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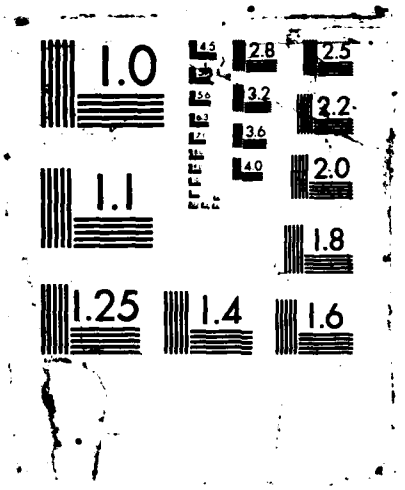
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Army combat forces involved in global military operations require knowledge of the terrain and accurate positioning and navigation capability to effectively perform their missions. Combat critical data from satellite-based systems to augment ground and airborne data collection, processing, and dissemination systems are crucial for the delivery and use of the needed information and intelligence in near-real time. The Army is developing ground-based testbed systems to utilize terrain and weather data collected from space-based platforms to enhance Army commanders' battlefield capabilities, and is researching new applications for the NAVSAT Global Positioning System and the Defense Advanced Research Projects Agency-sponsored (DARPA) LIGHTSAT program that are unique to the Army. In addition, the Army is designing experiments to be conducted on the space Shuttle.

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Army space systems for terrestrial applications

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ABSTRACT

Army combat forces involved in global military operations require knowledge of the terrain and accurate positioning and navigation capability to effectively perform their missions. Combat critical data from satellite-based systems to augment ground and airborne data collection, processing, and dissemination systems are crucial for the delivery and use of the needed information and intelligence in near-real time. The Army is developing ground-based testbed systems to utilize terrain and weather data collected from space-based platforms to enhance Army commanders' battlefield capabilities, and is researching new applications for the NAVSAT Global Positioning System and the Defense Advanced Research Projects Agency-sponsored (DARPA) LIGHTSAT program that are unique to the Army. In addition, the Army is designing experiments to be conducted on the Space Shuttle.

1. INTRODUCTION

Future U.S. Armies may engage in fast-paced battles where the tactical situation will be constantly changing due to military capabilities for relatively rapid movement. The Army Commander must have the ability to conduct battlefield maneuvers under adverse environmental conditions, such as darkness, rain, fog and snow; and he will likely have to operate at a numerical disadvantage and with an inferior logistical situation. He must, therefore, be able to incorporate sophisticated technology into his warfighting capabilities in order to overcome these disadvantages and successfully execute his battle plan.

The commander must be able to deploy his forces so as to husband available resources, yet still maximize his effect on enemy forces. To do this, he must have superior communications, positioning and navigating abilities, and fire control capabilities, as well as superior knowledge of the weather and terrain conditions. Army activities are presently applying space-related products and technology to ground-based Army systems in order to develop that superiority. Those activities are designed to exploit non-Army space-borne assets, such as NAVSAT Global Positioning System (GPS), LANDSAT, Defense Meteorological Satellite Program (DMSP) environmental satellites, and other satellite data.

2. SPACE TACTICAL DEMONSTRATIONS

The newly created Army Space Technology and Research Office (ASTRO) will manage a series of space tactical demonstrations designed to show Army commanders the advantages to be gained by applying space technology to Army requirements. These demonstrations will support the Army Space Institute's (ASI) three-phase effort to develop an Army space architecture for the future by integrating space capabilities into battlefield operating systems. The current phase is to obtain, or develop, the capability to receive processed data from satellite platforms and make use of that data. The second phase will be to develop an Army ability to process data from space assets. The experience gained in the first two phases will produce a set of Army space requirements, enabling the Army to more effectively influence satellite design and operation in the third phase.

One demonstration will provide individual soldiers with small, hand-held GPS receivers to give them an enhanced ability to position themselves. The second demonstration will use an array of GPS antennas and interferometric processing to position and point a simulated artillery barrel. A third demonstration will provide field commanders with weather information and images, as well as tactical decision aids based on that data. A fourth demonstration will use the DARPA LIGHTSAT Program, with Army assistance, to demonstrate a communications capability; it is intended to influence the technology necessary to support the development of small, tactically oriented satellites.

WEATHER AND TERRAIN DATA

Tactical Decision Aids (TDA's) are planning tools based on integrated weather and terrain data collected from various sources, which are provided to the commander in lieu of the raw data. The Digital Topographic Support System (DTSS), under development at the Corps of Engineers' Engineer Topographic Laboratories (USAETL), will

provide cross-country mobility and terrain model TDA's to the field commander. The DTSS requires an extensive digital terrain data base, provided by the Defense Mapping Agency, and operator-keyed current weather conditions to produce TDA's.

The AirLand Battlefield Environment Testbed (ALBE), managed by USAETL, provides a testbed system for evaluating both TDA's and the models for producing TDA's. Like DTSS, ALBE requires a digital terrain data base and weather data. However, ALBE has the capability for direct ground-level weather data input, such as temperature, humidity, air pressure, wind speed and direction, soil moisture, etc.

