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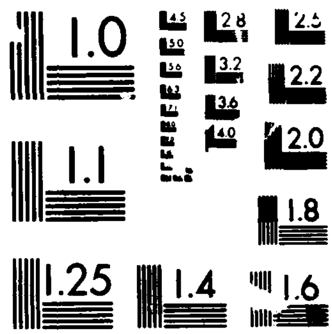

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AIR-LAND BATTLEFIELD ENVIRONMENT (ALBE) DEMONSTRATION

Laslo Greczy
U.S. Army Engineer Topographic Laboratories
Fort Belvoir, Virginia 22060-5546

ABSTRACT

Terrain and weather affect combat operations more significantly then any other physical factors on the battlefield. Historically, field commanders have not had the capability to fully exploit battlefield environmental effects for tactical advantage. The Corps of Engineers has initiated the ALBE program to develop and evaluate Tactical Decision Aid (TDA) software and products capable of integrating terrain and other environmental factors in the prediction of battlefield environmental effects. The TDA's, when implemented on target field systems, will provide the Army with an operational capability to assess and exploit battlefield environmental effects as a force multiplier in combat operations. A development strategy has been devised that involves assembling an ALBE Testbed System, installing the TDA software, conducting field demonstrations and evaluations, and transferring the TDA software to various target systems currently in the life cycle development process. This innovative approach will facilitate fielding of ALBE software and products, and will provide battlefield commanders and their staff with the ability to better exploit the combined effects of terrain and environment in the decision-making process.

87

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INTRODUCTION

To fight and win the AirLand Battle, the Army must field a combat force that can move quickly and lethally against the enemy. The speed and mobility of this force will depend in part on the availability of up-to-date information-information not only about the enemy, but about the terrain, weather and other environmental parameters. In order to make timely and effective decisions, combat commanders need to know as much as they can about the battlefield environment and its effects on both friendly and threat equipment, weapons systems and operations. They need to acquire, process, assimilate and disseminate this information as quickly and efficiently as possible.

Historically, battlefield commanders have had only limited access to environmental information during the planning process. The manual methods used to acquire and analyze such information precluded generation of products and decision aids with the speed needed to support combat operations on the quick response battlefield. Only under unusual circumstances did commanders have the capability and time to determine the combined effects of environmental parameters on men, material and equipment.

Battlefield terrain and environmental conditions will significantly affect the performance of current and planned high technology Army systems and will strongly influence the operations and tactics employed in future combat. The planned development and fielding of systems like the Maneuver Control System (MCS), the All Source Analysis System (ASAS), the Digital Topographic Support System (DTSS) and the proposed Integrated Meteorological System (IMETS) will provide field commanders and their staff with the capability to acquire and process maneuver, intelligence, terrain and environmental information in an efficient and timely manner. However, new capabilities are needed in several combat areas to insure that the combined effects of the battlefield environment are adequately assessed and properly exploited for maximum tactical advantage. In order to address this problem, the U.S. Army Corps of Engineers has instituted the AirLand Battlefield Environment (ALBE) initiative.

ALBE will result in the development and demonstration of Tactical Decision Aids (TDA) designed to facilitate the acquisition, integration and assessment of terrain, weather and other environmental information. Implementation of the Tactical Decision Aids on target field systems will provide the Army with an operational capability to assess and exploit battlefield environmental effects as a force multiplier in combat operations and to avoid the potentially adverse effects that would result from inadequate assessment of the terrain, weather and other environmental factors.

BACKGROUND

The U.S. Army Corps of Engineers initiated the ALBE program to focus Army efforts in the areas of atmospheric, terrestrial and topographic sciences and to insure that these areas are adequately considered and properly exploited in combat operation and in the research, development and acquisition process. The two major goals of ALBE are :

1. Provide Army material acquisition, training and doctrine activities with the capability of assessing and exploiting realistic battlefield environmental effects.

2. Provide the Army in the field with the capability to assess and exploit battlefield environmental effects for tactical advantage.

Goal 1 activities focus the Corps 6.1 and 6.2 research efforts to better support the Research, Development, Test and Evaluation Community. Goal 2 activities focus primarily on the demonstration, evaluation and implementation of Tactical Decision Aids for field Army applications. The remainder of this paper will be concerned primarily with ALBE Demonstration and Evaluation Program being conducted in support of Goal 2 activities.

