Advanced Research Projects Agency

REPORT OF THE SENIOR WORKING GROUP ON MILITARY OPERATIONS OTHER THAN WAR (OOTW)

May 1994

General Carl Stiner, U.S. Army (Retired)(Chairman)

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EXECUTIVE SUMMARY

> **"Today, as an older order passes, the new world is more free but less stable. Communism's collapse has called forth old animosities and new dangers."**
> ***President Bill Clinton, January 20,1993, Inaugural Address***

Introduction

. The world is no longer bipolar. Consequently, the post-Cold War strategic environment is ill-defined, dynamic, and unstable. The nature of this environment and the military threats it fosters indicate that U.S. forces (1) will face a widely diverse range of adversaries equipped with an ever increasing array of sophisticated weapons, and (2) will require a span of operational response capabilities that ranges from military operations other than war (OOTW)—such as deterring or engaging small, unsophisticated, fanatical terrorist groups—to conducting significant military operations against regional powers, which may well possess advanced weapons systems, including nuclear, biological and/or chemical weapons of mass destruction (WMD). The United States must be prepared for the challenges of this range of military threats. It must maintain enough capable, versatile, trained, and ready military forces able to meet this spectrum of security challenges that is unprecedented in ambiguity, diversity, and risk.

Objectives and Approach

Because of the increasing trend of U.S. military involvement in OOTW—particularly the events in Somalia during the summer and fall of 1993—the Advanced Research Projects Agency (ARPA) identified a need to enhance the effectiveness and survivability of U.S. forces engaged in these operations through the application of advanced technologies. ARPA convened a Senior Working Group (SWG) to assist in developing a vision and implementation plan for this initiative. Although the SWG focused on long-term development requirements, key near- and mid-term enabling technologies for application to immediate problems were also of interest.

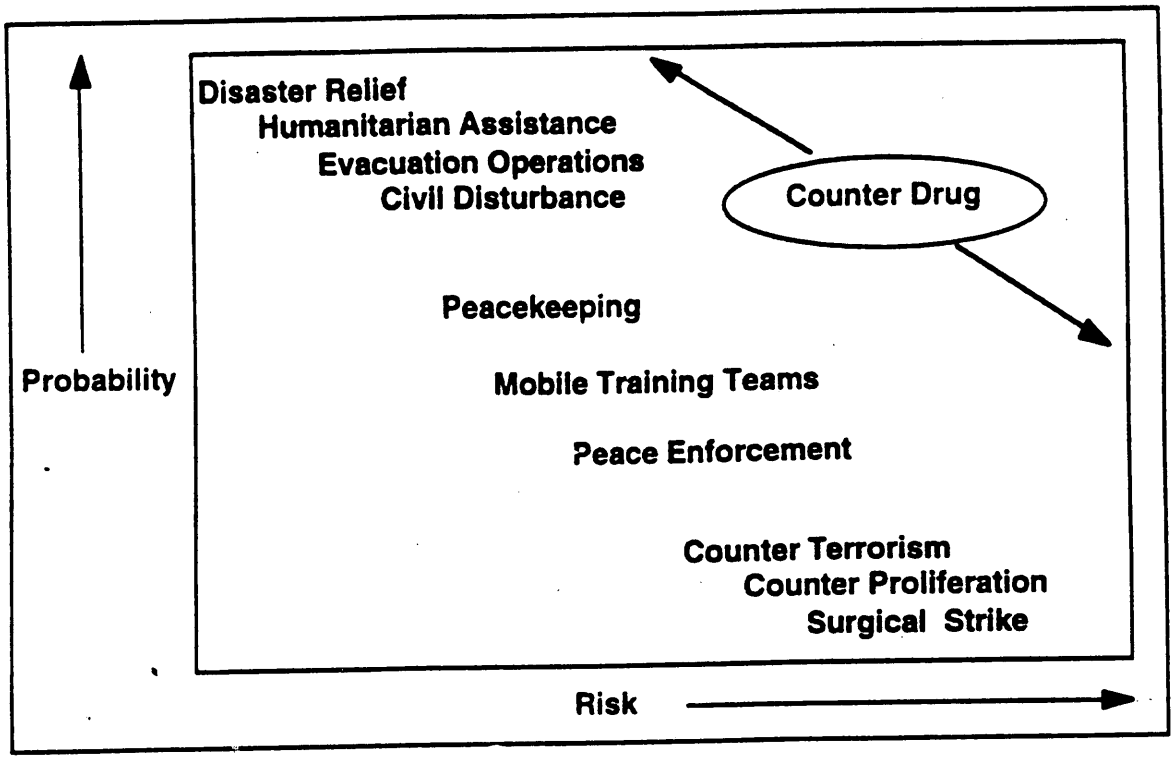

Figure ES-1. Spectrum of Operations Other Than War

The SWG viewed OOTW being the predominant form of future U.S. military operations at least well into the next century. Despite the normally relatively modest scale of OOTW operations as compared to other types of military operations, OOTW will be predominant in frequency, political impact, and long-term importance. Individually, these operations will initially reflect their political environment, then change and define it. In order for the nation to succeed in OOTW, it is imperative that the Armed Forces be adequately equipped, well supported, and well trained both as individuals and as units. The SWG envisioned ARPA's initiative as a means of providing the military commander, through the application of advanced technology, those capabilities necessary for the more effective employment of military force in OOTW; particularly with respect to accommodating the politically based mandates to keep casualties, both U.S. and others, to an absolute minimum.

Developing and fielding the technologies advocated in this study are offered as one of the few available options for providing value-added capability to U.S. Armed Forces

- Time limits on involvement are restrictive.

Key Problem Areas and Shortfalls

The first priority for our military is to maintain adequately prepared forces to successfully meet the requirements associated with major regional contingencies. However, the likelihood of involvement of U.S. forces in OOTW greatly exceeds that of their involvement in major regional contingencies. Considering the unique requirements associated with OOTW, the following are shortfalls in the current capabilities for which solutions should be found:

- Inadequate nuclear, biological and chemical detection capabilities in non-permissive environments
- Inadequate capabilities to detect, locate and neutralize bunkers, tunnels, and underground facilities
- Limited secure, real-time command and control to lower echelon units
- Limited operational intelligence collection and dissemination capabilities
- Inadequate mine, booby trap, and explosives detection capabilities
- Inadequate non-lethal capabilities for neutralizing equipment and personnel (Mission Kill)
- Limited non-intrusive drug detection capabilities
- Inadequate modeling/simulations for training, rehearsal, and operations
- No real-time voice recognition language translation capability
- Inadequate ability to deal with discrete hostile sniper and mortar attacks.

Many of these problem areas and shortfalls are obviously applicable to other types of military operations.

Required Technologies

Table ES-1 identifies technology requirements having key applicability and exceptional importance to OOTW. The breadth of the technologies identified reflect the great diversity of OOTW, ranging from capabilities to protect individuals, to those that

identify and invest in developing breakthrough technologies that synergistically provide U.S. Armed Forces and government and civil agencies distinct advantages in accomplishing OOTW missions. Further, these technologies have potential application in other areas of national importance.

