Army Science and Technology Analysis for Stabilization and Reconstruction Operations

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I. Introduction

In the area of stabilization and reconstruction (S&R) operations, this study examines capability gaps and science and technology (S&T) needs and concludes that some areas require renewed emphasis, to include: scaling Blue Force Tracking down to the individual soldier, developing an on-the-ground biometric identification device, and fielding "hover and stare" unmanned aerial vehicle (UAV) assets for use at the platoon level.

By way of background, Dr. Thomas Killion, Deputy Assistant Secretary of the Army for Research and Technology, has been seeking to strengthen the technology base and research planning of Army S&T programs as they relate to S&R operations. By identifying capability gaps and, where appropriate, applying technological approaches to addressing those gaps, the Army should be better positioned to meet its increasingly S&R-focused mission requirements.

To support the Army in this effort, the Center for Technology and National Security Policy (CTNSP) at National Defense University (NDU) undertook a study to assess the technological capability gaps in the U.S. Army's ability to conduct S&R operations. The purpose of this study was threefold:

- through field surveys, interviews, and review of related studies, to identify the technological shortfalls most consistently cited in land force execution of phase IV operations;[1]
- with respect to these operations, to identify capability gaps and needs and assess them with specific focus on the issue of technology shortfalls; and
- with the gap analysis in hand, to highlight technology opportunities for consideration by Army S&T leadership.

As described in the 2004 CTNSP book, *Transformation for Stabilization and Reconstruction Operations*, S&R capabilities are critical to the transition from military-led, rapid, and decisive major combat missions to civilian-led, longer-term, post-conflict reconstruction missions.[2] The ongoing missions in Afghanistan and Iraq demonstrate that S&R operations are high priorities for the U.S. Army. The issuance of Department of Defense (DOD) Directive 300.05 (Military Support for SSTR) and the updating of FM 5-

[1] The most widely accepted model for military campaigns involves four phases of operations. Phase I covers preparation for combat, Phase II encompasses initial offensive operations, Phase III is combat, and Phase IV involves post-conflict S&R operations. It is important to note that these phases are by no means discrete or sequential; thus, it is critical that the military retain full-spectrum capabilities. For a discussion of these four phases in Iraq, see the introduction to "On Point: The U.S. Army in Iraq," a study of Operation *Iraqi Freedom* conducted by the Center for Army Lessons Learned, Fort Leavenworth, KS . Available online at <http://call.army.mil/products/on-point/intro.asp>.

[2] Hans Binnendijk and Stuart E. Johnson, editors, *Transforming for Stabilization and Reconstruction Operations,* (Washington, DC: National Defense University Press, 2004).

0.1 Interim, "The Operations Process," (Appendix A: Stability and Reconstruction Operations) speak to the crucial role that S&R operations play. Traditionally-focused combat operations—major conflict between large forces employing total resources and involving large-scale, force-on-force engagements—have given way to more complex S&R missions requiring full-spectrum expertise.

In this study, the components of S&R operations are defined as follows:

- Stabilization operations include the spectrum of military and civilian activities, from conflict to peace, used to establish or maintain order in states and regions, as well as provide security for reconstruction operations. These activities are used to promote and protect U.S. national interests by influencing the security, political, and information dimensions of the operational environment through a combination of peacekeeping, cooperative activities, and coercive actions in response to crisis.[3,4]
- Reconstruction operations encompass the reestablishment of the governmental, security, judicial, health, transportation, commercial, and other infrastructures of states and regions. Activities include the identification and training of appropriate personnel; the reestablishment of governmental, transportation, health, education, and other related institutions; and facilities construction and the reconnection of communications, water, waste disposal, gas, electric, oil, and other utilities.[5]

Combat and combat support units are very much involved in stabilization operations. While the execution of reconstruction operations falls primarily on combat support and combat service support personnel—especially the Corps of Engineers; Transportation, Ordnance, and Quartermaster Corps; and civil affairs support personnel—reconstruction missions are also often supported by non-military personnel within DOD, non-DOD personnel, and non-governmental organizations (NGOs).

It also should be noted that stabilization missions and reconstruction missions are not unique, self-contained endeavors. They can occur concurrently in the same battlespace and are complementary operations supporting the full spectrum of military operations. For example, successful stabilization operations improve the security of reconstruction missions in a particular area of operation (AO), while at the same time, successful reconstruction operations help win the support of the local populace, which may reduce the number of significant hostile actions against U.S. forces. This phenomenon was identified and articulated by the then Commanding General, 1st Cavalry Division, Lieutenant General Peter W. Chiarelli, based on his experience in Baghdad in 2004.[6]

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[3] FM 3-0 and FM 3-07.
[4] DODD 3000.05, "Military Support to Stability, Security, Transition and Reconstruction (SSTR)," Undersecretary of Defense (Policy), November 28, 2005.
[5] As support for this discussion, see <http://www.rebuilding-iraq.net/portal/page?_pageid=95, 1&_dad=portal&_schema=PORTAL>.
[6] LTG Chiarelli is now Commander, Multi-National Corps-Iraq. Information here is drawn from: Peter W. Chiarelli and Patrick R. Michaelis, "Winning the Peace: The Requirement for Full-Spectrum Operations,"

Finally, the present study is organized along 10 major categories of military capabilities: battle command,[7] armored vehicles in urban environments, situational awareness (SA), intelligence, force protection, unmanned systems, non-lethal capabilities, information operations (IO), training and use of modeling and simulation, logistics. Within each category, existing and forthcoming Army S&T programs are mapped against stated technology shortfalls and capability gaps. While the issues of technology shortfalls in military capabilities as a whole are important, the overriding orientation of this analysis is focused on S&R operations. It is also important to note that the categories listed here are by no means discrete. In addition to the fact that many technologies have application for both combat and post-conflict environments, numerous issue areas noted have relevance in other categories. For example, intelligence has relevance to improvised explosive device (IED) detection and threat mitigation as well as to IO issues.

We begin the paper by detailing the methodology that was utilized to gather data in the categories noted above. This is followed by an analysis of the data for the same categories (Chapter III). The paper then closes with a discussion of the analyses and with some concluding remarks (Chapter IV).

Military Review, July–August 2005 and "RDECOM/ DARPA Future Technology and Equipment Brief," 1st Cavalry Division Briefing, June 1, 2005.

[7] For the purposes of this study, command, control, and communications will be placed in this category.

II. Data-Collecting Methodology

Building on the aforementioned book, *Transformation for Stabilization and Reconstruction Operations*, in particular chapter seven, "Supporting Technologies," the study team engaged land force leaders from the non-commissioned officer (NCO) to general officer-level who had experience in phase IV operations in Iraq, Afghanistan, the Balkans, and Haiti.

The report also draws from various studies by governmental organizations and other components, including: the U.S. Army Training and Doctrine Command (TRADOC), specifically the Army War College Peacekeeping and Stability Operations Institute, Carlisle Barracks, PA, and the Army Capabilities Integration Center-Forward (ARCIC-F), Arlington, VA; The Defense Science Board; The Defense Technical Information Center; The Defense Advanced Research Projects Agency (DARPA); private industry; interagency workshops; and a variety of other resources.

Details of the interface with the sources noted above are shown below:

Discussions with Commanding General, 1st Cavalry Division, and Deputy Director, U.S. Army Research Laboratory (ARL)

The impetus for this study came from a series of discussions with and documents provided by the Commanding General, 1st Cavalry Division. These included a published article,[8] presentations,[9,10] and verbal discussions.[11] To develop an appreciation of the state of Army S&T efforts at the time, members of CTNSP met with the Deputy Director, ARL, to discuss ongoing efforts to address S&R operations capability gaps and identify S&T opportunities.[12]

NDU Students with Recent Deployments

The proximity of CTNSP to a high-level institution of professional military education (PME) gave us access to a pool of senior field grade officers from across the service branches. These military leaders took time out of their schedules to respond to an extensive survey covering the gamut of technological issues facing units involved in S&R operations. While the majority of these respondents were returning from recent deployments in Iraq (over 70 percent), experience from operations in Afghanistan, Kosovo, Bosnia, and Somalia were also represented. The various experiences encompassed missions in joint and coalition environments, among different branches, at disparate echelons, and with varied equipment packages. The common themes that emerged from the surveys

[8] Chiarelli and Michaelis.
[9] Peter W. Chiarelli, *Task Force Baghdad, Operation Iraqi Freedom II*, presentation for RDECOM VTC, September 15, 2005.
[10] Chiarelli, RDECOM/ DARPA Brief.
[11] Peter W. Chiarelli meeting, ASA(ALT), September 22, 2005.
[12] Dr. Joseph Rocchio, Adelphi, MD. September 7, 2005

spoke to the overarching nature of some aspects of S&R operations (especially in urban environments). In addition to providing evaluation of equipment and technology in S&R operations, these officers also provided useful comments regarding issues wider in range; namely, highlighting the importance of coordinating the large number of actors (civilian and military) on the ground in post-conflict situations.

Military Personnel at Fort Knox, KY and Fort Hood, TX

Included in our data collection were interviews and focus group sessions at Fort Knox, Kentucky[13] and Fort Hood, Texas.[14] At Fort Knox, one general officer from the Corps of Engineers and field grade officers from the Transportation and Aviation Corps, as well as the Corps of Engineers, provided valuable insights concerning reconstruction and some stabilization operations. Their lessons learned gave us valuable information about the need for improved integration of S&R operations, better SA, and significantly improved communications in long-haul operations. At Fort Hood, combat arms officers and an NCO of the 1st Cavalry Division gave us detailed accounts of their recent deployment in Baghdad. Charged with security operations in and around the International Green Zone, these warfighters[15] executed many of the complex, full-spectrum operations required of S&R operations in urban environments. From establishing and defending traffic control points (TCPs) to conducting dismounted patrols in the neighborhood near the Green Zone, 1st Cavalry warfighters were attacked in a variety of ways—the most prominent threats came from IEDs, mortar fire, rocket propelled grenades (RPGs), and sniper fire. Their comments regarding the performance of vehicles, weapon systems, communications, and equipment in executing complex and dangerous stability operations were extremely valuable. Their critiques of battle command, SA, and local sensor networks were particularly thorough and consistently echoed by other data sources. Their description of the Abrams tank's performance in this environment was an especially useful example of the vulnerabilities of our military systems in chaotic urban environments. Moreover, their assessment of tools for the detection of explosives in TCP operations provided real insight into the daunting task of balancing security with convenience when screening for suicide bombers, vehicle borne IEDs (VBIEDs), and other force protection threats.

The Army Capabilities Integration Center-Forward (ARCIC-F)

The ARCIC-F staff's presentation and technical data provided insight into the Army's efforts to identify and address technology needs for S&R operations.[16] The comprehensive nature of the material provided to us gave our report a baseline from which to investigate additional issues and do follow-on analysis. The ARCIC-F has evaluated the Army's capabilities, and it was the "cross-

[13] November 17, 2005.
[14] November 15, 2005.
[15] The term *warfighter* is meant to imply a role not just in direct combat, but in the full-spectrum of related responsibilities, including stabilization and reconstruction.
[16] April 10, 2006 at ARCIC-Forward offices, Arlington, Virginia.

walking" of needs assessments and technological shortfalls against existing S&T programs where we saw the most potential for our current report. It goes without saying that we have sought in our research to avoid duplicating existing efforts. Instead, in our use of independent researchers and NDU surveys, for example, we hoped to give value-added analysis by incorporating information and comments from elements that might be outside the current purview of ARCIC-F. The technology need areas identified by this component of TRADOC served as a starting point for framing the capability gaps assessed through other resources. In the end, we hope we have enriched Army endeavors by approaching this study with a slightly different perspective and reference point.

AMC–Field Assistance in Science and Technology (FAST)

Meeting with FAST staff, we were able to acquire information pertaining to fielding and implementation of equipment and systems as well as get a picture of the needs of warfighters.[17] FAST serves as a conduit between the Army's Research, Development, and Engineering Command (RDECOM) and individual soldier suggestions, thereby reducing the fielding time required for new/modified equipment. The Science and Technology Assistance Teams (STATs) of FAST are attached to units on the ground to translate soldier needs into research and development (R&D) initiatives that address them. Through FAST publications and an interview, we surveyed the Army's ability to identify potential technological needs and bring solutions to the soldier.