The critical element for both DTSS and ALBE is the data input, i.e., the models for producing TDA's are only as good as the data used to derive the TDA. Unfortunately, the digital terrain data provided by the Defense Mapping Agency (DMA) will most likely lack critical pieces of terrain feature data; and in some cases will not be available at all. This is not due to any fault of DMA's; they simply do not have the resources to maintain up-to-date digital data bases for the entire globe at the scale required to meet all Army tactical requirements. Also, the weather data gathering systems are woefully deficient at this time. The SWO-provided weather parameters to DTSS are generalized to a great degree from meso-scale weather data. The ALBE weather collection capability only utilizes ground-based sensors, and does not have data input from the upper atmosphere or global data from satellite platforms, which is essential for predicting terrain and weather conditions for upcoming military activities. The Army is addressing the data availability problem by developing two testbed systems, the Test Weather System (TWS) and the Tactical Environment Analysis System (TEAS).

The Army Materiel Command's Atmospheric Sciences Laboratory (ASL) at White Sands, New Mexico is developing the TWS to integrate weather data collected from ground sensors, upper atmosphere sensors and satellite-borne sensors into a comprehensive description of the meteorological conditions within a given geographic area. The TWS will then produce weather TDA's for Army commanders and derive meteorological data for the Staff Weather Officer. The Engineer Topographic Laboratories is developing a TEAS to extract terrain feature data from LANDSAT and SPOT imagery in near-real time to update ALBE and DTSS data bases. The TWS, ALBE and TEAS capabilities will eventually be integrated and fielded either as a single operational system, or as an enhancement to the DTSS, which provides the Army commander with the ability to utilize space resources to improve his knowledge of the battlefield.

Army weather data requirements call for much denser data points and higher resolution than it currently receives. Therefore, the Army has provided its requirements to the Defense Meteorological Satellite Program (DMSP) Block VI Study, which is compiling a data base for the design of the next generation of space-borne meteorological sensors and satellite platforms. In addition, the TWS, ALBE and TEAS activities will enable the Army to further refine and extend its weather and terrain data requirements.

POSITION AND NAVIGATION

The Engineer Topographic Laboratories (USAETL), in conjunction with the Army Materiel Command's Armament Research, Development and Engineering Center (ARDEC) at Picatinny Arsenal, New Jersey is developing an azimuth determination capability based on interferometric processing of the signal received from the NAVSAT Global Positioning System. This capability can be used to position artillery pieces and as a fire control aid to point the weapon at a hidden target, improving the weapon's ability to hit targets and reducing the time required to set up the weapon. The reduction in setup time will make the weapon more mobile, thus reducing the risk from counterfire. The higher mobility combined with the improved accuracy, will increase the weapon's effectiveness and provide a higher probability of artillery support for the Army commander.

The Army Materiel Command's Communications and Electronics Command will demonstrate small, lightweight handheld GPS receivers in a tactical environment; the receivers are fairly inexpensive, are currently available commercially, and will be provided to users during field exercises to identify potential benefits. The demonstration results will help formulate requirements for the next generation of GPS receivers.

LIGHTSAT COMMUNICATIONS

The Army is assisting the DARPA Advanced Space Technology Program in developing small, tactically-

oriented satellites (LIGHTSAT). The LIGHTSAT capability will initially provide Army commanders with a locally controlled communications platform to support tactical communications. The first demonstration will be designed to support field exercises, sometime within the next two years.

3. SHUTTLE EXPERIMENTS

In addition to the activities noted in the previous paragraphs, the Army developed a number of space-related experiments to be flown on the Space Shuttle. The STARTRACKER experiment is designed to develop a highly accurate, autonomous, near-real time attitude determination subsystem for use in future orbital platforms. TERRA GEODE is an experiment with a qualified geologist on the Space Shuttle to determine the types of information to be derived from direct observation of the earth's surface as opposed to extracting information from various types of imagery, e.g., LANDSAT or SPOT. An Ice Radar Study will acquire Synthetic Aperture Radar (SAR) data over ice and snow covered areas to develop the capability to utilize SAR data to map global snow cover, ice cover and related terrain features. Both the STARTRACKER and the TERRA GEODE experiments are USAETL projects, and the Corps of Engineers' Cold Regions Research and Engineering Laboratory is conducting the Ice Radar Study.

The Corps of Engineers' Construction Engineering Research Laboratory in Champagne, Illinois is conducting research and developing requirements for a Large Space Structure activity. As part of that research, a Containerless Coating Process experiment will coat metallic and non-metallic substrates with conductive/reflective materials in space and evaluate both the process and the material performance versus materials coated on the earth.

4. CONCLUSION

The Army is developing systems to exploit space-related data and new applications for space-based positioning systems in order to improve the Army Commander's ability to execute maneuvers on the battlefield. In general, Army research and development is designed to exploit other agencies' space assets, i.e., LANDSAT, SPOT, GPS, etc., before developing its own assets. The Army is also developing data requirements for the design phase of future data collection systems, such as the Defense Environmental Support Satellite - Army, and other next generation DMSP environmental sensors and satellite platforms.

The Army will continue to develop and refine its ability to incorporate space-based technology into its battlefield capabilities. This development and refinement will follow the precepts outlined by the Army Space Institute, e.g., obtain the ability to use space-derived data, develop the ability to process that data, and develop requirements to influence the design of future space systems. In this manner, the Army will not only develop the capability to operate effectively on the future battlefield under rapidly changing conditions, it will also generate the ability to improve and extend that capability as new technology becomes available.

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