Because of the similarity of threats and the constraints placed on the application of force in OOTW, the challenges faced by military forces in OOTW and law enforcement agencies have converged. Consequently, technologies developed to enable military forces to better meet the challenges of the OOTW environment may also have applicability to law enforcement needs.

While this report focuses on technology, it must be noted that not all changes in the OOTW environment are related to technology. The changing political world and the tumultuous conditions discussed in Chapter II are having operational and doctrinal impacts that have little relationship to technology. One of the results of these conditions is that military operations that were of little consideration a decade ago are now of major concern. For example, regional conflict, once considered primarily an unwelcome diversion from the primary missions of deterring and preparing to defeat Warsaw Pact armies, now is a central mission. Counter drug and counter terrorism have been military missions for only 5 and 15 years respectively. Peace keeping and peace enforcement, considered inappropriate for U.S. Armed Forces in a bipolar world, have now become major concerns. The relative importance of each of the two dozen or more forms of OOTW is in flux as the nation struggles to identify its role in the new political order.

Given the dynamic rate of change in the strategic environment, it is important that ARPA consider the SWG's findings, however valid now, as neither all encompassing nor immutable. These findings are valid today, but require increased caution in application as time passes. *To ensure currency, ARPA should proceed in this initiative in close coordination with the user and periodically revisit the subject, using whatever means best meets its needs. Feasible approaches include: in-house, government, or academic*

- Establish a mechanism to periodically monitor program implementation and to identify emerging OOTW requirements.

I. INTRODUCTION

A. Senior Working Group Charter

The SWG was convened to assist ARPA in identifying OOTW unique requirements for which the application of advanced technology would make a significant contribution. The charter given the SWG was to:

> Assist ARPA in the *development of a vision* and *implementation plan for development of advanced technologies* to *enhance effectiveness and survivability* of U.S. forces engaged in *OOTW*...

Specific tasks given the SWG included: reviewing potential missions; identifying key problem areas; defining technology options; and recommending a strategy. While the SWG's focus was long-term, it was also directed to examine key near- and mid-term enabling technologies. At the conclusion of this effort, the SWG was directed to provide ARPA with this report containing:

- A vision statement for the proposed ARPA initiative, including a definition of OOTW
- Rationale supporting this proposed initiative that assesses requirements and technology
- Program recommendations with rationale that addresses new systems technologies.

The SWG Terms of Reference are provided in Appendix A.

B. Senior Working Group Composition

General Carl Stiner, U. S. Army (Retired), chaired the SWG. General and Field Grade Officers representing every branch of the Armed Forces and representatives of the national intelligence and law enforcement communities comprised the SWG. Members' backgrounds reflect extensive experience in special operations and combat in low- and mid-intensity conflict environments, and participation and experience in a broad range of

payoff. The SWG also carefully considered the applicability of the selected technologies to the law enforcement community.

This consideration was the result of the SWG's recognition of the convergence in the law enforcement and OOTW environments. Several factors have led to this convergence. The threats faced by both law enforcement personnel and military forces engaged in OOTW are now very similar. Widespread availability of increasingly sophisticated weapons has intensified the threat faced by law enforcement personnel. Terrorists, narcotics traffickers, and even common criminals are today equipped and armed as well as many irregular and some regular light forces. Further, the techniques and means they employ to further their objectives are in many ways similar to those of military forces. Concurrently, political considerations which mandate limiting non-combatant and even combatant casualties and collateral damage in OOTW have resulted in increasingly restrictive military rules of engagement that are not dissimilar to those common to police operations. This convergence of operational environments results in technologies—initially focused on military needs—being applicable to law enforcement and security needs as well.

The study was accomplished in a series of ten working sessions between October 14 and November 23, 1993.

II. EVOLVING STRATEGIC ENVIRONMENT

A. Current Threat

The United States faces the demands of an exceptionally diverse and unstable world (Figure II-1). Although the threat of global war has all but disappeared with the demise of the Soviet Union, it has been replaced by numerous, proliferating, smaller, highly diverse threats that challenge the nation both politically and militarily.

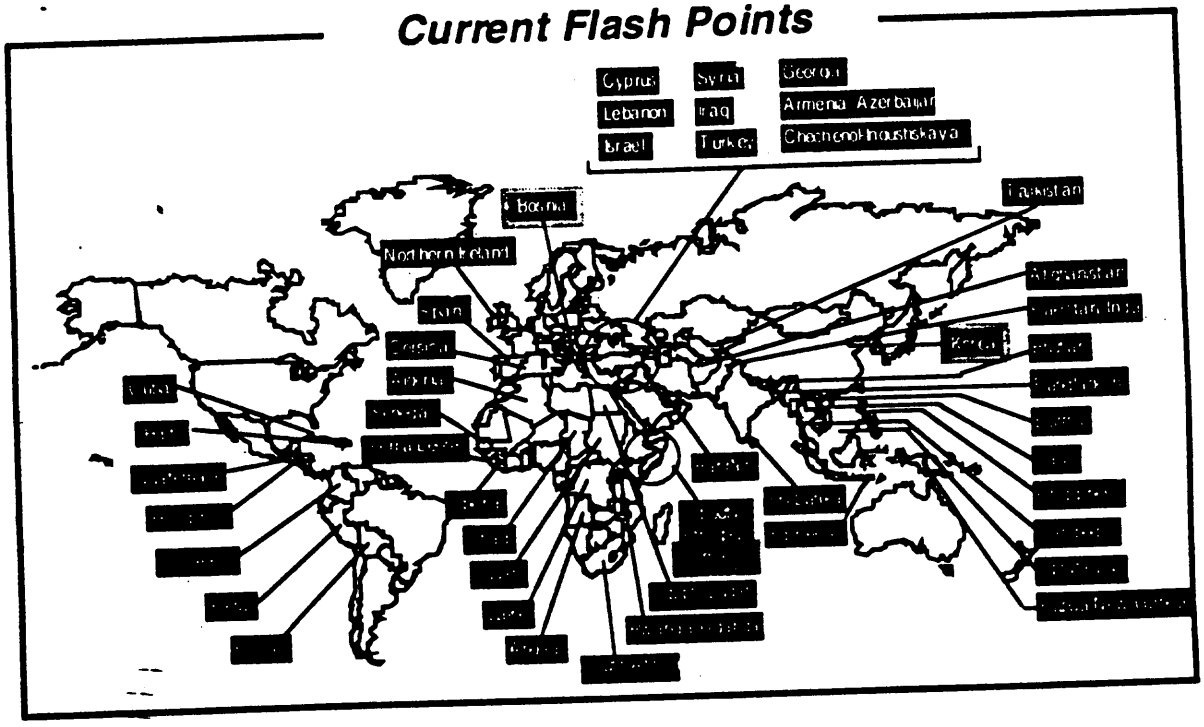

Figure II-1. The Unsettled World

While superpower rivalry during the Cold War spawned regional conflict—as the Soviet Union sought to expand its influence and the United States sought to contain that expansion—it also imposed stability. It was in neither superpower's advantage to have regional conflict escalate. Through a series of military alliances and employment of political, economic, and military means, the United States and the Soviet Union maintained a kind of "world order."

