follow-on, the Reaper, were mated with the Hellfire antitank missile. That unmanned hunter-killer concept is one of the most important of all military capabilities—a lesson identified—that will carry forward as the United States faces more sophisticated adversaries in the future.

However, Predator and Reaper had relatively narrow fields of view. Therefore, the unmanned, high-flying Global Hawk became particularly valuable to combat commanders owing to its ability to survey large geographic areas from an altitude of 60,000 feet. The United States also deployed in Afghanistan a classified, stealthy remotely piloted aircraft—once referred to as the "Beast of Kandahar"—since identified as the Sentinel, designed and deployed as a tactical reconnaissance asset. Unfortunately, this UAV surrendered its cloak of secrecy when it crash-landed over Iranian territory.[5]

Not all airborne ISR platforms used in Iraq and Afghanistan were unmanned. The MC-12 Liberty, an augmented version of the turbo-propelled King Air 350, was developed and fielded rapidly to focus on improvised explosive devices (IED) in Iraq. By cross-cueing full motion video (FMV), signals intelligence (SIGINT), and backtracking software, the Liberty system could determine not only the location of IEDs but also the events leading to their roadside insertion. Of course, the United States also deployed its more traditional manned ISR platforms to support conventional and counterinsurgency operations in Iraq and Afghanistan, such as the C-135-based capabilities of the Rivet Joint for SIGINT, the Joint Surveillance Target Attack Radar System aircraft for accurate radar imagery, ground-moving target indications and battle management, and the venerable U-2 for photo imagery. These aircraft were unimpeded by enemy air defenses in their ISR operations along and within uncontested airspace.

We should also note the term *nontraditional ISR*, which refers to the use of sensor systems such as targeting pods on manned fighter aircraft that, although not designed for ISR operations, proved very useful in contributing to battlespace awareness in these unconventional campaigns. Examples include F-18s and F-15s collecting imagery with targeting pods, F-16CJs designed for countering surface-to-air missiles collecting SIGINT, and AC-130s using video capabilities to monitor facilities of interest.[6] Such imagery has the advantage of being downloaded and transmitted over data links to the war fighter in near real time or simply returned to a bank of stored ISR data for processing and disseminating in a less time-sensitive environment.

Similar to the challenges facing platforms in low-intensity conflict, ISR sensors had to be adapted to concentrate on an unconventional adversary. Perhaps the most innovative—and arguably the most valuable—application was the use of FMV. Coupled with the persistence of platforms that could loiter for long periods of time, FMV could distinguish friend from foe on the ground and avoid collateral damage in the event of an attack. Prominent here were the multispectral targeting systems used by the Predator and Reaper drones, employing automated tracking, color, fused images, and electronic zoom.[7] To enlarge the field of view and allow a single aircraft to provide coverage of multiple targets, the "Gorgon Stare" system was designed to augment the FMV capability by adding 10 separate electro-optical (EO) and infrared (IR) sensors to offer a single wide-area perspective over a four-kilometer-square area. On the Project Liberty MC-12s, an IR pointer allowed the aircrew to designate an object to troops on the ground.

The sensors on these manned and unmanned systems were developed specifically for the unconventional, land-based target set in Iraq and Afghanistan. The Global Hawk, developed originally as a replacement for the manned U-2 in a strategic surveillance role, needed additional modification. Block 20 Global Hawks were equipped primarily for imagery intelligence and were later modified to serve as battlefield communications nodes. Block 30 Global Hawk aircraft acted as multispectral platforms with EO, IR, synthetic aperture radar, and SIGINT sensors. At its high-altitude, over-the-battlefield position and with its long endurance, Global Hawk could cross-cue, verify, and link similar sensors and systems operated by manned standoff ISR platforms.

