

# A Strategy to Grow the Fort Bragg Region's Defense & Homeland Security Economy

THE UNIVERSITY OF NORTH CAROLINA

FINAL REPORT

## Volume Three

### Labor Demand: Emerging Defense Technologies



## **Final Report**

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# **Strategy to Grow the Fort Bragg Region's Defense and Homeland Security Economy**

## ***Volume 3 – Labor Demand: Emerging Defense Technologies***

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## Table of Contents

I.	Introduction.....	1
II.	Research Methodology .....	1
III.	Changing Needs Resulting in New Innovations .....	1
IV.	A Sampling of Products .....	7
V.	Product and Services Vendors .....	12

## **I. Introduction**

This chapter identifies future technologies, products, and services of interest to the military, particularly the Army, U.S. Army Forces Command (FORSCOM), U.S. Army Reserve Command (USARC) and U.S. Army Special Operations Command (USASOC). Information was categorized into major thrust areas and types of infrastructure technology and battlefield technology. Infrastructure technology related to meeting the phenomenal growth expected at Fort Bragg is also discussed.

## **II. Research Methodology**

To capture major thrust areas for infrastructure and battlefield technology, the authors obtained information from subject matter experts at Booz-Allen-Hamilton and researched its internal library of presentations and materials for information that had been presented to a number of its Technology Focus Groups. These groups routinely present discussions and demonstrations of new technology to interested employees. Presentations are given by in-house experts and other firms that develop products or services, and are preserved in a library for research.

The authors are not endorsing any product in particular, nor does a product's exclusion from this report imply that another product is not available, of equal importance or of lesser quality. Any product names provided are examples of the described technology, and are intended as examples for informational use.

## **III. Changing Needs Resulting in New Innovations**

The Army is fundamentally changing the way it fights – lighter, more agile and flexible units are required. To more readily respond to ever changing threats, it must develop standard methods to be more responsive to strategic requirements. The Army must be rapidly deployable, seamlessly integrated, and capable of delivering decisive victory across multiple military operations. Future systems must leverage and harness the advantages of all available resources. The Army will heavily rely on the benefits of science and technology, as well as the power of its corporate knowledge, and innovative business solutions.

There have been several new innovations in technology that have contributed to successfully supporting the Army's mission execution. While the advances in technology have occurred across several areas, there are advances in some key areas that are of particular interest to the military. Innovations important to the military are in the area of biometrics, security, power and energy, information security, and battlefield technology. Table 1 summarizes some major trends in infrastructure and battlefield technology of particular interest to the military, particularly the Army, FORSCOM, USARC, and USASOC. Some of these technologies have applicability that overlap the infrastructure and battlefield technology categories, but have been placed in the category deemed most relevant to the discussion.

**Table 1. Major Technology Thrust Areas**

Infrastructure Technologies	
Access Control	Access control can refer to accessing installations and buildings, as well as IT networks and systems. Advances in the use of biometrics have increased applicability is access to specific buildings of secure areas within a building, as well as system or network access.
Information Security	The ability to verify, protect, and authenticate information has greatly increased in the modern era. The increases in cyber attacks has made it critical to several organizations including the military to protect its most sensitive information and infrastructure, preferably by fending off these attacks. The military has the need for highly complex and sophisticated encryption to protect information both in storage and transmission.
Data Transmission and Storage	The volume of data transmitted and stored continues to increase exponentially, hand in hand with the increasingly sophisticated applications and data types collected.
Battlefield Technologies	
C4ISR and Unmanned Systems	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) capability has significantly advanced of late, providing accurate, detailed, real-time information critical to the warfighter. Increased sophistication demands massive bandwidth and throughput. Unmanned vehicles allow for information gathering or task execution without human intervention.
Performance Materials	There are several advances that increase safety and personal, physical protection while still allowing the Soldier freedom of movement, particularly in combat situations.
Human Factors	There is much interest in the factors affecting a Soldier's performance, both related to mental acuity and physical stamina.
Mobile yet Rugged Devices	There is a growing trend towards devices that can be 'hung on the Soldier', pushing for smaller, more powerful, multi-use devices.
Fuel and Power	More efficient methods to create or use energy solves some dilemmas while away from constant sources of energy. Other advances have also come in the size and weight of energy producing devices.