Related Studies

Recent studies also proved to be valuable in assessing capability needs and potential technology opportunities. In particular, a counter-IED study sponsored by the Office of Naval Research (ONR) was helpful in assessing the magnitude of S&T efforts in support of this force protection issue.[18] A Natick Soldier Systems study provided information about the ingenuity of our warfighters in Afghanistan and Iraq in rapidly addressing equipment shortcomings for S&R operations.[19] Finally, a U.S. Marine Corps (USMC) study provided new tactical and doctrinal approaches for counter-insurgency operations.[20]

[17] August 8, 2005 and May 31, 2006, Ft. Belvoir, VA.
[18] Team IED Study for ONR Code 32 Final Program Review, October 6, 2005.
[19] Chuck Greene, "Soldier Innovation Report 1: Soldier Innovation, Ideas, and Standard Equipment Modifications in Iraq and Afghanistan," Operational Forces Interface Group, U.S. Army Soldier Systems Center–Natick, December 15, 2004.
[20] "Tentative Manual for Countering Irregular Threats: An Updated Approach to Counterinsurgency Operations," Marine Corps Combat Development Command, June 7, 2006.

III. Data Analysis

This chapter consolidates data from the interviews and reports identified in Chapter II into 10 areas: Battle Command, SA, Armored Vehicles in Urban Environments, Intelligence (including sensors), Force Protection, Unmanned Systems, Non-lethal Capabilities, IO, Training and Use of Modeling and Simulation, and Logistics.[21] In each category we listed the major needs assessed and matched current and forthcoming S&T projects oriented toward addressing those needs. A summary of the analysis for the above areas is shown in Appendix B, Table 1.

Battle Command

The primary limitations identified in this category had to do with operations in complex urban environments. The glut of commercial frequencies; the obstructions to friendly radio frequency propagation, global positioning system (GPS) reception, and multi-spectral emissions (for sensors); the density of people, buildings, and obstacles; and the general lack of maneuverability for large vehicles are all elements which contribute to the difficulties faced by warfighters in cities. Baghdad presents especially severe challenges in this area.

Due to its complexity, this topic is divided into several sub-categories. They are C2, integration of S&R operations, and communications.

Command and Control:

- *Inability to Track and Identify Dismounted Personnel in an Urban Environment.* The sheer number of civilians, coupled with poor infrastructure for vehicle and pedestrian traffic, make the tracking of dismounted friendly forces extremely difficult in urban terrain.[22] To assist with identifying friendly personnel in this very complex environment, new polymers are being developed to embed an identification system into the next generation of body armor and textiles. These polymers will allow for Blue Force Tracking-like signals to be sent to the next generation of SA systems from warfighter clothing and/or armor.[23] Scaling this

[21] These categories are based in part on the Army Capabilities Integration Center's identified shortfall areas, as well as consistently identified gaps resulting from surveys and interviews.
[22] Tracking of friendly personnel and equipment is an SA issue. Given its crucial importance, SA will be discussed in greater detail as a separate section.
[23] For more information on this technology's integration into the U.S. Army's Land Warrior System see, "Distributed Antenna Applications for Body Worn Platforms," at PEO Soldier, Soldier Systems Center (Natick) <http://www.dodsbir.net/sitis/archives_display_topic.asp?Bookmark=27994>, and "When Textiles Go Extreme," *Washington Post*, April 17, 2005. Available online at <http://www.washingtonpost.com/wp-dyn/articles/A56477-2005Apr15.html>.

type of signal down to the individual soldier level will increase the complexity of future SA systems; however, we believe that this innovation holds the most promise for enhancing the identification of friendly personnel in a complex urban environment.[24]

Assessment: This is a need for both combat and S&R operations. The identification system should be recognizable by both ground and air Blue Force Tracking systems. Since this is an ongoing need for combat operations, it has been and will continue to be addressed through S&T efforts within DOD. In terms of S&R operations applicability, it is also crucial to consider use of a solution system for non-DOD personnel, including U.S. government, non-government agency, and contractor personnel involved in S&R efforts.

- *Need for Tracking Civilians in C2 and SA Systems.* In S&R operations, especially in urban environments, friendly forces may need to identify and track indigenous civilian, non-combatants in their SA systems. This issue is discussed in detail in the subsection on force protection.

- *Better Opposing Forces (OPFOR) Icons in SA Systems.* To adjust from force-on-force engagements in traditional combat to counterinsurgency operations, warfighters require systems that allow for the identification and labeling of entities smaller than a platoon. Existing systems do not allow solders to label the location of suspected IEDs, individual combatants, or civilians with weapons. This is a stated at-risk shortfall identified by the Army (visual and virtual obstacle marking system).[25] While future C2 systems will include more details in an AO, this is critically lacking in current operations. However, since the overarching architecture for this system is already in place, this issue has more to do with adapting and modifying the existing system rather than developing new technology altogether. Therefore, the Army should focus on refining this system to better identify the myriad elements present in an urban environment, garnering soldier input to ensure that all components are addressed and that future symbology makes sense.

  Assessment: Current C2 systems need to be reengineered to incorporate appropriate OPFOR icons (and perhaps others) for S&R operations. Because of the unpredictable needs of our warfighters in day-to-day S&R operations, it might be beneficial for C2 systems to have a capability for the user to design and input icons as they need them. While this might present a problem as icons proliferate

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[24] For more information on these innovations, see "Electro-textiles in Future Warrior Systems" and "SPEAR Modular/Integrated Communications Helmet," U.S. Army Natick Soldier Center website at <http://nsc.natick.army.mil/media/fact/content.htm>.

[25] ARCIC designates this technology objective as ManSup3 in "Identifying Capabilities in Stability Operations Briefing," April 10, 2006. This is also addressed in the stated ARCIC at-risk shortfalls: Single SA system for processing and displaying intelligence information from multiple intelligence disciplines at all levels of classification (BA4 and BC3) and Future Force COP Visualization Capabilities (BC8).

without uniformity, we believe that the Army could counter this by periodically adopting accepted standards for new icons.

Integration of S&R Operations:

- *Need for an Integrated S&R Operational Planning and Execution C2 System.* The planning and execution of S&R missions should be integrated, providing a common operating picture (COP) to military and non-military personnel involved. For example, in addition to daily patrols, maneuver units need visibility of reconstruction activities (for example, size of quarry operations, truck routes and schedules for delivery of gravel, and/or the size of a security perimeter required for construction of an airfield) to determine and plan for daily security missions. This is complicated by the fact that a single reconstruction project often affects numerous U.S. and coalition unit sectors, especially in terms of supply movement. Reconstruction organizations need to base their construction plans, such as the delivery of materials, on the availability of security forces and must coordinate with U.S. and coalition units.

  Therefore, an information system is needed to integrate stabilization (maneuver, security, and combat missions) and reconstruction operations (construction of airports, buildings, communications infrastructure, etc.) into a single common operating environment (COE) with a COP. The system must be integrated across U.S. and coalition stabilization forces to account for reconstruction operations that may affect numerous unit AOs. The system should be similar in function to the Command Post of the Future (CPoF) system currently used as an operational C2 system in Iraq allowing collaborative planning across military, governmental, non-governmental, coalition, and host nation organizations. This effort may need to be done in steps, first synchronizing U.S. S&R operations, including contracted security teams.

  Assessment: This capability can be addressed by re-engineering current Joint/Army information systems, such as CPoF. S&T research potential appears minimal and any efforts like integrating non-military organizations into the COP have already been mentioned.[26]

Communications:

- *Need for Better Non-Line-of-Sight Communications Devices/Systems in Urban Environments.* The most cited shortfall in terms of communications was a general lack of range for devices when operating in/near buildings and urban centers. Current Army line-of-sight radios—for example, Single Channel Ground and Airborne Radio System (SINCGARS)—in many instances proved inadequate for urban operations because the signals cannot penetrate thick masonry walls and surrounding fences. Satellite radios are not the answer because they do not work

[26] It is important to note that a variety of policy and operational security issues are associated with this capability. This report focuses on the more technical aspects of this capability gap.

inside buildings. To add to the problem, most SINCGARS radios in mechanized forces are designed for vehicles not dismounted patrols, which are more the norm in S&R operations. To augment communications capabilities, units have been issued AN/PRC-148 (C) Multiband Inter/Intra Team Radios (MBITR). These also did not work well—they had poor range (only a couple of kilometers—depending on the structures) in urban environments. What was found useful was the use of "repeater" radios like the Enhanced Position Location Reporting System (EPLRS) on the Force XXI Battle Command, Brigade and Below (FBCB2) system, but this again is vehicle borne. In some cases, units ended up using a police scanner radio system, the Motorola XTS5000, for dismounted personnel. For this system to work, repeater radios were placed on top of high buildings. Using these radios and the repeaters, dismounted patrols found that they could maintain communications anywhere in their 30-km AO. However, an additional problem was created in that repeater radios had to be secured, which put additional manpower strains on units. Recent reports indicate that shortcomings are being overcome with changes to tactics, techniques, and procedures (TTPs), such as remaining tactically close to vehicle-based radios which are used as repeaters, as well as changes to standing operating procedures (SOPs), such as establishing temporary repeaters on top of buildings when patrols are out. Current Army S&T programs are working to address this shortfall through tactical mobile networks which will extend the range and reliability of devices.[27] Another innovative solution comes in the form of aerostats that provide temporary communications networks over a given AO. However, issues concerning aerostat vulnerability to attack must be addressed.

Assessment: This is both an urban combat and S&R operations critical need. It is being addressed with modified commercial-off-the-shelf systems (COTS), acquisition programs, and S&T programs.[28] Additional S&T efforts do not appear to be needed. In the meantime, warfighters will continue to cope with shortcomings by modifying their TTPs and unit SOPs.

- *Interoperability of Incompatible Tactical Radio Systems.* Closely related to the aforementioned shortfall, lack of interoperable communications equipment continues to plague S&R operations. Often within S&R operations, the interaction of joint, coalition, and host nation forces as well as non-military personnel occurs at very low organization levels. The compatibility of communications among these groups becomes critical. Assessments conducted in this regard see interoperability as an issue among four main groups: inter-echelon within a service; joint; military to host-nation or multinational entity; and military to civilian (whether contractor or non-governmental). DARPA's Future Combat Systems Communications (FCS-C) program is addressing this shortfall by linking

[27] ARCIC designates this technology objective as BC3 in "Identifying Capabilities in Stability Operations Briefing," April 10, 2006.

[28] In this regard, Soldier Radio Waveform (SRW) technology holds promise in overcoming the limitation of operating in urban environments. For a discussion of next generation communications technologies, see Larry Williams and Allen Kuptez, "The 4G soldier—New Developments in Military Mobile Communications," *Communications and RF Design*, June 2003 available at <http://rfdesign.com/images/archive/306mil_Williams52.pdf>.

previously incompatible systems into an interoperable network. This system is currently being transitioned to U.S. Special Forces Command for evaluation and fielding.[29]

Of continued concern, however, is the enduring inadequacy in tying nonmilitary elements into the COP of C2 systems during S&R operations. There is an over-reliance on cell phones among contractors, international government organizations (IGOs), and NGO elements in communicating with military entities. Obviously, operational security (OPSEC) is a crucial issue. While the creation of the Office of the Coordinator for Stabilization and Reconstruction at the State Department is a positive step in centralizing S&R operations management, specific technological solutions have yet to be applied uniformly. Low-level, commercially available communications security (COMSEC) does much to mitigate OPSEC issues, but it is hoped that further standardization of Provincial Reconstruction Team (PRT) doctrine and equipment packages will address this shortfall to some extent. Not surprisingly, evidence suggests that close coordination among military and non-military entities at the early stages of S&R operations does much to surmount obstacles in communications.

Assessment: Technical efforts appear to be on track for addressing communications interoperability issues, with near term solutions currently being evaluated and fielded. The identification and tracking of nonmilitary elements as well as their integration into the COP of C2 systems is most likely an acquisition activity. COMSEC of non-military systems within a military network continues to be a technical issue, and may benefit from S&T investments.

- *Too Few Translators and Translations Devices.* The bottom line here is that human translators are always considered more useful than translation devices. Translation devices, in addition to being scarce, do not always work well because of too many unrecognizable idioms or loss of nuance. In S&R operations, this lack of communication is debilitating.[30]

  DARPA's Global Autonomous Language Exploitation (GALE) program is seeking to address this capability gap in foreign language translation. The initial program, to be completed by 2010, is focused on Arabic and Chinese. While not specifically addressing the need for "pocket" translation devices (GALE focuses on distillation and translation of large media outlets into searchable databases) its development and fielding will likely create synergies in portable devices.

[29] Dr. Tony Tether, "DARPA Director's Testimony to the House Armed Services Committee," March 29, 2006.