Other ISR force multipliers included the targeting pods carried on tactical fighters—the so-called nontraditional ISR platforms. These pods contained high-resolution, forward-looking IR sensors displaying an image with a wide-angle search capability and a narrow field of view to acquire battlefield-sized targets. These images could be downlinked in streaming video to forward-deployed ground forces in a form of ISR close air support. Because of this innovation, nontraditional ISR was often specified as a fighter's primary task in the daily air tasking order and coordinated with UAV operations to supply long dwell time when needed and rapid reaction as necessary.[8]

Management and integration of these platforms and sensors have evolved over the last decade, and each of these airborne ISR systems has been adapted to facilitate real-time C2 in support of the war fighter. Unfortunately, as is often the case in individual systems, the C2 network put in place is stovepiped from platform and sensor to a specific user and service-specific distributed ground station, thus failing to cross the air, sea, and land domains and include joint customers seeking essential elements of information.

All of these ISR systems shared the objective of informing ground commanders and increasing their SA within a mobile and complex battlespace. As the initial air operations plan for Operation Enduring Freedom unfolded in late 2001, links between the Predator and AC-130U gunships were established using an omnidirectional C-band antenna. That innovation quickly led to sending Predator video to troops on the ground through a Remotely Operated Video Enhanced Receiver system, eventually supporting video feeds from multiple UAVs and downsized to handheld versions carried by troops on the ground.[9]

The object of Task Force Observe, Detect, Identify, and Neutralize (ODIN)—one of the best examples of air-ground ISR integration to come out of the Iraq and Afghanistan wars—was to counter the enemy's IED campaign. Components of the US integrated ISR system included UAVs with FMV and the Liberty King Airs, also equipped with video and SIGINT. In addition to ferreting out IEDs and shortening the decision chain with radio links to Apache helicopters, the ODIN system proved noteworthy for its ability to distribute collected data to common ground stations, cross-cueing human intelligence, imagery, and SIGINT to create "pattern of life" footprints leading to the acquisition of high-value targets and the unraveling of complex IED networks.[10]

One concern with the ODIN network had to do with its performance over the rugged and mountainous terrain of Afghanistan compared with that over the relatively flat landscape of Iraq. A solution to this issue involved the use of airborne communications systems to act as a relay to help integrate air and surface operations. The battlefield airborne communications node was developed to overcome these difficulties by allowing air and ground-based units operating far from each other to see the same ISR picture. The node has been deployed on both manned (the E-11A) and unmanned (Global Hawk) platforms to improve system integration, enhance SA, and strengthen beyond-line-of-sight communications.[11]

What might we conclude from this brief description of ISR platforms, sensors, and their integration employed in counterinsurgency and counterterror operations over the last decade? The demand signal was high, and the targets were time-sensitive, resulting in an emphasis on airborne platforms focused on supporting tactical ground operations in complex irregular warfare. Sensor systems deployed to Iraq and Afghanistan were tailored to a target set of IEDs, moving vehicles, and high-value individuals, driving the need for persistence. C2 of these ISR systems tended to emphasize single communications links between sensor and shooter rather than wideband communications conveying SA to the joint force. Clearly, the innovation in ISR brought to this unconventional battlefield was exemplary, from unmanned reconnaissance-strike systems to nontraditional tactics and techniques. Nevertheless, these platforms could operate only within a sanctuary of uncontested airspace. Had air defenses been more robust, these ISR operations might have proved far more difficult—and certainly less successful.

Priorities for Twenty-First-Century Defense: Implications for ISR

The shift from counterinsurgency to broader strategic engagement in support of US and allied security has a number of implications for ISR. The document *Sustaining U.S. Global Leadership*, mentioned above, generates these requirements, tilting America's strategic focus and force posture toward the Asia-Pacific. To credibly deter and defend in the future, the policy directs the US military to "invest as required to ensure its ability to operate effectively in anti-access and area denial . . . environments."[12]

These requirements stand in stark contrast to present US ISR capabilities that emphasize counterterror and counterinsurgency operations. ISR will now have to provide persistent coverage over a vast area that could come under attack by adversaries, threatening the operations of US and allied armed forces. The guidance further warns that adversaries in these A2/AD areas will present difficult obstacles to US military intervention. In a follow-on document, the Joint Chiefs of Staff have clarified the ISR requirements dictated by this strategic shift. Specifically, the *Joint Operational Access Concept* charges ISR assets to