The 6.3A ALBE Demonstration and Evaluation Program was implemented to provide a mechanism for demonstrating and evaluating Tactical Decision Aid products developed under the Corps' tech base efforts and to facilitate transitioning of these products to field Army systems. The main objectives of the Demonstration and Evaluation Program are as follows:

1. Develop and refine TDA software and develop the methodology to provide TDA software and products to Army operational units.

2. Demonstrate the use of advanced sensor systems for collection of near-real-time battlefield environmental data and use of the data in the generation of TDA products.

3. Obtain the test data necessary to support integration of ALBE TDA software and products on soon-to-be fielded Army systems.

The development strategy for the Demonstration and Evaluation program is relatively straight forward: (1) An ALBE Testbed System (ATS) is being assembled and will be used as the vehicle for conducting the ALBE demonstrations and evaluations. (2) Tactical Decision Aid software developed under Corps supported tech base programs is being integrated and implemented on the ATS for demonstration and evaluation. (3) A series of field demonstrations and evaluations will be conducted to gather data and develop methodologies that will facilitate transitioning of ALBE software and products to certain target field system. (4) Selected TDA software, appropriate documentation and test data will be transferred to the material developers of the field system for which ALBE software and products are targeted.

The ALBE Demonstration and Evaluation program is being conducted under the auspices of the Corps of Engineers Directorate of Research and Development with the work being performed cooperatively by Corps of Engineers (COE) and Army Materiel Command (AMC) laboratories. Participating laboratories include the Corps: Cold Regions Research and Engineering Laboratory (CRREL), the Construction Engineering Research Laboratory (CERL), the Engineer Topographic Laboratories (ETL), and the Waterways Experiment Station (WES); along with AMC's Atmospheric Sciences Laboratory (ASL). The TRADOC proponent for the ALBE Demonstration and Evaluation Program is the U.S. Army Intelligence Center and School (USAICS). The Army Development and Employment Agency (ADEA) will support the ALBE effort by: (1) Facilitating the coordination necessary to execute the field demonstrations and evaluations with the appropriate FORSCOM and TRADOC elements, and (2) Assisting in the integration of ALBE software and products into the Army's SIGMA C^3I architecture. The U.S. Army 9th Infantry Division will also support the Demonstration and Evaluation Program by providing troops to operate and evaluate the ALBE software during Command Post Exercises and Field Training Exercises.

TACTICAL DECISION AIDS (TDA)

ALBE Tactical Decision Aids (TDA) are digitally produced products that show commanders and their staffs the effects of terrain and environmental factors on both friendly and threat equipment, weapons systems and operations. TDA's will be used by commanders and their staff to determine the effects of environmental factors on combat operations. The TDA's are not intended to make decisions by themselves, but rather to supplement the tactician's knowledge base and help guide him during the decision making process by providing information useful in the formulation and execution of battle strategies. The TDA's are based on apriori digital terrain data (both feature and elevation data), historical climatological data, and real and near-real-time environmental sensor data. They take into account the combined effects of these factors and provide an invaluable aid in the formulation and execution of both pre-battle and near-real-time tactical decisions.

ALBE Tactical Decision Aids cover the effects of both the current and forecast state of the environment. They enable the tactical commander and his staff to evaluate weapon system effectiveness, determine the advantage of one system over another, and anticipate how operations will be degraded or improved during threat/U.S. engagements. The TDA's enhance the ability to plan and execute operations in a dynamic tactical situation, and let commanders and their staffs use weather and terrain as force multipliers in employing combat assets.

There are six ALBE Tactical Decision Aids Categories. They are:

Army Aviation
Countermobility
Ground Mobility
Nuclear, Biological, Chemical
Terrain and Atmospheric Utilities
Weapon System Performance

Each TDA category contains a number of modules; and each module produces one or more TDA products (A complete list of all currently planned modules by TDA category is given in Table 1). Inputs required to generate these TDA products consist of environmental data as well as data on military equipment, weapon system capabilities and characteristics, and operational parameters. Much of this information is contained in computer data bases that are prepared prior to combat. Near-real-time information obtained from currently fielded environmental sensors and data from sensor systems developed under the ALBE program will also be used as input to the TDA's. Processing of data to generate TDA products relates terrain and environmental factors to both friendly and threat system capabilities. TDA products generated through these processes will not merely reflect the effects of any single factor, such as terrain, weather or battle-induced conditions, but rather the combined synergistic effects of a number of factors.