### **A. Infrastructure Technologies**

Many of the infrastructure technologies have direct applicability to battlefield technology, such as bio-metrics and data transmission/bandwidth solutions. Infrastructure technology includes such things as physical security and access control, protection of data (both in stored format and while being transmitted), and the ability to store and transmit increasingly large amounts of data. When looking at infrastructure, in many ways the military has the same types of requirements as many corporations, but often with a need for higher levels of security. Organizations such as FORSCOM, USARC, and USASOC have the same office automation requirements, desire for effective collaboration tools, and knowledge managements as other complex organizations. The primary differences relate to the level of protection required, including those necessary to store and process Secret and Top Secret information.

Other technologies of interest to the military include advances in areas related to construction materials and design that reduce building and maintenance costs, as well as those that are environmentally friendly. An example of this technology is the use of motion sensors to control lighting. Lights, in areas such as restrooms, only go on when a person enters the room and go off

after a set amount of time passes without the detection of movement. These types of “green” products are gaining more attention than ever before.

This section focuses on technologies that support access control, information security, and data transmission and storage. The other areas noted are important, but not receiving as much attention at this time.

### **1. Biometrics Supporting Access Control**

Biometrics includes a broad range of methods and techniques, the most applicable to building and network/system access control being fingerprint and iris scans. These technologies are proven and reliable. Biometric technology makes it possible to add additional layers of security to gaining entry into modern day information networks. By allowing biometric devices that read fingerprints and iris scans to guard the gateways to information, organizations have reduced unauthorized access by users to systems or data that they are specifically not authorized to access, while permitting appropriate access, as well as decrease the possibilities of potential attacks from penetrating a system.

The common access card or “CAC card” currently in use by the military for identification and network access purposes includes a fingerprint stored on an embedded chip. Appropriate restrictions and access denial are the first step in information protection. This same technology can be used to restrict access to buildings or specific areas within a building.

### **2. Intrusion Prevention**

The complexity of modern information services and the sophistication, pace, and variety of attack techniques requires new thinking about the computer security problem. In spite of large investments in computer security, news stories continue to announce hackers’ successful intrusion into networks and databases, despite ever increasingly advanced intrusion prevention and detection systems. The military employs the most sophisticated software and methods to combat hackers, and have been extremely successful. Much of this success has been due to a shift in focus from intrusion detection to intrusion prevention.

A holistic approach to updating network infrastructure has been key to deterring and preventing warfare on sensitive information. One method of information protection is by limiting the exposure time of the server to the Internet. This approach achieves sub-minute exposure time for servers without service interruption. In this case network servers are focused on limiting losses because of an intrusion. Other methods include the use of proxy servers, complex firewalls, and intrusion prevention/detection products with event logging and alerting mechanisms.

### **3. Data Storage and Transmission**

For some time now, there has been a need to employ current, state-of-the-art technology providing maximum data storage and transmission capacity. As applications become more sophisticated, the types and amounts of data stored and utilized have increased exponentially.

Storage and virtual memory solutions are continuously researched to find solutions to meet demand.

Data transmission methods are also continuously researched for the same reasons. Over the years, military organizations have moved from transmission by such media as T1 phone lines to satellite and microwave transmissions, even for certain non-battlefield applications. Other technologies related to data storage and transmission that are of particular interest to the military are: encryption, backup and restoration, redundancy (to support contingency operations), and knowledge management.

#### **4. Infrastructure Concerns Specific to Fort Bragg's Upcoming Growth**

The tremendous growth that Fort Bragg is going to experience in the next three years will have tremendous impact on the installation's infrastructure. Impacts will be felt from the massive construction activity to the increase in traffic, housing demands, and many secondary impacts such as increased volume/capacity requirements in areas such as dining facilities, AAFES Shoppettes, and barber shops. Of primary concern are the information technology infrastructure demands.

When FORSCOM and USARC relocate to Fort Bragg/Pope AFB, there will be tremendous demand for network support, data storage and transmission infrastructure (bandwidth) and security prevention and detection. These headquarters have heavy requirements for both unclassified (but secured/protected) networks and classified networks. These types of requirements are not new to the Fort Bragg information technology (IT) community; the sheer volume is what is changing. The IT community understands networks, security, encryption, etc., but they will have to conduct analysis and determine how to deliver these services for a far greater user base. The IT community will need to either greatly increase the volume and capacity of people and equipment, or find solutions to more effectively and efficiently deliver IT services (to include telecommunications) in order to maximize their current resources.