- Prepare the operational area in advance to facilitate access. . . .
- Exploit advantages in one or more domains to disrupt or destroy enemy anti-access/area-denial capabilities in others.
- Disrupt enemy reconnaissance and surveillance efforts while protecting friendly efforts. . . .
- Attack enemy antiaccess/area-denial defenses in depth rather than rolling back those defenses from the perimeter.
- Maximize surprise through deception, stealth, and ambiguity to complicate enemy targeting.[13]

It further emphasizes that the "reconnaissance/counterreconnaissance fight is a critical multidomain contest in any combat operation to gain operational access, as each combatant attempts to gain better situational awareness than the other" and that the joint force will demand a major ISR effort applied aggressively. Finally, it notes that this concept will put a heavy burden on continued operations supported by robust C2: "Characterizing an adversary is a continuous activity, commencing years before hostilities begin and continuing during and after those hostilities. This has implications for steady state sizing, systemic capacity, and analytic technologies of intelligence forces. Specifically, the reconnaissance and surveillance contest is critical to access operations."[14]

In an open forum, we can best judge the requirements levied on airborne ISR assets through development of the nascent AirSea Battle operational concept. According to analysis conducted by the Center for Strategic and Budgetary Assessments (CSBA), a "blinding campaign" or "scouting battle" will be the first and most important military move in an A2/AD confrontation.[15] During this phase of the conflict, each side will seek to attack the other's ISR assets and battle networks to deprive the opponent of the ability to detect, identify, and target approaching forces at range. The CSBA study concludes that achieving the technical and procedural interoperability required for a successful joint AirSea Battle will "be toughest with respect to C2, communications, and ISR, simply because these drive the information and data flows" essential to SA.[16]

When the CSBA studies move beyond the A2/AD scenarios in the Western Pacific and the Persian Gulf, pondering the implementation problems inherent in AirSea Battle, they point to the need for rapid and continuing investment in integrated ISR systems.[17] This family of joint ISR systems necessary to underwrite AirSea Battle will have long lead times because of the complexity of integrating various platforms and sensors. Most challenging will be fully compatible and interoperable joint C2, ISR, and processing, exploitation, and dissemination (PED) architectures. Thus, the CSBA concludes that "early Air Force and Navy agreement on efficient migration paths for these architectures is particularly important."[18]

ISR in Contested Airspace: Platforms, Sensors, Integration

Two things are clear. First, over the last decade the US military put in place an effective ISR network to prosecute an irregular enemy in relatively uncontested airspace. Second, the United States now needs to replicate that capability in a far more formidable threat environment. In pursuit of this capability, a number of studies are under way that will undoubtedly build on the legacy of effective airborne ISR systems developed and deployed over the last decade. But they are also likely to suggest new approaches in platforms, sensors, and systems to operate effectively in contested airspace.

ISR platforms of the future will need all of the characteristics of those that performed so well over the last decade with one substantial added requirement: survivability in hostile airspace. Although endurance, payload, integration, and connectivity are essential, none of these attributes will be of value if the platform cannot survive in an A2/AD environment. Replacing the Predator and Reaper in the unmanned reconnaissance-strike role will call for new UAVs that can loiter, survive, and attack near and within heavily defended airspace. Most promising here is the unmanned combat air system demonstrator (UCAS-D) undergoing tests by the Navy and the separate but related unmanned carrier-launched airborne surveillance and strike system (UCLASS) program. Whether or not the former is folded into the latter, the unmanned combat aerial vehicle (UCAV) could be designed to carry a suite of sensors and weapons 2,000 nautical miles or more from the carrier without refueling and will have far greater range and persistence if the vehicle can be refueled while airborne. Important to the UAV's survival is its low observability—designed from the start with the stealth to penetrate highly defended airspace. Like its non-stealthy forebears, the UCAV will carry the sensors and weapons to conduct missions of both reconnaissance and precision strike.[19]

High-altitude, long-endurance UAVs will also play a role but, depending on the enemy's air order of battle, will have to be operated judiciously and equipped with self-defense capability. Global Hawk and the Navy's Broad Area Maritime Surveillance System, the Triton, might need a self-protection suite that includes a laser warning system, radar warning receiver, electronic attack or jamming system, and a towed decoy. The ISR provided by those high-altitude UAVs can be supplemented by the stealthy Sentinel drone at the tactical level—reportedly a key ISR asset in preparing the battlefield for the raid that killed Osama bin Laden.[20] For the longer term, it may make sense for the Air Force to convert its MQ-X UAV program, now on hold, into a land-based version of the vehicle emerging from the Navy's UCAS-D/UCLASS programs.[21]

