THE 2010 FLC MID-CONTINENT REGION ANNUAL AWARDS SAND2010-4754P

Nomination Form

Please note the specific criteria for the nominated award.

I nominate the following individual, technology, or organization for the following award (please √):

- ❑ Regional Laboratory Award
- ❑ Representative of the Year Award
- ❑ Notable Technology Development Award
- ❑ Regional Partnership Award
- ❑ STEM Mentorship Award (New Category!)
- ☒ **Excellence in Technology Transfer**

Nomination submitted by: Jackie Kerby Moore
Affiliation: Sandia National Laboratories
Phone: 505-845-8107 FAX: 505-844-1389 E-mail: jskerby@sandia.gov

Nominee's Name: Armin Doerry, Mike Knoll, Jim Hudgens, Surveillance & Recon. Systems Dept. (Sandia); Colin Smith Peter, Radar & Signal Analysis Dept. (Sandia); John Fanelle, Jean Valentine (General Atomics, Aeronautical Systems, Inc.)
Affiliation: Sandia National Laboratories and Generator Atomics
Laboratory Director/CEO or Point of Contact: Paul Hommert T#/email: 505-844-8789, pjhomme@sandia.gov

Basis for the nomination. Summarize in space below. Up to two additional pages of written justification may be appended. Total nomination should not exceed **two pages**, Times 12 pt, 1 ½ line spaced. Artwork, photographs are ***strongly*** encouraged and are not included in the page count.

Sandia National Laboratories-General Atomics Strategic Partnership

Basis for Nomination – Excellence in Technology Transfer

Sandia's Synthetic Aperture Radar (SAR) is a prime example of how technology transfer and commercialization was intended to work when the National Competitiveness Technology Transfer Act passed in 1989. Funded solely by the American taxpayer via DOE and DoD during the 1980s through the mid-90s, SAR matured to the point of attracting substantial additional funding from private industry partners, and in particular General Atomics (GA) (www.ga.com).

Environmental monitoring, earth resource mapping, and military systems require broad-area imaging at high resolutions. Many times imagery must be acquired in inclement weather, sandstorms, fog, or at night. SAR provides such a capability, which can be applied to treaty verification, nonproliferation, reconnaissance, and surveillance. Sandia's fruitful partnership with GA began in 1996, when the San Diego-based company set out to develop an advanced, light-weight SAR system. Searching the early internet, they discovered a site about SAR, created by Sandian Armin Doerry. It discussed Sandia's pioneering SAR development work for the Army.

Before the Sandia team had boarded their flight home following a proposal meeting with GA, one of its representatives let the Sandians know GA wanted to proceed with a radar development partnership. That led to a work-for-others agreement. In 2007, a CRADA was established to grow the partnership and continue development of the Lynx® SAR, a radar that provides unmatched performance for reconnaissance and surveillance in adverse weather conditions.

Sandia and GA continue to improve the Lynx® SAR as an integrated team across the two organizations. These improvements are addressing the urgent needs for currently deployed aircraft in the war on terror. This enduring partnership will continue to grow the U.S. economy and bolster national security. In fact, Sandia's CRADA, which is specifically with General Atomics-Aeronautical Systems, Inc. (www.ga-asi.com), was recently amended and its term extended through the middle of 2011.

Criteria Part A – Background and Technology Transfer Process

1. Description of Technology and Transfer (30points)

- What technology was transferred?
- Briefly describe features of the technology, benefits, and limitations.
- Who or what was the recipient of the transferred technology?
- Why was the technology needed?
- What problem was solved by the technology?

General Atomics (GA) builds the high-performance Lynx® family of Synthetic Aperture Radar (SAR) and Ground Moving Target Indicator (GMTI) radar systems. Sandia formed a strategic partnership with GA since 1996 when Sandia first designed the original Lynx® radar for GA. Since then Sandia and GA have collaborated on numerous enhancements to this leading edge system providing unmatched Intelligence, Surveillance, and Reconnaissance (ISR) capabilities. To date, approximately 150 radars have been delivered to various U.S. Government and Military customers, and flown on numerous manned and unmanned aircraft.