ARMY AVIATION

Weather Effects
Aircraft Vectoring
Aircraft Performance

COUNTERMOBILITY

Minefield Deployment Effectiveness
Obstacle Deployments
Barrier System
Integrated Minefield/Obstacle

GROUND MOBILITY

Off-Road Speed
Soil Moisture Mapping
Shallow Snow Module
On-Road Speed
Bridge Evaluation
Gap Crossing
Winter Bridging
Troop Formation
Route Cover and Concealment
Integrated Mobility
Road Useage
Resource Planning

NUCLEAR/BIOLOGICAL/CHEMICAL

NBC Hazard
Smoke Generation
Target Area Winds
Tube-Delivered Smoke
Chemical Decontamination

TERRAIN AND ATMOSPHERIC UTILITIES

Intervisibility
Sensor Communication and Data Handling
Weather Effects Messages
Surface and Upper Air Data
Military Hydrology

WEAPON SYSTEMS PERFORMANCE

E-O/MMW Systems
Passive Detection of Airborne Target
Top Attack SCM Systems
Seismic/Acoustic Systems
Advanced Munitions

Table 1. Tactical Decision Aid (TDA)
Catagories and Modules

ALBE TESTBED SYSTEM (ATS)

A major thrust of the ALBE program is to demonstrate and evaluate Tactical Decision Aid software and products. An ALBE Testbed System (ATS) is being assembled to provide a suitable vehicle for conducting the ALBE software and product demonstrations, tests and evaluations. The ATS is being designed to be compatible (to the maximum extent practical) with Army systems scheduled for fielding in the near future for which ALBE products are targeted.

The testbed system is being designed for maximum flexibility (in terms of both hardware and system software architecture) in meeting the anticipated needs of the TDA developers and at the same time is being designed to provide a suitable demonstration vehicle which can function in a realistic battlefield environment. The testbed system utilizes ruggedized hardware as necessary and appropriate. The equipment is being installed into Integrated Command Post (ICP) type shelters which are being mounted on Commercial Utility Cargo Vehicles (CUCVs) for transport during the ALBE demonstrations and evaluations. A system software architecture which facilitates development and integration of TDA software and products is being implemented. The operating system software, graphics libraries, user interface, Geographic Information System (GIS) and Data Base Management System (DBMS) will all be integrated to provide a cohesive software package which the TDA developers can use to facilitate their developments.

Acquisition and integration of the ATS hardware and implementation of the system software architecture is being accomplished by Battelle Pacific Northwest Laboratories (PNL) in direct support of the U.S. Army Engineer Topographic Laboratories.

Hardware Architecture

The ALBE Testbed System will consist of two central processing units (CPU's), and associated peripherals. These two central processing units, both ruggedized MicroVax II's, will support the production of weather and terrain related TDA's. The dual CPU configuration will insure adequate computational capability to collect, process and store weather and terrain data and simultaneously generate TDA products. Each processor and associated peripherals will be housed in its own Integrated Command Post shelter for transport. During actual field operations, certain peripherals will be removed from the shelters and operated in tents attached to the shelters.

During demonstrations and evaluations, the two CPU's will be netted to facilitate interchange of terrain and weather data and products. During exercises conducted in conjunction with ADEA and the 9ID, the two ATS

CPU's will also be connected to the ADEA Automated Division Intelligence System (ADIS) via a local area network (Figure 1). The connection of the ATS to the ADIS will provide the ALBE community the capability to communicate with other portions of the Army's SIGMA C^3I architecture (at least during the demonstrations) and will facilitate the electronic dissemination of ALBE products to various users.

Weather Intensive Processor (CPU-1)

The weather intensive processor (Figure 2) will be used for collecting, processing, and storing meteorological and other associated data needed for the generation of weather intensive TDA's. CPU-1 will support, primarily, the Staff Weather Officer (SWO). It will collect and provide environmental data to the TDA models as necessary and will generate weather intensive TDA's. Input data will be provided to CPU-1 by a suite of in-situ and mobile environmental sensors as shown in Figure 4.

Terrain Intensive Processor (CPU-1)

The terrain intensive processor (Figure 3) will be used to create, update, revise and intensify digital terrain data, provide terrain data to various TDA modules as required, and to generate terrain-intensive TDA products. CPU-2 will be operated by the terrain analysts and will support generation of terrain related products such as intervisibility, mobility, counter-mobility, etc. In addition, CPU-2 will contain hardware to digitize hardcopy products for use as background maps.