The F-22's and F-35's low observability could allow them to conduct nontraditional ISR missions in contested airspace. As the number of jointly operated Joint Strike Fighters increases, they will be able to operate in groups—separated at distances so as not to compromise their stealth but close enough to offer mutual support, such as standoff jamming by one flight of fighters while others penetrate. These stealthy aircraft will have impressive sensor suites characterized as "vacuum cleaners"—collecting data about the enemy's posture and feeding it to joint networks. Meanwhile, the F-35's formidable computational power will allow a real-time recalculation of alternative mission routing in response to intelligence regarding enemy air defenses.

Space-based platforms have been major contributors to collecting ISR data over Iraq and Afghanistan, particularly in cueing other platforms to areas and targets of interest. However, due to the strategic nature of their collection missions and the time that elapses between passes over those areas of interest, satellites have not been considered major players in the pursuit of high-value, mobile, tactical targets. Under new tasking that demands greater wide-area surveillance and strategic assessments over the Western Pacific and Persian Gulf, that perception is likely to change. The increased fidelity of satellite-mounted sensors such as IR and radar, as well as their significant contributions to communications and C2, will likely place greater priority on space-based ISR systems—including the X-37B reusable space plane—in the future.

The systems of targets and the wide-area surveillance needed for the rebalancing of US military forces to the Pacific will also prompt a shift in sensor focus and capability. Each of the platforms described above must tailor its sensing capabilities toward detecting the A2/AD forces and networks (e.g., antisatellite weapons, long-range ISR systems, and precision-guided conventional land-attack and antiship cruise and ballistic missiles) arrayed against the operation of US and allied assets in the region. The ISR capabilities of UAVs will have much to offer, as long as those platforms remain survivable. Thus, a suite of multi-intelligence (INT) sensors, similar to that carried by Reaper and Global Hawk but improved in terms of range and low observability, will allow a new generation of UAVs to make major contributions to SA. For example, advanced sensors with multispectral imaging and multiwave radars might penetrate structures, exposing anything hidden inside. Just as UAV remote sensor requirements stemmed from past changes in military missions, so will new capability requirements arise from emerging military doctrine, including the need for persistence and penetration of advanced air defenses.

UAV payloads might consist of a modular, open-architecture suite of sensors for collecting reconnaissance from across the electromagnetic spectrum and, in the UCAV version, precision munitions capable of exploiting processed information to target enemies with pinpoint accuracy. The requirement for high-definition FMV with its attendant bandwidth, considered so important over the last decade, may take a backseat to large, strategic UAVs with long-range radar, SIGINT, and EO/IR sensors and multifunction radio-frequency-sensor payloads. For example, the Global Hawk Block 40 aircraft with a high-range resolution sensor will allow precision target measurement and classification from high altitude and longer standoff ranges. Similar sensor payloads may let the UCAV find imprecisely located targets on its own, similar to programs such as Tacit Rainbow and the low-cost autonomous attack submunition—abandoned in the past because of uncertainty regarding the unmanned vehicles' reliability for autonomous munitions delivery.

The F-22 and F-35 will also assume ISR roles well beyond the nontraditional role played by fourth-generation fighters with targeting pods over Iraq and Afghanistan. Most notable may be the spherical SA system termed the distributed aperture system developed for the F-35. That system of six EO sensors offers ballistic missile detection and tracking, including launch point detection as well as IR search-and-track functions and day/night navigation. Moreover, both of the fifth-generation stealthy fighters will add ISR capability through their active electronically scanned array (AESA) radars, supplying enhanced target resolution with low probability of intercept and increased resistance to jamming. These aircraft have enhanced defensive sensor suites as well. Just as AESA radar can be used for electronic attack of enemy air defenses, so will the F-35's digital radio-frequency memory capabilities allow the aircraft "to duplicate incoming radar signals, alter them, and send them back to the receiver modified to suggest that the fighter is either not there or is somewhere else."[22]