The original Lynx® radar was developed from Sandia background IP and delivered to GA in 1999. This included novel advanced hardware, software, and radar algorithms. Since then the partnership has continuously developed enhancements to this system. Sandia's role varied from providing complete solutions to providing foundational IP that was then further advanced by GA.

Environmental monitoring, earth resource mapping, and military systems require broad-area imaging at high resolutions. Many times the imagery must be acquired in inclement weather, sandstorms, fog, or at night. Synthetic Aperture Radar (SAR) provides such a capability. SAR systems take advantage of the long-range propagation characteristics of radar signals and the complex information processing capability of modern digital electronics to provide high-resolution imagery. SAR complements photographic and other optical imaging techniques because of the minimum constraints on the time of day and atmospheric conditions and the unique responses of terrain and cultural targets to radar frequencies.

SAR technology has provided terrain structural information to geologists for mineral exploration, oil spill boundaries on water to environmentalists, sea state and ice hazard maps to navigators, and reconnaissance information to military operations. There are many other applications or potential applications. Some of these, particularly civilian, have not yet been adequately explored because lower-cost electronics are just beginning to make SAR technology economical for small-scale uses.

2. Initiation of Technology Transfer Partnership (5 points)

- Was the partnership for the technology initiated by the laboratory, the company or other entity?
- What were the roles and expectations of each partner?

In 1996 General Atomics Aeronautical Systems, Inc. (GA-ASI) wanted to develop an advanced, light-weight SAR system. Searching the early Internet, they discovered a public Sandia site about SAR. Sandia had been developing SAR since the mid-1980's, making record-breaking images since the beginning, and gradually adding features and tweaking performance since.

GA-ASI had been producing the RQ-1 Predator UAV for the Air Force, using an older, less capable version of SAR. General Atomics was the prime contractor on the UAV, itself, and all systems except the TESAR. The existing SAR did not integrate well into the rest of the systems, requiring its own separate ground station equipment and displays.

Montage to the left: The Lynx® radar is light enough to fit into small unmanned aerial vehicles such as (from left) Prowler, I-GNAT, Predator.

So GA-ASI considered making its own SAR. However, they talked with the Sandia team in August of 1996, sharing concepts and rough ideas for a possible agreement or partnership. That led to General Atomics funding a Work-for-Others agreement, focused on building a SAR that could be better integrated with the rest of the Predator's sensor systems, and could provide better and finer resolution images than the existing model. Then in 2007, a CRADA was established between Sandia and General Atomics.

3. Technology Transfer Processes and Innovations Used (5 points)

- What technology transfer processes (e.g. CRADAs, patents, licensing) were used to transfer the technology?
- To what extent did the federal laboratory fund the technology transfer effort?
- Describe any innovation or creativity demonstrated by the nominee(s) in transferring the technology.

In 1996, General Atomics funded a Work-for-Others (WFO) agreement with Sandia, which already had a sophisticated SAR, to implement an enhanced design as a commercial product and deliver two prototype units together with licenses and manufacturing information to produce the unit. The agreement built upon an array of Sandia's intellectual property at the time. The analog receiver structure, the processor architecture, and the real-time motion compensation algorithms all derived from earlier work at Sandia. In the ensuing years, the WFO agreement was amended seven times, and in 2007 a Cooperative Research and Development Agreement (CRADA) was established, which has been amended to add new tasks, most

recently in February 2010. This CRADA has both exploited Sandia background IP and created new IP. Background IP is in the form of licensed patents and copyrighted software. Today the strategic partnership has developed into mutually beneficial relationship, with IP flowing in both directions.

4. Time Frame Challenges (5 points)

- What was the time frame for the transfer? As succinctly as possible, provide a short outline of the events that led to technology transfer.

The GA/Sandia relationship began in 1996 and continues today. GA and Sandia have committed to continue to maintain and grow this unique relationship indefinitely.

5. Patents (5 points)

- Are there any pending patents or patents involved in this technology transfer?