The military has a detailed certification and accreditation process that is required for all of their IT systems to assure proper security and compatibility (usability/availability). The current process for accreditation is called the Defense Information Assurance Certification and Accreditation Process (DIACAP). Again, although the Fort Bragg IT community is familiar with this process, it is one that takes a significant time investment that will at best strain current personnel resources. As FORSCOM and USARC transition their systems and applications to Fort Bragg/Pope AFB, accreditation in the new location will be necessary.

#### **B. Battlefield Technologies**

The Army in its efforts to modernize the soldier has moved from concept to reality. Today's wars are won with information more so than brute force, as was the case not so many years ago. The ability to gather, process and analyze information, coupled with increasingly effective protective materials result in superior capability to the soldier.

Today, there are currently numerous hardware and software tests and evaluations in progress across the country. Equipment is in the hands of soldiers with successes such as movement of images from sensors across the battlefield using the network, field tests unmanned systems, and delivery of the first Manned Ground Vehicle prototype. The active use of such new age equipment proves the Army's dedication to totally transforming its traditional method of combat to remain a superior force in warfare. The future Army will provide soldiers vastly increased situational awareness, survivability, and lethality - ensuring they can take the fight to the enemy before the enemy has time to react.

## **1. C4ISR and Unmanned Systems**

There are vast amounts of information available to aid the military in times of combat. Changes in C4ISR technology have been instrumental in increasing the Army's ability to respond to its enemies. Advances in computing technology allow faster and more accurate processing of radar images. Advances have also resulted in more powerful computers that have progressively become much smaller and thus more portable. A combination of these advances has allowed advanced C4ISR technology to become more readily available to users while in the field and adapt as necessary.

The emergence of a multitude of "bandwidth hungry" applications has exacerbated the need for multi-gigabit wireless solutions, out-of-reach of conventional Wireless Local Area Network (WLAN) technology, or more recent emerging Ultra Wide-Band (UWB) and Multiple Input Multiple Output (MIMO) systems. As standardization efforts catalyze the interest of the commercial market, the development of ultra-high bandwidth Complementary Metal Oxide Semiconductor (CMOS) millimeter waves portable radar platform is the key enabler for a successful deployment of multi-gigabit wireless solutions and future digital radar.

Other components of evaluating the environment include reconnaissance equipment, and landmine and explosive detection. Progress in this field includes the functionality increases in unmanned vehicles, antennas, materials design, and explosive testing.

## **2. Performance Material**

Protection of the soldier during combat is vital to the success of the Army, and given top priority. The ability to quickly evaluate and react to the environment, as well as protect the soldier when hit by lethal weapons or chemicals is critical. There are several classes of products developed to assist the soldier in this mission. Some of the products are designed to protect the body, including advances made in fabrics, clothing, and lightweight machinery. Sensor technology has resulted in the ability to monitor and communicate a soldier's vital sign information remotely and in real time. Others are geared towards quickly identifying threats with minimum exposure of the soldier. This includes reconnaissance devices that can be carried by the soldier such as small robotic devices.

### **3. Human Factors**

With the massive amounts of information to assimilate, pressure of combat (particularly in ‘unconventional’ warfare), and physical endurance pressures, the military is continuously looking for ways to increase a soldier’s performance – physical strength and endurance, as well as mental acuity.

### **4. Fuel and Power**

Today’s soldier must be more agile, lighter, and quickly responsive to changing environments. The trends are moving to smaller and lighter equipment. Today’s equipment must be able to fit on the soldier’s body without adding additional weight. Other product enhancements have been made in the area of personal protection of the soldier.

The portability of computers has allowed the processing power and speeds once only possible with large mainframes to be readily available to field teams. Smaller chip technologies have placed smaller computers on the soldier to be used while on the battlefield. In conjunction with advances in Biometric technology, portable durable computing now makes it possible to identify enemies and allies while in the field. Key to this success is technology advances that have produced such devices that are incredibly powerful, yet small and light enough to enable mobility.

Along these same lines is an overall interest in small, light, powerful devices that serve multiple purposes, particularly in an integrated manner. There is an ever increasing push for devices that can be ‘hung on the Soldier’, providing them with immediate information and communications capability with maximum flexibility and mobility.