[30] From a doctrinal aspect, the Army leadership is looking to revamp the military education of the enlisted and officer ranks to possibly make language instruction a more central component. However, this issue is outside the scope of this study. For a deeper look at reforming PME with respect to language ability and cultural knowledge, see Henry Leonard et. al, "Something Old, Something New: Army Leader Development in a Dynamic Environment." *Rand Arroyo Center Report*, February 2006. This report can be found at <www.rand.org/pubs/monographs/2006/RAND_MG281.pdf>.

Assessment: More sophisticated language translation software is needed and is being addressed by DARPA. Army S&T efforts in this regard would have limited utility. Making use of existing language training technology to train deploying soldiers might go part of the way in addressing this need, but the pace and scope of future missions will most likely outstrip language training efforts.

Situational Awareness

Currently, friendly forces in vehicles are linked to FBCB2 systems. Dismounted personnel are not linked to this system. In order to address this shortfall, several efforts within the military (to include DARPA, PEO Soldier, Natick, and Army S&T) are trying to scale Blue Force Tracking technology down to the individual soldier level.

- *Limited SA Capability in an Urban Environment.* A common complaint of warfighters operating in Baghdad is that the current standard-issue Precision Lightweight GPS Receiver (PLGR), in addition to being too cumbersome, lacks the detail and specificity to show locations in urban environments. These same soldiers have also noted the ability to display location in three dimensions would be especially useful. At the company level, some dismounted military personnel have resorted to individually purchasing COTS solutions, such as Garmin systems, which are smaller and easier to use than vehicle-based systems and primarily support the self-location of dismounted personnel. However, the major trade-off in making use of such commercial systems is the lack of detailed map databases (most databases identify only major roads, even in cities such as Baghdad; a view of maps on the Internet illustrates the problem). The inability to self-locate inside large buildings, observe the location of other friendly forces, view OPFOR data, and link GPS devices together into netcentric C2 systems are additional shortcomings of current COTS positioning systems. We feel that it might be useful for current operations in Iraq and Afghanistan, as well as in future contingencies, for COTS systems to be specially adapted and fielded for military use only. These systems would then be compatible with military-grade map databases, while avoiding most OPSEC threats.

  The Army is seeking to address this capability gap with alternatives to GPS for location and navigation in complex environments.[31] Related to this overriding initiative are a variety of geospatial information integration and generation tools. The challenge continues to be providing the dismounted soldier the ability to access accurate map databases with a system that is secure, mobile, and easy to use.

  In terms of reconstruction operations, GPS systems are pivotal to the coordination and delivery of relief supplies, building materials, and other civil operations. Next

[31] ARCIC designates this technology objective as BC6 in "Identifying Capabilities in Stability Operations Briefing," April 10, 2006.

generation GPS use must incorporate the many participants involved in S&R operations while not forfeiting OPSEC.

Assessment: Additional S&T efforts are required and must continue to address the problem of limited SA capabilities, especially in 3-dimensional location (3-D positioning synchronized and presented with 3-D displays) of dismounted personnel in large urban environments, including above-ground and sub-surface structures.[32] *The capability to disseminate this information to appropriate SA systems is also a requirement. The enhancement of commercial map databases for current AOs in Iraq and Afghanistan is a non-S&T effort, but must take place to provide an interim solution.*

Armored Vehicles in Urban Environments

In S&R operations (especially in urban operations), a trade-off must be made between armor and maneuverability. The Abrams tank is extremely survivable; for example, only one tank crewman died (and two were wounded) during the entire tour of the 3rd-8th Cavalry.[33] (The death occurred when the tank struck an IED with an estimated 15 152mm rounds in a daisy chain.) Tanks are so survivable that they are used to escort soldiers going on leave. However, tank mobility in urban environments is significantly inhibited by low hanging electrical wires (due to a do-it-yourself electrical system in Iraq); cars, pedestrians, and children playing in the streets, among other obstacles. Figure 1 provides a view of a typical street in Baghdad. Under these conditions, if tanks move slowly enough to minimize damage to their surroundings, they become very vulnerable to attack. To make matters worse, rules of engagement (ROE) normally prevent the use of the main tank gun, so machine guns become the weapon of choice. Further limitations of the Abrams tank in an urban environment include: the viewing systems, which are in the horizontal plane and mostly oriented toward the front of the tank and in line with the turret; the mounted machine guns, which must be fired with the commander and loader partially exposed outside of the tank; the lack of mounted external phones for communications with dismounted infantry;[34] and the vulnerability to attacks from the rear. Thus, SA, lethality, combined operations, and survivability are significantly degraded during movements through narrow urban streets. The Tank Urban Survivability Kit (TUSK) program addresses all of these shortcomings and allows tanks to move at the slower speeds required to prevent damage to the local urban infrastructure, as well as to support the infantry.

[32] This encompasses location tracking by higher echelon elements, other units within an area, and self-location of the individual soldier.
[33] Interviews with warfighters of the 3rd-8th Cavalry, Ft. Hood, TX, November 15, 2005.
[34] The TUSK program calls this the "Tank Infantry Phone."

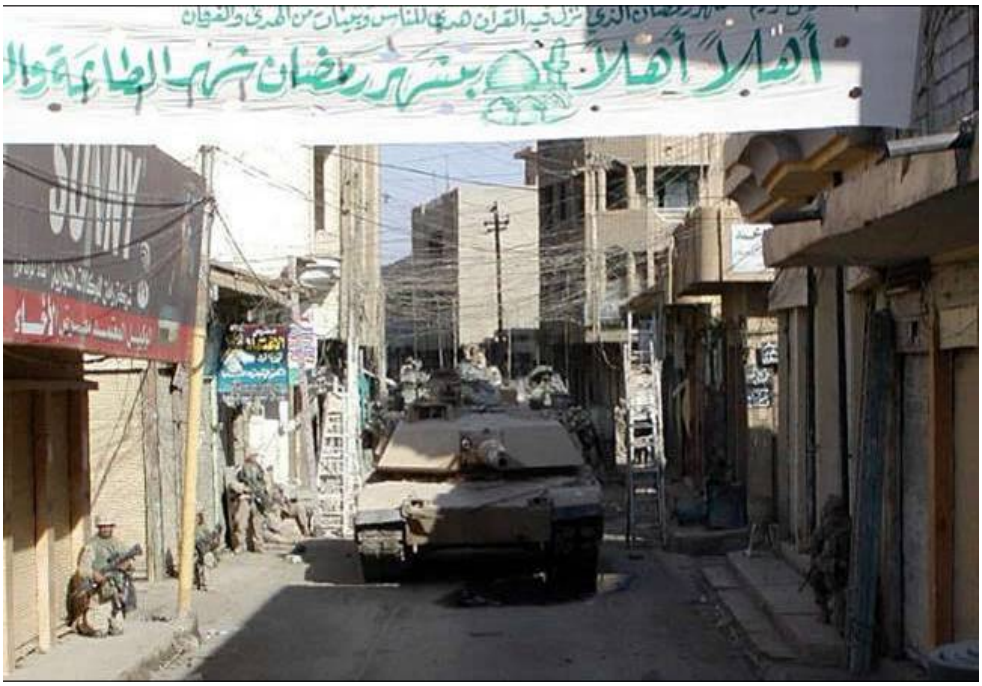

Figure 1: Abrams tank with dismounted infantry during confined urban operations.

Assessment: Fighting in urban environments will become increasingly important, as evidenced by the following: in the past 13 years, the U.S. military has been engaged in 13 operations in complex urban terrain; most of the operations in Iraq have been S&R operations in urban environments; all intelligence and defense analyses point to a persistent requirement for U.S. forces to operate in urban environments for both the near and far-term; and the 2006 Quadrennial Defense Report (QDR) lists the ability to operate in urban terrain as a critical capability requirement.

The introduction of the Future Combat Systems (FCS) will greatly enhance the Army's ability to conduct combat operations in urban environments. There is also an increasing likelihood that post-combat operations for FCS will center on S&R operations in urban environments. To prevent problems such as those faced by the Abrams in S&R operations, the design of and the technologies feeding into FCS must take into account the constraints of full-spectrum operations. These constraints, driven by ROEs and the desire to protect non-combatants and minimize collateral damage, include: the inability to fire large caliber weapons and missiles; the lack of long range fires: maneuverability hampered by civilian vehicles and infrastructure obstructions; and critically, the inability to turn on active protection systems. Additionally, close-in, constrained fights, including attacks from rooftops are a high likelihood. S&T efforts must support a full-spectrum design of FCS for combat and S&R operations.[35]

[35] For a detailed discussion of FCS, see "The Army's Future Combat Systems Program and Alternatives," *Congressional Budget Office Report*, August 2006. Available at <http://www.cbo.gov/ftpdocs/74xx/doc7461/08-02-Army.pdf>.

Intelligence (Including Sensors)

Because of its direct applicability to combat operations, the issue of operational intelligence is addressed by many S&T programs. As is the case across the board in the evolution of military operations, warfighters will be required to deal with an ever-increasing volume and complexity of intelligence. In terms of phase IV operations, better tools to collect, process, and disseminate intelligence will serve to mitigate the actions of "spoilers" seeking to disrupt S&R operations. In addition, better intelligence gathering and analytical tools will allow the Army to apply more focused and efficient energy to those S&R operations objectives most sorely needed in a given AO. Intelligence is an issue that cuts across many of the other categories identified here. This section, therefore, will focus on issues not covered elsewhere.

- *Need for Undetectable, Long Duration Remote Networked Sensor Systems.* In S&R operations, most military units operate from static bases, often within urban areas. Their bases are susceptible to sniper attacks and harassing fires from small mortars and RPG shots. Perimeter security, especially at night, is needed to reduce these attacks but is very manpower-intensive. Undetectable, long duration remote networked sensor systems with automated monitors would address this issue. Autonomous monitoring is important as human error becomes more likely as the number of displays to monitor and the amount of time spent staring at screens increases. With this in mind, the Army Battlespace Terrain Reasoning and Awareness program acts as an overarching system that addresses components of this need by analyzing topographic and climatic information in order to help commanders plan actions appropriate for their missions (especially in regard to security). The DARPA Persistent Operational Surface Surveillance and Engagement (POSSE) program adds further capabilities in this regard. To mitigate the interference of hostile and non-hostile personnel on autonomous sensing systems, DARPA is also developing a host of technological solutions stemming from its formerly named Smart Dust program. This project sought to integrate sensing devices onto platforms measuring no bigger than a cubic millimeter. Leveraging nanotechnology, the objective is to create completely undetectable systems that mimic dust particles.[36] Army efforts such as the Disposable Sensor Network project are also of benefit in addressing this problem.[37]

  Assessment: Army and DARPA S&T efforts emphasize the need for establishing networks comprised of cheap, expendable sensors. However, these programs are more in line with the scenario of a unit using a short-duration sensor network prior to and during an attack to provide immediate information. S&R operations

[36] For more information, see the University of California at Berkeley's Robotics Department website at <http://robotics.eecs.berkeley.edu/~pister/SmartDust/>.

[37] Research in this technology is being led by the Night Vision and Electronic Sensor Directorate (NVESD), Communications-Electronics Research, Development, and Engineering Center (CERDEC), U.S. Army RDECOM. For current information on this technology, see "Sensors and Electronics," *Army Science and Technology Master Plan*, Volume 1, July 2005.

are unique in that they require long-duration, tamper-proof sensor networks. Longer duration sensing is closely linked to extended battery life, which is a capability being addressed in many DOD programs. Many commercial perimeter security systems exist which can satisfy the need for long duration sensing, so it seems more advantageous to re-engineer COTS systems than to expend S&T funds.

- *Need "See Through the Wall" Capability.* This capability is consistently cited as a technological shortfall. It is needed to effectively maintain security in urban environments and support the clearing of rooms and buildings. The Army's suite of sensing through-the-wall technologies, as well as third generation infrared technologies, are the most prominent programs in place seeking to address this need.[38] DARPA is also developing a radar scope that will allow warfighters to detect the presence of personnel within rooms (stated to be successful through 12 inches of concrete). There are also mobile sensor systems (using unmanned ground vehicle (UGV) platforms), which can provide the required information indirectly by moving into rooms and behind the walls in question.

  Assessment: S&T programs are adequately addressing this issue.

Force Protection

If personnel central to the execution of S&R operations cannot perform their duties, stability and reconstruction cannot take place. Security is a sine qua non for rebuilding in a post-conflict environment. Technologies such as enhanced body and vehicle armor, as well as impressive advances in medical response, have done much for soldier survivability. However, shortfalls in this category have the most impact on U.S. casualties and therefore hold a high priority.

