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Electronic Mapping Systems, Inc.

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INTEGRATION OF AUTOMATED TOOLS WITH WIRELESS TECHNOLOGY FROM AN OPERATIONAL PERSPECTIVE

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Integration of Automated Tools with Wireless Technology From an Operational Perspective

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CHAPTER 1

INTRODUCTION

101. This paper discusses how the Integrated Marine Multi-Agent Command and Control System (IMMACCS) and the Wide Area Relay Network (WARNET) can be used to support mission accomplishment by improving command and control. IMMACCS and WARNET are important tools because (1) information overload threaten commanders and leaders at all levels, and (2) IMMACCS and WARNET provide a means to disseminate information more rapidly than was the case in the past.

Information overload seems a new threat to most people because they have experienced it only recently. The truth is that information overload has occurred repeatedly in history. Radar and code breaking, for example, created information overload in the 1930s. The Royal Air Force created the organizations and processes to handle the large amounts of data produced by its radar. As a result of the successful exploitation of radar, the Battle of Britain was called Great Britain's finest hours. Fifteen months after the Battle of Britain, the United States was caught by surprise at Pearl Harbor, even though the attacking Japanese aircraft were detected by U.S. radar and Japanese intentions to attack unspecified U.S. bases were clear in the messages decoded by the U.S. cryptographers. A close reading of the history of most apparent surprise attacks reveals that the indicators were available but hidden among other information. The Chosin Reservoir campaign is another classic example of this. The commander of X Corps was pressing the Marines to moving faster and spread out because he read his intelligence as indicating that there was no appreciable threat to the Marines. The Marine commander, Major General Oliver Smith, read the intelligence differently. As they say, the rest is history, with General Smith's superior information management leading to better intelligence and a military action that is celebrated because it occurred in circumstances that favored defeat.

Warfare has always been plagued by information received too late for it to be exploited or for a problem to be avoided. This information problem and the potential gain to be realized by reducing it has been captured in the concept of the Observe, Orient, Decide, and Act (OODA) loop. Using IMMACCS and WARNET, an intelligence analyst can create a piece of intelligence or an observation can be made and the resulting information entered into IMMACCS through the BVT. As soon as the intelligence or observation is saved in IMMACCS, anyone who has registered a need to receive that information will see it on his screen. Through its agents, IMMACCS can alert users to a variety of events (e.g., nearby enemy elements; a named area of interest (NAI), a target area of interest (TAI), or a decision point (DP) activated; a fire mission called on a friendly unit; or a fire mission recently received.)

These IMMACCS and WARNET capabilities hold the potential for members of a reconnaissance team or squad who observe something important to disseminate that information immediately to those who need it. As soon as a squad leader makes his report, those to his left

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and right can see a visual cue that a report had been submitted and they can easily access the report. The squad leader's superiors can also see and exploit this new information immediately.

As is common in all aspects of military operations, the exploitation of IMMACCS and WARNET requires imagination and planning. This paper describes IMMACCS and WARNET uses.

IMMACCS is a collection of software and data. WARNET is a communications system that exploits wireless technology to provide a communications vehicle over which IMMACCS can operate.

IMMACCS and WARNET are tools for leaders, commanders, and their staffs. IMMACCS and WARNET can only automate repetitive actions. The higher realms of warfighting that require critical judgement and intuition can only be accomplished by people with good judgement and solid experience.

102. Structure of This Paper. This paper is divided into five parts.

- a. Introduction, this part.
- b. Command and Control, a discussion of the command and control concepts that are particularly important to the effective use of IMMACCS and WARNET.
- c. Performing Warfighting Information Functions with IMMACCS, descriptions of IMMACCS functions (e.g., facilitating the creation of intelligence from SALUTE reports).
- d. IMMACCS and WARNET, a brief description of the aspects of IMMACCS and WARNET that are the most important to MSD II participants.
- e. Conclusion.

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CHAPTER 2

COMMAND AND CONTROL

201. The purpose of command and control is to support commanders with everything that is required for them to (1) receive important information, (2) analyze and understand it, (3) make good decisions, (4) disseminate their decisions, and (5) monitor unfolding events. While the tools of command and control change, their purpose remains the same - to place the right information in the right form in front of the right decision maker at the right time. Command and control aims to provide situational awareness.

Because the Marine Corps Doctrinal Publications (MCDPs) have excellent, detailed discussions of the concepts of command and control, this paper will touch on only those few concepts that are needed to:

- a. Understand how to adapt command and control processes to systems such as IMMACCS and WARNET, and
- b. Adapt IMMACCS and WARNET to command and control processes.

202. As every Marine learns early in his training, it is impossible to create or obtain absolutely complete and correct information. Those inclined to question this should remember that an infinite amount of information can be created on any object or situation. People learned long ago to create or collect only that information that is important to what they are doing. We are so accustomed to this approach that many of us think that when we collect the important information, we are collecting *all* the information.

The military has long conducted its command and control activities on the assumption that it can collect only some of the information, and that this should be the most important information. That is the reason for designating Commander's Critical Information Requirements (CCIRs), and Priority Intelligence Requirements (PIRs). As the amount of information available has increased, these concepts have become more important.