### **5. Biometrics Directly Supporting the Warfighter**

Biometrics, in its many forms, is a very reliable method of verifying a person’s identity. Of all biometrics, such as fingerprint, iris scan, face, signature, and voice, the face biometric is the most desired and most natural biometric. It is easily obtained, and is also the most familiar identification method for humans to understand and remember. The U.S. Army intelligence system uses state of the art products in its Biometric Automated Toolset. Personal security, enterprise asset, military force protection, and the war on terrorism security are areas where biometrics provides powerful solutions. The future of biometrics will bring more complete security application solutions, such as an identity management system with applications for surveillance, access control, data base searching, video analyzing, and mobility.

### **6. Energy Advances**

Energy innovations have been important in providing cost savings in facility maintenance and convenience through such things as longer lasting power sources for office laptop computer. These needs will continue, but focus has also been on the use of energy technology in direct support of the warfighter.

While the size and processing power of other technologies has increased capabilities while on the battlefield, the advances in power management have been critical. Newer trends are in production of more efficient, stable, greener energy. The power generators of the future must take advantage of alternative sources of energy such as solar, thermoelectric, and vibrations while producing maximum output.

#### IV. A Sampling of Products

There have been a number of product developments that increase the capability or protection of the modern day fighting forces. Table 2 highlights some these new products, and the applicable thrust areas. As illustrated by this table, many products overlap thrust areas, thus address multiple areas of particular interest to the military. A few are included here that fell outside of the major thrust areas in this report, but appeared particularly interesting and may provide additional insights. Products are listed in no particular order.

**Table 2. Sampling of Products**

Thrust Areas/ Product	Description
Data Transmission; Biometrics; Mobile Yet Rugged Devices; and Multi-purpose Handheld	
CATCHER	CATCHER stands for Communications and Telemetry Computing Handheld for Emergency Response. This handheld computer incorporates GPS, voice, data, video, biometrics, and communications capabilities into an all-in-one rugged system for command and control situations in extreme conditions. Mobile, rugged, and convergent, the CATCHER eliminates the need to carry multiple devices in the field. The unit includes two digital cameras, a fingerprint sensor, and microphone to capture biometric data in the field. Wireless communication standards include 802.11b/g Wi-Fi, CDMA, GSM, Bluetooth, and a GPS receiver for location-based applications and tracking. The cameras can capture full motion video, enabling wireless video conferencing viewable on the CATCHER's 6.4-inch sunlight-readable display. The CATCHER has been ruggedized to meet MIL-STD-810F. At less than six pounds, it is portable for use in the field and delivers up to eight hours of power with two batteries.
RADAR; and Data Transmission	
Sigma S6 Radar Processor	The Sigma S6 Radar Processor removes radar clutter and processes received data in real time to significantly enhance radar images. This is accomplished through the use of various digital processors including the Pulse-to-Pulse Scanner for radar noise reduction, the Scan Average Processor for slow object tracking, and the CFAR Processor to remove weather clutter at a distance. Some radar interference sources mitigated by this system include precipitation, atmospheric turbulence, radar clutter from buildings, and even clutter caused by animals. The Sigma S6's processing technology can also be combined with many legacy radar systems to produce near photographic results. Due to the Sigma S6 Radar Processor's image refinement capabilities, target identification and detection is improved – enabling a radar technician to identify and track small and slow moving objects, even those as small as individual swimmers. By removing the clutter typically associated with radar systems, the ability to track small objects, multiple objects, or objects in cluttered environments is greatly improved. This is of particular use in port security, naval traffic systems, search and rescue operations, and costal surveillance applications.

