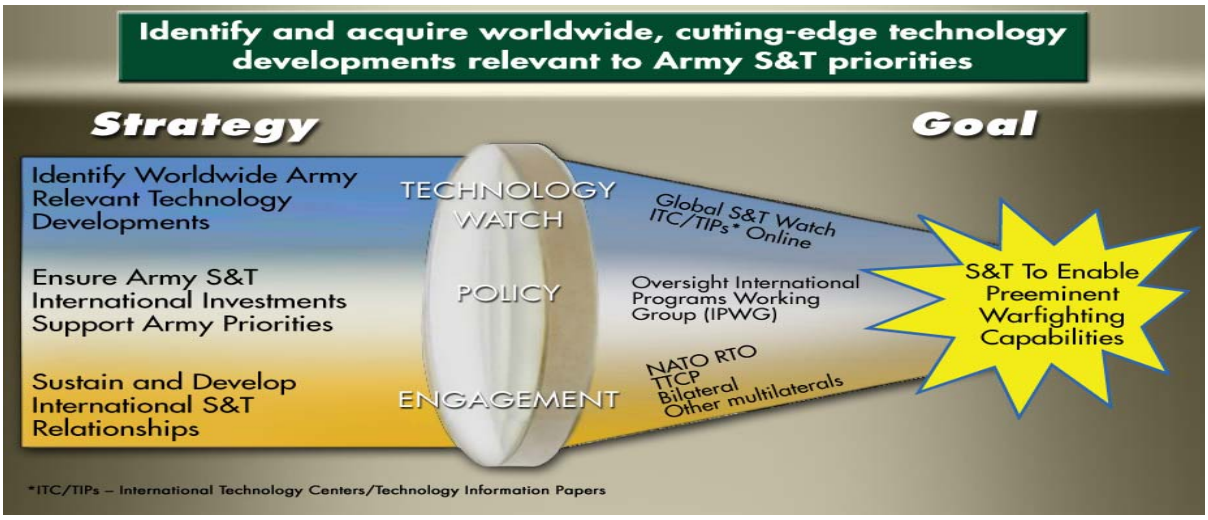
ANNEX B
INTERNATIONAL SCIENCE AND TECHNOLOGY: GLOBAL SCIENCE AND TECHNOLOGY WATCH

The Army science and technology community pursues world-class research and technology to enhance warfighting capabilities of U.S. military forces and to improve joint and coalition force effectiveness. This annex presents the Army's international S&T strategy and its major thrusts of Global S&T Watch (GSTW), which assesses the relevance of foreign technology, and describes how the Army enhances relationships with the scientific communities of our allies. The Army identifies foreign technologies of interest and acquires those most relevant to Army priorities and those that support interoperability. When foreign governments develop relevant technologies, the Army actively seeks collaborations to leverage their technology developments and enhance relationships with their scientific communities. The challenge is to focus international armaments cooperation on research and technology developments that address Army priorities, substantially contribute to Army's S&T needs, and improve technical capabilities among those seeking to advance the state of the art for improved interoperability.

The international S&T strategy (Figure B–1) provides the framework for identifying and acquiring foreign science and technology of interest to the Army. Through the GSTW program, the Army uses a systematic process for identifying foreign S&T developments of potential interest. When foreign-developed technologies reside in the public sector, government-to-government collaborations are proposed to co-develop or acquire the technologies of interest. The International Programs Working Group (IPWG) provides leadership visibility and oversight to ensure that new international S&T collaborations are focused on Army priorities. Successful international collaborations depend on identifying areas of mutual interest and building trust with our partners. Through selected engagement initiatives, the Deputy Assistant Secretary of the Army for Research and Technology/Chief Scientist (DASA(R&T)) has enhanced the Army S&T community's relationship with selected allies, the NATO Research Technology Organization, and The Technical Cooperation Program (TTCP). The success of the Army's international engagements, collaborations, and ultimately our relationships with our allies is vital to our nation's security and the Army's ability to effectively conduct coalition operations.



International S&T strategy seeks to advance U.S. military dominance by identifying and acquiring cutting-edge technologies and to promote interoperability by sharing technology approaches.

Figure B–1. International Science and Technology Strategy

A. TECHNOLOGY WATCH

As a requirement of the Army Technology Objective nomination and approval process, S&T program developers must assess the utility and potential contributions of relevant non-Army technology programs to assure Army resources are spent on new technology developments that will enhance warfighter capabilities. The Army's GSTW program provides Army users information on relevant foreign S&T developments to meet ATO nomination requirements for assessing relevant foreign technologies.