Software Architecture

The ALBE Demonstration and Evaluation program is primarily a software development and integration effort. Essentially all of the TDA modules use large amounts of meteorological and terrain data to produce graphic and textual hard and soft copy products as output for the user. In order to facilitate consistent TDA software and product development, a cohesive system software architecture is being developed and implemented. This architecture includes a common operating system, graphics library and system support routines and a consistent and fully integrated user interface, Data Base Management System (DBMS) and Geographic Information System (GIS). The system software architecture is being developed by Battelle Pacific Northwest Laboratories (PNL) and will provide the basic framework for the TDA developers to implement their software. Figure 5 shows a conceptual design for the system software architecture.

System Support Modules

Various system support functions will be implemented on the ATS not only to satisfy the needs of the TDA developers, but also to guarantee that users have timely access to programs and data. ATS system support modules will include:

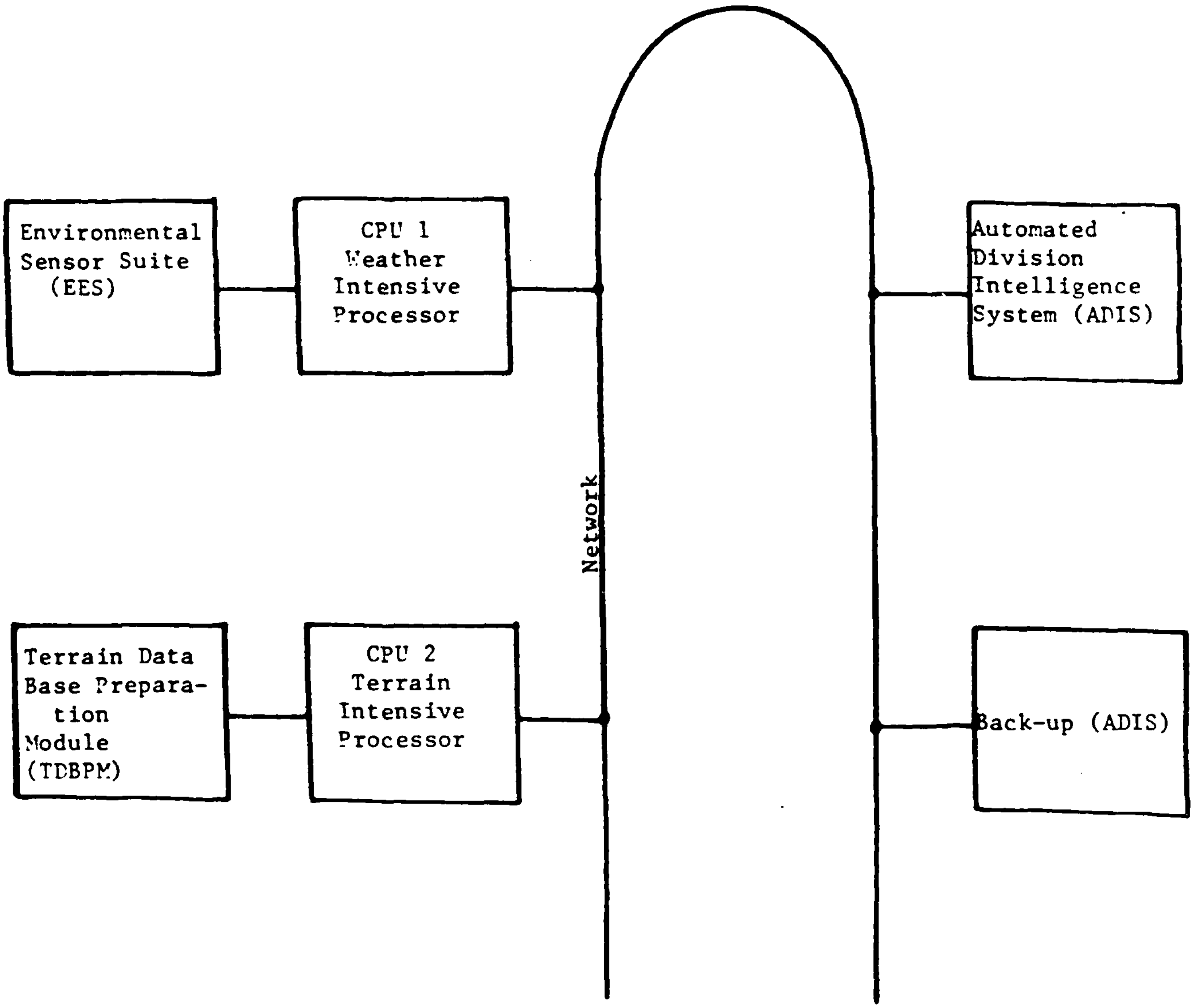

Figure 1. ALBE Demonstration Testbed.