Thrust Areas/ Product	Description
Unmanned Vehicle; Portable Device; and Personal Protection	
Voyeur	<p>The Voyeur, by Lite Machines, is a canister launched, near silent mini UAV for intelligence, reconnaissance, or surveillance applications. This battery powered unit utilizes foldable counter-rotating rotors to allow for 30 minute flights at an endurance speed of 10 to 15 knots. With a diameter of only four inches (with the rotors folded) and a height of 27 inches, the Voyeur is intended as a man portable device that can be deployed in the field. This can be either by hand launching, or by dropping the unit over a target area from another aircraft. Once launched, the unit can then be manually controlled or fully automated during flight. The automation component functions by navigating the unit through a series of GPS waypoints set by a ground based control unit. A system like this could be deployed for a variety of military or law enforcement applications. Specific military usages include target acquisition, covert sensor placement, and counter IED sweeps.</p>
Information Security	
Bouncer	<p>A simple solution to minimize attacks on computer systems is a Bouncer by CoreTrace. The Bouncer compares each application that attempts to launch against a list of approved applications. If the application is not on the whitelist, it is not allowed to run.</p>
Personal Protection	
Shear Thickening Fluid	<p>Shear Thickening Fluid, or STF, is a mixture of hard nanoparticles and non-evaporating liquid. These particles are composed of 450 nm silica and a polyethylene glycol fluid that flows normally under low-energy conditions, but when a shear impact occurs, it stiffens and behaves like a solid. This process of hardening occurs when the nanoparticles expand and wedge together in the fraction of a second after impact occurs. A piece of Kevlar or other fabric, can be coated with this solution and become dramatically more resistant to puncture and much better at reducing blunt trauma. In this way, STF can yield a light and flexible material that provides hard impenetrable protection only at the moment of impact. Among its many potential uses, this can be used in applications involving armor for ballistics, protection/support for clothing and athletic gear, or as a material to help create safer automobiles.</p>
Smart Shirt System & LifeShirt	<p>The Smart Shirt System incorporates sensors into everyday fabrics for the purpose of reporting the wearer's health and environmental health indicators in real time. The Sensatex fabric was first developed by researchers under the auspices of the U.S. military's 21st Century Land Warrior Program and the Defense Advance Research Projects Agency (DARPA), the research and development arm of the U.S. Department of Defense. The technology can be incorporated into any fabric (cotton, lycra, wool, silk, etc.) or blend of fabrics without effecting the look, feel, or integrity of the fabric that it is replacing.</p> <p>LifeShirt is an additional wearable piece of equipment. It is a lightweight chest strap with embedded sensors that monitor a user's vital signs. The sensors observe respiration, heart rate, activity, posture, and skin temperature. Using the LifeShirt software in combination with radio and telemetry systems, a user's vital sign information can be monitored remotely and in real time.</p>
Data Transmission; Personal Protection (through stealth); and Portable Devices	
Plasma Antennas	<p>Gaseous Plasma antennas are tubes of a gas like Argon, Neon, or even Hydrogen that, when ionized by high voltage, transform to a plasma state and assume many of the behavioral characteristics of a metal antenna. Plasma antennas are light weight as they are usually made of thin glass tubes similar to fluorescent light bulbs. They can be tuned to transmit at frequencies between 500 MHz and 20 GHz with comparable efficiencies to copper wire antennas of the same configuration. When de-energized they revert back to a dielectric tube with a very small radar cross-section. They therefore have a greater stealth advantage over metal antennas. As they can be turned on and off (made to exist as an antenna and then not exist as an antenna) they can be used effectively for both transmit/receive and shielding purposes. Research shows the antennas can be made using flexible tubing which allows reconfiguration and compression for storage. Military applications for plasma antennas include stealth, reconfigurability, and protection against electronic warfare, and commercial for broadband, weather, spread spectrum, collision avoidance, etc.</p>