No program in the current Army (and joint) R&D effort commands more attention than counter-IED research and development. IEDs have become the number one cause of U.S. military casualties from hostile action in Iraq since the conclusion of major combat operations.[39] Without delving into any classified material, we have attempted here to outline some of the force protection measures in place and to evaluate future needs. However, for security reasons, we have not included S&T issues related to the IED threat. This detailed information will be included in a classified version given to the project sponsor.

- *Need for Rapidly Locating Point of Origin for Mortar and Sniper Attacks.* It is no surprise that urban environments make identifying attackers in a civilian

[38] Commercial vendors are also working on this system. Most prominent among them the SoldierVision system from the Time Domain Corporation uses ultra-wideband pulses to "see through" most building materials (with a 30-foot standoff capability).

[39] "Iraq Index: Tracking Variables of Reconstruction and Security in Post-Saddam Iraq," Saban Center for Middle East Policy, The Brookings Institution. Available online at <http://www.brookings.edu/fp/saban/iraq/index.pdf>.

population incredibly difficult. An important follow-on effect, aggressive U.S. response to attacks, can lead to further alienation of the civilian population. When collateral damage (namely, innocent casualties) occurs, a shift from a neutral to a hostile orientation in indigenous populations cripples S&R operations objectives. Therefore, accurate and rapid identification of combatants becomes a key capability.

In terms of locating snipers, promising technological advances are being made with the DARPA Boomerang shooter detection system. More than 100 of these systems, which use advanced acoustical analysis to hone in on gunshots, are currently in use in Iraq.[40] Anecdotal evidence suggests that these systems are more helpful in giving SA in convoy operations where road noises usually drown out hostile fire. In addition, the Networked Embedded Systems Technology (NEST) system is providing a common software infrastructure for sensor nets. In a test in 2005, an ad hoc system of acoustic sensors using this architecture was able to detect, within two meters and in two seconds, a rifle shot. For mortar attacks, current counter-battery radar (AN/TPQ Firefinder series) meets operational needs. However, some warfighters complain about too many false positives being registered. The most recent ARL effort, Unattended Transient MASINT[41] System (UTAMS), has performed very well in addressing this problem and others. Given that most mortar attacks in Iraq occur on time-delay or through remote means, DARPA's development of high-strength counter-mortar nets that catch rounds might prove to be a more efficient and effective way to protect U.S. warfighters. The Army Counter Rocket Artillery Mortar (C-RAM) program also holds promise for active protection of static sites against incoming threats.

Assessment: S&T efforts are adequately addressing this problem.

Inability to Quickly Check People, Baggage, and Vehicles at Check Points. The need to effectively screen a civilian population for security purposes must be balanced with the importance of allowing the unimpeded flow of commercial traffic. Security must be conducted in a way that accounts for the potential that a populace, frustrated with limited freedom of movement and invasive checks, will become uncooperative and even hostile. Most evidence suggests that the chemical-reaction based sprays, x-rays, and other technological tools used for screening are time-consuming and give too many false positives. A recent field report verified that checking traffic and personnel at control points continues to be an issue—even with warfighters using an array of sensors and dogs to assist with the screening process.[42] The sensors, however, still tend to have high false alarm rates and often generate more information than an operator can handle. Because of varying cultural constraints, dogs cannot, in certain situations, be used to sniff

[40] Dr. Tony Tether, "DARPA Director's Testimony to the House Armed Services Committee," March 29, 2006.
[41] Measurements and Signatures Intelligence.
[42] Bing West field report, June 1, 2006. This field report will be discussed further in Chapter IV.

people. Tailored TTPs, as well as bomb-sniffing dogs, are currently the most effective screening tools.

Commercial entities are working to develop more effective, simple sprays and electronics that can detect the presence of explosives. No single, stand-alone detection technology can accomplish this security screening task. The bottom line is that several technologies and tools must be integrated into an effective whole. Efforts like the DOD Vehicle Entry-Point Screening program are underway.[43] Complicating these efforts are environments such as Baghdad, where explosive residue and an ambient residual presence of explosive particulate is prevalent due to frequent bombings.

There is also a related expressed need for a system of traffic control at control points. Portable "stoplights" and other foreign language-capable digital signage could potentially make operations at these high density points run more smoothly. This, of course, is not an S&T issue as such, but a portable system that could become an organic issue item to military police units would be advantageous.

Assessment: S&T efforts are needed to reduce false alarm rates of sensors for detecting explosives and to develop automated systems for fusing and analyzing the overwhelming amount of data and imagery being generated by current sensors.

- *Inability to Quickly Identify and Track the Population.* In S&R operations, identifying large numbers of civilians is a daily need. Current approaches use face-to-face interactions, reviewing personal identification documentation, and maintaining lists of citizens on cumbersome databases such as Microsoft Excel spreadsheets. These approaches are very tedious and inefficient. Local police forces in the U.S. successfully use systems based on the "reach-back" identification of fingerprints, photos, and license plates.[44] This system is adequate for the occasional ID check for a traffic violation or apprehension. S&R operations, however, demand magnitudes more in the number of daily checks. For example, the 3rd-8th Cav processed approximately 10,000 pedestrians and 3,500 vehicles each day through six traffic control points to the International Green Zone. With such numbers of people, automated systems are needed that are very user-friendly and have a high throughput.

  The Army currently does not have the capability to biometrically identify an individual on-the-spot. There exists in limited commercial use a highly portable, thumbprint-centered biometric identification device.[45] For usefulness in military application, a device of this type would have to be properly interfaced with the

[43] Defense Technology Objective JD.09.
[44] By "reach-back," we mean the remote checking of information contained in a centralized database.
[45] The Chicago Police Department makes use of a portable biometric device that can take a thumbprint as well as a digital picture. This information is provided by Dr. Samuel Musa, Senior Research Fellow, CTNSP.

existing Biometric Automated Toolset System (BATS). Doing so, would greatly enhance warfighter capabilities. For future S&R operations, the Army must incorporate a hand-held system that will allow on-the-spot identity checking as well as the capability to remotely input identification data into a centralized database.

Assessment: Although this is a need that exists across the full range of military operations, the scale of the task in S&R operations is usually much more challenging. Potential solutions should be assessed in terms of accuracy and throughput. For example, to increase throughput, there should be minimal input on the part of the person being identified, ideally a passive rapid face recognition system would be better than an active fingerprint identification system. The approach for addressing this problem includes a combination of: assessing commercially fielded systems used by U.S. police forces and emergency responders, responding to user feedback on developed DOD systems, and considering novel S&T approaches like stand-off biometric identification.[46] The creation of an Army Technology Objective (ATO) with regard to this challenge is recommended.

Counter-IED Technology. Due to the sensitivity of the issue, the discussion for this topic is withheld in order to comply with DOD OPSEC policies. The material has been provided to the sponsor.

Unmanned Systems

UAVs perform a variety of crucial tasks in current operations ranging from intelligence and surveillance to attack functions. [47,48] UGVs are important in explosive ordnance disposal (EOD) and other potential-IED investigations, as well as for reconnaissance of rooms, underground structures, and caves. Unmanned systems are playing an important and growing role in reconnaissance and security of convoy routes. Taking things a step further, DARPA's "Grand Challenge" seeks to develop a fleet of wholly autonomous ground vehicles that would be able to conduct supply and logistics missions without human drivers.[49] Early successes bode well for this endeavor.

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[46] Stand-off biometric identification technologies are characterized by little or no cooperation on the part of the individual being identified. These methods include voice analysis and facial recognition software. For more detailed information on this technology, see: *The National Biometrics Challenge*, National Science and Technology Council, Subcommittee on Biometrics, Executive Office of the President, August 2006.

[47] Comments from officers recently returned from duty in Iraq cited UAV sound signatures as an issue on some missions, with the buzzing of the current systems compromising stealth. However, development and wider deployment of aerostats and electric motor UAVs are addressing this issue.

[48] For an in-depth look at how DOD plans to integrate UAVs, as well as UGVs, into future operations, see "Unmanned Aircraft Systems Roadmap: 2005-2030," Undersecretary of Defense (AT&L), August 2005. The report can be accessed at <http://www.acq.osd.mil/usd/Roadmap%20Final2.pdf>.

[49] For more information, see DARPA's "Grand Challenge" website at <http://www.darpa.mil/grandchallenge/index.asp>.

Unmanned Systems:

- *Fixed-wing UAVs do not provide uninterrupted viewing.* Fixed-wing UAVs cannot "hover and stare," so if a particular sector of interest is to be viewed repeatedly, the vehicle has to circle back to the point. This is time-consuming and cumbersome. In order to address this shortcoming, DARPA has developed a suite of rotary-wing UAVs: the A-160 unmanned helicopter, the company-level Organic Air Vehicle-II, and the platoon-level Micro Air Vehicle and Wasp systems. Rotary-wing UAVs use more fuel than fixed-wing UAVs of similar size and thus have less "on-station" time.

  Assessment: The Army should continue to coordinate its S&T efforts with DARPA to develop longer duration, "hover and stare" capabilities. To avoid limitations due to airspace congestion, the most promise seems to center on platoon-level systems which are "backpack-able."

- *Deconflicting Airspace Issues*. Members of the 1st Cavalry Division noted their inability to use organic UAVs because of airspace restrictions. To address this, formerly battalion-level organic UAV assets have been consolidated at higher echelons in order to more comprehensively coordinate their deployment. While this might improve de-confliction capabilities, it also might increase the response time when units request UAV assets.

  Assessment: S&T efforts are needed for both deconflicting airspace and enhancing obstacle/crash avoidance capabilities of tactical UAVs. However, payload limitations will most likely make this a very difficult capability to integrate onto existing platforms. The de-confliction of airspace for UAVs must be addressed since the Army will continue to push toward a future force comprised of many UAVs, which will compete for airspace with each other, Army manned systems, and joint manned and unmanned systems.

- *Availability and Affordability of UAV and UGV Assets.* Rapid fielding continues apace. In terms of UGVs used in bomb disposal, there seems to be a need for expendable, scout systems for use in EOD investigations and IED detonations. Currently, the loss of expensive EOD robots—Threat and Local Observation Notice (TALON)—during IED neutralization missions constitutes monetary and operational costs.

  Assessment: S&T may be appropriate, especially in developing affordable, expendable UGVs.[50]

[50] One such robotic device that holds promise is the Bombot. A recent news report details its use as an expendable EOD device in Iraq. See Shelby Spires, "Robot Role Saving Lives in War Zone," *Huntsville Times*, September 18, 2006.

- *Limited Range Issue when Operating UGVs in Urban Environments.* As with radio systems in urban settings, radio frequencies used by the operating control unit for TALON EOD robots have limited range in built-up environments. Although systems such as the TALON can also be operated by a command wire, it is often not feasible for control since it necessitates some proximity for the operator as well as the likelihood of the wire becoming entangled. As a possible solution, some EOD personnel have suggested that a companion UGV could act as a mobile repeater for the TALON, retransmitting the control signal and boosting its range.

  Assessment: Efforts to adapt signal repeaters for use in UGV operations in urban environments should be pursued to a greater extent.

Non-lethal Capabilities

Non-lethal weapon (NLW) capabilities are an identified Army S&R operational shortfall. This capability is important in performing crowd control duties and restoring maintenance of order in riot situations. Beside Tazers and other hand-held devices used mainly in detainee operations, few consistent NLW systems are in use by warfighters. Creative applications of existing equipment—such as driving a tank in reverse so that hot exhaust dispels crowds—have been seen. Having been designated the executive agent for the DOD NLW weapons program, the USMC-led Joint Non-lethal Weapons Directorate (JNLWD) drives research and application endeavors in this field.

- *Limitations on the Availability and Use of NLWs.* Given that the line between combat operations and stability operations is often not definitive, warfighters are forced to perform a wide spectrum of duties in stressful, ambiguous environments. Overwhelming use of force, the trademark of the U.S. military, is no longer an appropriate response in current operations where combatants and densely packed civilian populations commingle. Therefore, to control threatening situations without causing the harmful collateral damage attendant with modern firepower, NLWs will and should serve a more central role. The USMC is leading this effort with acoustic and directed energy weapons as well as non-lethal rounds in existing firearms. DARPA (along with the JNLWD) is also developing an artificial polymer "snow," which can cause a surface to quickly become slippery, with an accompanying technology for rapidly returning the surface to normal traction. This holds potential for guarding against VBIEDs.

  NLWs give commanders and warfighters a wider range of options for dealing with threats and disturbances. Moreover, the very nature of NLW use (temporary, reversible effects) ensures that collateral damage is kept to a minimum in operations where civilians are a large presence. However, one problem that must be addressed is that, on the receiving end, NLWs still look like lethal weapons, so the use of NLWs could potentially escalate a situation.