The GSTW program provides Army scientists and engineers real-time access to a knowledgebase of foreign technologies as identified by the Research, Development, and Engineering Command (RDECOM) international technology centers (ITCs) and documented in technology information papers (TIPs). The TIPs-o-Line (TOL) knowledgebase provides a dynamic, real-time S&T information source that allows remote access and data retrieval through an Army Knowledge Online (AKO)-enabled portal (https://tips.altess.army.mil) as shown in Figure B–2. Each TIP provides a summary description of the foreign technology, an assessment of its potential utility, relevance, and overall quality as compared to the state of the art. The S&T technology assessments are subjective, but in general adhere to the following factors:

- ***Comparative demonstrated technical performance.*** Technologies are examined for materials, components, or systems produced indigenously, relative to best U.S. practice.
- ***Indicators of recognized quality.*** Commercial and defense products are based on the technology's market share or impact on research and technology as judged by citations of the work in referenced journals.
- ***Maturity and level of investment.*** The technology's current level of maturity (expressed as a technology readiness level (TRL)) and the sponsoring organization's current level of investment in maturing this technology are considered.
- ***Expert consensus.*** U.S. Army subject-matter experts review the analyses for technical accuracy and relevance to U.S. Army needs.

Figure B–2. TIPs-on-Line and Global Science and Technology Watch Home Page

The GSTW program's systematic approach for assessing the relative value of foreign technology developments has strengthened the process of international S&T cooperation by building consensus within the Army's scientific, international, and intelligence communities. Through enhanced dialog among these communities, the quality of foreign collaborative technology developments has been improved by reaching a common understanding on S&T priorities and the development of an accepted methodology to assess the value of foreign technology. These assessments are summarized online at https://tips.altess.army.mil.

A snapshot of the country capabilities as reflected by the TIPs' technology assessments is shown in Table B–1. This table provides an overall assessment of country capabilities derived from TIPS and the country summaries in the GSTW, as verified and supported by information used in the preparation of those summaries. Additional details can be found at https://tips.altess.army.mil.

Table B–1. Comparing Country Technical Capabilities Based on an Assessment of Technology Leveraging Opportunities

	APPLIED TECHNOLOGY	RESEARCH CAPABILITIES
♦♦♦♦ **World-Class S&T Capabilities** The country has strong and broad capabilities in most aspects of major technology or research areas, a significant academic and industrial infrastructure facilitating the integration of technologies into new or improved military capabilities, and world-class capabilities in identified major areas.	Canada France Germany Israel Japan United Kingdom	Canada France Germany Israel Japan United Kingdom
♦♦♦ **Significant S&T Capabilities** The country has significant capabilities in some aspects of the major technology or research areas with an academic and industrial infrastructure providing a limited capability to develop new or improved military capabilities, but does not have the breadth, depth, or capability to challenge world leaders across the militarily relevant research and technology areas.	Australia Italy Netherlands Russia Singapore South Africa South Korea Sweden Switzerland	Australia Italy Netherlands Russia Singapore South Africa South Korea Sweden Switzerland
♦♦ **Niche S&T Capabilities** The country has capabilities in a few niche technology or research areas that could beneficially contribute to U.S. Army S&T activities, but does not have a broad academic or industrial base, thereby limiting the ability to develop significant new capabilities.	Austria Belgium Czech Republic Denmark Finland Georgia Iceland India New Zealand Norway Poland Slovakia Spain Taiwan Ukraine	Argentina Austria Belgium Brazil Bulgaria Chile Czech Republic Denmark Finland Greece Hungary India Ireland Mexico New Zealand Norway Poland Spain Taiwan Ukraine

Validated against the GSTW TOL database.

