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Links to special points of interest:

Soldiers fire a 105 mm howitzer during the inauguration ceremony for Florida Gov. Rick Scott at the Old Capitol in Tallahassee, Fla., Jan. 6, 2015. The soldiers are assigned to Florida Army National Guard's 2nd Battalion, 116th Field Artillery Regiment. (U.S. Army National Guard photo by Master Sgt. Thomas Kielbasa/Released)

HDIAC Journal

Volume 2, Issue 1

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Perovskite Solar Cells

R. Smardzewski

Solar power has been and will continue to be instrumental in the DoD's efforts to procure more secure and independent energy. On-site solar generation allows the military to be less reliant on aging transmission infrastructure and remote power plants. A solar energy system, coupled with a battery backup, diesel generator or thermal energy storage, can operate in island mode. This allows the solar project to continue to provide power independent from the grid, which provides an extra layer of redundancy and reduces the risk posed by blackouts and potential cyber-attacks. As the military shifts to solar power and away from traditional generation sources, its energy supply will be less dependent on fossil fuels and less susceptible to global supply and price disruptions. Solar power provides the military with locally generated energy insulated from natural or man-made instabilities that could put missions at risk.

Currently, there are more than 36 MW (megawatt) of solar photovoltaic modules installed at different Army bases in at least 16 states. [1] While the Army has enough solar power installed to power well over 5,000 American homes, its solar portfolio is poised to expand significantly in the upcoming months and years. By 2020, the Army aims to produce one gigawatt of energy from renewable sources, earlier than its 2025 mandate. [2[Two 20 MW solar projects are planned for Fort Irwin, Calif. and Fort Bliss, Texas, as well as a "micro-grid ready" 18.6 MW system at Fort Detrick, Md., which will be able to provide critical power in the event of a power outage. [3] The Army also has plans to install solar panels on the roofs of 4,700 military homes at Fort Bliss, which will total more than 13 MW. [4]

Solar power also has a significant share of the Navy's current renewable energy portfolio. There are more than 58 MW of solar PV operating at Navy installations in 12 states and the District of Columbia. [5] The Navy has also awarded more than 20 MW of solar PV projects, including installations at Marine Corps Base Camp Lejeune, N.C. and MCB Camp Pendleton, Calif., among others that will come online in the near future. [6]

Solar power will be critical to the Air Force's efforts to meet its 2016 target. Solar PV power is going to account for over 70 percent of all new Air Force renewable energy capacity added from 2012 to 2017. [7] Currently, there is 38 MW of solar PV capacity operating at Air Force bases in 24 states, enough to power more than 5,600 American homes. [8] A 16.4 MW project at Davis-Monthan, Ariz. became the Air Force's largest operating solar project in February of 2014, and a six MW solar array at Otis Air National Guard Base, Mass. is expected to come online this year. [9,10] The Air Force has also outlined solar projects at military residences at Los Angeles Air Force Base and Schriever Air Force Base. All of these projects, both at the utility and distribution levels, are anticipated to provide the Air Force with millions of dollars in energy savings over the lifetimes of the systems.

Solar power will continue to be a vital piece of the Army, Navy and Air Force's efforts to meet their renewables targets moving forward. More specifically, solar PV power accounts for 58 percent of the 1.9 GW (gigawatt) of identified DoD renewable energy capacity additions from 2012 to 2017. [11] That equates to approximately 1.1 GW of planned new PV projects, which is roughly equal to the amount of installed global solar capacity in the year 2000.

"Solar PV power is going to account for over 70 percent of all new Air Force renewable energy capacity added from 2012 to 2017."

Figure 1. The morning sun hits the solar panels used to preheat water at the 115th Fighter Wing, Wisconsin Air National Guard in Madison, Wis., April 22, 2014. The ANG uses 100 percent green energy. (U.S. Air National Guard photo by 1st Lt. Matthew Wunderlin/Released)

Perovskite Solar Cells—continued

R. Smardzewski

Of all the technologies under research for the practical use of photovoltaic solar cells, perovskite-based solar cells are the single most intensely investigated technology. Perovskites comprise a class of minerals, named after a Russian mineralogist (L.A. Perovski, 1792-1856), that are based on calcium titanate, $CaTiO_3$. The terminology is loosely used these days to refer to any compound of ABX_3 stoichiometry that exhibits the perovskite crystal structure. The perovskites that researchers are most excited about are the organometal trihalides, the most commonly studied of which is $CH_3NH_3PbI_3$, where A = CH_3NH_3 (methylammonium), B = Pb (lead) and X = I (iodide). Other mixed halides such as $CH_3NH_3Pb(I_{1-x}Cl_x)_3$ and $CH_3NH_3Pb(I_{1-x}Br_x)_3$ have been studied as well.

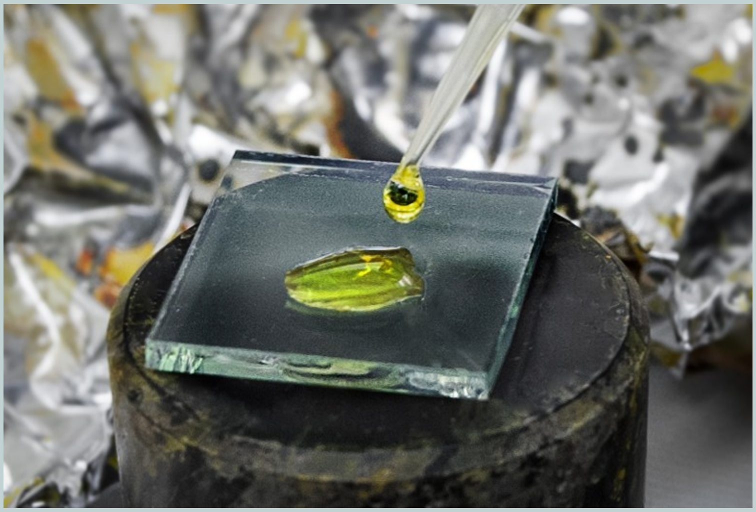

Figure 2. National Renewable Energy Laboratory (NREL) Senior Scientist Kai Zhu applies a dye-sensitized precursor solution to make a perovskite cell. (Photo by Dennis Schroeder/Released)

Researchers and research teams are attracted by the potential of perovskite solar cells to be both high-performing and inexpensive to manufacture. Since their first investigation in 2009 by Tsutomu Miyasaka in Yokohama, Japan, the solar efficiencies of perovskite cells have significantly improved from 3.8 percent to upwards of 16 percent in 2014 with most of these advances coming in the two year period of 2012-2014. [12,13] These notable improvements in the photo-conversion efficiencies over this short period, as well as their higher open-circuit voltage (1.1 V) versus silicon (0.6 V), have attracted world-wide attention. In addition, the ability of these materials to be solution-processed via liquid-phase chemical reactions and material coating/deposition by methods such as spraying, roll-to-roll printing and spin-coating make it possible for solar-cell manufacturers to eventually replace expensive clean rooms and sophisticated vapor-deposition equipment with simple, inexpensive benchtop processes. [14]

Moreover, target efficiencies of 20 percent have been identified as a feasible goal, which rivals that of currently available crystalline silicon (20-25 percent). [15]

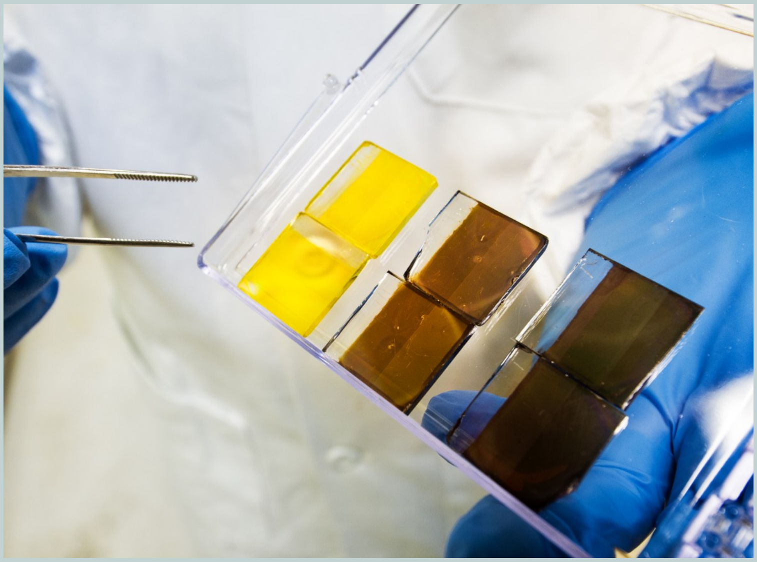

Figure 3. National Renewable Energy Laboratory (NREL) Senior Scientist Kai Zhu holds several perovskite cells he made in his lab using a precursor solution that converts from a liquid base to an absorber in a device. (Photo by Dennis Schroeder/Released)