Yes, a variety of patents already are being applied to this technology. See that listing in the box immediately below.

Patent No. 5,608,404—"Imaging Synthetic Aperture Radar." ***Small, real-time, synthetic aperture radar using phase rotations and overlapped subaperture processing to correct for motion through resolution cells.***

Patent No. 6,469,661—"Correction of I/Q Channel Errors Without Calibration." ***Means of correcting imbalances in quadrature demodulators.***

Patent No. 6,614,813—"Multiplexed Chirp Waveform Synthesizer." ***Multiplexed chirp synthesizer for RADAR.***

Patent No. 6,864,827—"Digital Intermediate Frequency Receiver Module for Use in Airborne SAR Applications." ***ADC dithering technique employing out-of-band noise, oversampling, and digital filtering (DRX).***

Patent No. 7,391,357—"Correction of Motion Measurement Errors Beyond the Range Resolution of a Synthetic Aperture Radar." ***Autofocus correction of excessive migration in SAR images.***

Patent No. 7,397,418—"SAR Image with Azimuth Interpolation After Azimuth Tranform." ***A fast polar format algorithm for SAR images using a post-azimuth transform interpolation kernel.***

Patent No. 7,498,968—"Synthetic Aperture Design for Increased SAR Image Rate." ***Sandia VideoSAR algorithm.***

Patent No. 7,551,119—"Flight Path-Driven Mitigation of Wavefront Curvature Effects in SAR Images." ***Wavefront curvature correction in SAR images for arbitrary flight path.***

Additional patents expected for application in the near future. There also are some applicable patents pending.

1. New Relationships Formed as the Result of the Transfer (5 points)

GA's Lynx® family of high-performance radar systems containing Sandia IP are flying in numerous U.S. Government and military manned and unmanned aircraft. More than 150 systems have been delivered, which means that as a result of this long-term strategic tech transfer partnership a variety of specific users form the roster of new relationships formed and continuing relationships enhanced. They include U.S. Air Force, Army, and Navy; DHS Customs and Border Patrol; NASA, as well as a number of U.S. allies and coalition partners. These systems are widely regarded as premier ISR assets. Current developmental activities are continuously bringing on line new capabilities, enhancing our national security, both at home and overseas.

2. Outcome of the Technology Transfer Effort (45 points)

- What was the result of the technology transfer effort—a commercial product, CRADA, positive impact in the community or public sector, spinoff company, license etc.?
- What agreements are pending and/or final regarding this technology?
- What are the tangible benefits of the transfer?
- What future benefits are expected from the transfer?
- Wherever possible, provide quantitative data. This includes: creation of a new industry, development of a new product, community/public sector impact, higher profit margins, cost savings, improved health and safety, environmental benefits, etc.

The result of the most recent technology transfer effort associated with the General Atomics Strategic Partnership with Sandia National Laboratories was the development of the Lynx® SAR, now placed in more than 100 UAVs purchased by the U. S. Department of Defense and State Department. These new SAR systems enhance the surveillance capability of the General Atomics Aeronautical Systems, Inc., UAVs and other reconnaissance aircraft, which previously were equipped only with cameras, infrared sensors, and older-generation SAR equipment.

Sandia researcher Bill Hensley checks the Lynx synthetic-aperture radar (SAR) installed on a General Atomics I-GNAT unmanned aerial vehicle.

The Lynx® radar package provides unmatched performance for reconnaissance and surveillance in adverse weather conditions and is light enough to fit into small UAVs. Important features of the Lynx® SAR are the following:

- Available as a commercial off-the-shelf (COTS) sensor
- Designed for use in UAVs and manned platforms
- State-of-the-art technology at Ku-band frequency
- Ability to zoom in on targets
- Real-time video and digital displays
- Image formation on board the aircraft

General Atomics has implemented production of SAR units for commercial sales to other governments and corporations, subject to strict Export Controls.

Sandia and General Atomics continue to explore ways to improve the Lynx® SAR. The strategic partnership between Sandia and General Atomics is expected to continue indefinitely.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94AL85000.