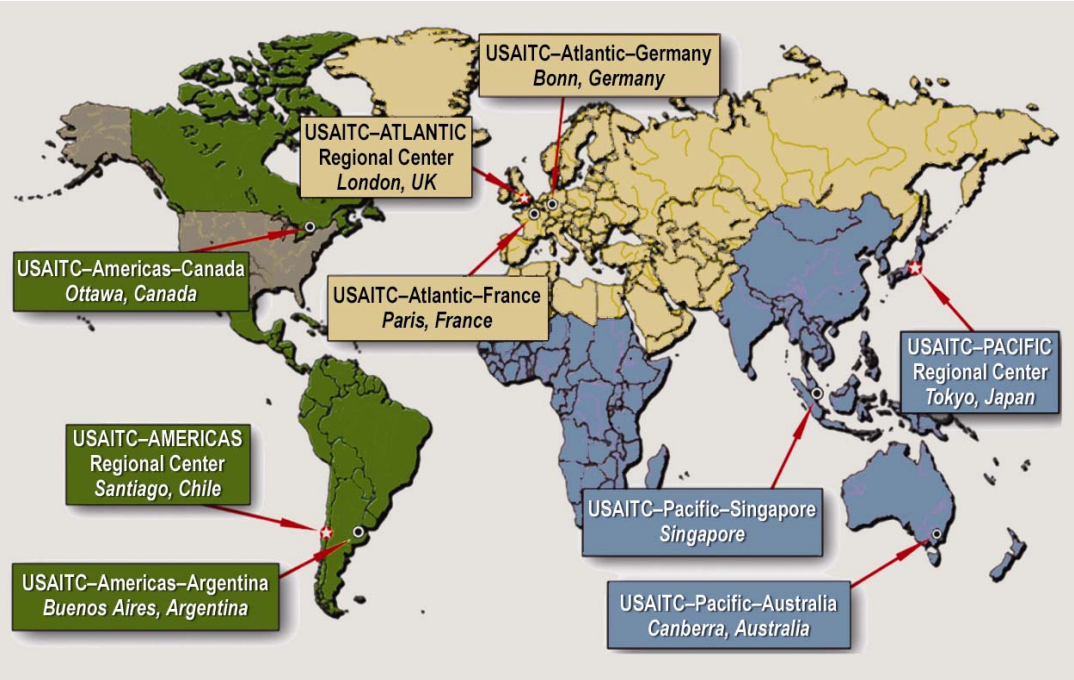
The Army, working with its sister Services, has explored the potential for sharing information on foreign S&T research and development among the Services. Using the GSTW program as a model, a tentative agreement was reached by the Services on a standardized data structure for future data sharing. This proposed standardized data structure, along with the GSTW's net-worthy application on AKO, provides the department with a knowledge management approach, compatible with Defense Knowledge Online, that has the potential to enhance the visibility and availability of Services' reports on foreign S&T developments.

1. U.S. Army Foreign-Based Technology Centers and Research Laboratories

The U.S. Army Medical Research and Materiel Command, Army Corps of Engineers, Space and Missile Defense Command, and Army Material Command, with its research, development, and engineering centers and laboratories, have extensive international investments with numerous foreign partners from both the private and the public sectors. RDECOM and USAMRMC have established overseas offices to maintain cognizance of foreign S&T developments or to conduct research.

2. International Technology Centers

The Army's ITCs and foreign-based laboratories are charged with identifying and documenting information on foreign S&T developments of potential interest to the Army and facilitate collaboration or acquisition as required. The U.S. AMC RDECOM ITCs have been aligned with the regional combatant commands—to support a more joint perspective—for expansion into new geographic regions and increasing their interaction with foreign industry and academia (Figure B–3).



The ITC's mission is to identify and facilitate acquisition of cutting-edge S&T that provides "boots on the ground" in support of the Current Force and Future Force.

Figure B–3. International Technology Centers

These outside the continental United States RDECOM organizations are responsible for identifying and documenting information on foreign S&T developments of potential interest to the Army. TIPs are structured to capture essential information about the nature, quality, and maturity of foreign S&T activities as they relate to Army needs. The TIPs are electronically documented and retrievable through the web-based GSTW AKO/DKO portal.

An example of an international technology find is "green" energetic materials—a new class of environmentally friendly, highly energetic materials developed by German researchers (Figure B–4). Thomas Klapötke, Professor of Chemistry at Ludwig Maximilians University, Munich, Germany, described a new series of compounds based on hydrazine, tetrazole, and biuret moieties. Many research groups are looking into new explosive materials because the conventionally used materials often produce environmentally harmful byproducts and can be easily detected by satellite or radar.

Green energetic materials, developed in Germany, eliminate harmful environmental byproducts from fuels and explosives.

Figure B–4. International Technology Find

Rockets, missiles, and spacecraft are powered by solid propellants composed of a mixture of chemicals and metals. Upon combustion, these fuels emit hydrochloric acid and aluminum oxide, which are linked to acid rain, damage to the ozone layer, and destruction of plants. Researchers working with the German army are trying to develop alternative fuels and explosives that emit less noxious fumes. Dr. Klapötke said they were trying to replace conventional explosives containing chlorine and metals with ones that contain only nitrogen, oxygen, and carbon. Such chemicals would be converted into "hot air" upon combustion, eliminating environmentally harmful byproducts.