In these trihalide perovskites, it was experimentally determined that the photo-excited electron-hole diffusion lengths are greater than one micrometer, a value that is about 10X the absorption depth. [16,17] This means that the charge carrier (electrons and holes) diffusion lengths in these solution-processed compounds are comparable to the optical absorption lengths, resulting in high photoconversion efficiencies. A low efficiency photovoltaic exhibits electron-hole diffusion lengths on the order of 10 nm. [17] This means that significant charge recombinations occur, which waste the converted energy as heat and reduce the overall efficiency of the solar cell. In addition, recent (2014) transient laser spectroscopy and impedance measurements of the photoinduced charge-transfer processes in a thin $CH_3NH_3PbI_3$ perovskite film indicated ultrafast electron and hole injection rates taking place at the film interfaces on the order of femtoseconds (10^{-15} s) to picoseconds (10^{-12} s). [18,19] Vapor deposition of these materials has also demonstrated that nanostructuring is not necessary to achieve high (about 15 percent) conversion efficiencies. [20]

Perovskite Solar Cells—continued

R. Smardzewski

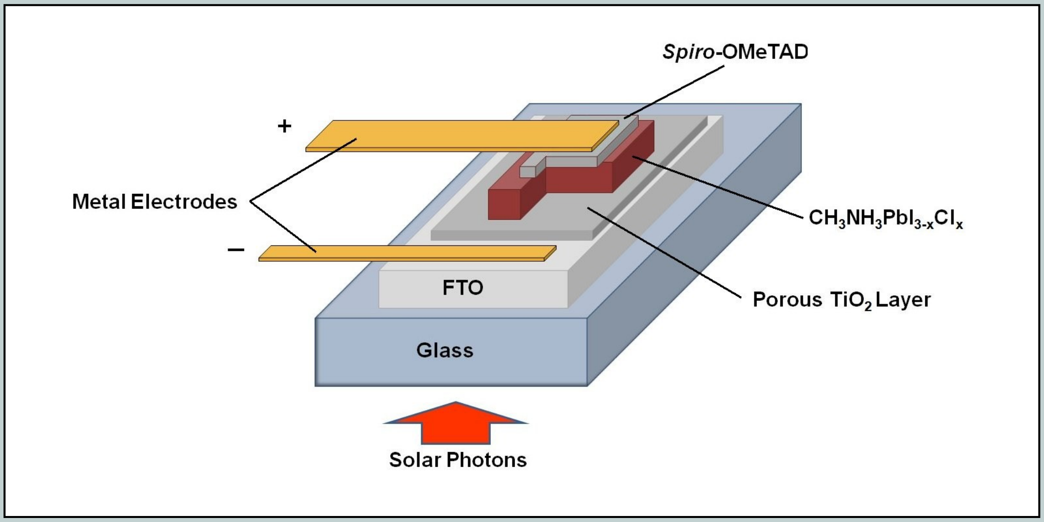

Figure 4. Diagram of the thin film device structure of a perovskite solar cell. (Courtesy of Richard Smardzewski/Released)

Figure 4 illustrates a thin film arrangement of a perovskite solar cell prepared by a spin-coating method over a thin, compact layer of porous titanium dioxide (TiO_2). In this arrangement, sunlight passes through the glass substrate and transparent fluorine-doped tin oxide (FTO) conducting electrode through a thin, porous TiO_2 layer onto a layer of photosensitive perovskite film (red) to stimulate the creation of electron-hole pairs (e-/h+) called excitons. These charged particles separate and diffuse to the two charge-conducting layers (TiO_2, *Spiro*-OMeTAD) and opposing electrodes to generate a working voltage and current. Porous TiO_2 is a conductor of electrons, while *Spiro*-OMeTAD [2,2',7,7'-tetrakis-(*N*, *N*-di-4-methoxyphenylamino)-9,9'-spirobifluorene] is a solid polyaromatic ring compound that serves as a hole (positive charge) conductor.

Recently, a study showed that this synthetically-complex (and expensive) organic arylamine hole-conductor, *Spiro*-OMeTAD, can be eliminated by fabricating a perovskite solar cell that does not require a hole-conducting layer. [21] This was accomplished by using a double-layer of mesoporous TiO_2 and ZrO_2 as a scaffold infiltrated with perovskite material to produce a solar cell with a certified power conversion efficiency of 12.8 percent.

Studies on the analogous solution-processed lead bromide perovskites have yielded cells with higher open-circuit voltages of about 1.3 V, and these materials have been deposited on flexible polymer substrates. [22,23] A recent study has even deposited these materials on graphene/TiO_2 composites [24] using solution-based deposition procedures at temperatures below 150 C to produce solar cells with efficiencies up to 15.6 percent.

To date, halide perovskite materials for solar cell applications exhibit impressive properties in comparison to other photovoltaic techniques because of their unique advantages, which are:

1. Low cost, abundant materials, simple preparation
2. Near-perfect crystallinity at low temperatures
3. Large charge-carrier diffusion lengths (~one micrometer), 100X higher than other photovoltaics
4. High open-circuit operating voltages (1.1-1.3 V) compared to silicon (0.6-0.7 V)
5. Tunable bandgap range (1.48-2.23 eV) to better match the solar spectrum
6. Better than silicon at absorbing higher-energy blue and green photons

However, perovskite materials do have some material disadvantages, which are:

1. Sensitivity to oxygen and water vapor, which may necessitate preparation under an inert atmosphere and encapsulation in a final module form
2. Difficulty in preparing large, continuous films
3. Toxic lead (Pb) in the most-used perovskite material ($CH_3NH_3PbI_3$) may leach out of solar panels into the environment and presents a barrier to commercialization. Several recent attempts have been made to replace the lead with tin (Sn) in these perovskite materials. [25,26] Unfortunately, low photoconversion efficiencies (five to six percent) were observed and Sn (unlike Pb) has a strong tendency to convert to its more stable 4^+ oxidation state, which is promoted by moisture (to yield SnO_2, tin oxide), and degrade overall cell performance. Nonetheless, efforts are still underway to resolve these issues.
4. A phase transition from tetragonal to cubic at 55 C, which may impact the long-term stability of these materials
Lifetime studies must be done to evaluate this issue. [27]

With these issues in mind, these highly-efficient solar cells will continue to be evaluated and developed. The current overall consensus seems to be that most researchers are optimistic that perovskite solar cells will eventually find widespread application and may ultimately lead to devices that will rival today's conventional silicon-based versions.

Perovskite Solar Cells—continued

R. Smardzewski

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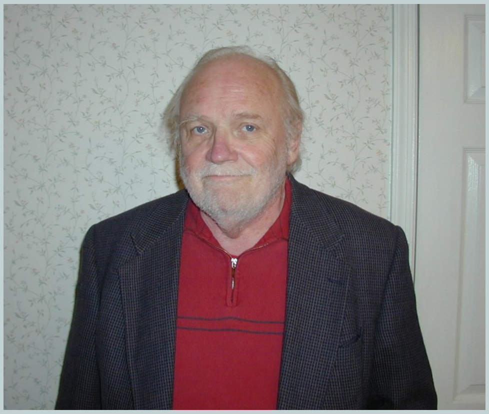

A Brief Overview of Privacy Policy in the European Union

C. Daub

The DoD has played an active military role in Europe for more than half of the past century. During this time, the DoD has transitioned from active combat to training and various states of combat readiness, culminating in the present phase of training, operations support, facilitation of the North Atlantic Treaty Organization, partner nation military engagement, and coalition and NATO Allied military contingency operations such as Kosovo Force Operations. The focus has also shifted from a relatively stationary target to a nebulous transnational and transregional threat emanating from various parts of the globe. An important aspect of DoD's partner nation, military-to-military, NATO and law enforcement engagement strategy and activities is the development, maintenance and use of biometric capabilities to support a spectrum of military missions and operations. The use of biometrics for any DoD operations in the EU will be subject to the various EU privacy laws. This article will provide a summary of some of the relevant privacy policies in the EU.

The EU defines personal data as "any information relating to an identified or identifiable person ('data subject') who can be identified, directly or indirectly, in particular by reference to an identification number or to one or more specific factors (physical, physiological, mental, economic, cultural and social)." [1] The EU definition of personal data includes all modalities of biometrics, leading to broad interpretations of rules, guidelines and laws that pertain to personal privacy and the use of personal data.

European Convention of Human Rights

All privacy laws and policies in the EU are based on the ECHR. The ECHR was drafted in 1950 by the Council of Europe and entered into force in 1953, and its ratification is a prerequisite to join the Council of Europe. Article 8 provides a right to privacy to respect for one's "private and family life, his home and his correspondence," subject to certain restrictions that are "in accordance with law" and "necessary in a democratic society."

Article 8: "There shall be no interference by a public authority with the exercise of this right except such as is in accordance with the law and is necessary in a democratic society in the interests of national security, public safety or the economic well-being of the country, for the prevention of disorder or crime, for the protection of health or morals, or for the protection of the rights and freedoms of others."

Figure 1. European Court of Human Rights building (Courtesy of en.wikipedia.org/Released)

Data Protection Convention

The legal evolution of personal privacy law in the EU is intertwined with the adoption of the DPC or the Convention for the Protection of Individuals with Regard to Automatic Processing of Personal Data, an international agreement enacted in 1981 after four years of development by the Council of Europe. The DPC now has 46 countries with ratified membership, including Uruguay as of April 2013, which makes the DPC an international treaty that continues to add members. [2] The DPC is not enforced with punitive measures, but it is used as a guideline for further participation in other EU initiatives and as a standard for the development of the civil infrastructure of participating nations.