Thrust Areas/ Product	Description
Biometrics; and Portable Devices	
IFace	IFace, by Animetrics, is a facial identification application that leverages handheld computing systems with built in cameras. It uses standard internet protocols to send facial imagery to the Face Identity Management System (FIMS) server for identification. IFace can be used with multiple internet protocol (IP) enabled camera systems such as web, cell phone, and surveillance cameras.
HIIDE	Handheld Interagency Identity Detection Equipment (HIIDE) - HIIDE is the world's first handheld multi-modal biometric device, capturing iris, fingerprint, and face images for enrollment and recognition. It was developed for the U.S. Department of Defense to identify individuals in the field.
Biometrics; and Data Transmission	
PIER	PIER is a standalone handheld biometric system employed for iris enrollment and recognition. The device can also be used in combination with network applications for identity recognition and security. The device includes a built-in keypad to enter information about the enrollee, such as first and last name and eye enrolled (R/L).
Personal Protection (through unmanned surveillance); and Portable, Durable Devices	
Recon Scout	Recon Robotics' Recon Scout, a one-pound mobile robot that provides real-time video reconnaissance, is constructed of aircraft aluminum, titanium, cast urethane, and plastic. The entire unit is seven inches in length and one and a half inches in diameter. An Operator Control Unit (OCU) controls the device's movement and receives the video feed from a distance of up to 300 feet outdoors, and 100 feet indoors. Setup and activation of the Recon Scout and OCU takes less than 20 seconds. The device can be thrown through a window, tossed over a wall or dropped from a low-flying unmanned aerial vehicle. The Recon Scout can survive a throw of 120 feet and a vertical drop of 30 feet. Incorporated into Recon scout's design is the ability to move quickly and quietly. It can travel one foot per second with a maximum level of 20 decibels. By comparison, a whisper measures 30 decibels. Current applications for the Recon Scout technology include use by military and law enforcement to provide covert reconnaissance before engaging a situation. Future applications could include search and rescue assistance, chemical and explosive detection, and exploration of unknown areas.
Energy; and Protection	
Aerogel	An aerogel is a light-weight, low-density, solid material created by removing the gel component from a hydrogel—through a rapid drying process called supercritical drying—and replacing it with air. Thus the material becomes up to 99.8% air making it light weight. AT the same time aerogels are strong structurally and can withstand up to 4,000 times their weight in applied force. Another important property of this material is its extremely high surface area, making it excellent for insulation applications due to its ability to disperse heat. Aerogels are currently used as thermal insulation for buildings, windows, spacecrafts/spacesuits, sound reflectors, and even as a capture mechanism for high velocity space particles for NASA.
Energy	
Carbon-Graphite Foam	Batteries use Carbon-Graphite Foam to address the issues faced by lead-acid batteries. Batteries can resist damage by layering Carbon-Graphite Foam material on top of the negative lead plates. The foam also facilitates the battery's quick recharge and deep discharge capabilities. The foam solution increases the energy density of a battery due to the porous nature of the foam and its increased surface area. Further, the finalized carbon-graphite material allows for the removal of a battery's lead plates, resulting in a significant weight reduction. Any system that experiences significant periods of non-use or exposure to harsh environmental conditions could benefit from this technology.

Thrust Areas/ Product	Description
Hydrogen Fuel Cells	<p>This is a small form factor hydrogen fuel cell that places power storage and generation within the outside shell of a device rather than on the inside. By placing power externally, the entire internal volume normally occupied by a battery is available to store fuel, thereby maximizing the runtime of the device. A fuel cell uses a Proton Exchange Membrane (PEM) to combine hydrogen fuel and oxygen from the air to produce electricity. Each cell is capable of providing a continuous power output of .33W at .6 V while maintaining a small form factor (an area of 10 cm<sup>2</sup> and a thickness of 3.5 mm). Current applications include powering remote cameras and sensors. This technology could enable a new generation of personal electronic devices that require light, thin, and flexible power sources.</p>
Multi-Source Ambient Power Supply Module	<p>The Multi-Source Ambient Power Supply Module (MS-AMPS) collects energy simultaneously from multiple sources. The module harvests power from radio frequency waves, thermoelectric, vibration, and solar. MS-AMPS is ideally suited for environments where energy sources vary or are inconsistent. This combination of environmental energy sources increases the power and versatility of the device. The technology provides a small, lightweight, and long-lasting power supply to support wireless devices and unmanned systems. MS-AMPS helps eliminate the need for batteries when battery replacement is impractical, costly, or dangerous. Current applications for this technology include power supplies for remote sensors, small reconnaissance vehicles and unmanned aerial vehicles. Future implementations could be as a power provider for pacemakers, small robots, digital signage, and streetlights as well as mobile and wearable electronics.</p>
Dye Solar Cells	<p>Dyesol has created Dye Solar Cells, a breakthrough in photovoltaic technology that uses a process best described as "artificial photosynthesis" to produce electricity. The Dye Solar Cells are built using an electrolyte—a layer of titania (a pigment used in white paints and tooth paste)—and ruthenium dye sandwiched between glass. When light strikes the dye, it excites electrons that are then absorbed by the titania to become an electric current that is many times stronger than that found in natural plant photosynthesis. There are many advantages for Dye Solar Cells in comparison to conventional silicon-based photovoltaic technology. Dye Solar Cells cost much less to produce since the manufacturing process consists of applying dye to a substrate and does not necessitate the use of high-priced raw materials. Moreover, manufacturing Dye Solar Cells does not produce toxic emissions. These new solar cells can also produce electricity more efficiently than silicon cells, even in low-light conditions. They are designed to be incorporated into buildings by replacing conventional glass panels, and do not require taking up roof or extra land area. Dye Solar Cells are built into modules or tiles. Each tile is ochre, with the introduction of other colors such as grey, green, and blue to be made shortly. Panels are constructed in a laminated structure, with the tiles connected and sandwiched between two panes of glass and fully encapsulated in the UV resistant transparent laminating polymer. Dye Solar Cells can be used as an enterprise power source, or to provide power to first responders or the military in the field.</p>