Colombian state by the Medellin drug cartel is a clear example of the "military" power of narcotics traffickers. Confrontation on the Korean peninsula and the ascension of China as a regional power also offer potential threats to U.S. interest. These conditions and other factors depicted in Figure II-2, will create or foster a variety of potential specific threats to U.S. interests.

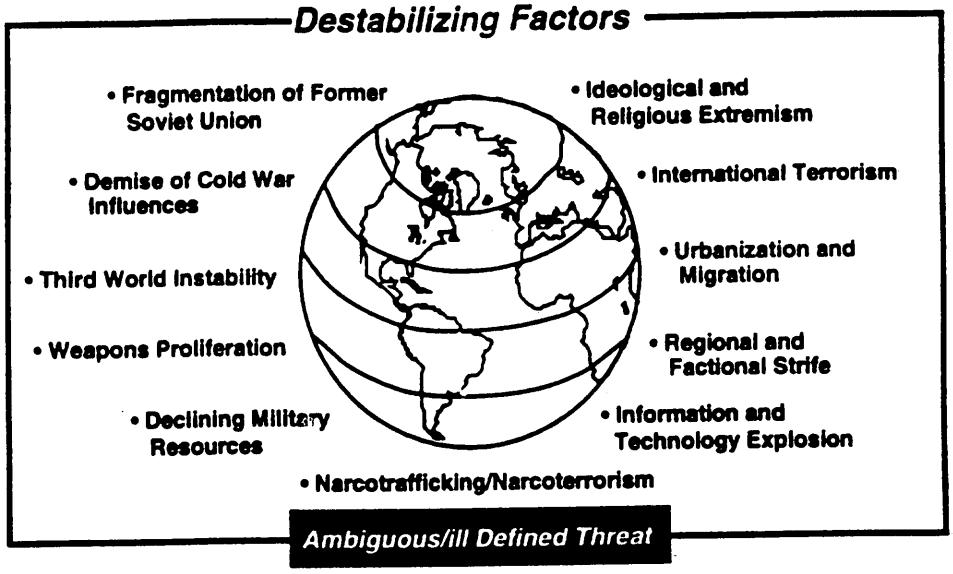

Figure II-2. Causes of Instability

B. Future Threat

There will be no general remission in the threats to U. S. interests in the near-term. The underlying problems that are their cause are long-term, complex, and in many instances either intractable or beyond the limits of the resources that the United States, other nations, or coalitions of nations are willing to dedicate to them. In relatively few instances does it appear likely that current or developing conditions will result in U.S. involvement in war. It is predictable, however, that the United States frequently will find it necessary to engage in OOTW if it is to defend its interests, assist its allies, protect its citizens and maintain its position of leadership.

C. Specific Challenges

On the positive side, there is no immediate major threat from another world power. Although Russia could be a potential future threat, it is only an immediate threat in

deterrence; rescue of U. S. citizens abroad; and establishing, enforcing and supervising conditions of peace.

D. Current U.S. Military Capabilities

As evidenced by the conduct and results of the Gulf War, the United States recently possessed the world's preeminent military force. This force, however, is rapidly declining in both numbers and capability under the impact of drastically reduced budgets. The impressive technology edge enjoyed by the U. S. Armed Forces is eroding as the equipment providing that edge grows obsolescent without next generation replacement, while other nations, duly impressed by the Gulf War, modernize their forces.

Although also applicable to major regional contingency requirements for the future, Table II-1 lists key problem areas or capability shortfalls that will affect mission success in OOTW.

- **Inadequate nuclear/biological/chemical detection in non permissive environments**
- **Inadequate capabilities to detect, locate and neutralize bunkers, tunnels, and underground facilities**
- **Limited secure, real-time C2 to lower echelon units**
- **Limited operational intel/collection/dissemination**
- **Inadequate mine/booby trap/explosive detection**
- **Inadequate non-lethal capabilities for equipment and crowd neutralization**
- **Limited non-intrusive drug detection**
- **Inadequate OOTW modeling and simulations for training, rehearsals, and operations**
- **No real time common language voice recognition translation capability**

Table II-1. Key Problem Areas and Shortfalls

Two of the major capabilities U.S. forces must have to effectively prosecute OOTW are strategic deployablity and the ability to discreetly apply force. In the future, as U.S. forces are withdrawn from overseas and redeployed in the Continental United States

F. OOTW Specific Challenges

OOTW may vary from simple disaster relief at the lower end of the spectrum of potential operations to major military intervention short of declared war or major conflict at the upper end (Figure II-3). They are not necessarily limited in scope, complexity, property cost, money, or lives. Moreover, such operations may escalate gradually or suddenly to situations of greater seriousness, complexity, importance and commitment than originally expected. Thus, the nature of a specific operation lies in the circumstances that originated the operation, the character of the opposing forces, the operation's objectives relative importance to U. S. interests, and finally, the intended outcome of the operation.

STATUS*	GOAL	MILITARY OPERATIONS	EXAMPLES	
War	Fight and Win	War	COMBAT	Large-Scale Combat Operations
Conflict	Deter War and Resolve Conflict	Other than War	COMBAT	Strikes Peace Enforcement Counter-terrorism Support to Insurgency
			NONCOMBAT	Peace Keeping Counter-Drug NEO
Peace	Promote Peace	Other than War	NONCOMBAT	Disaster Relief Civil Support Nation Assistance

** The states of peace, conflict and war could exist simultaneously in the theater commander's strategic environment*

Figure II-3. Range of Military Operations

The predominant types of military operations for the foreseeable future will be OOTW, including both combat and non-combat missions, and in some instances concurrently. Whether humanitarian in nature or involving hostilities, such operations

given the pattern of development in LDC, those who live in capital cities, ports or other large urban areas. This is less often the case in war. Consequently, whereas in war urban areas are bypassed whenever possible because of the cost involved in taking and controlling them, in OOTW bypassing these population centers will usually not be possible.

In OOTW, U.S. forces will normally be operating in environments characterized by marked differences in language, culture, and religion from what they are used to—not only with respect to the indigenous population, but also regarding other members of the coalition force to which they may be assigned. Even nations with similar customs and language, such as the U.S. and Great Britain, differ somewhat in military doctrine and the conduct of operations.

Understanding and respecting local customs is vital to the success of OOTW because close contact with civilians is a critical facet in almost every form of these operations. All ranks, and especially unit leaders, must become familiar with the language, geography, and the political, cultural and religious factors that prevail in the country of operations as early as possible and preferably before deployment. Violations of local customs or psychological errors, no matter how innocently committed, may have far-reaching, adverse effects and may require a long period to re-establish confidence, respect, and order. This inherent involvement with civilian populaces of different cultures places a high premium on human source intelligence, psychological operations, and civil affairs operations.