The military has also long provided staffs to commanders of battalions and larger units as aids in avoiding information overload. Each staff section monitors and manages a particular category of information. Because this need to have specialized staff sections stems from peoples' limited capability to absorb information, particularly in a rapidly developing situation, staffs are just as important with IMMACCS as without IMMACCS.

203. Of all the ways of looking at information requirements, none is more basic than:

Where am I?

Where are you?

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Where are they?

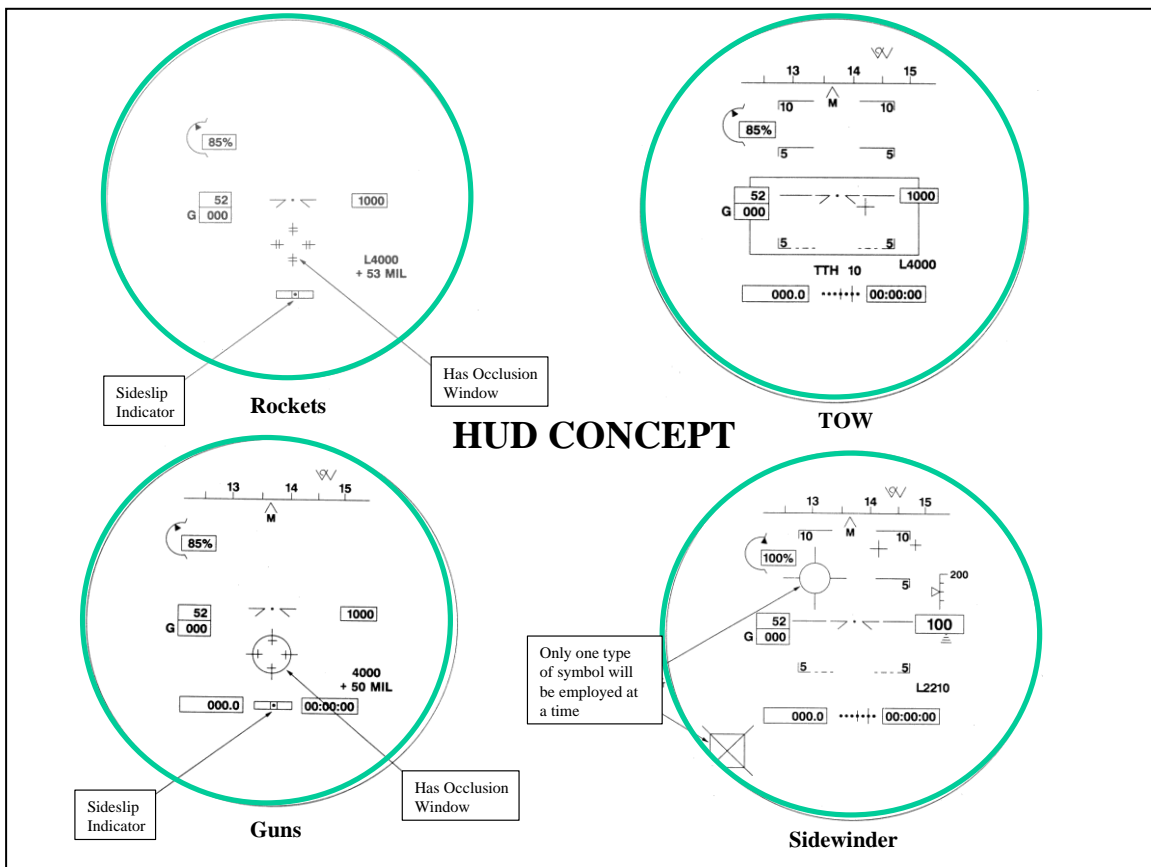
IMMACCS and WARNET, if focused properly, can answer these questions.

204. A great potential advantage of computer-based information systems is the capability to disseminate information simultaneously to any user with access to the command and control system. If a bridge is destroyed, all who need this information can receive it as soon as the information is entered into the command and control system. If a weakness is found in the disposition of enemy forces, it too can be readily known by everyone. This potential for shortening the Observe, Orient, Decide, and Act (OODA) loop is obvious.

205. People can keep track of very few changing objects at any one time. Usually, the limit is five to nine objects. (This is reflected in the statement that the span of control should not exceed seven subordinates.) When events are unfolding very rapidly, most people can keep track of only three objects.

206. It is a well-worn but true statement that a picture is worth a thousand words. Thus, overlays, maps and other forms of images are used extensively in command and control. Every operations center has map boards. Operations orders usually include maps or overlays. Pilots use heads-up displays and digital map screens.

Interestingly, it has been found that visual information displays are most effective when they show only a few objects of interest, usually five to nine. An operations center may have big map displays with many details, but most of those details such as contour lines, road networks, and rivers provide a background against which to view the few objects of interest. The image below,



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taken from four Cobra helicopter heads-up displays, provides examples. The terrain outside the helicopter provides the background or context against which the few pieces of information in the heads up display are viewed. Notice that the information varies with the weapon to be fired. An information display appropriate to one weapon (and situation) is not appropriate to another.

207. The concept of a common tactical picture (CTP) was framed several years ago to explain the potential impact of computerization on command and control. As was explained above, many past battlefield failings have stemmed from the failure of commanders to have available all the information they needed. If all commanders could share the same picture, a common tactical picture, the reasoning went, failings due to inadequate information management would be a thing of the past.

