



INTELLIGENCE • SURVEILLANCE • RECONNAISSANCE



ISR

*Science & Technology
Strategy*

Air Force Research Laboratory ~ Wright-Patterson Air Force Base ~ Dayton, Ohio

JUN 11 2013

I am pleased to present AFRL's Intelligence, Surveillance, and Reconnaissance (ISR) Science and Technology Strategy. As the Air Force's only organization wholly dedicated to leading the discovery, development, and integration of warfighting technologies, we strive to create the future Air Force through cutting-edge science and technology.

This Strategy, aimed at identifying the Air Force's future research and development goals for ISR S&T, will establish overarching strategic, technical, and resource guidance to respond to critical ISR demands. The end goal will include the transition of unrivaled decision-making capability into the hands of tomorrow's warfighters, ultimately meeting ISR demands and ensuring preeminent ISR on the battlefield.

Today's modern conflicts demand rapid, agile, and assured operations to meet decision support needs across air, space, and cyberspace domains, and all environments from permissive to denied. Synchronizing forces across the three domains in time and purpose for effect is paramount for mission success and a major S&T challenge. The air, space, and cyber domains possess dramatically different characteristics with respect to speed, time, distance, and governing physics and forces. Future ISR S&T will be key in providing our men and women with the very best in operational capability, to ensure mission success anytime, anyplace, anywhere.



WILLIAM N. McCASLAND
Major General, USAF
Commander, Air Force Research Laboratory

Introduction

Our ISR capabilities are key to operating in today's information dominated environment...getting the right information to the right people to make the best possible decisions. And ISR demands will only increase in future conflicts.

— Lt Gen Larry D. James, Deputy Chief of Staff for ISR

ISR is a rapidly changing mission set that is heavily reliant on technology and human analytical capabilities. — Air Force Doctrine Document 2-0

The U.S. Air Force operates the world's premier Intelligence, Surveillance, and Reconnaissance (ISR) enterprise with unique capabilities that are fundamental to the nation's security and defense. The Air Force Research Laboratory's (AFRL) many technical solutions underpin Air Force capabilities across the entire ISR cycle to include planning and direction; collection; processing and exploitation; analysis and production; and dissemination (PCPAD). In supporting Air Force ISR over the last decade, AFRL repeatedly found innovative ways to provide strategic advantage to theater operations. Discoveries include near real-time and forensic tactical situational awareness in day and night operations with the first-ever integration of wide-area motion imagery and signals intelligence; positive impact on multiple significant improvised explosive device defeat discoveries; major advances in satellite data collections, and improvement of tools and data management for analysts.

Consistent with the defense strategic guidance, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*, and in response to the Global Integrated ISR (GIISR) Core Function Master Plan (CFMP) capability requirements, AFRL is committed to Science and Technology (S&T) discovery and the application of science that enables game-changing future capabilities. As part of Air Force Materiel Command's enterprise, AFRL conducts research that provides new and expanded ISR technical options to address new and enduring air, space, and cyber operational requirements. AFRL is the Air Force's S&T agent and will continue

Multi-INT processing, exploitation, and analysis tools for ISR operations



to provide objective assessment of external S&T and potential solutions, as well as support technology maturation that enables technology transition to capabilities.

A significant challenge for Air Force ISR concerns operations in anti-access/area denial environments (A2/AD). AFRL is uniquely positioned to address these challenges through improved sensing, processing, exploitation, data integration, and dissemination technologies. This includes reaching across domains in order to combine the information received from air, space, and cyber sources.

AFRL ISR S&T Vision and Mission

AFRL's ISR S&T vision and mission are driven by several key Air Force and joint documents:

ISR is defined in Joint Publication 1-02, *Department of Defense (DoD) Dictionary of Military and Associated Terms* as “An activity that synchronizes and integrates the planning and operations of sensors, assets, processing, exploitation, and dissemination systems in direct support of current and future operations. This is an integrated intelligence operations function.”