"The Convention's [DPC] approach is not that processing of personal data should always be considered as an interference with right to privacy, but rather that for the protection of privacy and other fundamental rights and freedoms, any processing of data must always observe certain legal conditions. Such as the principle that personal data may only be processed for specified legitimate purposes, where necessary for these purposes, and not used in a way incompatible with those purposes." [3]

A Brief Overview of Privacy Policy—continued

C. Daub

Figure 2. European Union Logo

Directive 95/46/EC

Current data protection laws in the EU are guided by Directive 95/46/EC, which the office of the European Data Protection Supervisor commonly refers to as the Data Protection Directive. While the DPD was developed over a period of years leading up to implementation in 1995, prior to some major advances in technology, the legal frameworks are still used, even with their technological shortcomings. It has been up to court proceedings and legal reviews to interpret the legal framework in light of advances in technology. "Directive 95/46/EC…is now the subject of a wide ranging review to make it more effective in a world where information technology is playing a prominent role in all fields of life – both public and private." [4] However, several clauses in the Preamble of the Directive 95/46/EC, specifically 13, 16, 46 and 56, provide for governmental exceptions in cases of national security or defense, and these clauses would likely be relevant to any potential DoD operations in the EU.

The Prüm Convention (Schengen III Agreement, 2005)

The Prüm Convention is an agreement that seeks "to step up cross-border cooperation, particularly mutual exchange of information." [5] The agreement deals with the issues of personal privacy and biometrics. The agreement goes on to outline how the individual laws of contracting parties and member states will comply with the national law of the states involved. These national laws have been moving towards uniform compliance with Directive 95/46/EC. The Prüm agreement is meticulous in its compliance and appears to avoid obvious pitfalls associated with biometrics and privacy. The Convention was adopted so the signatories could exchange DNA and fingerprint data from persons of interest.

The Prüm Treaty also includes counter-terrorism amongst its articles in Article 16: "Supply of Information in order to Prevent Terrorist Offenses." Article 16 provides a proactive legal framework that seeks to prevent terrorist offenses by having participating nations supply personal data to each other, even without a request for information. "For the prevention of terrorist offences, the Contracting Parties may, in compliance with national law, in individual cases, even without being requested to do so, supply other Contracting Parties' national contact points, as referred to in paragraph 3, with the personal data and information specified in paragraph 2, in so far as is necessary because particular circumstances give reason to believe that the data subjects will commit criminal offences as referred to in Articles 1 to 3 of EU Council Framework Decision 2002/475/JHA of 13 June 2002 on combating terrorism. This is a critical aspect of sharing to prevent." [6] The chapter continues in the second clause stating that, "The data to be supplied shall comprise surname, first names, date and place of birth, and a description of the circumstances giving reason for the belief referred to in paragraph 1." [7] The Prüm Convention gives participating members legal justification to develop broad counter-terrorism initiatives based on a reasonable belief of an impending threat "because particular circumstances give reason to believe that the data subjects will commit criminal offenses…" [8]

"In June 2008, the Council of the European Union converted the Treaty of Prüm into EU legislation (The EU-Prüm-Decision). The new EU legislation requires every EU member state to establish a forensic DNA database and to make this database available for automated searches by other EU member states. As DNA profiles are regarded as personal data, national privacy legislation derived from the European Data Protection Directive 95/46 also applies to forensic DNA databases." [9]

General Data Protection Regulation

Recognizing that the digital world has changed in the past two decades since the advent of the Internet, the European Commission proposed a comprehensive reform of the EU's data protection rules to strengthen privacy rights and boost Europe's digital economy on January 25, 2012. [10]

A Brief Overview of Privacy Policy—continued

C. Daub

A few of the "Information Age" factors driving the need for a redefinition of personal data and levels of protection include the increasing use of:

- Social networking sites
- Cloud Computing
- Location-based services
- Smart cards

EU member states have implemented the 1995 rules very differently with disparate degrees of enforcement. A uniform, single law across the EU would eliminate the current patch-work implements and attendant administrative burdens. The EU's European Council aims for adoption soon, and the regulation will take effect after a transition period of two years.

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Collaborative Efforts Responding to the Missions Associated with Addressing CBRN and Explosive Acts of Domestic Terrorism

T. Karpetsky

Terrorists have and will continue to desire weapons of mass destruction, such as CBRNE, to further their agendas here and abroad. The use of WMDs can result in significant casualties and cause widespread panic from fear of further attacks and/or spread of disease instigated by terrorists. In response to this and other hazards to national security, the national leadership has called for a general unified, collaborative approach to deal with national level incidents, including those from CBRNE terrorism. “Our ability to effectively solve today’s problems while preparing for tomorrow’s challenges will not only require us to work together within the whole of government, but effectively collaborate beyond traditional boundaries into national and international areas of expertise in an increasingly unified and collective approach.” [1]

Countering the Threat

Homeland Security Policy Directive-5 states that “To prevent, prepare for, respond to, and recover from terrorist attacks, major disasters, and other emergencies, the United States government shall establish a single, comprehensive approach to domestic incident management.” [2] It further establishes the Secretary of Homeland Security as the principal federal official for such management. The Secretary is responsible for coordinating federal operations and administering a National Incident Management System.

Homeland Security Policy Directive-8: National Preparedness (March 2011) establishes the goal of strengthening national security through systematic preparation for the threats that pose the greatest risk, and it calls for the coordination and implementation of all-hazards preparedness. [3] HSPD 8 is supported by a Strategic National Risk Assessment that includes natural, technological/accidental and adversarial/human caused national-level incidents, which certainly involve WMDs. [4] It affirms the need for an all-threats/hazards capability-based approach to preparedness planning by establishing a scalable, flexible framework for the management structure, capabilities required, critical tasks to be accomplished and responsibilities for accomplishment.

Preparedness Mission Areas, National Preparedness Goal and Required Core Capabilities

HSPD 8 defines five preparedness mission areas—prevention, protection, mitigation, response and recovery. The National Preparedness Goal defines the 31 core capabilities required for preparedness. [5] The core capabilities are intended to embrace a wide variety of expert experiences, skills, knowledge, training, responsibilities, equipment, documentation and timeliness. The National Planning Frameworks, which are part of the National Preparedness System, set the strategy and doctrine for building, sustaining and delivering the core capabilities for each of the five preparedness mission areas. [6-11] Each framework supplies objectives and critical tasks defining the actions required to build and deliver each core capability. They describe the coordinating structures and alignment of key roles and responsibilities for the whole community and are integrated to ensure interoperability across all mission areas. Frameworks acknowledge the concept of tiered response, which emphasizes that response to incidents should be handled at the lowest capable jurisdictional level. Selective implementation allows for a scaled response, delivery of the exact resources needed and a level of coordination appropriate to each incident.

Figure 1. CBRN defense training at Camp Lejeune, NC, March 11, 2014. (U.S. Marine Corps photo by Lance Cpl. Joshua W. Brown/Released)

Coordinating Structures and Integration – Delivering Capabilities

Coordinating structures bring together those entities involved in conducting activities and operations to address the requirements of the mission and serve both readiness and operational roles. Their size and membership can differ according to the mission area and hazard. They bring together those that can most effectively deal with the mission area in the context of the hazard at hand, including CBRNE. Coordinating structures ensure ongoing communication and coordination among all parties, as applicable. They facilitate problem solving, improve access to resources and foster coordination and information sharing. The flexibility of such structures helps ensure that communities across the country can organize response efforts to address a variety of risks based on their unique needs, capabilities, demographics, governing structures and non-traditional partners. Coordinating structures use different types of arrangements to achieve their objectives.

Collaborative Efforts—continued

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At least six different types of arrangements have been identified in a variety of areas, and the U.S. Government Accountability Office has also examined "Key Considerations for Implementing Interagency Collaborative Mechanisms," and they are listed below: [12,13]

1. **Collaboration** relies on voluntary or discretionary participation among the members, who are relatively equal or at least have parity in such an activity and arrangement;

2. **Coordination**, in which a lead agency or officer directs an operation, project or program among one or more other agencies;

3. **Mergers**, by which all or parts of different agencies or their authorities, jurisdictions, personnel and resources are merged with or transferred to another organization;

4. **Integration**, which brings together relevant parts of agencies on either a long-term or a temporary ad hoc basis, to carry out a particular operation, project, program or policy;

5. **Networks**, which involves the federal government and all or several other levels of government: federal, state, local, tribal, or, in some cases, foreign countries; and

6. **Partnerships**, which feature public-private partnerships. [12]

These arrangements require significant attention to ensure success. There are many reasons why they may fail or result in poor or unsatisfactory results, as noted in Figure 2.

Figure 2. Reasons underlying poor collaboration results. (Courtesy of Frederick Kaiser [14] /Released)

The National Frameworks and their annexes, training, exercises, appropriate equipment, resources, knowledge-sharing technology and experienced leadership go a long way to ensure collaborative arrangements work to deal rapidly and successfully with such national incidents.