Because of this civilian-military intermixing, distinguishing those who actively oppose our presence—the "enemy"—from the large mass of uninvolved civilians will be exceptionally important and usually extremely difficult. In clashes between troops and the local populace, identifying and taking actions that are appropriate, effective, and acceptable to domestic and international observers may be the single greatest challenge.

- May have the support of significant segments of the indigenous population, which:
  - -- provide intelligence on U.S. forces
  - -- provide cover for their operations
  - -- give protection to their leaders and forces
  - -- create a climate of resistance and non-compliance
- Have unique knowledge of the environs, the indigenous culture, and the local power structure
- Understand and exploit peculiar U.S. force vulnerabilities:
  - -- the strong political sensitivity to the commitment of U.S. forces abroad
  - -- an inability of sustained operations
  - -- the scrutiny of U.S. forces and operations by a ubiquitous media presence.

Our forces are now, in many regards, neither well equipped nor adequately trained to deal with these difficult circumstances.

Identifying these shortfalls in equipment and training was a major concern of this effort. The SWG's deliberations were illuminated by briefings on current and recent OOTW experience, on the views of responsible commands as to their needs for improved capabilities, by recent reviews of military technology quite separate from this study in which nearly all members had participated, and by knowledge gained through experience with many operations over many years. The shortfalls and vulnerabilities identified as the result of these deliberations guided the search for and selection of technological opportunities to support OOTW missions. These opportunities are individually identified and discussed in Section III.

OOTW are the military operations of today and for the foreseeable future. These operations cannot be prepared for and conducted at the expense of the Armed Forces'

III. ADVANCED CAPABILITY REQUIREMENTS

A. Vision

The SWG viewed OOTW as encompassing the predominant forms of future U.S. military operations at least well into the next century. Despite the relatively modest scale of the operations normally associated with OOTW, it will be predominant in frequency, political impact, and long-term importance. These operations will initially reflect their political environments, and then change and redefine them. In order for the nation to succeed in these operations, it is imperative that the Armed Forces be adequately equipped, well supported, and well trained both as individuals and as units. The SWG envisioned the ARPA initiative as a means of providing to the military commander, through the application of advanced technology, those capabilities necessarily for the more effective employment of military force in OOTW; particularly with respect to accommodating the politically based mandates to keep casualties, both U.S. and others, to an absolute minimum.

As previously discussed in Chapter II, the probable opponents in most foreseeable non-domestic OOTW will be irregular forces: terrorist, paramilitary, militia, or national forces operating in an irregular or deniable mode. These forces may well have unprecedented access to highly potent and sophisticated weaponry. At this revolutionary turning point in political and military affairs, it is of vital interest that the Armed Forces identify and implement the major changes required to appropriately meet the challenges of a markedly altered worldwide political environment.

Developing and fielding the technologies advocated in this study are offered as one of the few available options for providing value-added capability to U.S. Armed Forces that will be engaged in OOTW. The path that such developmental efforts should take is reflected Figure III-1. It includes:

- Identifying OOTW-unique requirements, in close cooperation with the user.

improve United States forces' capabilities for war and, in many instances, have important applications to other government and civilian organizations, particularly in law enforcement. The recommendations range from technologies that are critical to the protection of entire cities—by the remote tactical detection of WMD, to those which will protect single or small groups of soldiers—by the detection of a mortar round in flight to warn them or to limit or neutralize its impact. The vision suggests programs of great scope, such as a modernized bio-medical treatment program, to some as basic as developing a non-lethal weapon (e.g., a sticky foam) that will temporarily incapacitate an individual. The range of technologies reflects the great diversity of OOTW

CATEGORY	FORCE PROTECTION	FORCE ENHANCEMENTS	COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, AND INTELLIGENCE (C4I)	FORCE PROJECTION & SUSTAINMENT
Priority I	• Invisible Soldier - Image avoidance - Signature reduction • Mine, Booby Trap and Explosive Detection and Neutralization	• Tactical Detection of Weapons of Mass Destruction (WMD) • Advanced Night Vision (NV) Equipment • Non-lethal Weapons Systems • Mission Kill - Area and Point	• Low-Signature Unmanned Aerial Vehicles (UAV) • Common Language Voice Recognition Translator	• Reduced Visibility Penetrator Aircraft
Priority II	• Anti-Mortar (Light Indirect Fire) Capability • Extremities Protection • Anti-sniper System	• Detection and Destruction of Underground Facilities • Non-intrusive Drug Detection	• Room Monitor • Chemical/Biological Expert System • Virtual Reality Modeling and Simulations for Training, Planning and Rehearsals	• Survival Tag and Tracking System • Combat Search and Rescue (CSAR) Command and Control (C^2) System
Priority III	• Biological-Medical Treatment Capability	• Stand-off Precision Breaching Weapons (Squad/Team) • Stand-off Neutralization of Weapons of Mass Destruction	• See-through Capability for Buildings and Structures • Strategic/ Discriminating Remote Sensors	• Universal Long-Life/ Light-Weight Power Source • Strategic Airlift Capability • Floating Sea Base Capability

Table III-1. Required Technologies.

PRIORITY I

Tactical Detection of Weapons of Mass Destruction (WMD)

a. General. This addresses both nuclear and chemical and biological WMD.

b. Nuclear Weapons

1) Desired Capability. A stand-off means for small tactical units operating in non-permissive environments to detect the location of, or assembly areas of, nuclear weapons.

2) Rationale. The proliferation of nuclear weapons technology has placed the production of such weapons within the capability of terrorist-supporting or unstable regimes. This capability offers ideological and state supported terrorists a means of international political blackmail. This is probably the most dangerous single threat facing the United States in the foreseeable future. It is of vital necessity that U. S. forces be able to quickly locate these weapons so operations may be conducted to secure or disable them. Celerity is the key to such operations: the weapons must be secured before the opposition is aware that there is a force in the area dedicated to this goal. Once the device is located, the force must be able to capture the site and then remove, disable, or destroy the device before its defenders can mobilize and employ a counterattacking force. Such weapons are sufficiently compact to be easily concealed in forests, jungles, rural buildings or in urban areas. Urban areas constitute the most demanding environment: compartmentation precludes rapid search, and even the threat of such a weapon's presence makes the population hostage. Current U. S. capabilities in this arena are inadequate to meet the demands of a threat that is growing in magnitude and sophistication.

3) Operational Concept. By means of intelligence, or opponents' threats or demands, the U. S. would likely have general knowledge of the class and nature of the weapon(s) of concern. The desired technology must permit rapid scanning of large areas to determine

medium of terrorism or political blackmail or for use on the conventional battlefield. Although not perceived to be as devastating as nuclear weapons, to unsophisticated opponents these threat agents hold even greater potential as MD. It is of vital necessity that U. S. forces are able to locate these agents quickly and identify the specific threat posed by the agent. As with the nuclear threat, it is important that the agent be identified, secured, or neutralized before the opposition can launch a counter force. Such weapons are sufficiently compact to be easily concealed in forests, jungles, rural buildings, or urban areas. Highly populated urban areas, the compartmentation of which precluding rapid searches, constitute the most demanding environment. Even the threat of such a weapon's presence makes the population hostage. Current U. S. capabilities in this arena are inadequate to meet the demands of a threat that is growing in magnitude and sophistication.