Thrust Areas/ Product	Description
Personal Protection	
Smart Tire	<p>A sensor technology developed by Gary Krutz and his team at Purdue University can detect impending structural failures in many types of polymers. Sensing techniques to analyze failures in polymers were originally designed to warn of failures in hydraulic hoses. Currently the team's major research focuses on early detection of tire damage that may lead to failure. Existing tire technology detects when air pressure is low but not structural damage. The technology developed by Krutz can detect failures such as cuts, punctures, manufacturing defects, imbalance, and degradation. Tires designed by the researchers are made of specially selected rubber containing multiple layers of different materials with various electrical properties. Sensors placed inside the tires pick up changes in electrical signals on the various layers and a special chip relays that information to the driver. This technology creates an early warning system that can help prevent accidents for drivers and users of components containing polymers. It has been tested on more than 100 different products including shoes, airplane wing composites, boat hulls, orthopedic devices, and automotive seals. Using this technology to predict failure of devices, to determine the need for inspection, or for preventative maintenance could prove invaluable in many markets. The immediate benefits will be realized by a reduced safety risk and economic loss due to equipment down time. Knowledge of impending failure supports a Just-In-Time supply chain strategy. This strategy reduces cost by ordering equipment based on need, and diminishing the requirement for inventory. Early notification of damage provides information on whether to order replacements or if there is stock on hand so a change can be made with a buffer period and minimal downtime. Future applications could include vehicle electrical systems, chemical protection suits, and medical devices such as pacemakers or artificial hips.</p>
Application Development; and Data Storage and Transmission	
Chumby	<p>The Chumby by Chumby Industries is an example of an open hardware device that gives a user the ability to modify all aspects of its design and interface. Generally when the word "open" is used in reference to technology, it refers to software. Open software provides the source code so users can change, revise, and modify applications. Open hardware designers share their work by disclosing the schematics and software used in their designs. An open source community encourages users to meet, have discussions, and ask each other for assistance in finding parts, or seek ideas to solve design problems. The designers deliberately build and assemble the physical components of a technology so they are easily expandable and have backdoors for hackers. An open hardware device's source code, schematics, circuit board layout, and skin design information are either shipped to the user or are available online. There are many types of open hardware technologies including, vehicles, 3d printers, CPU's, telephones, MP3 players, and alternative energy devices. Open source technologies foster an environment where individuals can create their own variations of the device. "Open" systems have benefits for the U.S. Department of Defense and a variety of government agencies. Using different hardware and software configurations may help to prevent against unauthorized hacking and reduce the likelihood of one attack affecting all equipment. Multiple agencies can use the same platform, but make small adjustments that make each system or group of systems unique. Open hardware communities are a growing facet of the open source community. Currently open hardware systems are used to spur innovation, create low-cost alternative electronics, and contribute to the social networking community. Future applications may see the technology becoming more mainstream and being used for secure environments.</p>