Example: National Response Framework [10]

The NRF is founded upon the National Incident Management System core set of doctrines, concepts, principles, terminology and organizational processes that enable effective, efficient and collaborative incident management. Personnel and organizations that have adopted this common framework are able to work together, fostering cohesion among the various organizations involved in all aspects of an incident. [15] Multi-agency coordination and unified command are essential to effective response operations because they address the importance of: (1) developing a single objectives set; (2) using a collective, strategic approach; (3) improving information flow and coordination; (4) creating a common understanding of joint priorities and limitations; (5) ensuring that no agency's legal authorities are compromised or neglected; and (6) optimizing the combined efforts of all participants under a single plan.

The NRF is a guide to how the Nation responds to all types of disasters and emergencies. It sets the doctrine for how the Nation builds, sustains and delivers the response core capabilities identified in the National Preparedness Goal. "Response," as used in the NRF, includes actions to save lives, protect property and the environment, stabilize communities and meet basic human needs following an incident. The Federal Emergency Management Agency engages all levels of governments when putting the NRF into operation. The NRF describes specific authorities and best practices for managing incidents that range from serious but purely local, to large-scale terrorist attacks or catastrophic disasters, defined as any natural or manmade incident, including terrorism, that results in extraordinary levels of mass casualties, damage or disruption severely affecting the population, infrastructure, environment, economy, national morale or government functions. The following annexes provide more detailed information to assist practitioners in implementing the Framework.

Emergency Support Function annexes group federal resources and capabilities into functional areas most frequently needed in a national response (e.g., transportation, communications, public works & engineering, firefighting and emergency management).

Incident annexes address the unique aspects of responses to seven broad incident categories (e.g., biological, catastrophic, nuclear/radiological, cyber, food & agriculture, mass evacuation, terrorism incident, law enforcement and investigation).

Collaborative Efforts—continued

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Support annexes describe how all organizations coordinate and execute the common functional processes and administrative requirements necessary for efficient and effective incident management. They describe essential supporting aspects that are common to all incidents. [10]

Coordinating agencies support the Department of Homeland Security incident management mission, providing the leadership, expertise and authorities to implement critical and specific aspects of the response. Cooperating agencies are entities that have specific expertise and capabilities to assist the coordinating agency in executing incident-related tasks or processes. For example, the DoD can provide defense support of civil authorities during domestic incidents.

Figure 3. Members of the 101st CBRN Company are trained during a mass casualty decontamination validation class, July 20, 2011. (Photo by Kevin Goode/Released)

DoD plays an essential role in countering WMDs through operational capabilities that protect from the threat or actual use of WMDs. DoD is a cooperating agency for the majority of support annexes. [16] In the CBRN area, DoD forces are important for detecting, preventing, mitigating and responding to incidents requiring specially trained and equipped response forces postured for rapid deployment. DoD general purpose forces include medical, security, engineering, logistics and transportation capabilities, and command-and-control capabilities to manage the specialized and general purpose forces that will likely be needed to support civilian agencies after a CBRN incident. [17]

Training and exercises are key elements of preparedness. Several groups and/or consortiums offer many different types of training. These include the National Domestic Preparedness Consortium, where over two million participants have been trained [18], the Rural Domestic Preparedness Consortium, the Naval Postgraduate School, and the National Training and Education Division. For example, the NTED Center for Domestic Preparedness identifies, develops, tests and delivers training for emergency response providers, with on-site and mobile training at the performance, management and planning levels.

Figure 4. 5th Army WMD Civil Support Teams Receive Training at Edgewood Chemical Biological Center. (Courtesy of ECBC/Released)

At the Chemical, Ordnance, Biological and Radiological Training Facility, the Center for Domestic Preparedness offers the only program in the nation featuring civilian training exercises in a true toxic environment, using chemical agents and biological materials. The former Noble Army Hospital has been converted to a training site (Noble Training Facility) for health and medical education in disasters, to include both acts of terrorism and natural disasters. The Advanced Responder Training Complex offers a cross-section of environments found in any community throughout the nation and provides responders with a realistic training environment. The Department of Homeland Security also has access to lessons learned and other resources, such as a documents library, information on the Homeland Security Exercise and Evaluation Program, threats/hazards, core capabilities initiatives, knowledge base, mitigation best practices, forums and collaboration channels.

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Equipment

The InterAgency Board for Equipment Standardization and Interoperability was founded by the DoD and the Department of Justice to emphasize interoperability, compatibility and standardization; foster a multidisciplinary perspective; facilitate effective intergovernmental partnerships; serve as a credible voice for the responder community; and share field operational experiences and practices. The IAB provides a standardized equipment list, containing a list of generic equipment recommended by the IAB to local, state and federal government organizations in preparing for and responding to all CBRNE events. [19] The IAB also provides a list of relevant priority research and development topics. [20]

Figure 5. Sgt. 1st Class Alphonso Meriweather, a chemical, biological, radiological and nuclear specialist with the 52nd Civil Support Team out of Columbus, Ohio, conducted CBRN reconnaissance of a hotel during the Vibrant Response training exercise July 27, 2012. Vibrant Response is a major field training exercise conducted by U.S. Northern Command and led by U.S. Army North. (U.S. Army photo by Sgt. Candice Harrison/Released)

Summary

There are many different types of naturally and accidently occurring events that qualify as national level incidents. Added to these are human-caused/terrorism incidents such as CBRNE use. Recognition that these incidents all have common features that require similar actions was a key perception underlying the development of an all-hazard response system. Five mission areas defining needs common to such hazards underpin the system: Prevention of such incidents, particularly those due to accidents and acts of terrorism; Protection of the populace from incident effects; Mitigation of such effects; Response in a quick and effective manner; and Restore the affected area. Core capabilities associated with each mission area are defined and related to critical tasks that must be performed to achieve desired results. Successful implementation of the frameworks addresses the five mission areas for many different types of national level incidents and requires collaboration among different agencies, levels of government, non-government organizations, private companies and others, with definitions of which players play what roles. Also, different scales and types of incidents may likely require different types and amounts of attention. Therefore, the frameworks were designed to be adaptable, flexible and scalable. Finally, there are organizations that deal with the resources needed for effective response, including training, equipment, exercises and lessons learned. All of these efforts represent a translation of Presidential Policy Directives to actions on the parts of organizations and individuals, enabling effective and rapid action to deal with national level incidents such as those posed by CBRNE usage. They are also key parts of the National Preparedness System, which outlines an organized process for everyone in the whole community to move forward with their preparedness activities and achieve the National Preparedness Goal: identifying and assessing risk, estimating capability requirements, building and sustaining capabilities, planning to deliver capabilities, validating capabilities and reviewing/updating. [21]

Figure 6. Sgt. 1st Class Alphonso Meriweather checks detection equipment while Sgt. Adam Long, also a CBRN specialist with the team, looks over his shoulder during reconnaissance training at Muscatatuck Urban Training Complex, Ind., July 27, 2012 during the Vibrant 13 training exercise. (U.S. Army photo by Sgt. Candice Harrison/Released)

Collaborative Efforts—continued

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About the Author:

Timothy Karpetsky, Ph.D., has over 40 years hands-on experience with CBRNE materials. He has conceived, developed and produced diverse equipment for the detection, identification of, and surveillance for such materials. Over this time, he has worked for and with the U.S. government and private companies, including heading a detection innovation skunk works. Originator of 14 published patents, he has written many technical papers, including readiness assessments for manufacturing CBRNE defense equipment.

Lean-Sensing: Intelligent, Low-Cost, Remote Detection by Integrating Currently Available Components for Distant Early Warning

H. Hwang, C. R. Prasad, R. M. Serino

The battlefield effects of WMDs can be catastrophic to the warfighter, and exposure can cause significant loss of life and property. The best counter to prevent such a catastrophe is complete contamination avoidance, which is only possible with fast, reliable, low-cost early warning, preferably from a distance. Today, new capabilities that leverage government and/or commercial components through a thoughtfully integrated construct are being seen. This construct does not involve another sophisticated computerized network of pre-positioned and expensive sensors in a presumably correct matrix. Instead, the constructs use a Lean-Sensing approach, which is composed of a small Lidar plus a low-cost, quad-rotor Small Unmanned Aircraft System. These systems can geo-locate hazards from a distance in real-time using Lidar, and they can detect/identify/report the hazard via on-board camera and communications. This is all accomplished in minutes using a quad-rotor SUAS vectored directly to the suspected WMD hazard location. On-board sensing can be as simple as M-8 Paper or more sophisticated and involve the use of a JCAD, Radiac, TacBio, or IBAC. System integration of required elements can come under Force Protection Architecture when in a fixed-base or “as is” when isolated and/or deploying.

In a preliminary construct of lean-sensing operations, a small Lidar detects and geo-locates a possible CBRN hazard in real-time with collaboration from Force Protection assets. A quad-rotor SUAS is then positioned to “perch and stare” and/or “perch and sense” by autonomously moving quickly to a hazard site to hover and survey based on situational need. This is in contrast to a fixed-wing UAS, which must constantly move to stay aloft. In the simplest embodiment, the quad-rotor SUAS with attached M-8 paper can land directly in a chemical and image any chemical change using an on-board camera in daylight or with headlights at night. Imagery is then streamed in real-time from the quad-rotor SUAS back to the Force Protection Architecture or a ground station.