Evidence shows that soldiers are making use of powerful lights to ward off civilian vehicles when they veer too close.[51] Green-light lasers and pin-flares also have been fired at civilian vehicles that did not slow down at check points or encroached upon convoys. While protecting the force against VBIEDs and other threats of this nature remains critical, it is hard to argue with the contention that innocent civilians should not have their bad driving punished by lethal force. Moreover, future NLWs should be added to existing weapons platforms so that soldiers do not have to take their hands off their weapon. In this regard, lethal and non-lethal options should be within easy reach. This capability will necessitate a high level of training for warfighters to make split-second decisions about what type of force to use. This is no different, however, from the types of choices they are often forced to make. The caliber and intensity of their training will continue to stand warfighters in good stead.

The Army should increase its interaction with the USMC in regard to NLW and seek to concentrate on how this capability can be used in S&R operations. It seems that these weapons would be most useful during convoy operations and traffic control point screening, where the intentions of civilians in vehicles are unclear or when mutual misunderstanding can result in civilian casualties. A NLW that could affect a moving vehicle (by cutting off the engine or incapacitating the occupant) would be especially useful in preventing innocent civilian casualties.[52]

Finally, NLWs should not detract from a warfighter's ability to use lethal force. In other words, the NLW should not be so cumbersome that it prevents the warfighter from using his lethal weapon in a timely manner.

Assessment: The Army should continue to work collaboratively with the JNLWD on NLW S&T efforts. The NLWs should be designed in a manner that does not degrade the warfighter's ability to engage the enemy with lethal force, if needed.

Information Operations

With the instantaneous transmission of words and images around the globe, IO takes on an importance never before seen. Insurgencies, such as in Iraq, have used this changed dynamic to their greatest advantage—waging an effective "hearts and minds" campaign to rally individuals against coalition efforts. Almost nothing is more important than the attitude of the public the United States is seeking to help in S&R operations. The capacity of the Army (and, indeed DOD) for addressing this notion of strategic communication in

[51] Interview with Major Lawrence Dring, Former FAST Officer, May 31, 2005.
[52] The field report in Chapter IV states that the TTP most often used by warfighters when vehicles come too close to a convoy is firing a shot near or into the civilian's car.

S&R operations is not robust.[53] Responses to our survey, discussions in our interviews, articles quoting General John Abizaid (CENTCOM Commander),[54] and an IO article written by Colonel Ralph Baker (Commander of 2nd Brigade Combat Team, 1st Armored Division)[55] all point to the need for better IO in S&R operations. These individuals and others call for better IO policies, unit operating procedures, employment, and awareness of the value of IO. The last two points are drivers for technology improvements, namely IO tools and education/training systems.

While translation devices such as DARPA's GALE project will help the Army gain awareness of indigenous populations' media and general orientation, there seems to be little by way of new technology that will increase its ability to more effectively publicize reconstruction successes and counter deleterious insurgent propaganda.[56] One IO product that may be of benefit would be a planning tool that maps cultural diversity, identifying the population of an area by ethnicity, religion, and race, and then uses that information in enhanced political, military (air, land and sea), economic, social, information, and infrastructure (PMESII) planning tools. Help in this area is coming from DARPA with its initiation of a PMESII tool effort entitled the Integrated Battle Command.

We live in, as several reports on IO have stated, the age of the "strategic corporal." Individual events at the tactical level truly have strategic implications in terms of international media coverage and insurgent propaganda. Moreover, reports of collateral damage and innocent casualties always reverberate stronger and farther than stories centered on the opening of a new school or water treatment facility. Credibility is an important issue here as well. Last year's revelation that a defense contractor was paid to plant favorable news reports about U.S. reconstruction efforts in the Iraqi media severely undermined American credibility regarding free press and democracy issues.[57]

Assessment: Overall, S&T and acquisition programs are in place to address IO needs. However, one area where an impact can potentially be made is in the development of PMESII planning tools which take into account IO planning. In addition, technology can also be leveraged to improve military IO capabilities by developing realistic training models and simulations that create scenarios involving media relations, civil-military interaction, and strategic communications elements of S&R operations (additional aspects of training using modeling and simulation is discussed further in the following portion of this study).[58]

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[53] This assessment comes directly from *Report of the Defense Science Board Task Force on Institutionalizing Stability Operations within DOD* (Washington, DC: Office of the Secretary of Defense, September 2005), 15.

[54] Paul De La Garza, "In Search of Ground Truth," *St. Petersburg Times*, September 3, 2006.

[55] Ralph O. Baker, "The Decisive Weapon. A Brigade Combat Team Commander's Perspective on Information Operations," *Military Review*, May–June 2006, 13-32.

[56] Respondents to the NDU survey wanted tools that could assist them in getting the positive word out (about American reconstruction efforts) to the populace as quickly and efficiently as possible.

[57] For more information about the controversy surrounding Lincoln Group actions, see "U.S. Is Said to Pay to Plant Articles in Iraq Papers," *The New York Times*, December 1, 2005.

[58] For a more detailed discussion of some of these aspects—especially civil-military interaction—see Franklin Kramer, Stuart Starr, and Larry Wentz, "Perspectives on Information and Communications Technology (ICT) for Civil-Military Coordination in Crises," *Command and Control Research and*

Training and Use of Modeling and Simulation

While U.S. warfighters are unparalleled in their training for traditional combat engagements, their readiness for taking on S&R operations is lacking. There are simply no Army-wide programs that standardize S&R operations training. To be fair, it is difficult to create such a standardized curriculum given that experiences can be so varied, but core skills such as language and cultural knowledge are simply indispensable and should be cultivated as much as possible in the pre-deployment phase. As the Interagency Working Group (IWG) on building S&R operations capacity has stated, the U.S. government must actively predict and prepare for intervention in failed and failing states.[59]

- *Lack of Adequate Training in S&R Operations for U.S. Personnel.*[60,61] Simulations and models have the potential for equipping future forces with the tools necessary to assist with carrying out post-conflict reconstruction missions. The Army, in particular, increasingly will be called on to perform S&R operations. Therefore, future leaders at all levels of command must be able to carry out the full gamut of operations: civil administration duties, humanitarian missions, security raids, and coordination with NGO and civilian elements—all under the intense scrutiny of the international press.[62] The Army has a host of training endeavors to address the changing nature of battle, but while taking into account asymmetric threats in models and simulations, it has not explicitly expressed an intention to focus on S&R operations. The Adapted Training System, the Dismounted Virtual Training System, and an assortment of gaming technologies are being refined and implemented. Given the flexibility of new modeling and simulation platforms, Army leaders can develop in their warfighters a level of proficiency in S&R operations to cope with ongoing and potential missions. Some NDU survey respondents have indicated as much by

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Technology Symposium 2006, June 20, 2006, and Larry Wentz, "An ICT Primer: Information and Communications Technologies for Civil-Military Coordination in Disaster Relief and Stabilization and Reconstruction," *Defense & Technology Paper 31,* (CTNSP: Washington, DC, July 2006).

[59] Dr. Barbara Sotirin et. al, "The Proceedings of the Conference on Interagency Requirements for Regional Stability/Capacity Building R&D," January 10, 2005.

[60] Related to this capability gap is a lack of adequate training on new equipment for use in S&R operations. With the rapid fielding of new and modified systems, some recently deployed officers have identified potential weaknesses in new equipment training (NET) and human systems integrations/manpower and personnel integration (HSI/MANPRINT) endeavors. Note: MANPRINT is defined as the principles, analyses, design parameters, and techniques to minimize total ownership costs and ensure individual systems are built to accommodate the human performance characteristics of the user population that will operate, maintain, and support the system.

[61] Under the rubric of communication, the issue of interagency cooperation is significant. The White House IWG for Capacity Building R&D, led by Dr. Barbara Sotirin, is heading R&D initiatives that address many of the other categories here. Germane to this section, their work identifies a necessity to coordinate a common lexicon among the U.S. government as it concerns S&R operations.

[62] For more information, see Henry Leonard et. al, *Something Old, Something New: Army Leader Development in a Dynamic Environment."* (Santa Monica, CA: Rand Arroyo Center, February 2006).

recommending that future simulations involve such scenarios as getting power to a civilian population or coordinating proper sewage disposal while simultaneously trying to track and capture insurgents. Moreover, cultural awareness training must go beyond the "pocket guide" level. A 2005 workshop on S&R operations education at the U.S. Army War College Peacekeeping and Stability Operations Institute brought together experts from within and outside the government to address these issues. While technology plays an important role in facilitating dissemination of information, the workshop participants acknowledged that creating common baseline knowledge of S&R operations across government agencies is still a formidable task.[63]

Additional R&D efforts, as identified by the White House IWG involve training that incorporates military interaction with civilian populations as well as a baseline level of media savvy for even the lowest level soldier. Finally, the current dynamic where "major parties leading S&R operations train and learn separately, with distinct and separable training, awareness, and simulation systems" must be changed.[64] Simulations must be accurate and involve all the elements that make real operations with its myriad actors so complex. Future modeling and simulation architecture in development has the capacity and sophistication to incorporate this complexity. It is the responsibility of higher echelon Army leaders to ensure that training is effective in this regard.

Assessment: An S&T need here is in the area of modeling the cultural and S&R operations details of the current AO and appropriately representing them in current Army training systems.

- *Lack of Adequate Training for Foreign S&R Operations Personnel.* Although it is paramount that U.S. personnel receive the training necessary to successfully execute S&R operations, models and simulations also could prove useful for helping host nation leaders and reconstruction personnel to build capacity in their own country.

  Assessment: Same as above, except with the additional problem of needing a training system that supports multiple foreign languages.

Logistics

Logistics and materiel are needed to rebuild the physical assets of a collapsed nation. Humanitarian and medical missions also rely heavily on tasks organized under this heading.

[63] The presentations and findings of the "Peace and Stability Operations Education Workshop" at the U.S. Army War College can be found at <http://www.carlisle.army.mil/usacsl/publications/Chapter%202.pdf>.
[64] Dr. Barbara Sotirin, "Civil Reconstruction and Force Transition (CRAFT) Advanced Concept Technology Demonstration (ACTD) Briefing," November 1, 2005.

- *Most Logistics Equipment Not Designed for Long-Duration Needs of S&R Operations.* Here, the most pressing issue has to do with generators. Instead of providing temporary power for contingency operations in Iraq, generators have become the main power source for many city-level S&R operations because of the lack (or unreliability) of a local power source. The Army has several technology programs that involve finding alternate, efficient power sources. Although not explicitly stated, these alternate power sources will have S&R operations applicability. Cheap, reliable, and portable generator capacity would do much to influence the indigenous population's attitude regarding U.S. S&R operations. This is especially true in the early stages of S&R operations, that crucial window of time when opinions are still being formed (this would also have IO ramifications).[65]

  Assessment: S&T efforts should focus on expanding power sources outside of fossil fuels. Innovations in harnessing wind and solar power in contingency environments would have great utility (especially in lowering the number of convoy missions). A durable, foldable solar energy panel, for example, that could store energy would go great lengths in satisfying military and civilian needs (obviously, this would be especially useful in sunny desert climates). A collapsible, portable wind turbine might serve the same purpose. The Army would do well to research how the private sector is approaching this alternative energy technology.

- *Dismounted Warfighters Have to Carry Too Many Types of Batteries to Power Critical Devices.* The Army has identified as a critical technological shortfall the lack of alternative power for dismounted warfighters. There is little interoperability for batteries and power sources among the host of devices used by the soldier on the ground. The DARPA Palm Power program is actively seeking to solve this problem by providing a "universal" power source that is light, portable, and reliable.

  Assessment: A number of S&T efforts are underway. These programs should also consider S&R operations-specific needs.

[65] For more on this topic of renewable energy, see "In Iraqi War Zone, U.S. Army Calls for 'Green' Power," *Christian Science Monitor*, September 7, 2006. Available online at <http://www.csmonitor.com/2006/0907/p01s04-usmi.html>.

IV. Discussion and Concluding Remarks

We begin by comparing the assessments presented in the previous section with a written assessment provided by a senior consultant to CTNSP as part of his recent trip to Iraq, henceforth referred to as the *field report*.[66] Traveling throughout Iraq, the CTNSP consultant was able to meet with a host of military professionals taking part in efforts there, ranging from general officer to corporal, from USMC combat teams to Army infantry units. Overall, many of the shortcomings cited in the *field report* corroborated the needs we have identified.