Establishing an Army presence and extending outreach into major international S&T activities, the ITC's recent significant accomplishments include:

- Government, industry, and academic forums:
  - ITC Americas supported the Western Hemisphere Information Exchange Program technology exchanges in environmental protection and remediation, renewable energy, increased capabilities for forward operations, humanitarian relief efforts, and other civil

applications. These efforts enhanced security cooperation and have the potential to reduce costs and logistics footprint in future joint operations.

- ITC Americas sponsored three workshops covering advanced materials (Mexico), unmanned vehicles/systems (Panama), and micro air vehicles (MAV 2008) (India) that provided a forum for information exchange.

- Identifying, leveraging, and acquiring foreign technologies:

  - ITC Atlantic facilitated ARL's leveraging of unique expertise at the University of Nottingham in power electronics, development of algorithms and advanced electronics for motor drive control, and new control methods for employing a pulsewidth modulation/genetic algorithm. These technologies support platform demonstrations designed to mimic hybrid electrical engines in future combat vehicles.

  - ITC Atlantic sponsored a demonstration of a German micro unmanned aerial vehicle (UAV), the Fancopter (Figure B–5 on page B–12), at the request of the Rapid Equipping Force and U.S. Army, Europe. This user-friendly, turnkey, commercial-off-the-shelf (COTS) system is suitable for use in urban operations and is currently in use by the German police.

  - As a result of an ITC Atlantic seed project on autonomous operations, a French autonomous tandem UAV was successfully demonstrated at the MAV 07 conference. Hardware and training were delivered to the Aviation and Missile Research, Development, and Engineering Center (AMRDEC), where a test of the nine-channel chemo-sensor detected the presence of various gases.

  - ITC Americas was instrumental in establishing a joint effort on information assurance with the cyber security program at the Institute of Scientific and Technological Research for the Defense, Argentina's premier military R&D center. The program is investigating the feasibility of identifying web intruders from their electronic signature so they can be blocked from accessing a network. This tri-Service program leverages a total investment of $1.56 million from DoD participants and the Argentine government.

  - ITC Pacific identified and forged a key technological collaboration with Japan's World Lab Company for ARL's High-Energy Laser program. This three-way collaboration provides access to an advanced technology in ceramic laser gain materials that will result in saving the U.S. Army at least 2 years of development time.

3. U.S. Army International Medical Laboratories

Within the military infectious diseases and military operational medicine S&T programs, the Army partners with foreign industry, academia, and governments to develop new medical technologies that enhance Soldier survivability and performance. The infectious diseases research program, with key U.S. overseas industrial partners and teams of military uniformed scientists, is located at Army and Navy research facilities in Europe, Asia (Thailand and Indonesia), Africa (Kenya and Egypt), and South America (Peru). Key initiatives include:

- The U.S. Army Medical Research Unit–Europe in Heidelberg, Germany, has successfully conducted psychological debriefings with Soldiers to determine whether a critical incident debriefing helps those who have been exposed to traumatic events. The laboratory is currently investigating bio-behavioral indicators of stress to determine whether sleep parameters monitored by an actigraph (a small wristwatch-type device that records sleep and wake times and sleep efficiency) predict post-traumatic stress disorders.

- The Armed Forces Research Institute of Medical Sciences in Bangkok, Thailand, is conducting the largest ever HIV vaccine clinical trial involving over 16,000 volunteers. This multiyear trial tests a vaccine composed of the HIV strains that are predominant in Thailand.
- The U.S. Army Medical Unit–Kenya is located in a region of high malaria transmission, making it an ideal and frequently used clinical trial site for testing malaria vaccines and drugs. A clinical trial of artesunate, a potential treatment drug for severe malaria, is in progress. Artesunate is available from the Centers for Disease Control and Prevention under an investigational new drug application for the emergency treatment of severe malaria and is expected to replace quinine as a safer, easier to administer, and more effective treatment product.
- A topical drug for cutaneous leishmaniasis (a parasitic infection of the skin transmitted by the bite of a sandfly) is currently undergoing a clinical field trial in Tunisia.
- Two overseas laboratories, located in Egypt and Thailand, currently serve as collaborating centers for the World Health Organization. Additionally, the WHO has identified all overseas laboratories as reference centers for the DoD Global Emerging Infections Surveillance and Response System.