Over the course of this article, commercial drones that may be useful for integrated remote sensing needs will be looked at, and recent work conducted at Dugway Proving Ground, Utah, in open terrain; at Redstone Arsenal, Ala., in complex terrain; and at Ellicott City, Md., in built-up areas, will be outlined. Examples of how a simple, rugged Lidar can rapidly detect, map and track a suspected WMD hazard will be shown along with how a small quad-rotor UAS can be directly vectored to a suspected site in real-time for survey and assessment. Based on the results to date, the methods and emerging capabilities demonstrated seem to indicate an effective construct that could be ready for a series of field trials in an Advanced Technology Demonstration.

"Knowing that forewarned is forearmed." Abraham Tucker in *The Light of Nature Pursued*, 1768

Combining Technologies for Disruptive Effects

The capabilities of unmanned (drone) aircraft created by industry over the last decade for the U.S. military and employed everyday world-wide are without peer. Names such as Raven, Shadow, Scan Eagle, Predator and Global Hawk call to mind incredible performances under demanding conditions. Here, key performance needs are oriented along the lines of speed, altitude, range, payload and supportability, and specific operational activity, which is largely conducted from a stand-off distance in order to preserve stealth, surprise and survivability. Thus, the very nature of unmanned, fixed-wing aircraft and how they are currently employed largely precludes operations close to the target or objective. This approach has been the focus of the military for quite some time. Concurrently, elements of the commercial sector have been moving in a slightly different direction.

Recent advances in unmanned, multi-rotor commercial technologies and aircraft from the public sector (**Figure 1**) have created a market place where drone performance and price-point achieve world-wide sales measured in the hundreds of thousands of units. For example, world-wide Parrot sales are on the order of 350,000, Phantom sales are on the order of 150,000 and Amazon sales are nearly 20,000 per month. Users include hobbyists, realtors, news media organizations and motion picture companies. The users have all realized that commercial-off-the-shelf, multi-rotor SUAS offer a reasonably solid value proposition for performance, reliability, usability and price. Also, commercial multi-rotor drone applications are mostly for closer-in vertical take-off and landing activities. In VTOL activities, the distance to the objective is measured in feet or meters, and stealth, surprise and survivability are of less concern than in current military needs.

The U.S. military has largely dominated creation of the technologies and systems that enable stand-off, fixed-wing drone needs, and the commercial sector has dominated creation of technologies and systems for close, multi-rotor VTOL drone needs. Based on some preliminary combinations and experiments, there are exceptional possibilities for leveraging multi-rotor commercial drones into lean-sensing constructs. In these constructs, the hazards are geo-located in real-time by optical means and then visually checked and initially identified using a multi-rotor commercial drone with a sensor payload vectored to the hazard location (**Figure 2**).

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	Phantom & FC40 / Phantom 2 Vision / Vision Plus	DJI F550	S800 EVO	S1000	SkyJib 8 – X4
Frame	Quadcopter	Hexacopter	Hexacoper	Octocoper	Octocoper
Manufacturer	DJI	DJI	DJI	DJI	Droidworx
Size (diameter)	15 inches	22 inches	32 inches	41 inches	46 inches
Flight range	~ 0.5 miles	~ 0.5 miles	~ 0.5 miles	~ 0.5 miles	~ 0.5 miles
Flight time	10-15min / 25min	~ 10-15min	~ 10-15min	~ 10-15min	~ 10-15min
Weight lift	~ 0.67 pounds	~ 1.5 pounds	4 lbs max. / 10+ lbs	4 lbs max. / 10+ lbs	~ 12 pounds
Price range	$479 - $2,999	$900 - $4,000	$4,099-$7,724	$6,000-$10,000	$7,600 - $10,000
Camera mount	Zenmuse H3-3D, GP-25, GP-35	Zenmuse H3-3D, GP-45, Alware 2-axis	Zenmuse H3-3D, Z15, GP-55, PhotoHigher	Zenmuse H3-3D, Z15, GP-55, PhotoHigher	Zenmuse Z15, PhotoHigher
Autopilot system	Naza-M	Naza-M, Wookong-M	Wookong, A2	Wookong, A2	Wookong, A2
Camera compatible	GoPro Hero, FLIR Tau 2	GoPro, FLIR Tau 2	GoPro, Sony NEX Series, GH3 / 5D	GoPro, Sony NEX Series, GH3 / 5D	Red Epic, Canon 5D
First Person view (FPV)	Monitor / Smartphone, Tablet	Monitor	Monitor / Smartphone, Tablet	Monitor / Smartphone, Tablet	Monitor / Smartphone, Tablet
Datalink (way point)	-	Laptop / IPad	Laptop / IPad	Laptop / IPad	Laptop / Tablet

Figure 1. (Above) Examples of COTS multi-rotor small unmanned aircraft (drones) at relatively low prices. (Courtesy of Intelligent UAS/Released)

Figure 2. (Below) Rethinking M-8 Paper on a stick. On-board GPS and camera with optional LED headlights can image, transmit and record first person video streaming of real-time M-8 paper color change with stimulant used here. Funding via IR&D. (Courtesy of Science and Engineering Services/ Released)

While operational experience combined with IR&D results suggest that lean-sensing can reduce exposure risk, response time and life-cycle cost by precise, unmanned delivery of a detector to a hazard site early in the response sequence, a question remains. How is a precise, unmanned delivery of a detector to a hazard site accomplished?

One of the techniques used to detect, map and track aerosol clouds is Lidar, and an example of a Lidar is the Standoff Detection System – Light Weight, or SDS-Lite (**Figures 3 and 4**). Another example is JBSDS, or Joint Biological Standoff Detection System. These are Class 1M eye-safe Lidars that operate in the infrared region (JBSDS also operates in the ultraviolet) and offer real-time eight digit latitudes and longitudes on/into/along a cloud target for a precise geo-location. The location information obtained by the Lidar can then be provided to the drone ground station for flight and mission planning. When appropriate, Lidar can be substituted with visible camera (s) or thermal camera(s), but the range and azimuth data handed off to the drone for mission planning will likely be far less exact and could result in the drone searching at the suspected hazard area.

Lean-Sensing—continued

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Figure 3. SDS-Lite evolution to support government needs. (Courtesy of Joint Program Executive Office for Chemical and Biological Defense (JPEO-CBD)/Released)

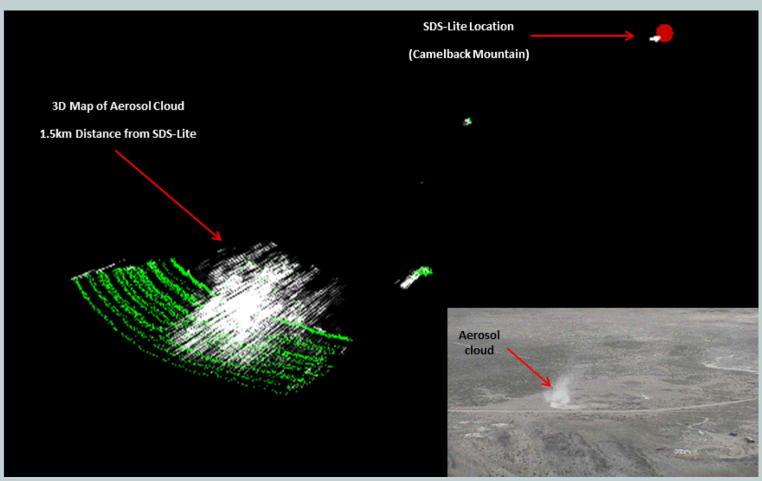

Figure 4. SDS-Lite cloud detection and 3-D mapping. (Courtesy of JPEO-CBD/Released)

Enabling Lean-Sensing Today

Chemical/biological/radiological sensors can be easily integrated on a commercial-off-the-shelf, multi-rotor drone, as the example in **Figure 2** shows. On-board GPS and camera with optional LED headlights allow for autonomous navigation of the drone to a site where it can land, image, transmit and record first person video streaming of the attached M-8 paper undergoing detection and color change in real-time (**Figure 5**).

Alternatively, a more sophisticated architecture that involves a higher level of sensor integration with the drone can be employed

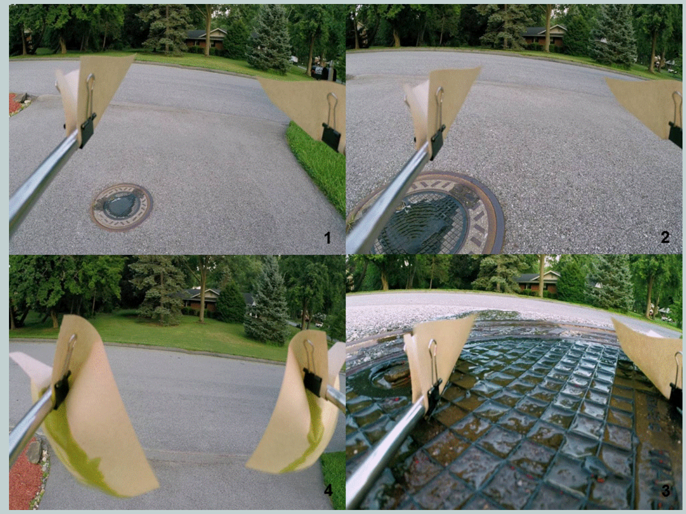

Figure 5. On-board recorded and transmitted drone landing with M-8 paper detection and color change. (Courtesy of Science and Engineering Services/Released)

(**Figure 6**). At the higher level, communications and power sharing can be hosted by the drone and data output presented as integrated information. This approach would be particularly useful if one wanted to create a more advanced CBR drone with an integrated package of chemical + biological + radiological sensors along with thermal and visible cameras. Sensor packages and cameras can also share battery power, and the battery pictured (**Figure 7**) is one of the best available for commercial VTOL drones. It is a smart, lithium-polymer (Li-PO) rechargeable cartridge that can provide a flight time of approximately 20 minutes. If a drone knows where it is going, 20 minutes is a significant amount of time. Additionally, the battery cartridge can be swapped as quickly as a rifle magazine.