DoD Directive (DoDD) 5100.01, *Functions of the Department of Defense and Its Major Components* directs the Air Force to “Provide timely, global integrated ISR capability and capacity from forward deployed locations and globally distributed centers to support world-wide operations.” GIISR is defined as cross-domain synchronization and integration of the planning and operation of ISR assets; sensors; processing, exploitation, and dissemination systems; and analysis and production capabilities across the globe to enable current and future operations.

JP 2-0, *Joint Intelligence*, provides guidance for conducting joint and multinational intelligence activities across the range of military operations. JP 2-0 defines the intelligence cycle as PCPAD -- Planning and Direction, Collection, Processing and Exploitation, Analysis and Production, and Dissemination. This joint intelligence process is described as tasks in *Chairman of the Joint Chiefs of Staff Manual (CJCSM) 3400.04D, Universal Joint Task List*, which provides a common language and reference system to communicate mission requirements.

Effective Air Force ISR requires synchronization and integration across intelligence sources (INTs), domains, systems, and services. The proliferation of multi-INT data coupled with a limited number of analysts drives the need for AFRL to take a human-centered approach focusing on the analyst.

Vision: Preeminent Air Force Intelligence, Surveillance, and
Reconnaissance Capabilities in All Domains and All Environments

From uncontested to completely denied environments, AFRL sees an Intelligence Community (IC) in great need of increased integration and autonomy; sensing modalities to support longer range and passive sensing; new ways to manage massive data stores; and tools to support both analysis and dissemination of product. The Air Force needs faster, better ways to accomplish ISR missions.

The mission of AFRL is to lead the discovery, development, and integration of affordable warfighting technologies for our air, space, and cyberspace force. The AFRL ISR mission is to discover, develop, and integrate technologies that enable capability solutions for Air Force ISR requirements, as identified in the GIISR CFMP. AFRL will provide Air Force ISR operators with technological choices to meet mission demands.



Pursuer technology provides users a graphical user interface for assimilating multi-sensor imagery and metadata for review in one composite display. (AFRL image)

Tenets Driving the AFRL ISR S&T Strategy:

AFRL has adapted the tenets identified in the overall *Air Force Science and Technology Strategy* to guide the AFRL ISR Strategy:

- **Align, Leverage, and Grow:** Align our S&T with Air Force ISR requirements and leverage DoD, IC, and global S&T developments to create affordable and effective capabilities. Continuously strengthen and grow our ISR competence and enhance our unique ISR research facilities so AFRL continues to develop preeminent ISR capabilities and serve as the S&T agent to the Air Force materiel acquisition enterprise and the broader DoD acquisition community.
- **Shape the Future:** Discover, investigate, and evaluate game-changing ISR technologies and perform S&T to develop, integrate, and demonstrate leap-ahead capabilities that meet documented warfighter needs for contested ISR environments. Lead the effort to optimize the capability of weapons systems for ISR. Through our IC involvement and in-depth understanding of past and present Air Force ISR operations, AFRL will shape the future by providing technological options that underpin future all-domain ISR capabilities.
- **Streamline:** Partner with operational communities to rapidly and affordably transform the art-of-the-possible into force multiplying ISR capabilities spanning air, space, and cyberspace. AFRL must work to accelerate and streamline the ISR technology lifecycle from research and development, to acquisition, fielding, and sustainment.

Environmental Assessment

Air Force ISR has been engaged in wartime and peacetime operations for decades to project U.S. power globally. ISR is often the first capability a combatant commander requests and employs prior to and upon the initiation of military operations. Often it must persist even after major combat operations have ended. Through global integrated ISR, the Air Force will continue to protect America and her interests (Air Force Doctrine Document 2-0).

The Air Force will face unprecedented challenges in future operating environments. Emerging technology, irregular warfare tactics, asymmetric warfare, and anti-access capabilities in air, space, and cyber domains will enable adversaries to disrupt, degrade, and deny certain ISR capabilities. Cross-domain challenges will require cross-domain synergy of ISR capabilities to maintain situational awareness dominance. Multiple classification levels require new ways of sharing appropriate information across security boundaries. In addition, the changing defense posture and declining budgetary resources reinforce the need to synthesize materiel improvements with changes in tactics, techniques, procedures, and training.