3) **Operational Concept**: Friendly forces should be able to discern the class and nature of the agents or weapon(s) of concern through intelligence operations, or the terrorists' demands or threats. The desired technology should permit rapid scanning of large areas to determine the presence of the agent. This scanning must be accomplished without alerting the force that is protecting the weapon and could be accomplished by mounting the scanning equipment in an unobtrusive vehicle, helicopter, light aircraft, or UAV. The technology must be able to establish the location of the MD in a relatively small area such as a specific floor of a specific building (more precise location desirable). Knowledge of the weapon's approximate location will eliminate lengthy ill-defined searches. Therefore, the recovery force can use the limited time available solely for securing or neutralizing the weapon and withdrawing before the opposition can react. This technology will also have significant applicability to the treaty-monitoring process by providing positive location of stored weapons and of biological or chemical production facilities.

safe passage and enhance mission execution by the operating force while minimizing the danger to non-combatants and collateral damage to vehicles or buildings.

c. **Operational Concept.** Government or law enforcement operatives will be able to detect and neutralize hidden explosives without subjecting themselves or non-combatants to the effects of intended or accidental explosions. Fully developed remote explosive detection devices will deny terrorist organizations a primary option of attack, and greatly reduce the risks of extensive casualties and mission failure by forces involved in high-risk operations. Military and law enforcement personnel will employ this capability in the full range of OOTW. This capability will also enhance the war fighting ability of conventional armed forces.

d. **Applicability.** The desired technologies are applicable to all military services, law enforcement agencies, and security services.

e. **Related Technology Areas:** Robotics, unmanned vehicles, fiber optics, display devices, air sampling, chemical trace detection, imaging technology capable of seeing through structures, magnetic, IR, acoustic and radar anomaly detection.

Mission Kill—Area and Point

a. **General.** "Mission Kill" devices are technologies that disrupt an operating system, precluding them from being able to perform their assigned function at the time or place required. These devices may be either lethal or non-lethal.

b. **Desired Capability.** A family of precision or area weapons systems that will preclude a hostile element or individual from carrying out the intended mission by disabling the individual, his equipment or his weapon with minimal or no collateral damage or casualties.

Non-lethal Weapons Systems

a. **Desired Capability.** A technique or system(s) that permit the temporary neutralization of hostile individuals or groups with no long-term debilitating effects and minimum casualties. The neutralizing effect should last at least 5 minutes (longer is desirable) and may be used in mixed crowds of combatants and non-combatants. It may take a variety of forms, including guided weapons, light, sound, gases, or aerosols.

b. **Rationale.** Friendly, non-combatant and hostile casualties have added significance in OOTW: These casualties would be considered acceptable in the pursuit of mission accomplishment during war but are often unacceptable in OOTW due to domestic and international political concerns. The introduction of non-lethal systems will provide military and police forces with benign options that are not now available for force protection and for neutralizing of hostile elements. Currently, the single course of action usually available to respond to life-threatening hostile situations is to apply lethal force--often under the restraints of restrictive rules of engagement established to limit non-combatants' casualties and collateral damage. The lack of effective but less lethal alternatives increases the risk to friendly forces and reduces options available to the commander for accomplishing the mission in the shortest time possible and on terms most favorable to the United States.

c. **Operational Concept.** These systems will be used by individuals and crews while dismounted or in vehicles or on airborne platforms. They could be applied in a whole range of potentially hostile situations to neutralize explosive situations, neutralize armed, threatening individuals in crowds, control civil disturbances or riots, and neutralize and detain individuals. These systems will offer military forces and police an option of applying the minimum force necessary to resolve a situation without resorting to lethal means--even when threatened by individuals or groups employing lethal means. This

permit entry into a target area either undetected or imprecisely detected, greatly enhancing the probability of mission success and reducing the probability of friendly casualties. While ideally one garment would defeat all detection efforts, it may consist of a series of levels of protection based on lighting, climatic conditions, and type of threat posed. Regaining tactical supremacy at night must be given priority.

d. **Applicability.** Invisible camouflage is applicable to a range of missions in OOTW that require the entry of individuals or small units into non-permissive or denied areas. It is equally applicable to a wide range of law enforcement missions and will significantly enhance conventional operations in war, particularly ground reconnaissance.

e. **Related Technology Areas.** Active camouflage technology, active thermoelectric ribbons, IR sensors, microprocessors, enhanced light weight power sources, heat dissipation, and radar absorptive materials.

Advanced Night Vision (NV) Equipment

a. **Desired Capability.** Provide military forces and law enforcement agencies with long-range night vision equipment that will allow them to exploit the full range of their weapons systems and equipment. The advanced night vision equipment must include systems for individual dismounted personnel, (e.g., snipers) and for the crews of aircraft, vehicles, and crew-served weapons.

b. **Rationale.** Current NV equipment is excellent compared to what was available just a few years ago, but it has numerous limitations of range, weight, power, and in the user's ability to maintain spatial orientation. Further, the world-wide commercial proliferation of early generation NV equipment has ended the United States' preeminence in this field

c. **Operational Concept.** Users of NV devices (infantrymen, vehicle and air crews) should be able to conduct operations without loss of direction, depth perception, peripheral vision, or spatial orientation. Improved NV capabilities should permit accurate

clandestine operations. A design that significantly reduces aircraft signature will increase the probability of success during critical phases of these operations. Such aircraft may eventually replace conventional aircraft that support a wide variety of tactical missions of conventional, airborne, and air-assault units.

d. Applicability. The desired technology is applicable to all conventional and special operations forces across the range of OOTW and war, to government agencies conducting covert operations, and to some law enforcement agency operations (e.g., counter drug).

e. Related Technology Areas. Absorptive materials, noise abatement technologies, quiet rotor blades, propulsion systems, and radar non-reflective materials.

Low -Signature Unmanned Aerial Vehicles (UAV)

a. Desired Capability. A UAV that, while not necessarily completely transparent to the electromagnetic spectrum, has reduced visual, audio and electromagnetic characteristics that will reduce the probability of detection and attack.

b. Rationale. The employment of UAVs by U. S. conventional and special operations forces will increase in all war and OOTW environments. Miniaturization and other technological advances will expand their capabilities to include even greater utility in various forms of reconnaissance, intelligence gathering, chemical testing, communications applications, and deceptions. The wide publicity about their use in combat by various countries and their relative low cost as compared to most aerial observation platforms ensure both their continued proliferation and an ever-increasing defensive consciousness of them among potential opponents. As both the effectiveness and knowledge of UAV capabilities increase, so will countermeasures and the willingness of opponents to expend assets to destroy or neutralize them.

c. Operational Concept. UAVs will be employed to provide intelligence, communications, and other assistance to commanders in all war and OOTW

interaction with allied, coalition, and host-nation forces and facilitated intelligence, civil affairs, psychological operations, and military training.

c. **Operational Concept.** Employ an automated capability that would recognize, understand, and translate voice both to and from the English language and transmit it over standard communication media. Simple software changes would enable the interface of different languages with English.

d. **Applicability.** In addition to military applications, the desired technology has applications to the Departments of State, Justice, Commerce, Education, and to institutions such as the Peace Corps, World Bank, and International Monetary Fund (IMF) revolutionizing how they do business. Commercially, its impact on the world marketplace could be astronomical.

e. **Related Technology Areas.** Speech recognition, speech understanding, speech synthesis, speech-to-speech translation, and dialogue management.

air-dropped sensors or a presence on the ground to emplace sensor elements. Investigation of suspected underground installations for targeting is likely to require a number of technologies and technological approaches, some requiring at least a temporary local on the ground presence.