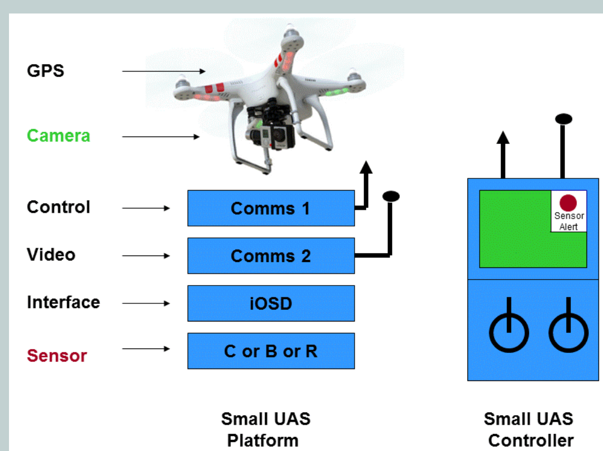

Figure 6. Architecture for sensor integration on quad-rotor small UAS drone. (Courtesy of Science and Engineering Services)

Lean-Sensing—continued

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Many advanced, commercial VTOL quad-rotor drones offer an iPad -based ground station feature (for example, see "Ground Station" under iPad Applications – Bluetooth 4.0 required) that allows for precision navigation using an on-board compass, on-board inertial measurement unit and a GPS-lock of 7 to 15 satellites. The key features of the ground station are home-lock, return-to-home, fail-safe, auto-land, pre-programmed navigation and way-points navigation with real-time flight status output such as altitude, vertical speed, horizontal speed, distance-from-home, distance-to-target, battery, radio communications and satellites. These are the exact features that are needed for the aircraft component of lean-sensing, where cloud or hazard site geo-location data is provided by Lidar (or less precise cameras) and can then be transferred into a drone mission plan. For example, **Figure 8** shows two operational templates for precision vectoring of a quad-rotor drone from command post to way-point(s) for single location remote sensing and route reconnaissance. These kinds of missions are easily set, programmed and flown. They are also flexible, i.e., if the drone finds something at a location that is hazardous enough that the drone should not come back, the drone mission plan can be immediately altered.

"...if the drone finds something at a location that is hazardous... the drone mission plan can be immediately altered."

Figure 7. Battery cartridges are evolving to be more efficient and logistically supportable. (Courtesy of Science and Engineering Services/Released)

Figure 8a. Precision vectoring of quad-rotor drone from command post to way-point(s) for remote sensing and reconnaissance. (Courtesy of Dugway Proving Ground, Utah/ Released)

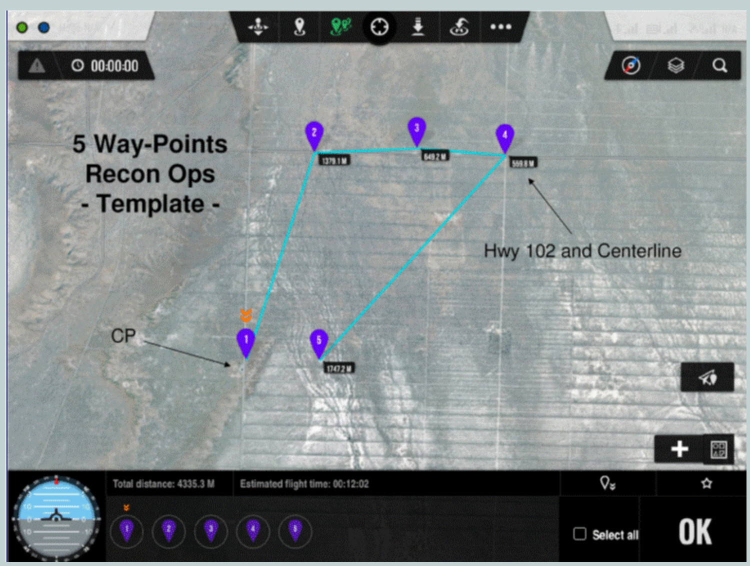

Figure 8b. Precision vectoring of quad-rotor drone from command post to way-point(s) for remote sensing and reconnaissance. (Courtesy of Dugway Proving Ground, Utah/ Released)

Lean-Sensing—continued

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Key aspects of the lean-sensing construct were recently tested (**Figure 9**). An SDS-Lite was used to detect, map and track a chemical cloud target measuring approximately 150 meters wide by 1,500 meters long. A logical geo-located point was obtained and then loaded into a quad-rotor drone mission plan. The cloud target longitude and latitude in the left of **Figure 9** match way-point 2 in the right. Based on the mission plan, the total mission time for travel and sensing/imaging was about four minutes, with another optional two minutes for a return flight with sample(s) for further analysis.

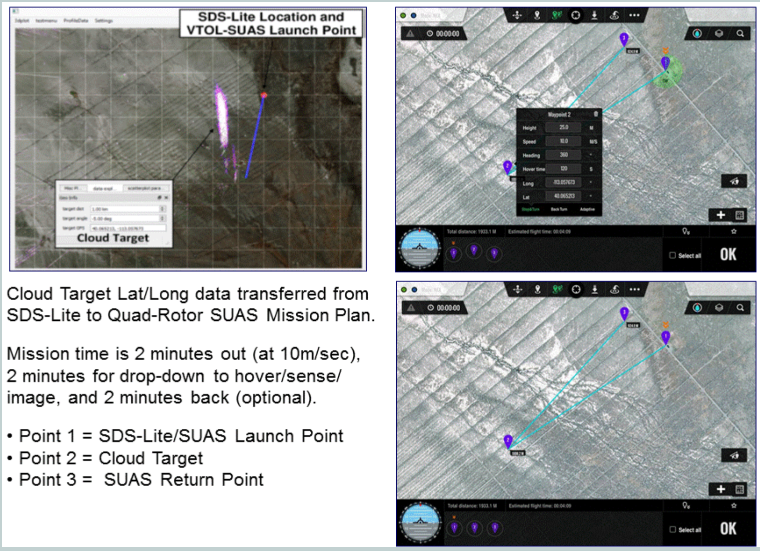

Figure 9. Small UAS mission plan via SDS-Lite (left) and latitude and longitude cloud data (right). (Courtesy of Dugway Proving Grounds, Utah, and JPEO-CBD/Released)

Some Thoughts on the Future

Based on current technologies and systems, test results, and government and IR&D investments, the materials and preliminary methods for executing lean-sensing are now available for geo-locating hazards in real-time by optical means. The hazards can be visually checked and initially identified using a VTOL drone with sensor payload vectored to the hazard location. Aircraft and sensors can be as simple as a Phantom 2 quad-rotor drone with M-8 paper or as sophisticated as an S1000 octo-rotor drone with an integrated CBR sensor package including JCAD + IBAC or TacBio + Radiac, such as AN/UDR-13. In either case, a scenario vectoring a VTOL drone via SDS-Lite could look like the following (**Figure 10**):

T+0 minutes: A 3-D cloud target or suspected hazard site is detected, mapped and tracked.

T+1 minute: Cloud coordinates are transferred to drone mission plan, and drone is launched.

T+3 minutes: Vectored drone reaches cloud or hazard site for detection and reporting.

T+4 minutes: Detection is made at the cloud or surface, and data/imagery are transmitted to command post for integration with FPA, JWARN, etc.

The lean-sensing approach offers real potential for cutting exposure risk, response time and life-cycle cost by precision unmanned delivery of a detector early in the response sequence using materials and preliminary methods now available. When lean-sensing combines with a networked decision-support system such as FPA or JWARN, the total system performance can be further enhanced.