Although the *field report* did not emphasize problems with **communications** in Iraq, we believe gaps remain and are currently being overcome in part by soldier TTPs. For example, dismounted patrols were conducted in close proximity to their respective High Mobility Multi Purpose Wheeled Vehicles (HMMWVs) both for command and control and hydration needs. However, it must be noted that in urban S&R operations this "tethering" of dismounted patrols to their command/transport vehicles greatly hinders interface with the civilian population and can lead to less thorough security operations. Given that most buildings in Iraq were no higher than three stories, no major communications issues were witnessed in regard to clearing buildings. However, taller buildings in Baghdad (and future operations in more sophisticated urban environments) require more robust communications assets. An interesting recommendation made was to modify the AN/PRC-148 radio to utilize a higher frequency, thereby increasing its range.[67] While this would help in extending the range of the radio over flat terrain, it would do little for warfighters operating in an urban area where structures have a significant impact on radio frequency propagation. Reinforcing our data, the *field report* cited the widespread use of commercial solutions such as the Motorola XTS series of radio. On the subject of inter-service and civil-military interoperability, the *field report* stated little by way of problems. However, the reason for this lack of observation was most likely due to the fact that when external elements entered Army or USMC AOs, they were issued Army or USMC equipment. Again, this does not appear to compensate for a more overarching capability gap.

In terms of **situational awareness**, the *field report* findings coincide directly with our study, especially in terms of tracking dismounted personnel. Warfighters are purchasing small, lightweight GPS devices for use on the ground (most prominently, Garmin systems) instead of using the military-issued PLGR, which is deemed cumbersome and not detailed enough for urban operations. Still, a consistent shortfall in this area is the inability to collect 3-D data and present 3-D situational awareness in a 2-D display. Moreover, warfighters in Iraq, as the *field report* and our study suggest, would benefit from scaling GPS and Blue Force Tracking down to the individual fire team/soldier. Corroborating our findings, the *field report* shows that this capability remains a priority.

[66] Bing West Interview, May 18, 2006 and Report dated June 1, 2006.
[67] Ibid.

The issue of **reconstruction operations** was also addressed in the *field report*. Bypassing any debate on whether improving the quality of life for a populace undercuts an insurgency's motivation and ability to wage violence, data here corresponds to our study's stated gap: technology which can coordinate efforts into a COP is lacking. The model we see as most beneficial in this endeavor is akin to the CPoF system which, if modified for S&R operations, could provide a collaborative tool to tie in military, interagency, NGO, and IGO elements for reconstruction operations. With regard to the underlying contention that S&R operations are as important a mission to the Army as traditional combat operations, it is important to note that the *field report* detailed an on-the-ground, maneuver force mindset that sees reconstruction operations as secondary to their stabilization efforts. While this might be a natural response to an environment such as Iraq where security continues to be a serious challenge, future operations will require a maneuver force invested in supporting reconstruction as well as stabilization.

See-through-wall capabilities and remote sensor systems were two other issues touched upon in the *field report*. Warfighters continue to express a need for both these technologies. In terms of the sensor systems, the field surveys of soldiers highlighted the fact that current systems, when emplaced, were often compromised by inquisitive civilians (mostly children) and/or insurgents. Our study advocates the development of autonomous sensors that are more difficult to detect in order to overcome this obstacle.

One of the most pressing issues in military operations is **force protection**. In Iraq, enemy snipers are especially deadly for warfighters. The *field report* showed that, although acoustic sensors were available to some units, the probability of having a device on hand, in operation at the moment of attack, and in line with the attack was low. Moreover, the ambient noise level of a place like Baghdad degraded the device's efficacy. In the end, a non-technical solution is usually employed to neutralize enemy snipers: slow, meticulous sweeps by Special Operations Forces (SOF).

Enemy mortar fire was sufficiently dealt with by using mortar-locating radar. Because of warfighters' ability to quickly respond to such attacks, this has become the less preferred method of attack by the insurgents.

The *field report* also covered the topic of **IEDs**, but due to security considerations its findings are not included in this discussion. This material has been provided to the sponsor.

The **inability to quickly identify individuals and screen people at control points** continue to be a problem faced by soldiers. The *field report* emphasized the fact that a system for rapidly identifying the civilian population is a crucial shortfall in Iraq. The BATS does not meet the task because it is too cumbersome and takes too much time to work. The *field report* goes on to point out that some units were making use of Excel spreadsheets to conduct censuses of their respective AOs. There exists a portable, thumbprint-based biometric device that might interface with the BATS database, potentially making it a more nimble system providing an on-the-spot readout of the

individual scanned. However, this device does not preclude the need to build a comprehensive identity database for Iraqi citizens.

Screening for suicide bombers at control points is another topic covered in the *field report*, but due to security considerations the findings are not included in this discussion. This material has been provided to the sponsor.

Unmanned systems play an invaluable role in Iraqi operations. The *field report* supported the identified need for a "hover and stare" capability that cannot be met with the current stable of fixed-wing UAVs. As both our study and the *field report* have pointed out, the complexity of urban operations necessitates such a capability. As an update to our findings, it seems that issues having to do with de-confliction of airspace have been dealt with by removing organic UAV assets from lower echelon forces and placing them at the brigade level and above. In addition, the policy of conducting helicopter operations mostly at night has, to some extent, cleared airspace. As far as integration of UAV assets goes, the *field report* shows that USMC and Army elements have worked out coordinated UAV operations (facilitated by familiarity of operators and the use of digital chat features).

A **non-lethal weapon capability** is possibly the one category where the *field report* and our findings are in most disagreement. Where NLWs can give warfighters more options and prevent the escalation of tense situations in stabilization operations, the *field report* from Iraq showed that they served almost no role whatsoever in the environments visited (where insurgents were constantly using deadly force). Other sources of information, as the body of our study has pointed out, have presented different findings. We believe that this contradiction has more to do with the current state of security in some parts of Iraq than with the overarching usefulness of NLWs in S&R operations in general.

By way of concluding remarks, we note that in undertaking our study, we have attempted to identify the potential for technology contributions to S&R operations. However, it is just as important to keep in mind the less tangible and interdependent aspects of these endeavors. The demands of on-the-ground execution of S&R operations are many and complex and only some have technical solutions. The Army also must attend to the overarching principles that govern the success of stability and reconstruction. As a starting point, stability cannot take place without the security that military forces provide. Accordingly, security cannot take root until the indigenous population views the potential for development as a viable alternative to violence. Though it is often more arduous and time-consuming to engage populations patiently and with regard for their own views on their development (rather than to simply impose U.S. objectives) culturally-sensitive interaction is more enduring and more effective in the long run.[68]

[68] In this regard, the former director of the U.S. Agency for International Development has laid out some overriding principles and their overlap with military doctrine. They are: ownership, capacity building, sustainability, assessment, results, partnership, flexibility, and accountability. In-depth study of these elements of S&R are outside the scope of this study, however this last point on culturally-sensitive interaction is a highlight worth noting. For more information, see Andrew Natsios, "The Nine Principles of Reconstruction and Development," *Parameters*, Autumn 2005.

In this vein, some critics contend that some of the very technological innovations the U.S. military seek to bring to S&R operations only serve to alienate American forces from the civilian populations they are attempting to help creating mutual rifts that are exacerbated by cultural and linguistic ignorance as well as external "spoilers."[69] Accordingly, post-conflict endeavors can become hobbled. Critics go on to posit that technological evolution also drives U.S. military (namely, Army) transformation along traditional and conventional warfare lines, all the while deluding ground force leaders with the sense that their organizations are adapting to the increasingly asymmetric and S&R operations-heavy nature of international engagements.[70]

We believe that while the dynamics cited above can certainly become pitfalls, technology can act as an enabler for helping U.S. soldiers achieve successes on the ground. Moreover, as we note in the previous chapter, training and use of modeling and simulation technology can be leveraged to better prepare warfighters for S&R missions, giving them the opportunity to achieve full-spectrum proficiency. It should also be noted that an additional critique (focused on technology limitations in combat operations) is shown and discussed in the sidebar.

Given that this study focused on the traditional combat operations involved in the invasion of Iraq across flat terrain, its findings have limited relevance to the focus of this report, which deals with S&R operations in urban environments. However, some useful parallels in terms of the technology gaps are identified. The MIT report corroborates our study in citing the limitations in line-of-sight communications systems. The Army's efforts to develop robust, long-range, non-line-of sight systems will be a key factor in equipping soldiers for future missions.

Where the MIT report cites the great effectiveness of Blue Force Tracking systems for keeping track of friendly forces in vehicles and tanks, our study takes that innovation a step further by focusing on efforts to scale the system down to the dismounted soldier level. As mentioned previously in our study, advanced materials are providing the enabling platforms that will incorporate these capabilities into wearable tracking devices.

The usefulness of new body armor and usage of UAVs were two further issues which reinforced points featured in our report. Moreover, the lack of a COP was identified as a shortfall during missions in Iraq. However, while the MIT study focused on traditional kinetic operations, our report focused on issues having to do with S&R operations.

David Talbot, "How Technology Failed in Iraq," *MIT Technology Review*, October 12, 2004.

Overall the Army (as well as the Defense Department as a whole) continues to identify and address shortfalls in a timely and capable manner, however there are a few areas that

[69] The most prominent of these criticisms is in BG Nigel Aylwin-Foster, "Changing the Army for Counterinsurgency Operations," *Military Review*, November–December 2005.
[70] Ibid., 14.

need more attention.[71] These high-payoff technological areas warrant increased investment. Scaling Blue Force Tracking technology down to the individual soldier level, and incorporating this into a newly configured situational awareness display (with a wider array of icons and 3-D viewing) is one such area. Re-engineering current Joint/Army information systems, such as CPoF, to develop integrated S&R operational planning and execution C2 systems also would be advantageous. Another area that would benefit from increased focus is development of on-the-ground biometric devices that can remotely record and submit data into a central population database as well as check a person's identity against that database. In terms of UAVs, the Army should increase the capabilities of platoon-level forces by incorporating "hover and stare" UAV assets down to this lower echelon. Moreover, NLWs should be developed that can disable a moving vehicle during convoy or traffic control point operations. The Army also should renew efforts to harness environmental energy sources while in austere environments by developing rugged, portable systems that can store energy derived from solar and wind power.

To facilitate continued efforts at addressing U.S. Army S&R operations shortfalls through technology, a follow-up workshop at some point in the future might well address the issues covered in this report. Potential attendees would include personnel from other government agencies as well as NGO and IGO representatives. In addition to providing a forum for more in-depth examination of these S&R operations-related technological aspects, a workshop would cultivate the kind of "cross-pollination" of ideas beneficial for integrating solutions across disparate actors. The White House IWG has gone far in coordinating this type of interaction and we would seek to build upon their momentum.[72]

> The White House IWG examined how training, modeling, and simulation technologies can be leveraged for increasing the proficiency and efficacy of U.S. S&R operations. Through continued lobbying for making these training aids as widely available as possible, the group has ensured that the varied actors involved in S&R operations at any given point in time are better able to overcome the difficulties inherent in coordinating and achieving unity of effort. The IWG's advocacy for development of a "social weather map" also highlights its work in linking disparate systems into coherent programs. This overarching program, for example, ties in the various elements of imagery intelligence, social science software, and telecommunications to provide predictive tools for analysts and policy makers alike.

Finally, the vital nature of S&R operations and the rapidly changing dynamics of current missions (as well as the potential requirements for future operations) necessitates the updating of the material found in this report. We will seek to keep the information here current and useful by updating this report with a continuing series of periodic surveys of NDU students. By doing so, we will gain a better understanding of how shortfalls are being addressed. This also will help us to see persistent and/or emerging trends in S&R

[71] It is significant to note that where the Army might not have a concentrated S&T effort (in translation devices, for example), there are DARPA endeavors which fill these gaps and are leveraged. Existing programs in other Services also address Army needs.
[72] Sotirin et. al, Regional Stability/Capacity Building R&D.

operations requirements. The comments and suggestions of these field grade officers will continue to play a major role in shaping how we analyze the challenges warfighters face in S&R missions.