Challenges to air dominance and freedom to operate will disrupt current persistent surveillance and lower altitude ISR operations, requiring new airborne ISR capabilities that still provide highly accurate intelligence. These include long-range sensing, passive sensing, stealth, and speed. Complex electronic warfare environments that degrade command, control, communications, and computers will disrupt timely collection and dissemination of ISR information.

Largely uncontested in past conflicts, the increasingly global access to space, proliferation of technologies, and space capability awareness have increased the possibility of disruption of the force multiplying services from space. In addition to creating technologies which are more cost effective with improved capabilities for space-based ISR services, AFRL seeks alternative options for high quality ISR capabilities to combat the increasing risk of possible disruption or denial of service including accurate geo-positional data - a crucial requirement for the targeting of precision-guided munitions. Many other space domain capabilities face similar challenges from any number of potential adversaries. The Air Force must plan for protection of these assets, as well as how to best provide contingent capability in a cost effective way.

The cyber domain offers threats and opportunities with regards to Air Force ISR. The cyber domain is a source of intelligence for Air Force ISR and also has ISR requirements. The Air Force and AFRL cyber strategies are therefore an essential element for protecting and maintaining effective ISR capabilities. The *AFRL Cyber S&T Strategy* guides the AFRL cyber portfolio across air, space, and cyberspace.

Contested environments compress decision timelines, which make the relevance and timeliness of ISR products ever more critical.



Fusion research in the areas of sensors, human effectiveness, and information contributes to data exploitation & reasoning tools.

These products must be tailored to meet the requestor's requirements in order to successfully achieve the commander's objectives. Additionally, ISR requirements should be timely enough to plan and execute effective operations. Intelligence resulting from timely ISR can provide information to aid a commander's decision-making and constantly improve the commander's understanding of the dynamic operational environment. Air Force ISR strategy will require technology improvements to further integrate cross-domain sensing capabilities, including technology to improve automated support to analysts to shorten timelines from tasking through product dissemination.

The Air Force requires a complete assessment of the impact that any new ISR capability will have on the IC - both in what the new capability will provide to the IC and in what the new capability will require of the IC. This is accomplished through early performance of Intelligence Supportability Analysis (ISA) per AFI 14-111, *Intelligence in Force Modernization*. Failure to assess the intelligence needs of a new capability leads to costly

changes further along in development. Therefore, AFRL considers ISA for ISR research efforts and increases the depth of ISA as a technology matures. Likewise, AFRL recognizes the exponentially increasing demands of weapon systems for intelligence mission data (IMD) to enable mission capability. AFRL is committed to developing the S&T that reduces system dependency on IMD and enables systems to be more self-sustaining.

Modernization cycle times for ISR capabilities are tied to rapidly increasing computer and communications capabilities, and the DoD faces challenges in its efforts to transition technology and field capability, taking advantage of the latest advances in technical capabilities. Two of the key processes facilitating technical transition planning, the CFMP process and Applied Technology Councils, are maturing and changing. AFRL must work with transition partners impacting the entire PCPAD cycle from sensor platforms to dissemination systems. For tools and analysis capabilities, the Air Force Distributed Common Ground Station (DCGS) is the Air Force’s intelligence weapon system and is the logical primary transition point for analysis capabilities. AFRL is committed to finding the right balance between distributed and forward Processing, Exploitation, and Dissemination (PED) concepts.

Regardless of the environment in which the U.S. Air Force will be required to operate, the goal remains the same – getting the right information to the right person at the right time.

ISR S&T Strategic Objectives:

Based on the environmental assessment and on current defense strategic guidance, providing responsive ISR will require pushing the boundaries of S&T in order to succeed in the future strategic environment. Table 1 captures AFRL’s major near-, mid-, and far-term strategic thrusts for the PCPAD cycle.