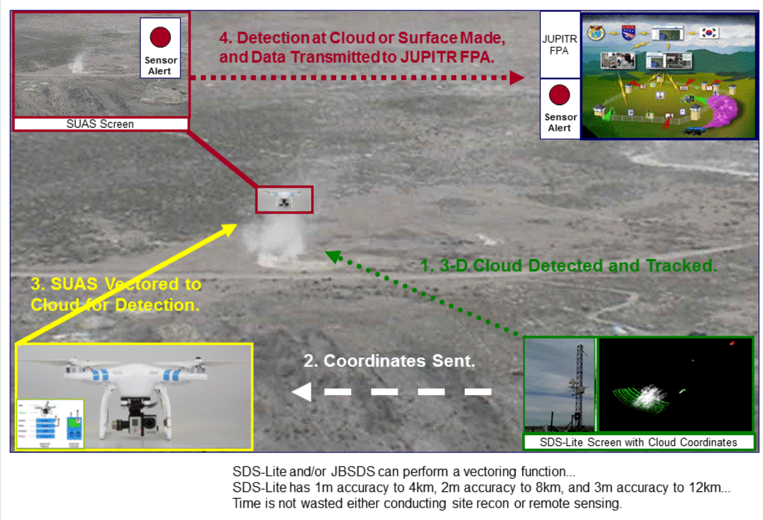

Figure 10. A scenario vectoring quad-rotor VTOL drone via SDS-Lite. (Courtesy of Dugway Proving Grounds, Utah, and JPEO-CBD/Released)

Lean-Sensing—continued

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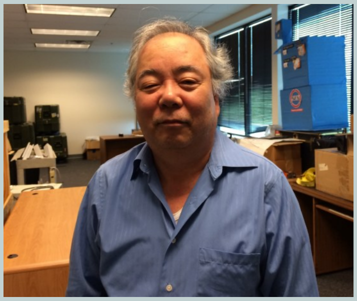

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Key Words and Notes:

COTS = Commercial-Off-The-Shelf
CP = Command Post
DTRA = Defense Threat Reduction Agency
FPA = Force Protection Architecture
GPS = Global Positioning System
IBAC = Instantaneous Bio-Analyzer and Collector
IR&D = Independent Research and Development
JBSDS = Joint Biological Standoff Detection System
JCAD = Joint Chemical Agent Detector
JPEO-CBD = Joint Program Executive Office for Chemical and Biological Defense
JWARN = Joint Warning and Reporting Network
LED = Light-Emitting Diode
Lidar = Light Detection and Ranging
Li-PO = Lithium-Polymer
Radiac = Radiation Detector
SDS-Lite = Standoff Detection System - Light Weight
SUAS = Small Unmanned Aircraft System
TacBio = Tactical Biological Detector
VTOL = Vertical Take Off and Land

Technical Inquiry Highlight

Gene Therapy

HDIAC recently conducted a search and analysis on gene therapy. Gene therapy is emerging as a powerful approach with the potential to treat and even cure some of the most common diseases of the nervous system. Gene therapy for neurological diseases has been made possible through progress in understanding the underlying disease mechanisms, particularly those involving sensory neurons, and also through improvement of gene vector design, therapeutic gene selection and methods of delivery.

All gene therapy on humans to date has been directed at somatic cells, which only affect the targeted cells in the patient and are not passed on to future generations. However, the effects of somatic cell therapy are often short-lived because cells in most tissues ultimately die and are replaced by new cells. This means repeated treatments are required over the course of the individual's life span to maintain the therapeutic effect. Transporting the gene to the target cells or tissue is also problematic. However, regardless of these difficulties, somatic cell gene therapy is an appropriate and acceptable treatment for many disorders including cystic fibrosis, muscular dystrophy, cancer and certain infectious diseases.

HDIAC highlighted some of the strategies being employed to improve direct and peripheral targeting of therapeutic vectors of central nervous system tissue and considered the significance of cellular and tissue transduction specificity, transgene regulation and other variables that influence the achievement of successful therapeutic goals. Diseases of the nervous system have devastating effects and are widely distributed among the population, especially in the elderly. These diseases are often caused by inherited genetic mutations that result in abnormal nervous system development, neurodegeneration or impaired neuronal function. Other causes of neurological diseases include genetic and epigenetic changes induced by environmental insults, injury, disease-related events or inflammatory processes. Standard medical and surgical practices have not proven to be effective in curing or treating these diseases, and appropriate pharmaceuticals do not exist or are insufficient to slow disease progression. Gene therapy is emerging as a powerful approach with the potential to treat and even cure some of the most common diseases of the nervous system.

HDIAC reviewed recent advances that underlie putative therapies for neuroprotection in Parkinson's disease and Huntington's disease and potential targets that might be exploited in the future. Although there are still important hurdles to overcome, especially in terms of clinical trial design, HDIAC was able to propose several target pathways that merit further study. In Parkinson's disease, these targets include agents that might improve mitochondrial function or increase degradation of defective mitochondria, kinase inhibitors, calcium channel blockers, and approaches that interfere with the misfolding, templating and transmission of α-synuclein. In Huntington's disease, strategies might also be directed at mitochondrial bioenergetics and turnover, prevention of protein dysregulation, disruption of the interaction between huntingtin and p53 or huntingtin interacting protein 1 to reduce apoptosis, and interference with expression of mutant huntingtin at both the nucleic acid and protein levels.

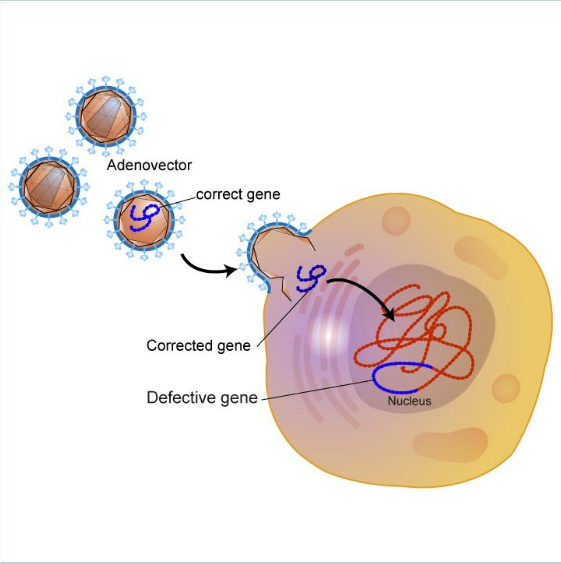

Diagram of gene therapy. (Courtesy of the National Human Genome Research Institute's Talking Glossary /Released)

Coming up next issue...

Alternative Energy

Power from the Sea

Humankind has been extracting energy from the sea throughout civilized history. For millennia, the sea's currents and winds have pushed ships and filled sails to provide transportation. For centuries, the sea's role as a heat sink and moisture source has provided the wind and precipitation patterns that spin windmills and water wheels, providing mechanical work. Currently, researchers are exploring the sea's ability to generate the energetic currency of our generation: electricity.

CBRN Defense

U.S. National Biosurveillance: An Integrated Enterprise

Since the 1970s, newly emerging diseases have been identified at a rate of one or more per year. Further, terrorism experts have warned that both terrorists and nations are seeking to obtain biological weapons. *The National Strategy for Countering Biological Threats*[3] notes that: (i) the risk is evolving in unpredictable ways; (ii) advances in enabling technologies will continue to be globally available; and (iii) the ability to exploit such advances will become increasingly accessible to those with ill intent as the technical expertise and monetary cost barriers decline. Finally, the nation's food and agriculture systems face threats from natural and intentional origin, and these threats could have devastating consequences in terms of both health and economic loss.

Biosurveillance is performed for two major reasons: (i) reducing the time it takes to recognize and characterize biological events with potentially catastrophic consequences and (ii) providing situational awareness (i.e., information that signals an event might be occurring, what those signals mean, and how events will likely unfold in the near future). It enables better decision making by gathering, integrating, interpreting, and commu-nicating essential information to achieve early detection and warning. Biosurveillance spans boundaries between surveillance for public health threats, protection and monitoring, and bioterrorism. Accordingly, traditional demarcations are increasingly fading among public health, animal health, ecological health, and biosecurity and bioterrorism defense surveillance capabilities.

The backbone of biosurveillance is comprised of traditional disease surveillance systems, which help professionals recognize unusual disease signals and analyze their meaning. These systems generally have inherent limitations that affect the speed at which results can be determined, communicated, and acted upon. Numerous federal, state, local, and private sector entities with responsibility for monitoring plant, animal, and human health, food, and the environment have roles to play both in supporting traditional surveillance activities and in designing systems to focus specifically on enhancing detection and situational awareness. Because of the array of activities and entities associated with effective biosurveillance, ongoing interagency, international, and intergovernmental collaboration is crucial.

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Coming up next issue...

Critical Infrastructure Protection

Death by Technology: The Need for Law to Mitigate Risk

During the Black Hat Conference of 2013, Jay Radcliff demonstrated how to hack an insulin pump to administer the wrong amount of insulin. The medical community has suggested that implanted medical devices could be subject to hacking attempts, and the Radcliff demonstration showed that the threat is now a reality. This article will examine the need for government standards and laws for networked medical device security to prevent death by technology via hacked networked medical devices. The need for higher security standards for medical manufacturers is high because the recent demonstration proves networked medical devices such as pacemakers, insulin pumps and defibrillators can be hacked. Patients who need these implanted devices are at a higher risk of health problems and death since the devices can be compromised. The first steps in comprehensive emergency management are prevention and mitigation. This issue is relevant to emergency management because better security standards will prevent attacks and mitigate the risk to those with medical devices. Standards and laws will also help influence policy and procedure, which will create training and awareness in this field.