Given the revived importance of satellites to ISR gathering under the new strategic priorities, space-based sensors must also receive added emphasis. Two capabilities appear particularly significant: space-based radar and IR. The former was an ambitious program initiated a decade ago, designed to provide high-volume, readily available synthetic aperture radar imaging, surface moving-target indications, and high-resolution terrain information to the joint war fighter. Although the program's complexity and cost led to its cancellation, the strategic pivot to A2/AD areas argues for its rebirth. Space radar, which offers coherent change detection to track an enemy order of battle in A2/AD scenarios, has the granularity to detect the launch and track the arc of cruise missiles.

A new generation of space-based IR satellites will make major contributions to denied-area ISR. Somewhat ironically, the difficulty experienced by the United States in locating the launch of Scud missiles during the 1991 Iraq war led to an improved capability that now has application in more far-flung theaters of operation. The new space-based IR system, in addition to detecting long-range ballistic missile launches, will contribute to SA of theater missile defense, characterize IR event signatures, and provide intelligence to support force protection, strike planning, and other missions conducted in an A2/AD scenario.[23]

The challenge of integrating ISR assets will become even more complex when military forces operate in A2/AD environments. Over Iraq and Afghanistan, the principal issue involved the quantity of ISR data—a complex system of PED moving vast amounts of data around the theater. In A2/AD airspace, we must pay greater attention not only to the joint and interoperable PED processes but also to their security. One of the approaches both to improving security and handling large amounts of data will entail improvements in the PED process at the multiservice distributed common ground/surface system nodes. A major task at hand involves integrating airborne ISR data into these communications centers. The ultimate architecture must create a network that can fuse and interpret data from multiple sources as well as process and disseminate those data to joint users at just the right time. Particularly important here is an integrated presentation of multisensor, multi-INT inputs on a common joint display.

No matter how streamlined and secure the PED process, however, disseminating ISR data to C2 facilities followed by subsequent tasking to a strike platform imposes unavoidable delays and inserts C2 uncertainties. We learned from operations in Afghanistan that sensor-to-shooter links communicated faster than could be supported by a C2 process requiring evaluation and approval at numerous decision levels. Inadequate communications links, incomplete bomb damage assessment, and poor dynamic airspace management all contributed to shortfalls in the ISR integration process. In uncontested airspace, the Predators and Reapers with FMV and precision-guided weapons filled this gap nicely. Building on that practice, ISR assets in A2/AD environments will need greater airborne persistence as well as sensor-to-sensor integration and data processing at the point of origin to supply real-time information on time-sensitive targets.[24]

A complex mix of platform, sensor, and integration attributes is required to effectively engage time-sensitive or mobile targets in contested airspace. They include range, endurance, survivability, short reaction time, flexible munitions mixes, network connectivity, and onboard mission planning and targeting.[25] Platforms possessing these attributes in varying degrees of effectiveness include the F-22 and F-35 fighters, an armed UCAV (presuming that strike authority is granted with a human in or on the loop), and the B-2 bomber or its advanced technology replacement now under the cloak of security and in development. As autonomous as these platforms and sensors might be, coordinated tactics and engagement profiles in antiaccess environments will demand that stealthy platforms be able to talk to each other. The multifunction advanced data link with high-data-rate, low-probability-of-intercept, and low-probability-of-detection properties is in development for the F-35, but plans to place the link on the B-2 (or the future bomber) and F-22 may have stalled. To integrate these stealthy ISR and strike systems, we must field this data link or something like it.[26]

Just as space-based sensors and platforms will prove critical to ISR in A2/AD scenarios, so will space-based communications prove essential to ISR integration. Replenishment of the Global Positioning System, now under way, is needed for the timing and positioning of ISR assets and required for the guidance of air-launched precision weapons. The jam-resistant and nuclear-hardened Milstar communication satellite constellation is being replaced by the advanced extremely high frequency (AEHF) satellite system, which will provide enhanced capacity and clarity-enabling ISR asset integration at both the strategic and tactical levels. The next generation of satellite terminals, known as the