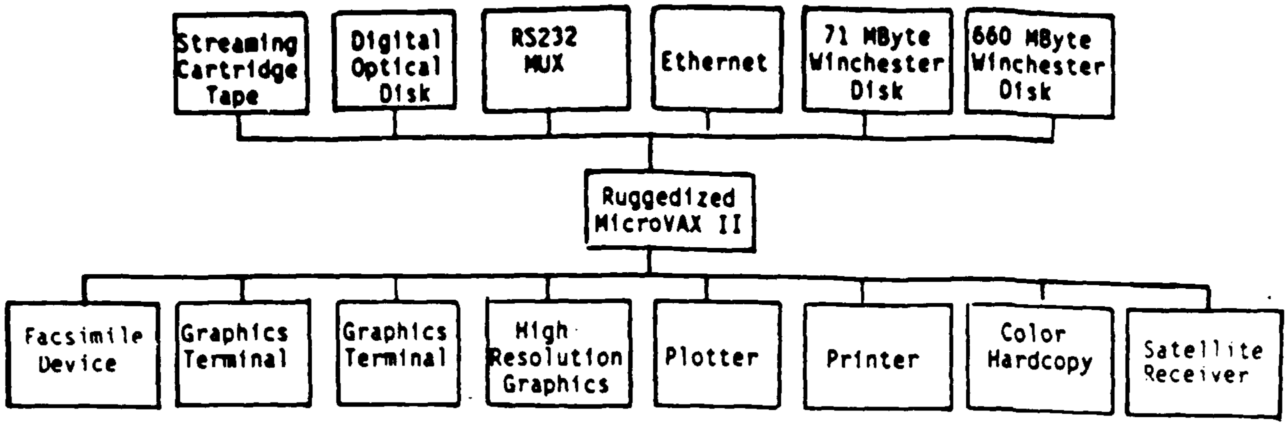

Figure 2. Block diagram of the Weather-Intensive ATS Processor.

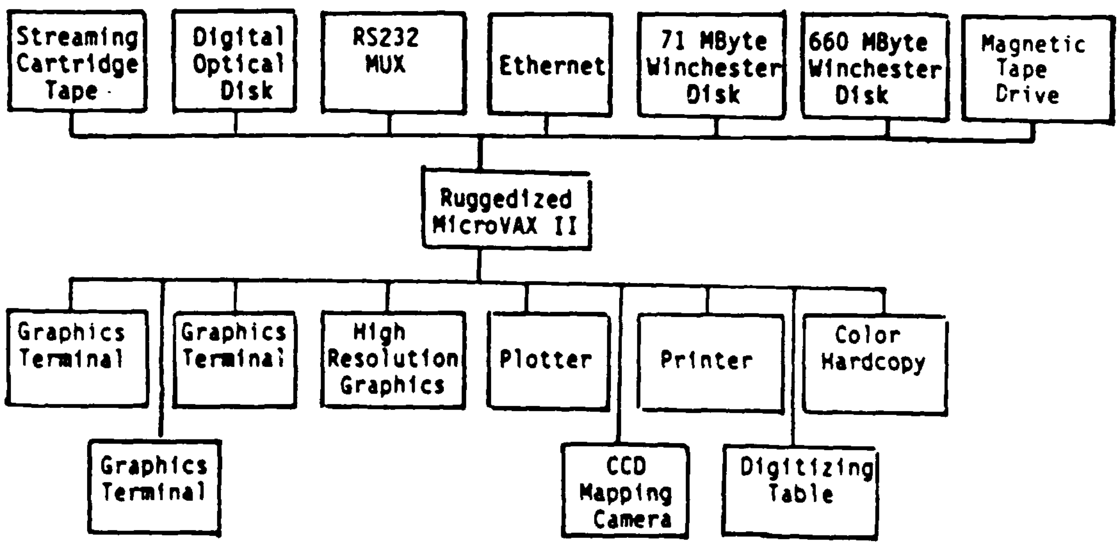

Figure 3. Block diagram of the Terrain-Intensive ATS Processor.