Table 1: Major S&T Strategic Thrusts for the PCPAD Cycle

Joint Intelligence Cycle (JP 2-0)	Near (Current FYDP ¹)	Mid (Next FYDP)	Far (FYDP After-Next)
Planning and Direction	Accurate, timely assessment of current ops across air, space, & cyber	Synchronize kinetic/ non-kinetic air, space, & cyber forces across full spectrum of conflict	Proactive Integrated Command and Control ISR Planning in A2/AD environments
Collection	Enhanced ISR and Combat Identification at long standoff ranges	Difficult targets and highly contested environments	Enabling technology for penetrating platforms
Processing and Exploitation	Movement from Permissive to Contested Environments	Real-time Sensor Exploitation in Contested Environments	Autonomous Sensing and Exploitation for Targeting in Denied Environment
Analysis and Production	Improved Data Access Across Systems and Classification Levels	Autonomous Management/Retrieval of Global Data	Enable End-to-End Multilayer Fusion for A2/AD Environments
Dissemination	Shifting focus from Permissive to Contested Environments	Enhanced net-centric operations in contested environments	Resilient, Fractionated End-to-End Info Mgmt for A2/AD environments

¹ Future Years Defense Program (FYDP)

Three S&T strategic goals have been identified to ensure forces retain the ability to quickly and efficiently gather and share information to enable battlespace awareness. These goals will enable AFRL to focus its ISR S&T efforts and drive toward achieving its vision:

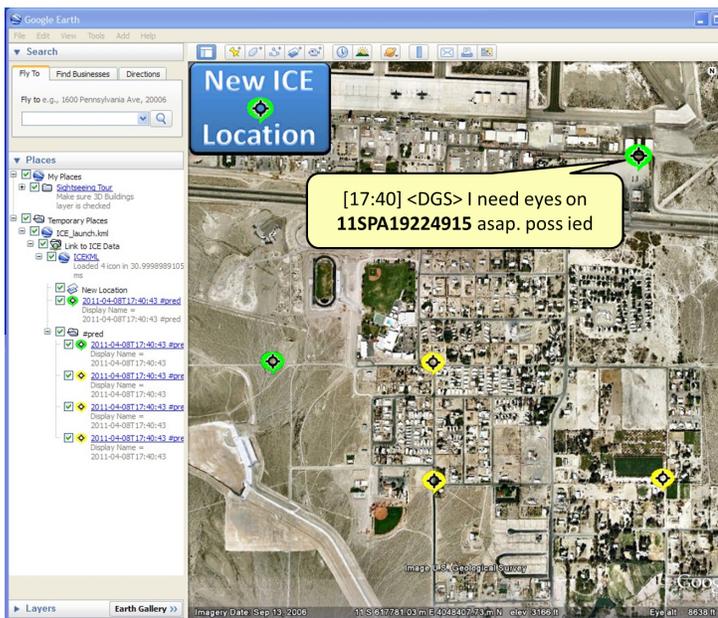
- **Advance ISR Technologies:** Advance S&T and apply new technologies to enable Air Force ISR operations in the A2/AD environment while preserving a reasonable level of investment in research supporting the permissive environment.

- **Increase Analyst/Operator Effectiveness:** Increase the effectiveness of Air Force analysts/operators by developing and integrating adaptable autonomy, effective human-machine teaming to augment Air Force ISR personnel, persistent and penetrating sensing capabilities, modern architectures, more efficient data management, and analyst/operator tools.
- **Leverage Partnerships:** Partner effectively with industry, coalition partners, academia, and other DoD and national labs to find the most cost-effective solutions for Air Force ISR needs and gaps.

Strategic Goal #1: Advance S&T and apply new technologies to enable Air Force ISR operations in the A2/AD environment while preserving a reasonable level of investment in research supporting the permissive environment.

The GIISR CFMP documents Air Force ISR needs across air, space, and cyber domains and includes needs related to both permissive and A2/AD environments. Through robust response to the GIISR CFMP, AFRL will integrate existing research to solve near-term and mid-term problems and will identify new research required to solve the most challenging problems and to serve as the foundation for long-term future solutions.

AFRL will demonstrate advanced technologies that address each element of the PCPAD cycle to achieve integrated outcomes in any environment. This includes material options and tactics to counter an adversary’s electromagnetic threats to ISR capabilities attempting to deny Air Force freedom of action, as well as access and operations in uncontested areas. AFRL will create technology options to achieve persistent and penetrative surveillance and integration of information to ensure decision superiority in the contested and denied air, space, and cyberspace of any adversary. This will include an intense focus on identifying and effectively leveraging all sources of intelligence such as operational reconnaissance sources like fighter aircraft sensors and weapons sensors.