It is essential that usable information be readily accessible to the commander on the ground who is contending with the problem or the threat. The selection of neutralization techniques should be guided by the characteristics of the facility and the degree of friendly control of the area in which it is located. In some instances, external weapons delivery support (e.g., laser target designation) may be required. Information, once acquired, should be formatted for storage in appropriate databases.

d. Applicability. In addition to the obvious military applications in OOTW and war, this capability would be of value to many levels of government and to agencies with many different responsibilities, particularly in mine rescue and disaster relief operations.

e. Related Technology Areas. Radar technology, seismology, solid state imaging arrays, acoustic sensor technology, digital signal processing, image processing, ultra wide band, high-power signal generation, Geology, mining, and magnetic anomaly detection.

Anti-Mortar (Light Indirect -Fire) Capability

a. Desired Capability. A system that provides for the detection and precise location of hostile indirect fire weapons (principally mortars) in sufficient time to provide warning to friendly forces and to engage the weapon with precision weapons. The system would optimally include the capability of neutralizing rounds at time of launch or in flight before impact.

b. Rationale. Aimed or random mortar or indirect fire artillery rounds launched from positions located in urban or densely populated areas take on added significance in OOTW. These weapons are a major cause of damage to fixed facilities, high-value

Extremities Protection

a. **Desired Capability.** Develop individual protective armor for the human body's extremities to be coupled with existing or developmental body armor to protect the soldier from common injuries (those produced by shell fragments and small-arms fire) while allowing full mobility without degradation of combat capability.

b. **Rationale.** Partially attributable to the advances in and increased use of body armor, a large portion of the casualties occurring in OOTW are the result of extremity wounds that usually reduce unit operating strength and sometimes cause fatalities. Body armor technology, while advanced, has yet to offer effective protection to the extremities without unacceptably hindering combat effectiveness. In OOTW, the soldier is exposed to indiscriminate attack throughout the operational area regardless of his specific job because of the ill-defined nature of the operational environment and the fluctuating levels of hostility of the threat. The soldier is often denied the standard self-protection measures available on the conventional battlefield, such as armored vehicles or shelter in buildings or fortifications.

c. **Operational Concept.** Extremity protection will be provided by a light-weight, highly flexible anti-ballistic material that will protect the soldier against grenade, mortar, and light shell fragments and small arms' rounds. This protection must permit the soldier to conduct activities without degradation as a result of rigidity, excess body heating, or weight. Ideally this garment, when coupled with advanced body armor, will significantly reduce disabling or fatal injuries to troops involved in all levels of military operations.

d. **Applicability.** The desired technology is applicable to all U. S. forces conducting OOTW or war, and to law enforcement personnel for specific missions. This concept may have additional applicability in protecting key government personnel requiring exceptional protective measures in peacetime.

with little possibility of collateral casualties or damage. The device will be employed on vehicles, on buildings, on airborne platforms, or with dismounted patrols. The device will allow instant and precise elimination of hostile shooters and will deter sniper activity. It may also be employed by law enforcement agencies for personal security and could be employed remotely to monitor high-crime areas in conjunction with cameras or other sensing devices to provide a record of firearms' activity for use in case prosecution.

d. Applicability. This capability will represent a singularly significant breakthrough for ground forces. It is applicable to all military ground forces in OOTW and war, all law enforcement in the execution of daily activities, and all government VIP protection agencies.

e. Related Technology Areas. Acoustic sensors, IR sensors, microprocessors, laser target designators, and aim point designators.

Room Monitor

a. Desired Capability. A means to monitor the activities occurring in a room without the need for access to the room's outer walls or to the room proper to emplace devices or sensors. The room being monitored must not be readily detectable or countered by subjects within the room. Optimally, it will be able to operate from short stand-off distances (e.g., from a building or vehicle across the street, from the roof of the subject's building). The greater the stand-off distance is, the better. At a minimum, the device should be transportable and operable from a light vehicle and, optimally, it should be person-portable. It should also be capable of being powered by multiple power sources (e.g., vehicle, battery, multi-voltage commercial).

b. Rationale. In many OOTW, including counter-terrorism, counter-drug and counter-proliferation, there is a need for friendly forces to know what is happening within an enclosed room. The specific requirement is to know exactly where individuals and

verify, or rule out, the presence of toxic materials among newly encountered substances in the operational area.

c. **Operational Concept.** The expert system, consisting of analysis instruments in the field with data connectivity to the database, would: (1) verify the presence of dangerous chemical or biological agents, (2) identify the agent, and (3) outline protective, antidote, and handling measures. This system could be interrogated from the field by special operations forces and treaty-compliance units to verify suspected chemical or biological weapons, storage, and manufacturing sites. It would be used by all conventional forces as part of their nuclear, bacteriological and chemical identification and protective systems.

d. **Applicability.** Satisfaction of this requirement fills the stated major identification needs of military forces and of civilian agencies responsible for countering terrorist threats.

e. **Related Technology Areas.** Database technology, chemical weapons and detection, biological weapons and detection, data transmission, micro processing, artificial intelligence, automated analysis, and low probability of detection communications.

Non-intrusive Drug Detection

a. **Desired Capability.** The ability to identify the presence of illicit drugs, primarily cocaine and heroin, in various preparatory and final states, without being in proximity of its location.

b. **Rationale.** The counter drug interdiction mission is one of the most technically demanding missions in OOTW. Interdiction operations are conducted both in (1) isolated, underdeveloped areas of the world where drug products are grown and processed, and (2) during their inter- and international transshipment. The ability to detect the presence of drug products, their intermediate states, or their precursor

provide a positive location and be "readable" from high-altitude aircraft or satellites as well as from near (3 to 5 km) hand-carried monitors.

b. Rationale.

1) Human Tag and Tracking. In OOTW, the taking of political hostages by a terrorist or dissident group is a tactic that immediately provides inordinate attention, publicity and political significance to that group. Release of the hostages is generally achieved by acceding to the demands of the terrorist organization or by military or police force rescue. The inability of government authorities to mount a rescue operation is often viewed as impotent, further enhancing the terrorists' stature. Failed rescue attempts cause political embarrassment far beyond the significance of the individual event. Positive location of hostages or captives remains the key intelligence element upon which the success of any rescue attempt depends. There is a critical need for an unobtrusive individual tracking tag for high-risk personnel that will provide a positive location by a means not discernible to their captors.