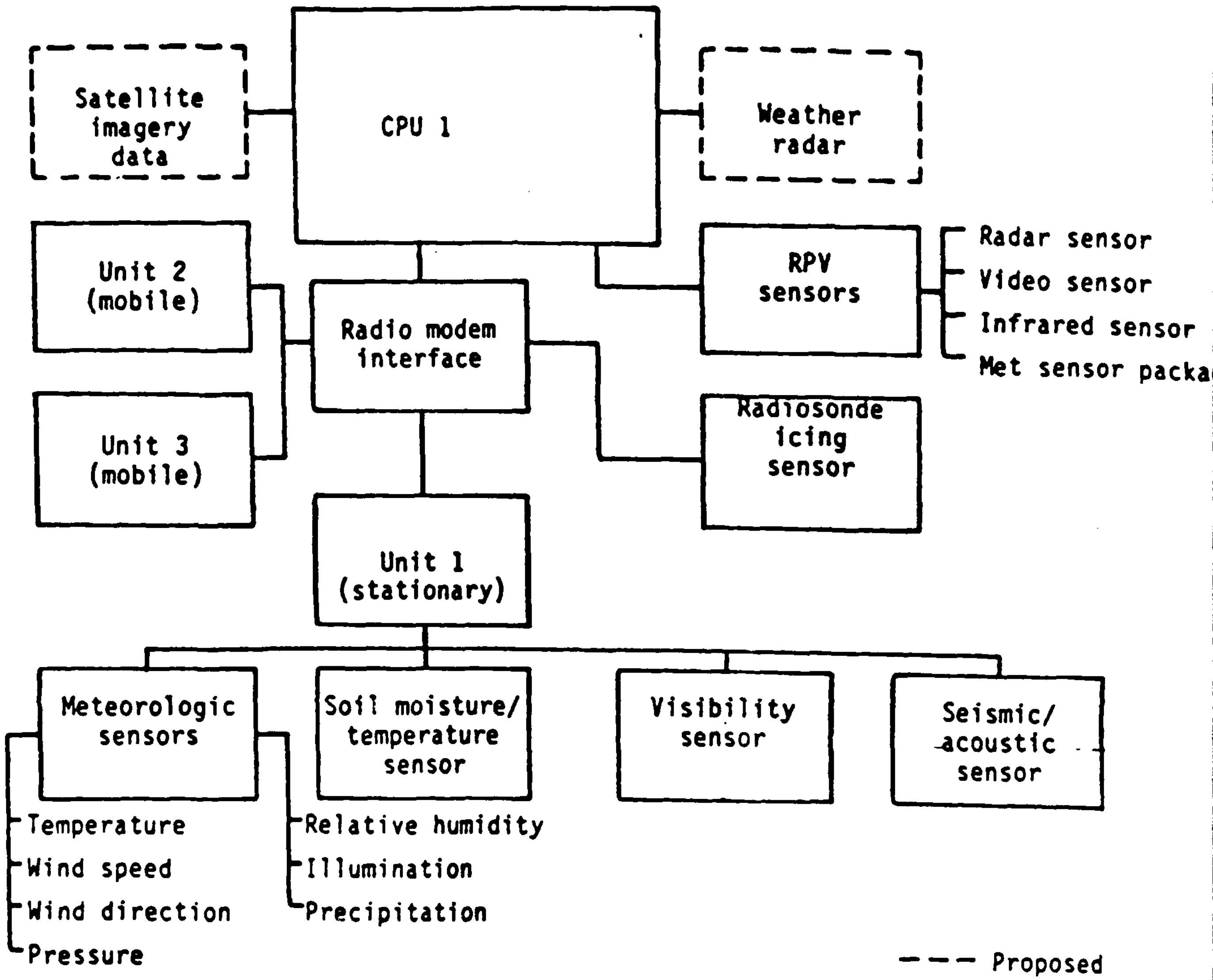

Figure 4. Environmental Sensor Suite

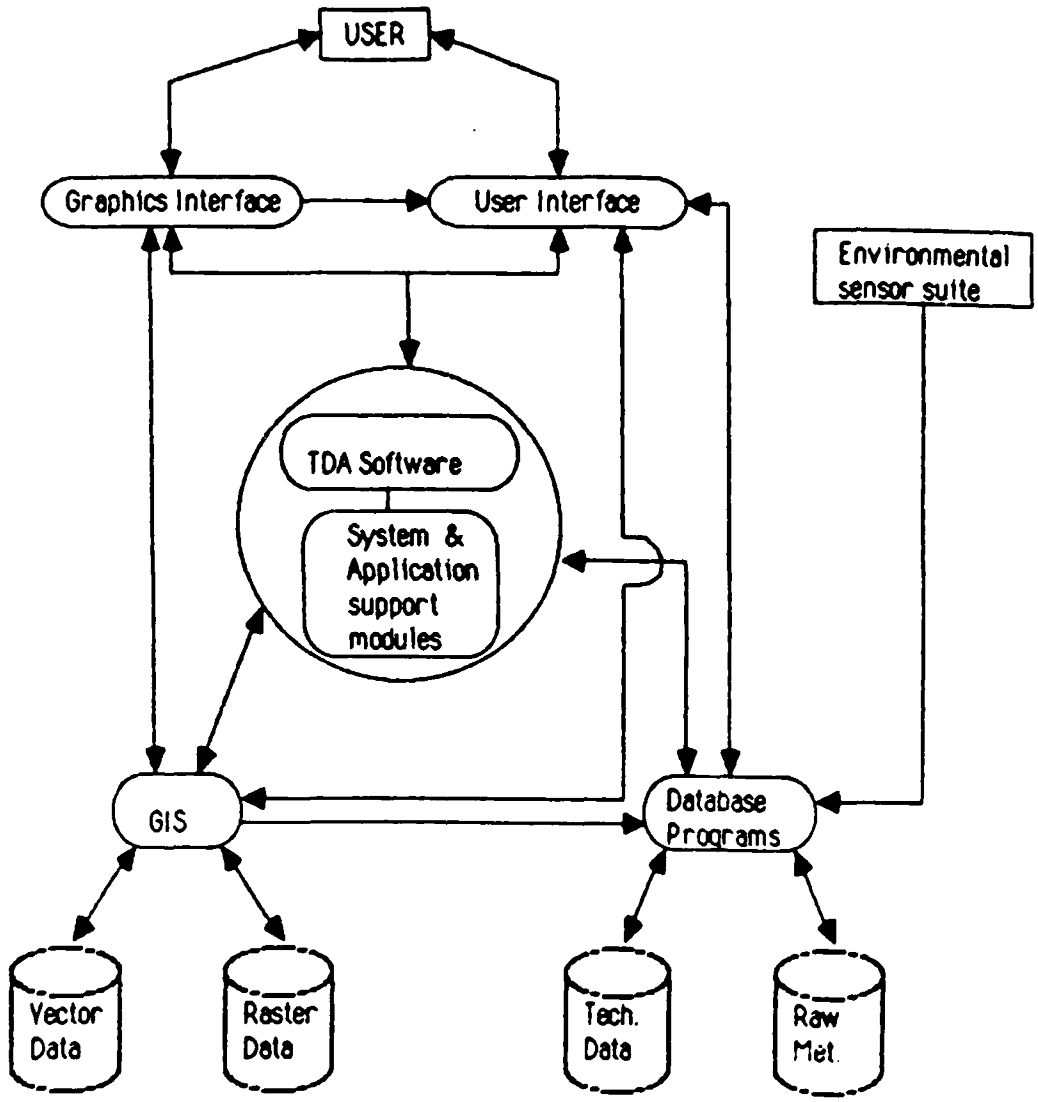

Figure 5. ALBE System Software Architecture

1. VMS operating system software

2. FORTRAN 77, PASCAL, C, and ADA compilers

3. Local Area Network (LAN) communication capabilities

4. Intertask communication, subtasking, and system common memory management routines

5. Interrupt handling mechanisms

6. Standard RS-232 communication support for remote sensing equipment (ie, meteorological sensors).

Process control routines, device interfaces and low-level library functions will also be implemented. All system routines will be highly optimized to insure that the ATS responds to users in a timely manner.

Data Base Management

There are three basic types of data that will be collected, stored, manipulated and used to generate TDA's on the ATS. These are: meteorological data, terrain data and miscellaneous data. Meteorological data will consist primarily of randomly spaced point measurements of such parameters as wind speed and direction, precipitation, soil moisture, etc., which will be collected by the environmental sensor suite and reported back to the weather-intensive processor. It will be converted to a regular gridded (raster) structure (and/or to a vector structure as the need arises) through interpolation or modeling. Terrain data will consist of point and spatial information such as elevation, soil type, vegetation type, roads, rivers, etc. in both vector and raster form. This data will be digitized manually and by CCD camera from existing hardcopy, entered from existing digital sources and generated by TDA models. Miscellaneous data such as vehicle specifications, structural information, capacity limits, etc. will be primarily textual or tabular and will be entered either manually or via digital media.