Family of Advanced Beyond-Line-of-Sight Terminals, is also necessary to facilitate communications between airborne ISR assets and AEHF satellites.[27] We can also protect satellite communication by restarting the laser-based transformational satellite system, once abandoned but now strengthened by a broadened industrial base and mature technology readiness.[28] Finally, self-defense will also be necessary for space-based assets in A2/AD scenarios.[29]

Conclusion

In directing a strategic shift away from a decade's emphasis on large-scale counterterror, counterinsurgency, and prolonged stability operations, the nation's defense leaders have issued a powerful challenge to the airborne ISR enterprise. Because of the uncontested environment for the operation of an ISR family of systems over Iraq and Afghanistan, the platforms, supporting sensors, and C2 connections cannot simply be lifted and relocated to a new theater of operations. Nevertheless, the joint force can still profit from years of effort in establishing tactics, techniques, and procedures that replaced the ponderous practice of transferring actionable intelligence to the operator, which so often had the counterproductive effect of disrupting the relationship among sensor, decider, and shooter.

Force planners with an airborne ISR portfolio can also profit from the joint "family of systems" approach adopted by their colleagues who deliberate future platforms, sensors, and integration for long-range strike.[30] As comparisons are drawn across different scenarios, the worth of these individual systems varies markedly. Penetrating deeply into defended territory, surveilling targets from long range, loitering and tracking time-sensitive targets, and surviving in defended airspace with integrated ISR and strike capabilities can all lead to differing solutions. Given this range of requirements, a family-of-systems approach that offers diverse ISR platforms, sensors, and integration options appears prudent in a security environment populated by emerging adversaries who present differing antiaccess challenges. But this family of systems must be connected across the armed services.

More work remains, and several studies exploring ISR in contested airspace are under way. Lessons identified from recent wars continue to stress the power of ISR integration for effective C2 while the challenges of operating in contested airspace will place a premium on varying approaches to survivability. In any scenario, the issue of ISR in A2/AD environments will involve getting the right information to the right person at the right time to make the right decision. We should use studies and war games to adapt the effective ISR network put in place over the last decade to more stressful conditions, and we should identify the investments needed, particularly when a long lead time is necessary to gain a desired ISR capability. To ensure that the prowess so ably demonstrated by airborne ISR systems in uncontested airspace does not atrophy in the face of increasingly nonpermissive environments, we must accelerate those studies and provide the needed investment. ✪

Notes

1. Joint Publication 2-01, *Joint and National Intelligence Support to Military Operations*, 5 January 2012, defines ISR as "an activity that synchronizes and integrates the planning and operation of sensors, assets, and processing, exploitation, and dissemination systems in direct support of current and future operations" (GL-12).

2. The battlefield airborne communications node is an airborne communications relay system mounted on manned and unmanned aircraft to link air and ground forces with a common ISR picture. See Adm Jonathan W. Greenert, USN, and Gen Norton A. Schwartz, USAF, "Air-Sea Battle," 20 February 2012, http://www.the-american-interest.com/articles/2012/02/20/air-sea-battle/.

3. Department of Defense, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense* (Washington, DC: Department of Defense, January 2012). For reinforcing guidance, see Department of Defense, *Quadrennial Defense Review 2014* (Washington, DC: Department of Defense, 2014), http://www.defense.gov/pubs/2014_Quadrennial_Defense_Review.pdf.

4. Richard Whittle, *Predator's Big Safari*, Mitchell Paper 7 (Washington, DC: Mitchell Institute for Airpower Studies, August 2011), 4.

5. The conditions surrounding the crash landing of the RQ-170 drone in Iran in December 2011 remain murky, and the competing claims on both sides are unlikely to be resolved

conclusively. Regardless, the United States lost a valuable ISR asset in defended airspace. See Robert Haffa and Anand Datla, "6 Ways to Improve UAVs," *C4ISR Journal* 11, no. 2 (March 2012): 30–31.

6. See Curtis E. LeMay Center for Doctrine Development and Education, "Annex 2-0, Global Integrated Intelligence, Surveillance and Reconnaissance Operations," 6 January 2012, https://doctrine.af.mil/DTM/dtmisroperations.htm.

7. "Raytheon Nets $31.4 Million Contract for MTS-A on MH-60, Predator," Space War, 28 September 2005, http://www.spacewar.com/news/uav-05zzzzl.html.