International agreements and cooperative R&D agreements provide the legal underpinnings that enable the Service laboratories to partner with foreign governments, industries, and academia, including but not limited to selected partnerships such as Sanofi–Pasteur (France), GlaxoSmithKline Biologicals (Belgium), Vical, Crucell Holland, and Cheiljedang (Republic of Korea). Collaborations with academia and government agencies include Oxford University (UK), the University of Tubingen (Germany), the University of Heidelberg (Germany), the European Union, and the Albert Schweitzer Hospital in Gabon. Under materiel transfer agreements, the U.S. Army has provided the vaccine seeds of a virus (chickungunya virus) to a French company (Inserm–Transfert) and to Singapore (Singvax) to continue developing a vaccine against this infectious disease. USAMRMC is finalizing an agreement with the French military to test the topical drug paramomycin for cutaneous leishmaniasis in French Guiana.

B. ACQUIRING INTERNATIONAL TECHNOLOGIES

The Army GSTW vision is to augment Army S&T investments by taking advantage of foreign-developed, world-class S&T capabilities to enable the Future Force while simultaneously seizing opportunities to enhance the Current Force. The Army can exploit international technology in two ways: either by co-development with international partners or by acquiring technology that has been developed by an international source. The challenge is to align international armaments cooperation on Army priorities, ensuring substantive contributions to the Army's S&T program while laying the technical foundation to enable interoperability with our allies and coalition partners. Improved business practices and enabling policies have increased relevance of international armaments cooperation contributions to the Army. The success of international collaboration, and ultimately interoperability with our allies, is vital to our nation's security as the Army accomplishes its national security imperatives through coalition operations.

1. Co-developing International Technology

International cooperative research and development agreements are required to co-develop new capabilities or acquire intellectual property rights to research and technology developed by foreign government laboratories and institutes. All international agreements are coordinated and staffed within the Department of the Army and the Office of the Secretary of Defense to ensure compliance with applicable laws, regulations, and policies. Within the Army, an international collaborative S&T project

must be approved by the IPWG, for the Army S&T Working Group before entering into negotiation with a foreign government. The IPWG is co-chaired by the Deputy Assistant Secretary of the Army for Defense Exports and Cooperation (DASA(DEC)) and the HQDA Director for International Science and Technology Programs, with membership from the Army commands that have S&T development or oversight responsibilities. Army international agreements are negotiated and approved by the DASA(DEC) before being submitted to the Office of Secretary of Defense (Acquisition, Technology and Logistics) for final U.S. government approval.

Three types of agreements are the primary legal instruments used to designate Army S&T funding for international technology developments: (1) memorandums of understanding (MOUs) or agreements (MOAs), (2) project agreements or arrangements (PAs), and (3) data or information exchange annexes (DEAs/IEAs). With the exception of DEAs and IEAs, these international cooperative agreements must be approved by the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)); in some cases, Congress must be notified prior to approval. For Army programs, the USD(AT&L) may delegate signature authority to DASA(DEC) or other senior Army officials. The approval authority for DEAs and IEAs, which only authorize the exchange of technical information, has been delegated to Army technical directors by the DASA(DEC).

2. Assessing and Acquiring International Technologies

In 2006, the Army established the Foreign Technology and Science Assessment Support (FTAS) program to assess and acquire technologies that have been developed in other countries. To facilitate this process, HQDA has assigned AMC ITCs the responsibility to identify unique foreign technologies documented in ITC-developed TIPs. The FTAS program provides funding for up to 1 year to an Army laboratory to technically assess a foreign technology identified in a TIP and validate that the foreign technology will provide better capability than existing U.S. technology. Foreign technology that is validated as superior must be used to satisfy the warfighter need rather than continuing the related U.S. technology development.

In its third year, the FTAS program has continued successfully to assess the relevance of foreign technologies to U.S. Army needs. For example, as a result of the technology gained during the German Viral-Inactivated, Pooled Freeze-Dried Human Plasma FTAS project, reported in the 2007 *Army Science and Technology Master Plan*, Appendix B, USAMRMC altered its testing to pursue a single-donor, freeze-dried plasma due to increase coagulation factor levels.

To assure Army resources are spent on new technology development that will enhance warfighter capabilities, S&T developers proposing new ATOs must assess relevant domestic and international technology sources as part of the ATO nomination approval process. The Army's GSTW program provides Army users (e.g., R&D program managers) a new capability to retrieve foreign S&T development information on demand and to meet ATO nomination requirements for assessing relevant foreign technologies.