Meteorological data and miscellaneous data will be managed using the INGRESS Data Base Management System. This DBMS will be used to enter, update, manipulate and retrieve data items from disparate sources having many and varied interrelations. Terrain and other spatial data will be managed and manipulated using a hybrid public domain Geographic Information System consisting of ETL's version of the Analytical Mapping System (AMS), the Map Overlay and Statistics System (MOSS), the Map Analysis and Processing System (MAPS) and Battelle PNL's "homegrown" GIS. The GIS will provide the data creation, storage, modification and retrieval capabilities for all ATS vector and raster data.

The DBMS will be integrated with the GIS so as to facilitate the interchange of data. The vector and raster access and processing functions required for the development of TDA's, will be executed via the GIS.

Graphics Interface

Most ALBE TDA's produce graphic displays as their primary output, and many will utilize graphics input when interacting with the user. To maintain a consistent user interface and minimize duplication of effort, all TDA software will be supported by a common graphics interface. To achieve ALBE development and demonstration goals, the graphics interface will:

1) Be device independent at the TDA software level (TDA software need not be concerned with the type of graphics devices being used)
2) Support both graphics input and output
3) Provide output from low-level manipulation routines as either data items or graphics displays
4) Be extremely efficient when handling large amounts of data (many TDA's will combine both raster and vector images into a single display)

To be compatible with graphics packages, planned for implementation on systems for which ALBE software is targeted and to provide portability and device independence, the ATS will utilize a Graphics Kernel System (GKS) graphics package.

User Interface

The design and development of a consistent and effective user interface is an important requirement for the ATS. Field personnel must be able to interact naturally with the system, which should appear as a single coherent package. Since TDA's interact with users in both graphics and standard text modes, a comprehensive user interface package is being implemented to provide a consistent mechanism for performing both types of interactions. The user interface routines being implemented will provide the following functional capabilities:

1) Menu display and control functions
2) Online help functions
3) Forms control capabilities
4) Consistent function key support
5) Support for the handling of interrupt conditions.

Standardization on the use of colors, line and text types, and higher-level output such as graphs, histograms, and data tables will also be provided within the user (or graphics) interface modules.

DEMONSTRATIONS AND EVALUATIONS

ALBE demonstrations and evaluations will be conducted to obtain data to validate the effectiveness of ALBE products and facilitate transitioning of these products to target systems. These data will be used to support Pre-Planned Product Improvements and/or Product Improvement Programs for software upgrades on ALBE target system. It will also be used to satisfy other requirements for test and evaluation documentation as appropriate. The demonstrations and evaluations will be conducted in conjunction with the Army Development and Employment Agency with the support of the 9th Infantry Division (Motorized). The evaluations will be fully coordinated with the ALBE proponent, appropriate test activity and the combat and material developers of the ALBE target systems. The current ALBE evaluation schedule is as follows:

Aug 87	CPX	Fort Lewis
Jun 88	CPX	Fort Lewis
Oct 88	CPX	Fort Lewis
Mar 89*	FTX	Fort Bliss

*Tentative

IMPLEMENTATION STRATEGY

The ALBE program seeks to implement its TDA software and products on field Army systems in a timely fashion. To accomplish this ALBE representatives will be working with TRADOC to facilitate the fielding of these new capabilities in the shortest time possible. The intent is to deliver a quality product that functions properly, meets the user's needs and is fully supportable during its life cycle by troops in the field. Since most of the ALBE software is somewhat specialized and requires extensive terrain and environmental data as well as significant computational capability, not all systems will be able to implement the ALBE software. Some systems such as DTSS, ASAS and IMETS will have access to the required data as well as compatible hardware and software architecture and may be primary generators as well as consumers of ALBE products. Other systems such as the Maneuver Control System and the Engineer Command and Control System may become primary consumers of ALBE products, provided the communication links are available and sufficient to support transfer of the products from the primary generators.

This innovative implementation strategy takes advantage of on-going life cycle developments while incorporating new capabilities developed in the Army laboratories. This approach of demonstrating and evaluating software on a tech base demonstration system and then incorporating these capabilities into developing field Army systems should prove extremely timely and cost effective. If the ALBE products were to go through the normal life cycle process, their field implementation would be significantly delayed if not canceled. This would deprive battlefield commanders and their staff of terrain and environmental data which is vital to the decision making process.

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