208. As is clear from the four heads-up displays, an information display that is right for one commander is not right for another. And a single information display that provides the information needed by both commanders will create information overload.

209. It follows, then, that information requirements will vary by mission and echelon, with one commander's critical information being a source of information overload for another commander. Information needed by the MAGTF commander will be different than the information needed by the commander of Company L. The area of interest to Company L will be different than the area of interest to Company C. IMMACCS, with the Battlespace Visualization Tool (BVT), has the capability to edit or focus the information display so that the area and objects overlaid in that area are appropriate to the circumstances. The common part of the tactical picture is a database accessed through IMMACCS and WARNET. Because of the briefness of Major System Demonstration II (MSD II) and the relative youth of IMMACCS, the displays produced with IMMACCS will fall far short of what they might they be were MSD II longer. The IMMACCS use in MSD II merely points us in a direction and allows us to keep moving down a road of leveraging technology.

210. One way to improve displays is with data reduction - reducing large quantities of data to the few important pieces of information through analysis and filtering. The aim of data reduction is to facilitate situational awareness. One example is computing the average of 100 numbers. A military example is the intelligence preparation of the battlefield (IPB) process. Users of this process start with scores, hundreds, or thousands of pieces of data representing hills, roads, rivers, marshes, towns, enemy units, weather, and the many other elements that collectively describe the site of a probable military action. Using the IPB process, successive new pieces of information are created until a few Named Areas of Interest (NAIs), Target Areas of Interest (TAIs), and Decision Points (DPs) are created. Military use of data reduction is not limited to the IPB process; all military planning involves data reduction in some form. IMMACCS is used as a tool for data reduction and a tool for recording the results of data reduction completed outside of IMMACCS.

211. When IMMACCS developers talk about using it to create knowledge, they are talking about using IMMACCS as a data-reduction tool to identify the few important pieces of information that will create situational awareness in the minds of skilled commanders.

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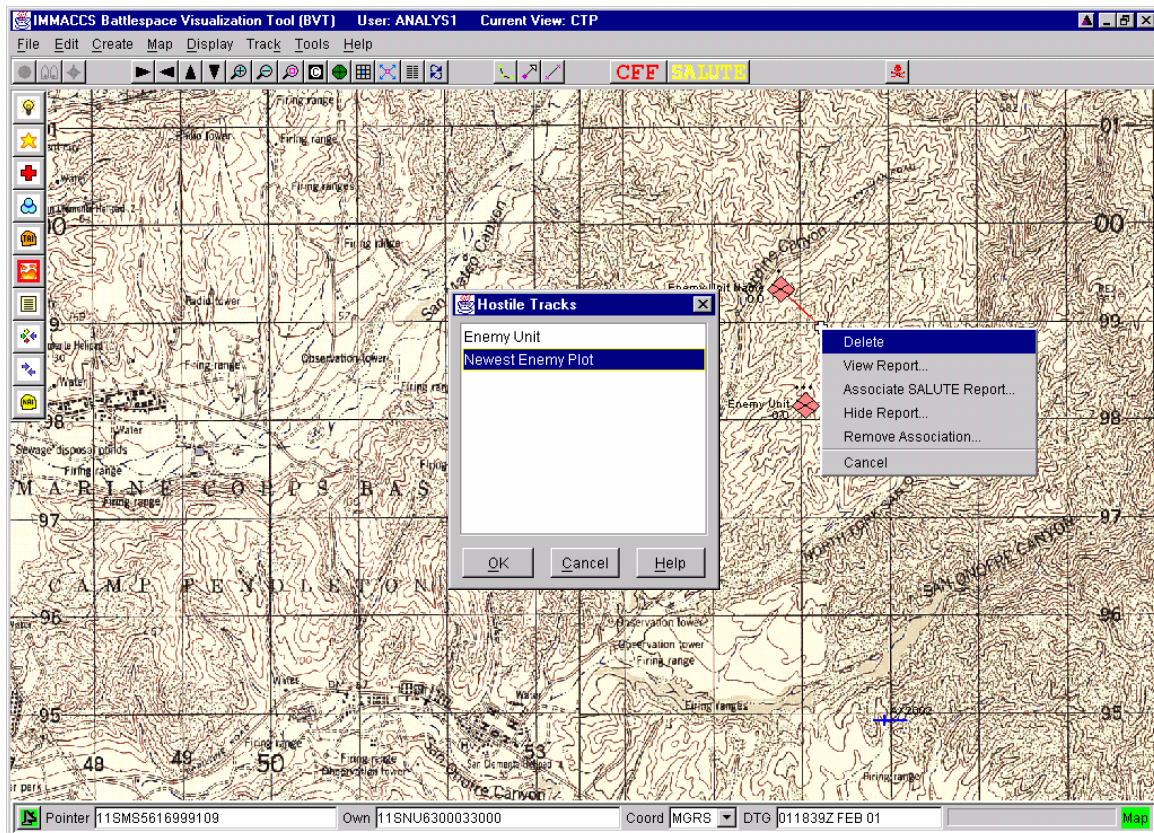
CHAPTER 3