Other highlights of the FTAS program are:

- ***Characterization of physical vapor deposition coating properties on parts of complex geometry (UK) and 8–12-micron imaging acousto-optic tunable filters research (Russia).*** These projects have successfully demonstrated new acousto-optic materials and devices that are useful at infrared wavelengths. In 2008, prototype devices were delivered to ARL to be assessed and characterized for hyperspectral imaging applications.
- ***Extended-life pulse-tube cryocooler for infrared application***. This TRL 5 technology from Germany, sponsored by the Night Vision and Electronic Sensors Directorate, has demonstrated a potential for fast cool-down times and long operating life, which is of critical

importance to infrared focal plane array devices used for various surveillance applications. (e.g., border surveillance, installation security).

- ***Counter IED/terahertz imaging.*** This project successfully demonstrated proof of principle for using a terahertz imaging technology to detect energetic materials. This technology, developed by the UK company Teraview, is currently the focus of a Goodrich/Teraview development effort to reduce the system's form factor to a tactically relevant size.
- ***Ballistic load sensing headform.*** This project successfully leveraged an instrumented 3D model of the human head developed by a Canadian firm specializing in engineered human impact protection solutions. The deliverable is a load-sensing headform designed to assess the risk of injury due to ballistic helmet behind-armor blunt trauma. The headform contains an array of sensors that determines the load applied to the skull during a nonperforating ballistic impact of a ballistic helmet by a soft-core bullet or fragment. It was specifically developed to aid in the design and evaluation of helmet system designs to improve warfighter safety and survivability. This development holds promise to be more accurate and robust than alternative methods evaluated at ARL.

C. ENGAGEMENT

The DASA(DEC) and the DASA(R&T) selectively engage allies when their technologies and materiel developments can contribute to Army needs and facilitate coalition interoperability. These leadership forums provide both visibility of and management decisions on allied developments that merit followup by Army commands. The DASA(R&T) sponsors senior leadership forums with select allies (1) to facilitate collaborations that enhance U.S. S&T developments and increase warfighting capabilities, (2) to identify where significant potential leveraging opportunities exist, and (3) to make progress toward interoperability for coalition operations. Currently, DASA(R&T) sponsors leadership forums with Canada, the United Kingdom, and Israel that have led to recent significant accomplishments, described below.

1. S&T Leadership Forums

U.S.–Canada Chief Scientists Counterparts Meeting. The fourth counterparts meeting focused on attaining greater impact from national S&T programs through collaborative efforts. Discussion on collaborations are ongoing in active protection systems and their component technologies; counter-IED indications and warnings technologies; a U.S./Canada joint display at the Army Science Conference highlighting AMRDEC's Smart Launcher work and Canada's 2.75 guided-rocket improvement program; and an agreement-in-principle to collaborate in testing, modeling, and analysis on the Extended-Area Protection and Survivability program.

U.S.–UK Joint Technology Development Initiative. The JTDi provides a leadership framework for the U.S. Army and UK Ministry of Defence S&T executives to consult on current priorities in the UK and U.S. Army. Collaborations from past meetings include an international technology alliance on network and information sciences and the Hostile Fire Indicator project arrangement providing enhanced rotorcraft survivability. Current areas of interest include force protection technologies, robotics, sniper detection, power and energy for the dismounted Soldier, and simulation for development of tactical and equipment solutions.

U.S.–Israel S&T Roundtable. The U.S.–Israel S&T roundtable serves as a leadership forum for senior S&T officials to determine the potential contribution of current Israeli technology developments to Army S&T priorities. The fourth roundtable theme was force protection, which covered a wide range of technologies including counter-IED collaborations in detection and neutralization, active protection

of ground and air vehicles, air defense against rockets and mortars, tunnel detection, and autonomous systems. Ongoing discussions on tunnel detection, autonomous systems, force protection technologies, and active protection component technologies hold potential for new collaborations.

Biennial American–Israeli SHORESH Conference. This conference solidifies a decade-old cooperative union between American and Israeli medical researchers held biennially to share knowledge on ways to protect Soldiers. This association began with a primary focus on chemical and biological defense. The conference, however, has grown to include collaborations in the areas of trauma and combat casualty care, psychological stress, infectious diseases, and laser safety. The two countries met in September 2008 to share research to establish collaboration goals for the next 2 years.

2. Bilateral and Five-Power Senior National Representatives (Army) Meetings

The DASA(DEC) sponsors bilateral and multilateral Senior National Representatives–Army (SNR(A)) meetings on international agreements and associated policies. These senior-level forums between the U.S. Army and a nation's corresponding land forces or defense research and development organizations promote and foster interoperability, cooperative research, development, and acquisition programs. SNR(A) activities seek to advance the development or acquisition of technologies to enable the Future Force and enhance the Current Force, while improving interoperability of all the SNR(A) forces. U.S. representatives consider the approved ATOs and GSTW, in conjunction with other Army and DoD guidance, when developing the agendas and plans of action for SNR(A)s.