Cultural Studies

Unresolved Questions of Cultural Awareness and Sensitivity Regarding the Development and Use of Nanotechnology in Medical Applications

The use of nanotechnology in medical applications is growing. However, as with any new discovery, unresolved issues have emerged as nanotechnology begins to hit the mainstream. One area that has not been sufficiently studied is the impact the use of nanomaterials in healthcare may have on particular cultural groups. A fair amount of research has looked at ethical and legal concerns regarding the use of nanotechnology, and most cultural research has focused on risk perception and general awareness of the technology, not on how different value-systems view the growing field of nanotechnology as it pertains to medicine. Historically underrepresented groups have not been given a voice, certainly when it involves philosophical concepts, religious beliefs, and group norms as applied to how various cultures might respond to the introduction of engineered nanomaterials into their bodies. Other issues also arise, such as ethical considerations. Would physicians have an obligation to inform their patients that pharmaceuticals or procedures might contain or involve engineered nanomaterials? In addition, would information be withheld from certain groups based on preconceived notions involving cultural identity? Even less research has been conducted on how certain groups that traditionally have little control over their choice of care, such as active duty military personnel and prisoners, would be treated if the use of nanotechnology conflicted with their personal beliefs. These issues will be discussed in an effort to promote open dialogue about difficult subjects, fostering an environment that is more conducive to developing a well-rounded approach to the application of new technologies.

Coming up next issue...

Cultural Studies

The Rise Before the Fall: Crises of Authority, ISIL's Oxygen and How the West Can Respond

ISIL exploits a power vacuum in Iraq, disillusionment in the Middle East and alienation from power in Western countries. ISIL appears strong where others appear weak, i.e., jihadists deferential to Al Qaeda, Western countries deferential to Syria's Asad regime or families and friends deferential to non-Muslim cultures.

The list of explanations for ISIL's success include, but are not limited to, unchecked sectarianism, absent representative government in Iraq, failure of the Arab Spring and general lack of democratic institutions in the Middle East. Western countries are not responsible for the factors that cause the Middle East to continue to divide and conquer itself, but nor are their actions separate from current tensions. In 2003, the U.S.-led coalition flipped the tables of power in Iraq. The early decisions of the interim government of the Coalition Provincial Authority systematically alienated Sunnis. They were then reintegrated during the "awakening" only to be re-alienated again by the Maliki government. The power dynamics in Iraq have not reached the equilibrium needed to form a new social contract accepted by a critical majority of the three major groups. All sides need a viable alternative to the status quo.

Homeland Defense and Security

Biobotic Insect Sensor Networks for Search and Rescue

Distributed robotics systems, or robotic swarms, have indisputable potential in applications requiring situational awareness, such as search-and-rescue in emergency situations. Robotic swarms or other distributed robotic systems are required to cope with uncertain and dynamic environmental conditions like those that occur after natural disasters. While current technology falls short of offering centimeter scale mobile agents, insects, the inspiration of many robotic swarms, exhibit an unmatched ability to navigate through dynamic environments. The latest techniques in neural engineering and neuromuscular stimulation research have recently been used to fuse the locomotory advantages of insects with the latest developments in wireless networking technologies to enable biobotic insect agents to function as search-and-rescue agents.

Homeland Defense and Security

Border Security, Part II: The Extent of the Border Security Challenge to our Homeland Defense and Security Mission and How the DoD Assists

This article is the second in a series highlighting current issues and challenges concerning the security aspects of our territorial borders. This article serves to highlight some of those challenges relevant to Homeland Defense and Security and Critical Infrastructure Protection. It will also show how technologies, developed for the DoD warfighter, can be leveraged to support the Department of Homeland Defense (DHS) to meet those border challenges. The article further describes the physical extent of our territorial borders and how DHS manages the normal cross border traffic while maintaining a vigilant watch for illegal or terrorist activities.

The challenge DHS faces is enormous. When we think of the borders surrounding the continental United States, we typically think of our territorial land borders to the southwest with Mexico, the U.S./Canadian border to our North, our highways, and seaports that provide entry in to the United States. The Homeland Defense and Security border concerns cover a much broader spectrum than the normal points of entry for vehicular traffic. This article will provide a description of our border security environment and how the DoD assists the DHS in maintaining border security.

Coming up next issue...

Medical

Battlefield MRI

Magnetic Resonance Imaging is the best method for non-invasive imaging of soft tissue anatomy, saving countless lives each year. It is regarded as the "gold standard" for diagnosis of mild to moderate traumatic brain injuries. However, conventional MRI relies on very high, fixed strength magnetic fields (> 1.5 T) with parts-per-million homogeneity, requiring large and expensive magnets. The overwhelming technological trend in MRI has been toward ever higher magnetic fields because the signal (sample magnetization) and the sensitivity of the Faraday detectors traditionally used scale (increase) with the applied magnetic field (readout frequency). Thus, bigger fields have been widely accepted as the only way to obtain quality images. High field MRI comes at a price: the method can only be used in highly controlled settings in well-funded medical centers where large magnetic fields can be generated without posing a hazard. MRI machines weigh many tons, cost $3-5 million, and typically require 100-1000 liters of cryogens (per year with a refrigeration system).

The high magnetic fields also restrict access in other ways. Traditional high field MRI is not available in rural settings, and it is not deployable to emergency situations or battlefield hospitals. The cost of a conventional MRI system is well beyond what billions of people in poor and developing countries can afford. Subjects with unknown medical histories (e.g. unconscious, soldiers with possible shrapnel injuries, etc.) cannot be imaged because of the potential hazards of heating or moving metal in the body. Even non-ferrous metal significantly distorts a high field MRI, precluding imaging of those with medical implants. Here, we present our progress toward developing a portable "Battlefield" MRI machine based on SQUID (superconducting quantum interference device) sensor technology and ultra-low field MRI techniques developed at Los Alamos National Laboratory. This device requires only 10s of liters of cryogens and makes use of very simple and light field generation, 10-100 times less than a traditional MRI machine. We present imaging of the human brain at fields 10,000 times lower than traditional MRI, using a pulsed-field method. We also demonstrate the capability for imaging injuries as small as a few millimeters, including brain bleeding and hydrocephalus. Operation in the presence of metal (or even through metal) is also shown. Compatibility with other medical equipment and brain imaging modalities as well as the potential for systems that can be easily deployed (e.g. truck or helicopter) will also be discussed.

HDIAC Calendar of Events

NCT CBRNe USA
29 April – 1 May 2015
Washington, DC

Medical Informatics World Conference 2015
4-5 May 2015
Boston, MA

International Conference on Big Data Analysis and Data Mining
4-6 May 2015
Lexington, KY

CARTES Secure Connections Exhibition and Conference
5-7 May 2015
Washington, DC

VA Health Care Summit
11-13 May 2015
Washington, DC

Humanitarian Technology: Science, Systems and Global Impact
12-14 May 2015
Boston, MA

8th European Symposium on Non-Lethal Weapons
18-20 May 2015
Ettlingen, Germany

35th IEEE Symposium on Security and Privacy
18-20 May 2015
San Jose, CA

NBC 2015
18-21 May 2015
Helsinki, Finland

WindPower 2015
18-21 May 2015
Orlando, FL

2015 SOFIC
19-21 May 2015
Tampa, FL

2015 LANPAC Symposium and Exposition
19-21 May 2015
Waikiki, HI

Noteworthy

Alternative Energy

Researchers find a way to convert waste heat to electricity at nano-scale
April 13, 2015

Graphene pushes the speed limit of light-to-electricity conversion
April 14, 2015

Biometrics

Australia's border security agency to install facial recognition terminals in airports
April 23, 2015

Biometrics Institute warns Australian government about collecting biometrics from children
April 23, 2015

CBRN Defense

Soldiers, astronauts to be protected by tough, flexible new material
April 9, 2015

New technology provides superior ability to rapidly detect volatile organic compounds
Apr 13, 2015

Critical Infrastructure Protection

Despite disasters, oil-by-rail transport is getting safer
April 16, 2015

More Americans at risk from strong earthquakes, says new report
April 22, 2015

Cultural Studies

Iraq's Youth Are Ticking Time Bombs That Can Still Be Defused
April 7, 2015

National Security Policy and Feminism Don't Have To Be Incompatible
April 7, 2015

Approved for public release; distribution unlimited.

Noteworthy

Homeland Defense and Security

Earth Day: Climate change and displacement across borders
April 21, 2015

Department of Homeland Security says flood of migrant kids is slowing
April 22, 2015

Medical

Pain-free blood tests
April 14, 2015

Zip me up! Zooming into wound healing
April 21, 2015

Weapons of Mass Destruction

U.S. military views North Korean ICBM as 'operational'
April 8, 2015

Assad regime continues to employ chemical weapons
April 22, 2015

The Homeland Defense & Security Information Analysis Center (HDIAC) is a Department of Defense (DoD) Information Analysis Center (IAC) providing scientific and technical information (STI) to the homeland defense and security communities.

HDIAC is managed by the DoD IACs Program Management Office (PMO) through the Defense Technical Information Center (DTIC).

DoDIACs

Department of Defense Information Analysis Centers

http://iac.dtic.mil/

CSIAC — Cyber Security & Information Systems Information Analysis Center

DSIAC — Defense Systems Information Analysis Center

HDIAC — Homeland Defense & Security Information Analysis Center

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