PERFORMING WARFIGHTING INFORMATION FUNCTIONS WITH IMMACCS

301. IMMACCS can be used for the following warfighting information functions:

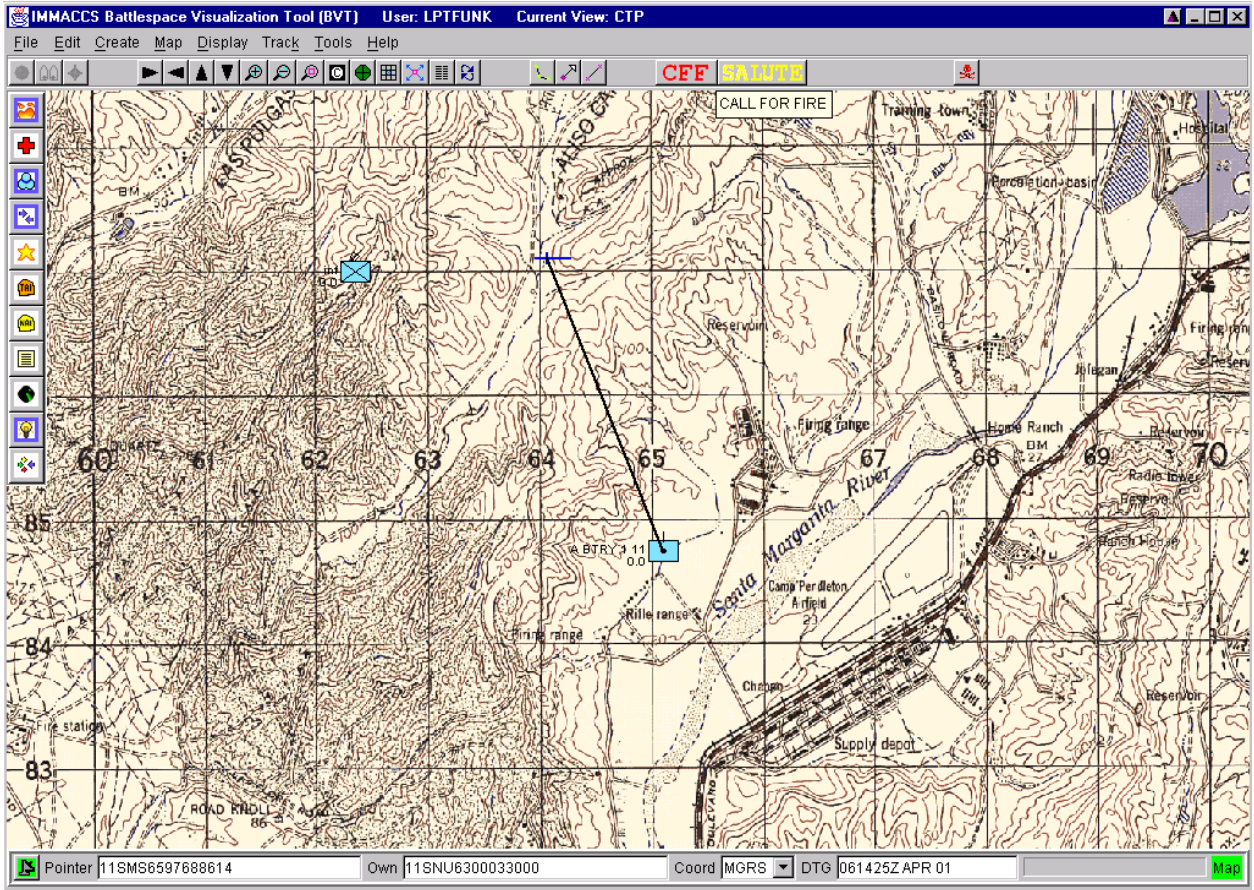
a. **Data reduction with SALUTE reports to produce intelligence.** An intelligence analyst can use IMMACCS and its Battlespace Visualization Tool (BVT) to assist in correlating reports of enemy activity by establishing relationships between SALUTE reports and enemy units. SALUTE reports (and other intelligence) will come from various sources, with various levels of accuracy, and various delays,. When an intelligence analyst displays all of the reports available, he often is confronted by ambiguity. Some software exists to help to correlate reports of enemy activity, but the intelligence analyst must still resolve some of the ambiguities using his own judgment.

Using IMMACCS and its BVT, an intelligence analyst can reduce the data on his screen by first creating an icon for the enemy element he believes exists. He can then “associate” the enemy unit icon with the icon of the SALUTE report(s) that led the analyst to believe the enemy element is where he thinks it is. Subsequently, the analyst can hide the SALUTE report’s icon. The report and its icon will be available if needed but do not otherwise clutter the map display.



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b. **Information processing and display for fire support coordination.** As can be seen in the image below, BVT can present a map showing the target, firing unit, and gun-target line. Such displays facilitate analysis and coordination by inspection.