Australia SNR(A): In August 2000, the DASA(DEC) established an SNR(A) forum with the Australian Director General Land Development. This forum focuses on technology development cooperation in directed energy, chemical and biological defense, penetrators and light armor, electronic warfare, operations and research analysis, unmanned systems, missile, battlefield combat identification, and network interoperability. MOUs and PAs facilitated collaborative programs. These international agreements include the Land Forces Capabilities Modernization MOU, Tactical Missile MOU, Soldier Combat Systems MOU, Tactical Land Warfare PA, and Network-Centric Warfare PA. In January 2009, a PA was signed with Australia to allow them to participate in the technology demonstration phase of the Joint Light Tactical Vehicle program.

Canada SNR(A): In 2003, the Army established an SNR(A) with the Canadian Department of National Defence. This forum focuses on a roadmap of agreed technology interests and has included C^4ISR, force protection, and power and energy areas over the past 3 years. Since its inception, this SNR(A), in coordination with the Chief Scientists Counterparts Meeting, has achieved a significant increase in international cooperative S&T agreements with Canada.

France SNR(A): The United States has maintained a long-standing cooperative relationship with the French Délégation Générale pour l'Armement. In the last few years, this cooperation has focused on C^4ISR, biological and chemical defense, ground combat systems (e.g., combat vehicles, armor protection, support systems), counter-IEDs, robotics, hybrid drive platforms, and survivability technologies (active and passive protection systems).

Germany SNR(A): The U.S.–Germany SNR(A) was relaunched in 2008 after a several year hiatus. New areas for cooperation include multiband sensor technology, recognition of combat vehicles, and blast effects on armored vehicles.

Italy SNR(A): In 2003, the Army established an SNR(A) with the Italian Ministry of Defense. Main areas of cooperation included near-term battlefield identification systems, modeling and simulation, chemical and biological defense, and Soldier systems.

Singapore SNR(A): In December 2000, the Department of the Army established an SNR(A) with the Singapore Ministry of Defence co-chaired by the DASA(DEC) and Singapore Chief Defence Scientist. Major accomplishments under this forum include cooperation in the following areas: chemical and biological defense, modeling and simulation, Soldier systems, unmanned systems, indirect fire systems, and land warfare concepts and technologies. The theme of the 2008 SNR(A) was power and energy and resulted in increased collaboration in the areas of fuel cell technology and Soldier portable power.

Sweden SNR(A): Established in 1995, the U.S.–Sweden SNR(A) has supported cooperation in the areas of signature management, combat networks, IED defense, counter-rocket and counter-mortar, interoperable battlefield management, and force protection. The SNR(A) forum has been a key vehicle for coordinating two MOUs regarding the Excalibur 155mm artillery projectile and a trilateral MOU for radar interchange. The relationship between the U.S. SNR(A) and Swedish counterpart has been critical in coordinating the use of Swedish agile multibeam radars in the United States.

Five-Power SNR(A): Established in 1995, this multilateral forum, composed of the land forces of France, Germany, Italy, the United Kingdom, and the United States, works collectively under the same general objectives as bilateral SNR(A)s. The Five-Power SNR(A) also serves as a forum for establishing a framework for initial consensus on NATO-wide programs and issues. Working groups cover a broad area of technologies, including mounted, dismounted, and deployed Soldier equipment. One recent area of focus was the newly signed Net-Centric Project Arrangement.

3. Micro-Autonomous Vehicles 2008 Technology Demonstration

The Army sponsors technical demonstrations and workshops in emerging technologies as a method to assess the state of the art and to build critical mass for new programs and collaborations. The first U.S.–Asian demonstration and assessment of MAV and UGV technologies was held in March 2008 in Agra, India. The event was sponsored by the U.S. Army and India's Defence Science and Technology Organization. The motivation for organizing the event was to showcase next-generation, COTS-enabled prototype systems of MAVs and UGVs to hasten their induction into the armed forces. Critical MAV technologies that require further development to meet warfighter needs were identified, as were ideas and strategies for countermeasures against MAV systems.

An international panel of judges assessed the merits of each entry in the demonstration. Several awards were presented to developers of prototype systems that were able to perform a prescribed mission that closely resembled an operational scenario. Twelve teams (two from the United States; one each from Germany, France, Spain, the Netherlands, Japan, and Australia; and four from India) displayed their entries and associated technologies and demonstrated their capability for mission compliance through aerial demonstrations (Figure B–5).