8. John A. Tirpak, "Eyes of the Fighter," *Air Force Magazine* 89, no. 1 (January 2006): 40–44.

9. Whittle, *Predator's Big Safari*, 28.

10. Jon W. Glass, "Taking Aim in Afghanistan," *DefenseNews*, 5 February 2009, http://defensenews.com/article/20090205/C4ISR02.

11. See "USAF Continues to Grow, Strengthen Its BACN Fleet with New E-11A Buy," InsideDefense.com, 30 August 2012.

12. Department of Defense, *Sustaining U.S. Global Leadership*, 4–5.

13. Department of Defense, *Joint Operational Access Concept*, Version 1.0 (Washington, DC: Department of Defense, 17 January 2012), iii.

14. Ibid., 22–23, 29. See also Joint Chiefs of Staff, *Capstone Concept for Joint Operations: Joint Force 2020* (Washington, DC: Joint Chiefs of Staff, 10 September 2012).

15. Jan van Tol et al., *AirSea Battle: A Point of Departure Operational Concept* (Washington, DC: Center for Strategic and Budgetary Assessments, 2010), xiii, 56.

16. Ibid., 112.

17. See also Mark Gunzinger with Chris Dougherty, *Outside-In: Operating from Range to Defeat Iran's Anti-access and Area-Denial Threats* (Washington, DC: Center for Strategic and Budgetary Assessments, 2011).

18. Van Tol et al., *AirSea Battle*, 122.

19. See Thomas P. Ehrhard, PhD, and Robert O. Work, *Range, Persistence, Stealth and Networking: The Case for a Carrier-Based Unmanned Combat Air System* (Washington, DC: Center for Strategic and Budgetary Assessments, 2008).

20. See "RQ-170 Unmanned Aerial Vehicle, United States of America," airforce-technology.com, accessed 7 March 2014, http://www.airforce-technology.com.

21. However, the Air Force may have another solution to conduct ISR in contested airspace—the RQ-180. See Amy Butler and Bill Sweetman, "Return of the Penetrator," *Aviation Week and Space Technology* 175, no. 42 (9 December 2013): 20.

22. John A. Tirpak, "A New Revolution in Military Affairs," *Air Force Magazine* 94, no. 7 (July 2011): 10, http://www.airforcemag.com/MagazineArchive/Pages/2011/July%20 2011/0711watch.aspx. See also Barry D. Watts, *The Maturing Revolution in Military Affairs* (Washington, DC: Center for Strategic and Budgetary Assessments, 2011), 29.

23. "Space Based Infrared System (SBIRS)," Lockheed Martin, accessed 7 March 2014, http://www.lockheedmartin.com/us/products/sbirs.html.

24. David Deptula, "Integration Nation," *C4ISR Journal* 11, no. 3 (April 2012): 32.

25. See Christopher J. Bowie, *Destroying Mobile Ground Targets in an Anti-access Environment*, Analysis Center Papers (Washington, DC: Northrop Grumman, December 2001).

26. The Air Force and its industry partners are working this problem. See Amy Butler, "Cross Talk," *Aviation Week and Space Technology* 176, no. 7 (3 March 2014): 24.

27. Amy Svitak and Amy Butler, "Fabulous Opportunity," *Aviation Week and Space Technology* 174, no. 26 (23 July 2012): 41.

28. See Stew Magnuson, "Military Space Communications Lacks Direction, Critics Say," *National Defense*, January 2013, http://www.nationaldefensemagazine.org/archive/2013/January/Pages/MilitarySpaceCommunicationsLacksDirection,CriticsSay.aspx.

29. See Robert P. Haffa Jr., *Full-Spectrum Air Power: Building the Air Force America Needs*, Special Report no. 122 (Washington, DC: Heritage Foundation, 12 October 2012), 18, http://thf_media.s3.amazonaws.com/2012/pdf/SR122.pdf.

30. See Robert P. Haffa Jr., and Michael W. Isherwood, "Long-Range Conventional Strike: A Joint Family of Systems," *Joint Force Quarterly* 60 (1st Quarter 2011): 102–7.

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