Appendix A: Acronyms

ACTD	Advanced Concept Technology Demonstration
AO	Area of Operation
ARCIC-F	U.S. Army Capabilities Integration Center–Forward
ARL	U.S. Army Research Laboratory
ASA(ALT)	Assistant Secretary of the Army for Acquisition, Logistics, and Technology
ATO	Army Technology Objective
BATS	Biometric Automated Toolset System
BG	Brigadier General
C2	Command and Control
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CENTCOM	U.S. Central Command
COE	Common Operating Environment
COMSEC	Communications Security
COP	Common Operating Picture
COTS	Commercial-Off-The-Shelf
CPoF	Command Post of the Future
C-RAM	Counter Rocket Artillery Mortar
CTNSP	Center for Technology and National Security Policy
DARPA	Defense Advanced Research Projects Agency
DOD	Department of Defense
DUSD(AS&C)	Deputy Undersecretary of Defense for Advanced Systems and Concepts
EPLRS	Enhanced Position Location Reporting System
FAST	Field Assistance in Science and Technology
FBCB2	Force XXI Battle Command, Brigade and Below
FCS	Future Combat Systems
FCS-C	Future Combat Systems Communications
FMSO	Foreign Military Studies Office
GALE	Global Autonomous Language Exploitation
GPS	Global Positioning System
HMMVW	High Mobility Multipurpose Wheeled Vehicle
HSI/MANPRINT	Human Systems Integration/Manpower and Personnel Integration
HUMINT	Human Intelligence
IED	Improvised Explosive Device
IGO	International Government Organization
IO	Information Operations
IWG	Interagency Working Group
JIEDDO	Joint Improvised Explosive Device Defeat Office
JNLWD	Joint Non-lethal Weapons Directorate

MASINT	Measurements and Signatures Intelligence
MBITR	MultiBand Inter/Intra Team Radio
MIT	Massachusetts Institute of Technology
NDU	National Defense University
NCO	Non-Commissioned Officer
NEST	Networked Embedded Systems Technology
NET	New Equipment Training
NGO	Non-Government Organization
NLW	Non-Lethal Weapon
ONR	Office of Naval Research
OPFOR	Opposing Force
OPSEC	Operational Security
PEO	Program Executive Office
PLGR	Precision Lightweight GPS Receiver
PMESII	Political, Military (air, land and sea), Economic, Social, Information and Infrastructure
POSSE	Persistent Operational Surface Surveillance and Engagement
PME	Professional Military Education
PRT	Provincial Reconstruction Team
R&D	Research and Development
RDECOM	U.S. Army Research, Development, and Engineering Command
RFID	Radio Frequency Identification
ROE	Rules of Engagement
RPG	Rocket Propelled Grenade
S&R	Stabilization and Reconstruction
S&T	Science and Technology
SA	Situational Awareness
SINCGARS	Single Channel Ground and Airborne Radio System
SOF	Special Operations Forces
SOP	Standard Operating Procedure
SSTR	Stability, Security, Transition and Reconstruction
STAT	Science and Technology Assistance Team
TALON	Threat and Local Observation Notice (robot)
TCP	Traffic Control Point
TRADOC	U.S. Army Training and Doctrine Command
TTPs	Tactics, Techniques, and Procedures
TUSK	Tank Urban Survivability Kit
UAV	Unmanned Aerial Vehicle
UGV	Unmanned Ground Vehicle
USMC	United States Marine Corps
UTAMS	Unattended Transient MASINT System (mortar location system)
VBIED	Vehicle Borne Improvised Explosive Device

Appendix B: Assessment Summary Table

Identified S&R Technology Limitation	Current Supporting Programs	Assessment	Action
BATTLE COMMAND			
Command and Control:			
• *Inability to Track and Identify Dismounted Personnel in an Urban Environment*	• Army Technology Objectives (ATOs): III.BC2006.01 [BC3, BC8, BA4][73]	• *S&T programs addressing this issue*	• *Maintain S&T effort in scaling down to soldier level*
• *Better "OPFOR" Icons in SA Systems*		• *Capabilities exist to address this issue, but specific programs are not currently underway. Not S&T*	• *No additional S&T effort* • *Add this requirement for Battle Command/SA systems in the field and for those under development*
Integration of S&R Operations:			
• *Need for an Integrated S&R Operational Planning and Execution C2 System*		• *This capability can be addressed by re-engineering current Joint/Army information systems (e.g., CPoF). S&T research potential appears minimal*	• *No additional S&T effort* • *Add this requirement to collaborative planning and execution C2 tools in the field (e.g., CPoF) and for those under development*

[73] All associated ARCIC shortfall categories are shown in brackets throughout this table.

Identified S&R Technology Limitation	Current Supporting Programs	Assessment	Action
Communications:			
• *Need for Better Non-Line-of-Sight Communications Devices/Systems in Urban Environments*	• ATOs: III.BC.2003.01; III.BC.2006.03; III.BC.2006.04; III.BC.2006.01; [BC1, BC3, BC6, ManSup4]	• *Sufficient S&T, acquisition, and COTS programs addressing this issue*	• *No additional S&T effort*
• *Interoperability of Incompatible Tactical Radio Systems*	• ATOs: III.BC.2003.01; III.BC.2006.03; III.BC.2006.04; III.BC.2006.01 [BC1, BC3, BC6, ManSup4]	• *S&T programs addressing parts of this issue. Gaps appear in secure military to non-military communications*	• *S&T should address gaps in interoperability of secure military to non-secure, non-military communications*
• *Too Few Translators and Translations Devices*	• DARPA S&T programs	• *DARPA S&T programs addressing this issue*	• *No additional S&T effort*

Identified S&R Technology Limitation	Current Supporting Programs	Assessment	Action
SITUATIONAL AWARENESS			
• *Limited SA Capability in Urban Environments*	• ATOs: IV.EN.2002.01; IV.EN.2003.03; III.BC.2006.01 [BA4, BC3, BC6,BC8, Manup3, ManSup4]	• *S&T programs addressing this issue are present, but insufficient. COTS provide limited solutions, but inadequate for dismounted personnel*	• *S&T needed to address tracking and SA of dismounted personnel in 3-dimensionions, especially within large buildings (above-ground and sub-surface)*
ARMORED VEHICLES IN URBAN ENVIRONMENTS			
• *Armored Vehicles in Urban Environments*	• [ManSup10]; Tank Urban Survivability Kit (TUSK)	• *S&T and acquisition programs addressing the problem*	• *S&T should ensure full-spectrum design for FCS for combat and S&R operations*

Identified S&R Technology Limitation	Current Supporting Programs	Assessment	Action
INTELLIGENCE (INCLUDING SENSORS)			
• *Need for Undetectable, Long Duration Remote Networked Sensor Systems*	• ATOs III.SE.2005.01; III.GC.2004.06; IV.EN.2002.01 [Protection 4, ManSup5] • DARPA S&T Programs	• *Sufficient S&T programs addressing short-duration tactical sensors, which have limited use in S&R. COTS solutions might prove more cost-effective and useful*	• *S&T should address increasingly important issues of undectability and long-duration functionality in remote sensors. Re-engineering of COTS solutions advantageous*
• *Need "See Through the Wall" Capability*	• ATOs III.SE.2004.04; III.SE.2006.01; IV.SE.2006.02 [MDM1, BA2] • DARPA S&T Programs	• *S&T addressing this issue*	• *No additional S&T effort*
FORCE PROTECTION			
• *Need for Rapidly Locating Point of Origin for Mortar and Sniper Attacks*	• ATOs III.BC.2006.01; IV.EN.2002.01 [BC7, BA1] • DARPA S&T Programs	• *Sufficient S&T programs addressing this issue.*	• *No additional S&T effort*

Identified S&R Technology Limitation	Current Supporting Programs	Assessment	Action
• *Inability to Quickly Check People, Baggage, and Vehicles at Check Points*	• ATOs III.SE.2006.05 [ManSup1, BA1]	• *S&T programs, but high false alarm rates and lack of an integrated, automated system persist*	• *S&T efforts needed in areas of (1) lowering false alarm rate and (2) fusion and automated analysis of data from multiple sensor systems*
• *Inability to Quickly Identify and Track the Population*	• [BATS, BA3]	• *S&T programs, but no specific ATOs to address this issue*	• *Increase focus of effort through creation of ATO*
• *Counter-IED Technology*		• *Assessment withheld to comply with DOD OPSEC policies. This material is provided to the sponsor*	

Identified S&R Technology Limitation	Current Supporting Programs	Assessment	Action
UNMANNED SYSTEMS			
• *Fixed-wing UAVs do not Provide Uninterrupted Viewing*	• ATOs III.BC.2006.02; IV.EN.2002.01 [BA4, HE1] • DARPA S&T Programs	• *Sufficient S&T and acquisition programs*	• *No additional S&T effort*
• *Deconflicting Airspace Issues*		• *No S&T programs for tactical level UAVs. Enhancements limited by very small payloads for these vehicles*	• *S&T efforts needed for both deconflicting airspace and enhancing obstacle/crash avoidance capabilities of tactical UAVs*
• *Availability of UAV and UGV Assets*	• ATO III.BC.2006.02	• *S&T and acquisition programs for UAVs, but affordable, expendable UGVs needed*	• *S&T efforts may be appropriate, especially in developing affordable, expendable UGVs*
• *Limited Range Issue when Operating UGVs in Urban Environments*		• *S&T program does not exist, but current technology can be used meet this need*	• *S&T efforts to adapt signal repeaters for use in UGV operations in urban environments should be pursued to a greater extent*

Identified S&R Technology Limitation	Current Supporting Programs	Assessment	Action
NON-LETHAL CAPABILITIES			
• *Limitations on the Availability and Use of Non-lethal Weapons*	• ATOs III.SE.2005.03 [Lethality2] • JNLWD S&T Programs	• *Sufficient S&T and acquisition programs*	• *No additional Army S&T effort needed*
INFORMATION OPERATIONS			
• *Information Operations*	• [BA1, TLDE1]	• *Sufficient S&T and acquisition programs*	• *S&T and acquisition programs in place, but Army could benefit from developing PMESII planning tools which take into account IO planning*
TRAINING AND USE OF MODELING AND SIMULATION			
• *Lack of Adequate Training in S&R Operations for U.S. Personnel*	• ATOs II.MS.2006.01; IV.HS.2003.03; IV.HS.2006.01 [TLDE1, TLDE2, TLDE3, TLDE4, TLDE5, TLDE6]	• *S&T and acquisition programs, however they are not geared toward cultural and/or integrated S&R missions*	• *S&T efforts needed to develop and integrate cultural behavior and S&R operations into current training systems*

Identified S&R Technology Limitation	Current Supporting Programs	Assessment	Action
• *Lack of Adequate Training for Foreign S&R Personnel*	• ATOs II.MS.2006.01; IV.HS.2003.03; IV.HS.2006.01 [TLDE1, TLDE2, TLDE3, TLDE4, TLDE5, TLDE6]	• *S&T and acquisition programs, however they are not geared toward cultural and/or S&R missions*	• *S&T efforts needed to develop and integrate cultural behavior and S&R operations into current training systems, with added foreign languages capabilities*
LOGISTICS			
• *Most Logistics Equipment not Designed for Long-Duration Needs of S&R operations*	• ATOs III.GC.2004.02; III.LG.2004.03; III.SS.2002.01; IV.LG.2006.03; [ManSust3, MDM4, MDM5] • DARPA S&T Programs	• *S&T and acquisition programs*	• *No additional S&T effort specifically needed, however the Army would benefit by examining private sector solutions for alternative energy sources*
• *Dismounted Warfighters Have to Carry Too Many Types of Batteries to Power Critical Devices*	• ATOs III.GC.2004.02; III.LG.2004.03; III.SS.2002.01; IV.LG.2006.03; [ManSust3, MDM4, MDM5] • DARPA S&T Programs	• *S&T and acquisition programs, but not geared for S&R operations*	• *Current S&T efforts must consider S&R operations*

Appendix C: Interviews in Chronological Order

Field Assistance in Science and Technology, Army Materiel Command, Ft. Belvoir, VA (August 8, 2005 and May 31, 2006)

- Mr. James Gibson, Director
- Major Lawrence Dring, Ordnance Corps, Former FAST Officer in Iraq. Currently Assistant Project Manager, Soldier, Weapons Picatinny Arsenal, NJ.

U.S. Army Research Laboratory (ARL), Army Research, Development, and Engineering Command (RDECOM) (September 7, 2005)

- Mr. Joseph Rocchio, Deputy Director

Meeting in Arlington, VA (September 22, 2005)

- Major General Peter W. Chiarelli, Commanding General, 1st Cavalry Division[74]

1st Cavalry Division, Fort Hood, TX (November 11, 2005)

- Major Tim Karcher, Armor Corps, Operations Officer (S3), 1st Battalion - 9th Cavalry Regiment, 1st Cavalry Division, Fort Hood, TX. He served in this position in Iraq.
- Major Scott Taylor, Armor Corps, Executive Officer, 3rd Battalion - 8th Cavalry Regiment, 1st Cavalry Division, Fort Hood, TX. He served in this position in Iraq.
- Sergeant Ken Raymos, Armor Corps, Abrams Tank Gunner, 3rd Battalion - 8th Cavalry Regiment, 1st Cavalry Division, Fort Hood, TX. He served in this position in Iraq.