2) Vehicle and Cargo Tag and Tracking. A perhaps less complex problem, but one of significance, is the requirement of a similar device that, once emplaced, will provide positive locations for vehicles with willing or unwilling occupants and cargo, particularly contraband drugs or weapons.

c. Operational Concept. Individual Tracking Tag for Personnel. Personnel at high risk of capture in war or by terrorists would be equipped with this tag. The tag system must be unobtrusive and undetectable, withstanding even the most thorough personal search. The tag should be "interrogatable" by remote satellite airborne sensors or terrestrial sensors to provide a positive pinpoint location within 50m of the individual without alerting the captors.

Vehicle and Cargo Tracking and Tag. The tag will be emplaced in vehicles and cargo to provide positive tracking through non-permissive environments providing

evaders and methodical searches by slow-moving aircraft are precluded because they lead to certain compromise, minimally resulting in capture of the evaders and possibly resulting in the ambush of a rescue force. The envisioned system must provide an immediate positive location and verification of the identity of the evader and provide for subsequent two-way communications with high-performance aircraft that can penetrate denied areas with relative safety. This would permit the launch of a rescue force with minimum delay and with greatly chances of success. Optimally, such a system would interface with satellites removing the requirement for an aircraft to be overhead to complete the link.

c. **Operational Concept**. The technology would be provided to all military aircrews and other military elements normally employed in denied or high-risk areas (e.g., special operation forces, reconnaissance units). Configured for satellite interface, this capability may be extended to civil aviation and marine activities, greatly enhancing non-combat search and rescue operations.

d. **Applicability**. The desired technology is applicable to all pilots in OOTW, war, or routine peacetime emergencies and to selected other military and civilian LEA personnel. The technology, once developed, will have broad applicability in the civilian aviation and maritime fields.

e. **Related Technology Areas**. Global Positioning System (GPS), data processing, secure communications, world-wide telecommunications nets, and micro-transmitters.

Virtual Reality Modeling and Simulations for Training, Planning, and Rehearsal

a. **Desired Capability**. A system that will project a variety of realistic OOTW operational environments. It must have broad applicability ranging from the projection of information in great detail for the micro-environments faced by individuals and small

PRIORITY III

Stand-Off Precision Breaching Weapons (Squad/Team)

a. Desired Capability. A person-portable weapons capability to penetrate walls or bunkers. Initially it should have sufficient accuracy to ensure hitting a target not larger than 1 meter square from a distance beyond effective small-arms range (500 meters). Subsequent development should permit successive increases in range: first to the limit of optically aided eyesight and eventually 5 to 10 kilometers using the assistance of implanted sensors and designators. (Weapon propellant would probably determine ultimate range.)

b. Rationale. Light forces, whether employed in war or OOTW, are at a marked disadvantage in penetrating buildings, bunkers, or fortified positions. Currently, weapons used for this purpose (usually available anti-armor weapons) have major limitations in explosive power, accuracy, and range. These limitations require that they be employed from short ranges and in multiples and even then produce only a minimal breaching effect. These characteristics limit effectiveness and increase the hazard to the soldiers employing them to attack fixed positions, particularly in urban areas.

c. Operational Concept. The weapon would be distributed as an ammunition item to light forces and would be a weapon option for special operations forces missions and conventional forces. The employment of the weapon would depend on the operational environment, but might include creating avenues of entry into buildings, rooms, and fortifications, as a fortification attack weapon ("bunker buster") for any type of ground units attacking fortifications or defended buildings. The weapon will also have utility as a stand-off weapon for use by special operations forces for road or waterway ambushes or the attack of critical targets such as missiles and their launch vehicles, ammunition storage sites, aircraft on the ground, electrical generation and transformer sites, and fuel

major obstacles would represent a significant breakthrough in the ability to discriminate between potential targets and uninvolved persons.

c. **Operational Concept.** This capability would be used by military and counter-terrorist forces conducting hostage rescue attempts or raids. It would aid in positively identifying the target and location of people and things. It could also be used by LEA to screen suspected structures to verify the contents and activity going on inside. It would have utility in some disaster relief or rescue operations.

d. **Applicability.** The desired technology would be applicable to military forces involved in OOTW and law enforcement agencies in a variety of police raids and counter-drug activities. It could be used for disaster relief rescue operations as well as by intelligence agencies.

e. **Related Technology Areas.** X-ray and millimeter wavelength.

Universal, Long-life,/Light-Weight Power Source

a. **Desired Capability.** Individual power source that can provide power to various types of equipment (e.g., radios, position/navigation, mini-computer) within a wide range of terrain and climatic conditions.

b. **Rationale.** The electronics revolution has provided the individual soldier with a wide range of valuable electronic aids, each requiring a power source. Currently, these are powered by a variety of different and exorbitantly expensive batteries. Each battery (and its backup battery) adds to the weight the soldier must carry, thereby inducing fatigue and reducing effectiveness. Each battery has a different life expectancy, complicating resupply and increasing the risk to deep penetration forces and the logistics burden of all forces. For logistic efficiency, the number of different types of batteries must be reduced; for individual efficiency, the total weight of power sources must be

manner that does not result in their detonation or the unacceptable release of their nuclear, biological, or chemical (NBC) contents.

c. **Operational Concept.** When the approximate location of the WMD is determined, it is attacked by the neutralizing weapon. Depending on the tactical environment (location, terrain, enemy air and ground defenses, etc.), this attack may be delivered by artillery, aircraft, UAV, missile, or small ground force units. Upon initiation, the attacking weapon neutralizes the WMD by disabling one or more of its vulnerable critical components. These components typically include the warhead's contents; the terminal fuzing; the propellant and propellant ignition systems; and the electrical, and control and communications systems.

d. **Applicability.** The weapons would be employed in OOTW and war by conventional air and ground forces and special operation forces. In addition, they could be used by national level-law enforcement organizations (e.g., FBI).

e. **Related Technology Areas.** Bacteriology, chemistry, rocketry, nuclear physics, and high-voltage electricity.