The event demonstrated that significant progress had been made in MAV system technologies. Achieving a physical size of less than 300mm was now possible. However, issues of system integration and reliability, sensing, and efficient communication between MAVs and among MAVs and ground systems (including UGV) were brought to focus and need to be addressed before these systems gain user acceptance.

Fancopter was one of the many UAVs demonstrated at the 1st U.S.–Asian MAV Demonstration.

Figure B–5. Fancopter

D. 2008 ARMY SCIENCE CONFERENCE INTERNATIONAL COLLABORATION AWARD

The Army Science Conference International Collaboration Award is presented for the most outstanding collaborative research effort between U.S. Army and foreign scientists. It must have expanded and enhanced the Army's research and technology program while benefiting the scientific interests of the collaborating foreign scientist(s). The 2008 International Collaborative Award was chosen from nominations that covered a variety of topics: rotorcraft heavy lift, green energetic materials, network science, and disease prevention. The winning effort titled "Development and Clinical Testing in Humans of a Gene Gun-Delivered DNA Vaccine To Prevent Hemorrhagic Fever With Renal Syndrome" was authored by U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) scientists Connie Schmaljohn, Ph.D.; Jay W. Hooper, Ph.D.; Ellen Boudreau, Ph.D.; and U.S. Army Medical Materiel Development Activity scientist Diane Ullman with their UK collaborators from PowderMed Vaccines: Priya Mande, Ph.D.; Richard Cartwright, Ph.D.; and Peter Loudon, Ph.D.

In collaboration with PowderMed Vaccines, Dr. Schmaljohn and her USAMRIID colleagues have developed vaccines against the Hantaan and Puumala viruses, two types of hantaviruses that are known health threats to U.S. troops stationed in Europe and Asia. Earlier this year, the two vaccines entered Phase I clinical testing at USAMRIID, the first step on the path toward licensure by the U.S. Food and Drug Administration.

Hantaviruses cause a sometimes fatal disease known as hemorrhagic fever with renal syndrome, which was responsible for more than 3,000 cases of illness and death in U.S. troops during the Korean conflict. Soldiers who live in tent settings where rodents are prevalent are especially vulnerable, as the viruses are usually transmitted by exposure to rodent droppings.

The USAMRIID research team used small amounts of genetic material from the Hantaan and Puumala viruses to develop the vaccines. A fragment of the viral genes, or RNA, is converted to DNA by molecular cloning and is then coated onto the surface of tiny gold beads. A PowderMed device com-

monly known as a "gene gun" uses a puff of helium gas to push the gold beads into the outside layer of the vaccine recipient's skin. The gold beads are delivered directly into the host cells where the DNA comes off the gold beads and is then converted by the cells into proteins that stimulate a protective immune response against Hantaan and Puumala viruses.

This painless, needle-free method of vaccine delivery is more cost effective than traditional vaccines, is safer to administer, and significantly enhances the immune response. The same approach could one day be used to develop a multivalent vaccine for hantaviruses that would be broadly protective against all forms of the disease.

E. THE FUTURE

The three major economies and markets—Europe, Asia–Pacific, and North America—will foster new technology advances, while the economies of China and India will emerge with increasing economic and technological strength. Nanotechnology, modeling and simulation, smart materials, robotics, biotechnology, green manufacturing, power and energy, electronics, computers, and sensors will be enablers and are becoming more widely available as advances spread rapidly throughout global markets. These commodities for S&T development are basic tools for studying the scientific areas of interest to these countries. Notwithstanding the state of the global economy, expect continued investment in these enabling technologies.

Leadership in the development and integration of applied technologies into new or improved capabilities, with identified military relevance, is shared among relatively few countries. These countries typically have a significant research and industrial infrastructure required for integrating technology developments into new military capabilities that relatively few other countries possess. The number and geographic distribution of countries having significant S&T capabilities, but without a large industrial infrastructure, are large and can be expected to increase given current economic and scientific trends. The U.S. Army R&D elements based in these geographical regions are best positioned to assume a leadership role in the identification of relevant S&T developments that contribute to the Army's S&T priorities.

As new S&T investments are made, the GSTW/TOL knowledgebase will provide access to the wealth of foreign S&T developments as identified by the Army ITCs. By understanding other countries' S&T investments and leveraging or acquiring those that have value and through a holistic approach of collaborations, grants, and acquisitions, the U.S. Army will maintain its global dominance and overmatch warfighting capabilities.