Internet Relay Chat Coordinate Extractor (ICE) software tool monitors operational chat rooms for geospatial information and automatically plots that information in various mapping programs, such as FalconView and Google Earth.

Addressing the A2/AD environment will require increased emphasis on air, space, and cyberspace ISR and the leveraging of IC, civil, and commercial assets. AFRL will develop and transition innovative high payoff space technologies supporting the warfighter, while leveraging commercial, civil, and other government space capabilities to ensure America’s advantage. This will require working across the entire U.S. and coalition space enterprise to ensure the DoD has the technology needed to maintain air, space, and cyberspace superiority and an ISR advantage.

Current defense strategic guidance changes DoD’s focus from the uncontested, irregular, land-based wars to a future contested, state-backed, sea-rimmed conflict - a swing toward the Asia-Pacific region. ISR needs will become even more demanding in more difficult and complex scenarios. This shift and the associated focus on the contested environment finds AFRL well-invested in supporting the A2/AD environment. As with all other GIISR CFMP priorities, AFRL subject matter experts have been in tune with mission needs and have quite appropriately been doing research with broader applicability to include contested environments.

AFRL invests about \$200M per year of Air Force funding on S&T supporting Strategic Goal #1. The Sensors, and Information Directorates, and 711th Human Performance Wing contribute a significant portion of their budgets, manpower, and facilities to this goal. Other directorates such as Aerospace Systems, Materials and Manufacturing, and Space Vehicles also support Air Force ISR with new technologies to enable operations in the A2/AD environment.

Strategic Goal #2: Increase the effectiveness of Air Force analysts/operators by developing and integrating increased and adaptable autonomy, effective human-machine teaming to augment ISR personnel, machine-to-machine autonomy where appropriate,

persistent sensing capabilities, modern architectures, more efficient data management, and analyst/operator tools.

Within the PCPAD cycle, a special focus on intelligence analysts is essential in order to increase analyst efficiency, improve analysis products, and shorten timelines for the PCPAD cycle. Whether in the data rich environment to which Air Force analysts have become accustomed in the current fight or in the alternate data source environments expected in future engagements, the analyst is key to converting sensor data to finished intelligence products. We cannot, nor do we want to, replace the essential function provided by the analyst. We also recognize that in many cases it is the inherent human limitations of the analyst which become the bottleneck in the cycle so we must always consider the analyst in the process. AFRL will continually define and evaluate the integration of ISR capability in relationship to intelligence analysts.

AFRL research is not limited to materiel solutions. In many cases, AFRL research, especially human effectiveness research, may lead to recommendations for changes in tactics, techniques, and procedures (TTP). This may at times be the most effective solution, especially for the near-term. AFRL will continue to use and improve virtual environments, such as its PCPAD-X (Planning and Direction, Collection, Processing and Exploitation, Analysis and Production, and Dissemination-eXperimental) testbed to develop new materiel solutions, as well as TTP improvements.

AFRL will leverage the unique breadth of competencies in sensor, human effectiveness, information, material and manufacturing technologies, and space and vehicle platforms to develop technology solutions addressing the entire ISR cycle. This includes improved modeling and planning tools to plan ISR missions; human-centered analyst augmentation methods and technologies; automated tools and analyst visualization software to conduct the mission; and tools to cull through post-mission data.

AFRL invests over \$100M per year in processing, exploitation, and decision support. Technical contributions from Sensors and Information Directorates, and 711th Human Performance Wing make up the bulk of this investment. Results are focused on GIISR CFMP needs and operational capability solutions are primarily aimed to transition into the DCGS, the Air Force weapon system for intelligence. AFRL partners closely with Air Force ISR Agency and with the sustainment center for DCGS. AFRL solutions also transition to airborne ISR platforms, AOCs, NASIC, and joint customers.

Strategic Goal #3: Partner effectively with industry, coalition partners, academia, and other DoD and national labs to find the most cost-effective solutions for Air Force ISR needs and gaps.