Strategic/ Discriminating Remote Sensors

a. **Desired Capability.** A remote sensor family that could be emplaced by a variety of means to include air, artillery, or ground emplacement. The family would include an assortment of interchangeable sensors that could be used in multiple configurations as desired. Sensors would include IR imagery, seismic, audio, electronic emission, compressed imaging, low-light television, and neutron and other nuclear detection systems. The sensors and their communications processors and transmitter should permit entry into communications systems through ground, aerial, or satellite links. The power supply must be small, but capable of sustaining the system for up to a year. Packaging

(e.g., alive versus dead, serious or minor injury, shock, hypothermia)

- Provide remote treatment (including surgery) and to sustain life support during evacuation (Trauma Pod)
- Provide expert medical assistance through telemedicine as far rearward as CONUS
- Train surgeons in treatment of battlefield casualties through advanced simulation with virtual reality.

b. **Rationale.** On the battlefield, 90 percent of casualties occur in the far forward combat zone, where advanced medical capabilities are generally not available. The first and most critical hour is often consumed in locating, preparing and transporting the casualty. This situation is exacerbated in OOTW where advanced medical aid and logistic support are even more tenuous. Analogous situations may occur in law enforcement as well as in national disasters.

c. **Operational Concept.** The individual soldier or policeman will wear a Personal Status Monitor. When injured, his location and extent of injury will be immediately known. A medic can go directly to the injured individual, doing enroute triage based on reported vital signs. If too severely injured, a mobile surgical van (remote telepresence surgery) would allow a surgeon to provide life-saving surgery at the injured person's location by robotics. In addition, medical specialists from a CONUS or regional major medical center can provide medical assistance to the remote location. Using a virtual reality surgical simulator, surgeons can practice surgical procedures on simulated battlefield casualties.

d. **Applicability.** This technology is applicable to all forms of military engagement, civilian law enforcement, emergency medical care, and natural disaster crisis management.

aircraft should be adaptable to plug-in modules that will provide deploying forces C4I support enroute as required.

d. **Applicability.** The aircraft would be applicable to all military OOTW, to support UN or allied forces, and to most humanitarian assistance operations.

e. **Related Technology Areas.** Composite technology, short takeoff and landing (STOL), heavy-lift or specially designed helicopters, aerial refueling, sophisticated navigation and defensive electronic equipment, aerial port technology, radar, IR, night vision, satellite and other communications, navigation/position locating devices, aerial, sea- and land-based sensor technology, and materiel handling, loadmaster simulation model.

Floating Sea Base Capability

a. **Desired Capability.** An off-shore floating logistics base capable of receiving intra theater medium airlift and sealift The off-shore installation should consist of a floating modular system that can be tailored for specific operations to preclude or minimize U. S. presence on-shore. It must be able to sustain all-weather support for on-shore operations and receive replenishment by air or sea to maintain operations. It must be relocatable within 90 days.

b. **Rationale.** Developing U. S strategy is based on CONUS-based power projection. The sea-based platform will minimize U. S. presence on-shore and obviate the establishment of expensive fixed bases where no long-term presence is required. The sea base will provide for uninterrupted sustainment of on-shore activities, and provide for a secure haven remote from local harassing attacks. This will also reduce exposure of troops and equipment in theater.

c. **Operational Concept.** The off-shore logistics base will be positioned over-the-horizon (OTH) but within supporting range of ongoing long-term disaster relief, nation-

APPENDIX A

TERMS OF REFERENCE FOR

ARPA MILITARY OPERATIONS OTHER THAN WAR

SENIOR WORKING GROUP

BACKGROUND

Based on discussions with a number of DoD and Service organizations, and recent events in Somalia, ARPA has identified both a need and an opportunity to make a significant contribution to U. S. military capability through the development of advanced technologies to enhance the effectiveness and survivability of U. S. forces engaged in OOTW. Although the focus of this effort is long-term, development of key near- and mid-term enabling technologies are also of interest for application to real time problems in such areas as Somalia.

CONCLUSION

The objective of this Steering Committee is to assist ARPA in the development of a vision and implement plan for this effort. In this regard, the Committee will:

- Review potential missions
- Identify key problem areas
- Define technology options
- Recommend a strategy.

At the conclusion of its efforts, the Committee will provide ARPA with a report that includes:

- A vision statement for the ARPA initiative to include a definition of OOTW
- Rationale supporting this initiative, assessing requirements and technology
- Program recommendations with rationale, addressing new systems technologies.

APPENDIX B

BRIEFINGS

Subject	Office	Presenter
Advanced Land Systems Steering Committee Outbrief	ARPA	GEN Glenn Otis
GPS Receiver on Multichip Form	ARPA	Maj. Beth Kasper
Micro Tracker Receivers	ARPA	Maj. Beth Kasper
Advanced Biomedical Technology Program	ARPA	COL Richard Satava
Voice Recognition/Understanding/Translation	ARPA	Dr. George Doddington
BCI Process	ARPA	Mr. Tom Hafer
Directed Energy Weapons	ARPA	Dr. L.N. Durvasula
ARPA/ASTO	ARPA	Dr. Bill Scheuren
Digitizing the Battlefield	ARPA/ CECOM	Mr. Tom Hafer/ Mr. Rob Ruth
Warbreaker/Weapons of Mass Destruction	ARPA	Mr. Chuck Heber
Quick Reaction Effort for U.S. Forces in Somalia	ARPA	LTC Robert Kocher
Counter-Proliferation	ARPA	Dr. Judith Daly
Counter Drug Program	ARPA	Mr. John Pennella
UAV Technology Demonstrations Program	PEO Cruise Missile/UAV	
Joint Unmanned Aerial Vehicle Program Hand-Launched Unmanned Aerial Vehicle		COL Brad Brown LTC Tim Lindsey
Smart Bullet Briefing	Martin Marietta	Mr. W.P. Bonnell
Military Operations Other Than War	JCS J-7	COL Tackaberry
Joint Doctrine Development	JCS J-7	COL Tackaberry
Non-Lethal Technologies	TECHMATICS	Mr. Paul Evancoe
Low Energy Lasers		

Operations Other Than War, Peace Enforcement	USAIS Close Combat Battle Laboratory	LTC Mike Smith
Electromagnetic Weapons	Idaho National Lab	Mr. Harry Feuerstein/ Dr. Clifton Stine
Active Camouflage	David Sarnoff Laboratory	Dr. Tom Lippert
Policy	Director, Policy & Plans, OASD, SO/LIC	Dr. Chris Lamb
Future Plans for Forces and Material	Director, Acquisition OASD, SO/LIC	Mr. Bob Doheny
DIA Briefing		Mr. John Sullivan
CIA Briefing	Office of R&D	Mr. Dennis Fitzgerald

APPENDIX C

GLOSSARY

AFSOF	Air Force Special Operations Forces
ARPA	Advanced Research Projects Agency
BAA	Broad Agency Announcement
C^2	Command and Control
C^3	Command, Control and Communications
C^4I	Command, Control, Communications, Computers and Intelligence
CECOM	Communications Electronics Command, U.S. Army
CIA	Central Intelligence Agency
CINC	Commander-in-Chief
CONUS	Continental United States
CSAR	Combat Search and Rescue
DEA	Drug Enforcement Administration
DIA	Defense Intelligence Agency
DLEA	Drug Law Enforcement Agencies
DoD	Department of Defense
DSRV	Deep Submersible Recovery Vehicle
EMP	Electro-magnetic Pulse
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
GCCS	Global Command and Control Systems
GPS	Global Positioning Systems
HPCC	High Performance Computing and Communications
HUMINT	Human Resources Intelligence
IR	Infrared
JCS	Joint Chiefs of Staff
LDC	Less Developed Country(s)
LEA	Law Enforcement Agencies
LLNL	Lawrence Livermore National Laboratory
LPI	Low Probability of Intercept
NBC	Nuclear, Biological, Chemical
NAVSPECWAR	Naval Special Warfare (U.S .Navy)
NSA	National Security Agency
NV	Night Vision
OTH	Over-the-Horizon

ANNEX D

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