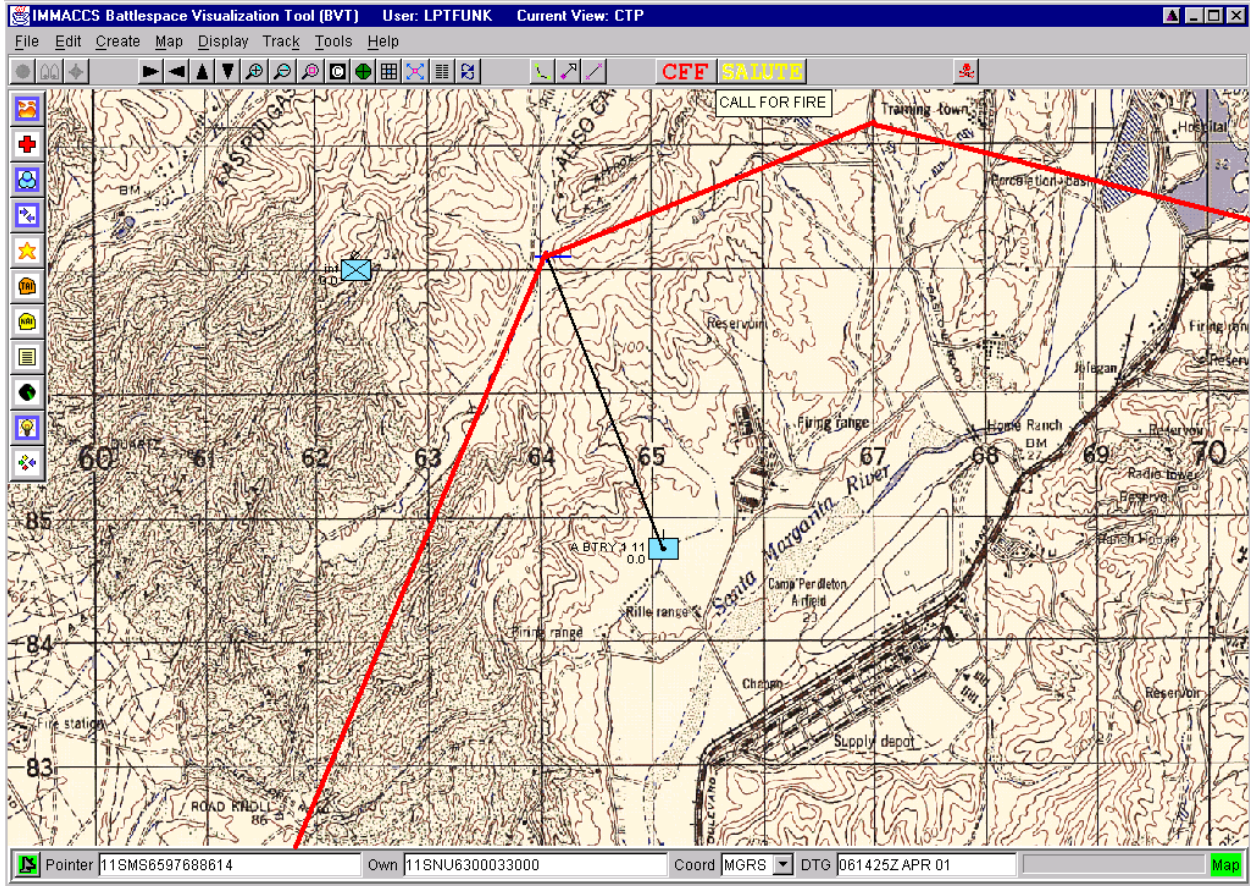


In processing fires, IMMACCS interacts with AFTADS and LAWS and provides fire support coordination tools to monitor the progress a mission's coordination. The image below is a sample IMMACCS information display.

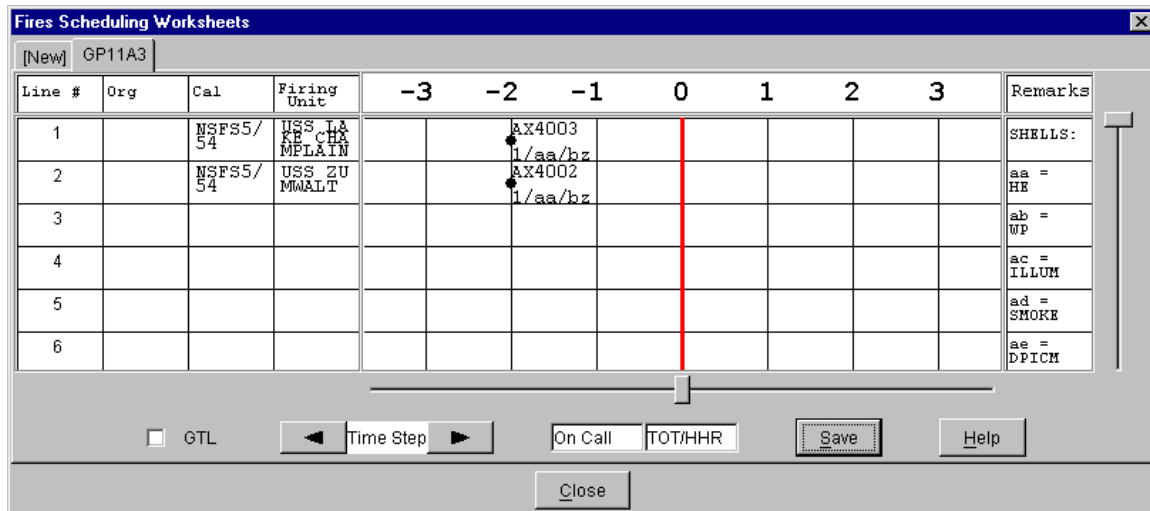
Mission Coordination: Fires											
Tgt No.	Description	Nominator	Max Ord	GTL	Firing Unit	Munition	FSC	ALO	NLD	WRD	FRD
AX4001	CFF-ARMOR /HV	KCO					■	■	■	■	■
AX4002	CFF-ADA /HV	KCO			USS ZUMWALT	HIGH EXPLO	■	■	■	■	■
AX1001	CFF-CEN /UNK	M_DPSCHF					■	■	■	■	■
AX4003	CFF-ARMOR /HV	KCO					■	■	■	■	■