Thrust Areas/ Product	Description
Mobile Computing	
XO Laptop	The XO laptop created by the One Laptop Per Child non-profit organization is a low cost, small form factor laptop incorporating built-in mesh networking capabilities and a custom Linux based operating system. The XO was designed for children in developing worlds that do not have ready access to grid-based electricity and cannot afford traditional computing systems. This device includes a 433Mhz processor, 256MB of RAM, 1024KB of flash storage, digital video camera, and swiveling display that can be turned into a monochrome eBook reader. The XO laptop was designed with rugged characteristics to withstand harsh environments. It is dirt and moisture resistant with a sunlight readable display and weighs less than 3.5 pounds. The system's unique user interface and open source software creates an inviting programming environment for developers. That environment could lead to the development of many new applications to take advantage of the XO's mesh networking and social computing capabilities. Currently the scope of the project is focused on providing laptops to children all over the world. Future applications could lead to widespread mobile communications or disaster recovery solutions.
Medical Advances Improving Recovery from Injury	
My Own Motion	My Own Motion (MYOMO) is a wearable, portable, exoskeleton that helps an individual relearn how to move weak or partially paralyzed limbs. The name "My-Own-Motion" comes from the technique that is used to regain motor function. The theory behind MYOMO is that a user can reconfigure nerve and brain pathways through repeated motion. To facilitate training, the device contains real-time adjustable parameters to customize the amount of help that the patient is given, based on need or skill level. MYOMO uses electromyography (EMG) to detect the electrical signals sent to muscles during contraction and relaxation. An EMG sensor sits on the skin's surface to detect and monitor residual electrical muscle activity. When signals fire in response to attempted movement, the device senses the signal and forwards the data to the motor in the exoskeleton. This is non-invasive and does not apply any electrical stimulation to create muscle reaction. The technology provides mechanical assistance to movement initiated by the user. Current applications for this technology include treating movement-impairing effects of stroke patients and individuals with spinal cord injuries. Future applications could include rehabilitation for muscle and range of motion injuries in multiple areas of the body. This technology could also lead to developments of exoskeletons for soldiers to assist in carrying heavy loads or by athletes to train their bodies to better perform their sport.

## V. Product and Services Vendors

There have been a number of product developments that increases the capability or protection of the modern day fighting forces. Table 3 lists some of the vendors presently providing products and services to the military. The included list is not a complete comprehensive list of all vendors providing products. It is merely intended to provide a random subset of vendors. Vendors are listed in no particular order.

**Table 3. Product Vendors**

Thrust Area	Vendors		
Mobile Computing	Catcher Holdings	Intel	Sabtech Industries
	Roper Mobile Technology	Hybricon Corp.	Excalibur Systems, Inc.
	Alphi Technology Corporation	DSS Networks	Dell
	Mercury Computer Systems, Inc.	Carlo Gavazzi Computing Solutions	Microsoft
	Interface Concept		

Thrust Area	Vendors		
Biometrics	Animetrics Ectaco Vivometrics Securimetrics Inc. AcSys Biometrics Attrasoft AWT	Biometrica Systems BIOVISEC Cognitec Systems GmbH CyberExtruder Cryptometrics FACE Technologies (PTY) Ltd. Genex Technologies, Inc.	Geometrix Identix Image-Metrics, Ltd. MIT Media Laboratory Vision Modeling Group Neven Vision (formally Eyematic Interfaces) Sintec Co., Ltd.
C4ISR	COFREXPORT LockHeed Martin	Rutter Technologies ASI Technology Corporation	Center for Remote Sensing
Performance Materials	Sensatex Vivometrics	Dupont	BMI Combat Systems
Unmanned Systems	Adaptive Flight AeroVironment, Inc (AV) Airborne Systems Group Automated Dynamics Boeing Brock Technologies Dragonfly Innovations, Inc. DRS Technologies Dynetics Evergreen Unmanned Systems	General Atomics Aeronautical Systems, Inc. General Dynamics Robotics Systems Honeywell iRobot Corporation Lite Machines Corporation Microbotics Microhard Systems, Inc. MicroPilot	NovAtel Inc. Raytheon Robotic Systems JPO Stealth, Micronetcs Sullivan UV Teledyne UAV Engines Ltd. ViaSat, Inc.
Fuel & Power	MilleniumCell Ambient Micro Dyesol	Energy Technologies Inc. Global Solar	Konarka Technologies Protonex

FORSCOM, USARC, and USASOC have a vast list of vendors and contractors at their disposal to provide IT Infrastructure services through the General Services Administration (GSA) contract vehicles. The list below highlights some of the vendors presently providing infrastructure services.

- Advanced C4 Solutions
- EDM International
- Metters Industries
- Dynanet Corporation
- T3 Corporation
- BTG Inc.

- STG Inc.
- Booz Allen Hamilton