As the technology arm of the Air Force, AFRL will continue to conduct world-class in-house research and will also:

- **Inform:** AFRL will inform industry, coalition partners, academia, other-service labs, national labs, etc. of Air Force ISR needs and of Air Force S&T planning to ensure we are drawing from a multitude of technology sources to address Air Force ISR needs.
- **Partner:** AFRL will partner with technology sources to leverage independent research and development funds (IR&D) in industry, to provide challenges to academic institutions, and to connect with other government funded labs to ensure we apply their research results to Air Force needs.
- **Drive:** AFRL will roadmap and track progress toward meeting capability deliveries in the GIISR CFMP. We will exploit emerging technologies to develop improved processing (size, weight, and power) and communications connectivity (reliability, higher bandwidth, lower power, and improved distances) needed for ISR sensing and data management, and work with industry partners to build the robust manufacturing base necessary to ensure these technologies can be affordably acquired. AFRL will support the technical evaluation of new technologies and new TTP improvements to ensure measureable mission improvements. AFRL will develop and transition innovative high payoff space technologies supporting the warfighter, while leveraging commercial, civil, and other government space capabilities to ensure America's advantage.

Air Force Office of Scientific Research (AFOSR) funds \$60M per year in basic research supporting solutions to Air Force ISR needs. In-house basic research support by AFOSR addressing Air Force ISR needs is executed through the Sensors, Information, and Space Vehicles directorates and 711th Human Performance Wing. These directorates ensure alignment with Air Force ISR needs while maintaining innovative research for tomorrow's Air Force. AFRL informs the GIISR core function team of future projected capability allowing them to forecast operational needs based on the art of the possible. AFRL also executed over \$100M of Intelligence Advanced Research Projects Activity (IARPA) funding in FY12, and AFRL work with IARPA is trending upward. Over \$200M of Defense Advanced Research Projects Agency (DARPA) funding is executed by AFRL and applied to Air Force ISR. An additional \$200M is leveraged from the combination of Joint Improvised Explosive Device Defeat Organization, Air Force Life Cycle Management Center, and the IC. This total comes to over \$500M that AFRL typically leverages to the benefit of ISR.

Summary

AFRL fully understands its role in supporting a properly balanced ISR force structure for the USAF. AFRL must, with all its S&T capability, underpin ISR capabilities necessary in a future world where the air, land, sea, space, and cyber domains are partially or highly contested, either independently or simultaneously. This AFRL ISR Strategy is guided by multiple guidance documents including *Technology Horizons*, *the Air Force S&T Strategy*, *the Air Force S&T Plan*, *DoD Guidance*, *the 2012 Posture Statement*, and the *USAF GIISR CFMP*. AFRL strives to balance the immediate ISR technology needs of the warfighter with investments in cutting edge S&T that will lay the groundwork for future warfighter capabilities.

AFRL pursues a truly joint approach to S&T as we collaborate and leverage the resources and talents of our Defense Services and Federal Agencies in support of both Air Force technology needs and the joint mission. As the Air Force's materiel acquisition enterprise technology agent of the Air Force, AFRL will find, apply, or develop capabilities addressing the ISR needs of the Air Force for all domains.

References

- Sustaining U.S. Global Leadership: Priorities for 21st Century Defense, January 2012*
- USAF Global Integrated Intelligence, Surveillance & Reconnaissance Core Function Master Plan*
- Global Integrated Intelligence, Surveillance & Reconnaissance Operations, Air Force Doctrine Document 2-0, 6 January 2012*
- Air Force Science & Technology Strategy, 2010*
- Air Force Research Laboratory Cyber Science & Technology Strategy, 2012*
- United States Air Force Posture Statement, 2012*
- Air Force Priorities for a New Strategy with Constrained Budgets, February 2012*
- Strategic Environmental Assessment, 2010-2030*
- Air Combat Command Strategic Plan, 2012*
- Air Force Science & Technology Plan, 2011*

AFRL partnered with other military branches and industry to develop the Speckles aircraft/sensors package which provides preliminary knowledge of where to patrol. Many times Speckles has helped troops look in the right spot for IEDs and to disarm them in a timely fashion.