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c. **Information processing and display for integration of air and surface fires.** As can be seen in the image below, the BVT can present a map showing the target, firing unit, gun-target line, and the planned path of an aircraft. Such displays facilitate analysis and coordination by inspection. (The planned path of the aircraft must be inserted manually.)

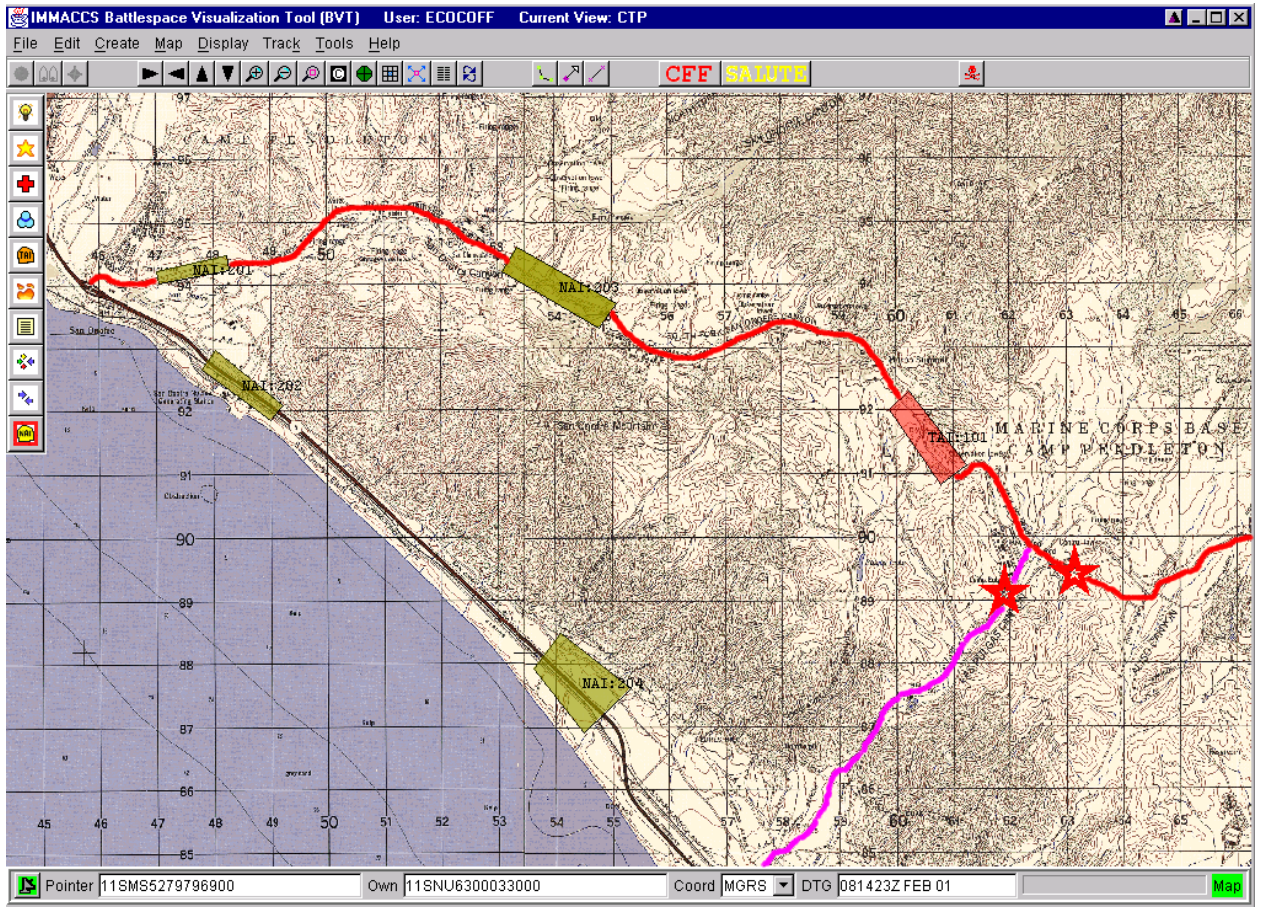


d. **Fire planning.** IMMACCS includes features to support building a fire plan. The image below shows an IMMACCS fires scheduling worksheet.