U.S. Army Recruiting Command, Fort Knox, KY (November 17, 2005)

- Major General Thomas P. Bostick, Commanding General, Corps of Engineers. He served as the Assistant Division Commander-Maneuver, and then as Assistant Division Commander-Support, 1st Cavalry Division at Fort Hood, from August 2002–June 2004, deploying with the division in support of Operation *Iraqi Freedom*. From June 2004–June 2005 he served as Commander of the Gulf Region Division of the U.S. Army Corps of Engineers and Deputy for Construction, Project and Contracting Office in Baghdad, Iraq where he was responsible for over $18 billion in reconstruction.
- Major John Wrann, Corps of Engineers, U.S. Army Recruiting Command, Fort Knox, KY. He served as a Combat Engineer Company Commander in the 4th

[74] MG Chiarelli served in this position until November 2005. After promotion to the rank of Lieutenant General, he assumed command of the Multi National Corps-Iraq (MNC-I).

Infantry Division as the Operation *Iraqi Freedom* (the Iraq War) ended. He then operated his own forward operating base and had responsibility for administering a city of about 200,000 people in an area of about 25 square kilometers, about 80 km north of Baghdad.

- Major Kim Phillips, Transportation Corps, U.S. Army Recruiting Command, Fort Knox, KY. She served as a Transportation Officer in the 101st Corps Support Group in direct support of 1st Cavalry Division. Her mission included coordinating transportation assets over most of Iraq.
- Captain Gabe Marriott, Aviation, U.S. Army Recruiting Command, Fort Knox, KY. He served as an aviator in Afghanistan and as the Battalion Adjutant (S1), 3rd-101st Avn (Apache) in Iraq from February–September 2003. He served in the same unit in Afghanistan as an Attack Platoon Leader from February–August 2002.

Independent Contractor/CTNSP Consultant (May 22, 2006)

- Mr. Bing West

Appendix D: S&R Operations Questionnaire for NDU Students

Your Personal Information

Name
Phone
Branch of Service:
Grade
Location of Most Recent Overseas Deployment
Dates of most recent tour:
Unit/Organization:
Position within Unit/Organization:
Brief Description of Activities:

From A (excellent) to F (Failing) rate the following. If not applicable, then NA.

Communications capabilities
Battalion and Below: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of communications and SRO.)

(Percentages)	A	B	C	D	F	N/A
Small Unit Level: Open, uncluttered terrain						
Small Unit Level: Urban environments						
Within your service: Open, uncluttered terrain:						
Within your service: Urban environments						
Your service to other services: Open, uncluttered terrain						
Your service to other services: Urban environments						
Military-to-non governmental organizations (to include contractors):						
Military-to-host nation military and security forces:						
Military-to-host nation civilians:						
Military-to-U.S. civilian agencies:						

Additional comments:

Battalion to Brigade and above: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of communications and SRO.)

(Percentages)	A	B	C	D	F	N/A
Within your service: Open, uncluttered terrain:						
Within your service: Urban environments						
Your service to other services: Open, uncluttered terrain						
Your service to other services: Urban environments						
Military-to-non governmental organizations (to include international organizations, charities, and contractors):						
Military-to-host nation military and security forces:						
Military-to-civilian leadership:						

Additional comments:

Please assess the ability of existing TRANSLATION ASSETS to support the following: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of translation and SRO.

(Percentages)	A	B	C	D	F	N/A
Translation of spoken language:						
Translation of written language:						

Additional comments:

Open, uncluttered terrain: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of sensor capabilities and SRO.)

(Percentages)	A	B	C	D	F	N/A
Daytime, clear weather: Battalion and below						
Daytime, clear weather: Battalion to Brigade and above						
Nighttime, clear weather: Battalion and below						
Nighttime, clear weather: Battalion to Brigade and above						
Daytime, adverse weather: Battalion and below						
Daytime, adverse weather: Battalion to Brigade and above						
Nighttime, adverse weather: Battalion and below						
Nighttime, adverse weather: Battalion to Brigade and above						

Additional comments:

Urban Environment: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of sensor capabilities and SRO.)

(Percentages)	A	B	C	D	F	N/A
Daytime, clear weather: Battalion and below						
Daytime, clear weather: Battalion to Brigade and above						
Nighttime, clear weather: Battalion and below						
Nighttime, clear weather: Battalion to Brigade and above						
Daytime, adverse weather: Battalion and below						
Daytime, adverse weather: Battalion to Brigade and above						
Nighttime, adverse weather: Battalion and below						
Nighttime, adverse weather: Battalion to Brigade and above						

Additional comments:

Assess the value of the support that was received from the sensors on the following platforms:

(Percentages)	A	B	C	D	F	N / A
Manned aircraft: Fixed wing						
Manned aircraft: Rotary wing						
Satellites:						

Additional comments:

Survivability: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of vehicle survivability capabilities and SRO. If you have significant experience with an additional vehicle or vehicles, we would especially welcome your additional comments on those vehicles.)

(Percentages)	A	B	C	D	F	N / A
Ability of vehicle to operate after small arms attack:						
Ability of vehicle to operate after RPG attack:						
Ability of vehicle to operate after IED attack:						

Additional comments:

Crew Protection: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of vehicle crew protection capabilities and SRO. If you have significant experience with an additional vehicle or vehicles, we would especially welcome your additional comments on those vehicles.)

(Percentages)	A	B	C	D	F	N / A
Ability of vehicle to protect the crew from small arms attack:						
Ability of vehicle to protect the crew from RPG attack:						
Ability of vehicle to protect the crew from IED attack:						

Additional comments

Reliability: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of vehicle reliability and SRO. If you have significant experience with an additional vehicle or vehicles, we would especially welcome your additional comments on those vehicles.)

A	
B	
C	
D	
F	
N/A	

Additional comments:

Agility: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of vehicle agility capabilities and SRO. If you have significant experience with an additional vehicle or vehicles, we would especially welcome your additional comments on those vehicles.)

(Percentages)	A	B	C	D	F	N/A
In an urban environment:						
In open terrain:						

Additional comments:

C3 and displays capability on board: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of vehicle C3 and display capabilities and SRO. If you have significant experience with an additional vehicle or vehicles, we would especially welcome your additional comments on those vehicles.)

A	
B	
C	
D	
F	
N/A	

Additional comments:

Lethality: (In the "Comments" field, identify your vehicle's lethality/weapon systems. If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of vehicle lethality and SRO. If you have significant experience with an additional vehicle or vehicles, we would especially welcome your additional comments on those vehicles.)

(Percentages)	A	B	C	D	F	N/A
Firepower:						
Accuracy:						
Suitability of armament in an urban environment:						
Suitability of armament in open terrain:						

Additional comments:

Urban Environment: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of indirect fire capabilities and SRO.)

(Percentages)	A	B	C	D	F	N/A
Availability:						
Effectiveness:						

Additional comments:

Open terrain: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of indirect fire capabilities and SRO.)

(Percentages)	A	B	C	D	F	N/A
Availability:						
Effectiveness:						

Additional comments:

Urban Environment: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of air support capabilities and SRO.)

(Percentages)	A	B	C	D	F	N/A
Availability:						
Effectiveness:						

Additional comments:

Open terrain: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of air support capabilities and SRO.)

(Percentages)	A	B	C	D	F	N/A
Availability:						
Effectiveness:						

Additional comments:

Assess the ability of existing NAVIGATION SYSTEMS to support your needs in: (In the "Comments" field identify any Navigation Systems being assessed by you. If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of navigation systems and SRO.)

(Percentages)	A	B	C	D	F	N/A
Open terrain:						
Urban terrain:						
Within large buildings:						

Additional comments:

To supply and re-supply materiel in a timely fashion in an urban environment: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of logistics capabilities and SRO.)

(Percentages)	A	B	C	D	F	N/A
Supply of war fighting materiel (ammunition, armor, fuel, batteries, night vision goggles, weapons, vehicles, etc.):						
Supply of soldier's needs (medical care, food, clothing, shelter, recreation):						

Additional comments:

To supply and re-supply materiel in a timely fashion in open terrain: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of logistics capabilities and SRO.)

(Percentages)	A	B	C	D	F	N/A
Supply of war fighting materiel (ammunition, armor, fuel, batteries, night vision goggles, weapons, vehicles, etc.):						
Supply of soldier's needs (medical care, food, clothing, shelter, recreation):						

Additional comments:

The ability of existing power sources to support your needs for: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of logistics capabilities and SRO.)

(Percentages)	A	B	C	D	F	N/A
Hand-held devices:						
Transportable/mobile systems:						

Additional comments:

Did you receive ROBOTIC SYSTEM support from unmanned ground vehicles (UGVs) or unmanned aerial vehicles (UAVs))?

Yes	
No	

If "yes" was indicated on the previous question, assess the quality of support you received from the following sources: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of robotic systems and SRO.)

(Percentages)	A	B	C	D	F	N / A
Ground based:						
UAVs (low altitude):						
UAVs (high altitude):						

Additional comments:

Assess existing FORCE PROTECTION capabilities in the following areas: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of force protection and SRO.)

(Percentages)	A	B	C	D	F	N / A
Ability to locate sources of indirect fire:						
Ability to locate snipers:						
Effectiveness of body armor:						

Additional comments:

Ability to deal with improvised explosive devices (IEDs): (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of force protection and SRO.)

(Percentages)	A	B	C	D	F	N / A
Prediction (Battlespace awareness, use of automated tools, situational awareness information, C3 systems):						
Detection (detection of IED components, insurgents, etc.):						
Prevention (prevent enemy C2, prevent enemy attack):						
Neutralization (render IED useless, safe disposal):						
Mitigation (armor, first responders, MEDEVAC, C3):						
Post attack forensics (rapid determination of IED components and opposing force tactics; and rapid dissemination of that information):						

Additional comments:

Please assess the ability of NON-LETHAL WEAPONS to support your operational needs: (In the "Comments" field identify any Non-Lethal Weapons being assessed by you. If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of non-lethal weapons and SRO.)

A	
B	
C	
D	
F	
N/A	

Additional comments:

For each of the following INFORMATION OPERATIONS (IO) AND IO-RELATED functions in which you participated, please assess the quality of the support that you were provided by existing technology: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of information operations and SRO.)

(Percentages)	A	B	C	D	F	N/A
Psychological operations:						
Computer network operations:						
Electronic warfare:						
Military deception:						
Operational security:						
Counter intelligence:						
Physical security:						
Information assurance:						
Combat camera:						
Public affairs:						
Civil-Military operations:						

Defense support to public diplomacy:						
Intelligence support:						

Additional comments:

Please assess the ability of existing Models, Simulations, and Games to support the following functions: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of modeling and simulation and SRO.)

(Percentages)	A	B	C	D	F	N/A
Education on the culture of the area of responsibility (AOR):						
Training and preparation for deployment to the AOR:						
Operations support, including course of action identification and assessment:						
Mission rehearsal:						
Planning combat service support (e.g., logistics, resupply):						

Additional comments:

Assess the TRAINING received from the following sources and in the following areas in preparation for stabilization and reconstruction operations: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of training and SRO.)

(Percentages)	A	B	C	D	F	N/A
Combat Training Center:						
Classroom training:						
Distributed on-line training:						
Training for civil affairs:						
Language training:						

Additional comments:

Please assess the ability of existing DATABASES to support the following: (If you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments" field. We would also welcome any further thoughts on the subject of databases and SRO.)

(Percentages)	A	B	C	D	F	N/A
Detainee identification:						
Vehicle identification:						

Additional comments:

Were you involved with RECONSTRUCTION operations?

Yes	
No	

If "yes" was indicated on the previous question, please assess the following reconstruction-related capabilities: (In the "Comments" field below, briefly describe your reconstruction activities. Also, if you give a grade of D or F for any of the answers below, please expand on your response(s) in the "Comments' field". We would also welcome any further thoughts on the subject of ability to support reconstruction.)

(Percentages)	A	B	C	D	F	N/A
Ability to prioritize reconstruction projects:						
Ability to understand the impact of reconstruction efforts on local communities:						
Ability to integrate new utility services with existing services:						
Availability of repair and construction equipment:						
Quality of repair and construction equipment:						
Ability to translate structural, roadway, or utility designs/blueprints:						
Ability to locate utility tunnels and service lines buried underground or embedded in structures:						
Ability to test utility services and existing/installed lines:						
Ability to coordinate and transport materials to the right place at the right time:						

Additional comments:

Please offer your overall impression of the state of SRO technology capabilities and your top priorities for improvement. We would also welcome any further expansion on, or explanation of, your answers above.