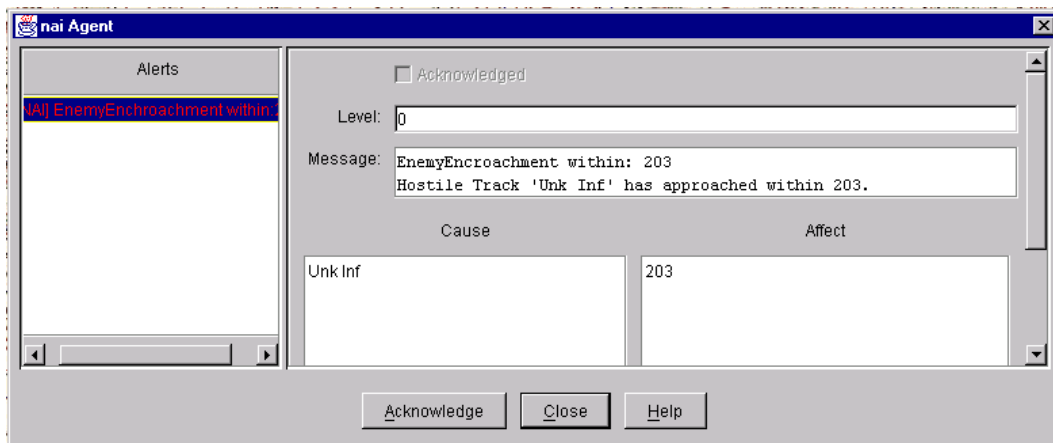


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e. **Providing assistance with creating and monitoring NAIs, TAIs, and DPs.** The map below is an example of a BVT display showing a hostile force's most likely course of action, its most dangerous course of action, NAIs to assist in monitoring the hostile force's movement, TAIs to assist in targeting the hostile force, and DPs to assist in making timely decisions in rapidly developing situations.

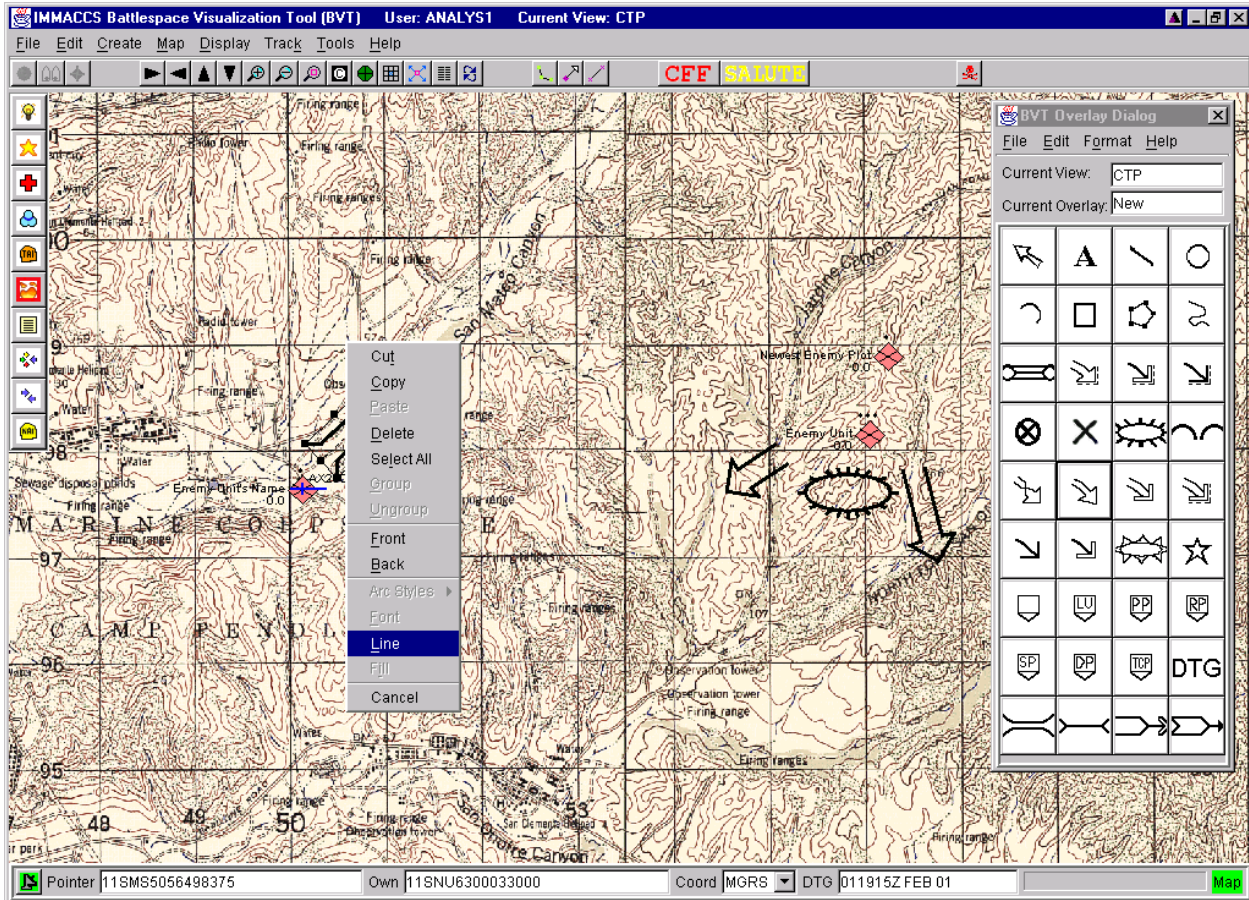


When IMMACCS receives information that hostile elements are passing through an NAI or TAI or within a given distance of a DP (the distance having been designated by the BVT's user), IMMACCS provides an alert and additional information. See below.



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f. **Create and display overlays.** IMMACCS provides tools for creating overlays. (The number of graphics that can be created is limited.) WARNET provides the means to disseminate an overlay throughout a force. The image below shows an overlay created with the BVT, along with the overlay graphics available in the BVT.



Note: Successful exploitation of the overlay capability will require a plan for naming and using overlays.

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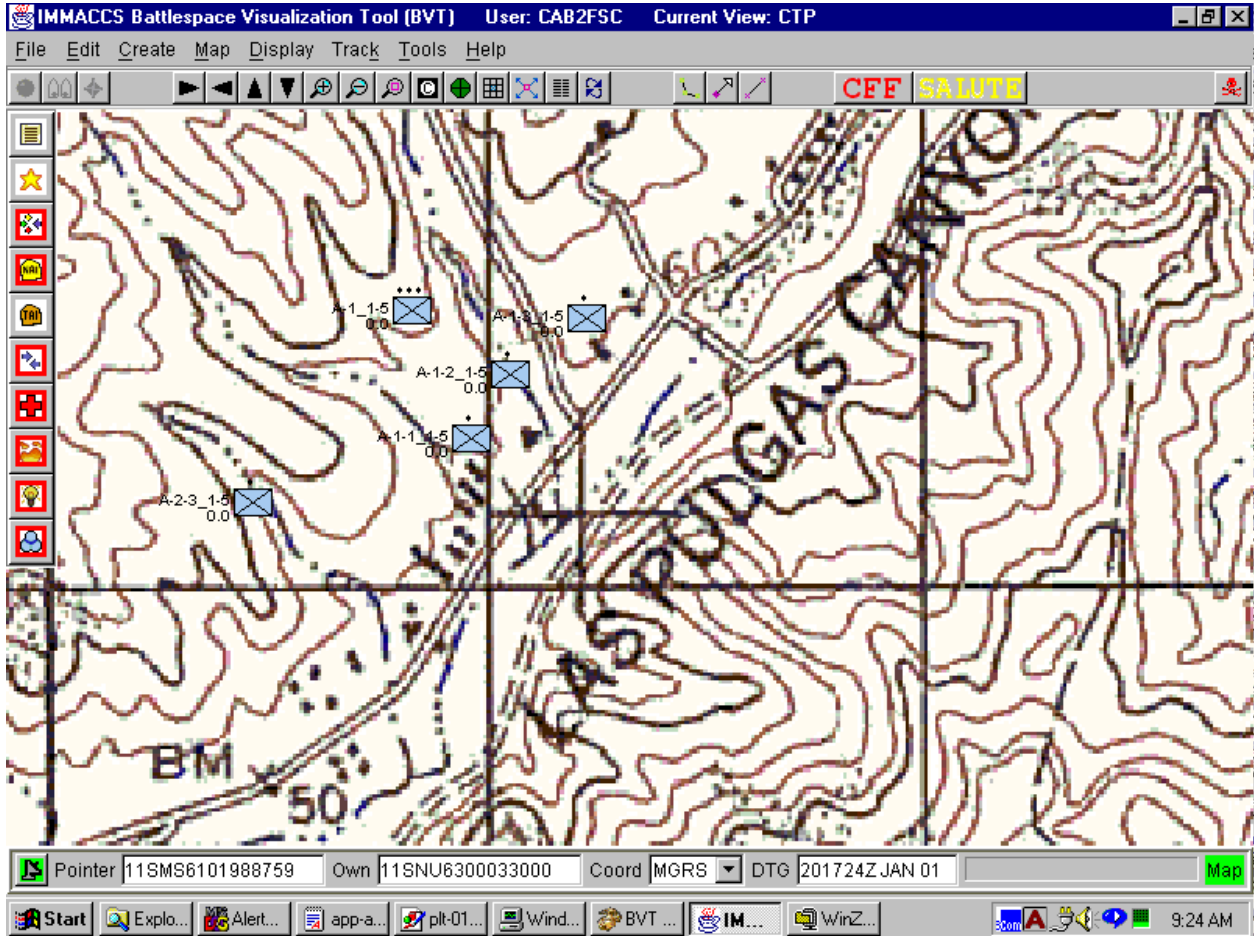
g. **Maintain accurate maps.** Because of the tremendous effort required to create a map, the National Imagery and Mapping Agency (NIMA) is able to revise its 1:50,000 scale maps only about every six to 10 years. This means that NIMA's maps are usually several years old. IMMACCS has the potential to improve this situation and make it more manageable. Most of the features (e.g., hills and rivers) on topographic maps such as the map shown below remain unchanged for decades if not centuries. There are only a few features that change and are important to military operations. These can be represented as icons on a BVT overlay and updated the same way any feature on an overlay would be updated.



Note: For this capability to be effective, careful planning is needed to ensure important requirements are identified and irrelevant features are not designated for plotting and updating. As with all else in information management, unneeded information can hinder the processing of important information and lead to the unimportant obscuring the important on information displays.

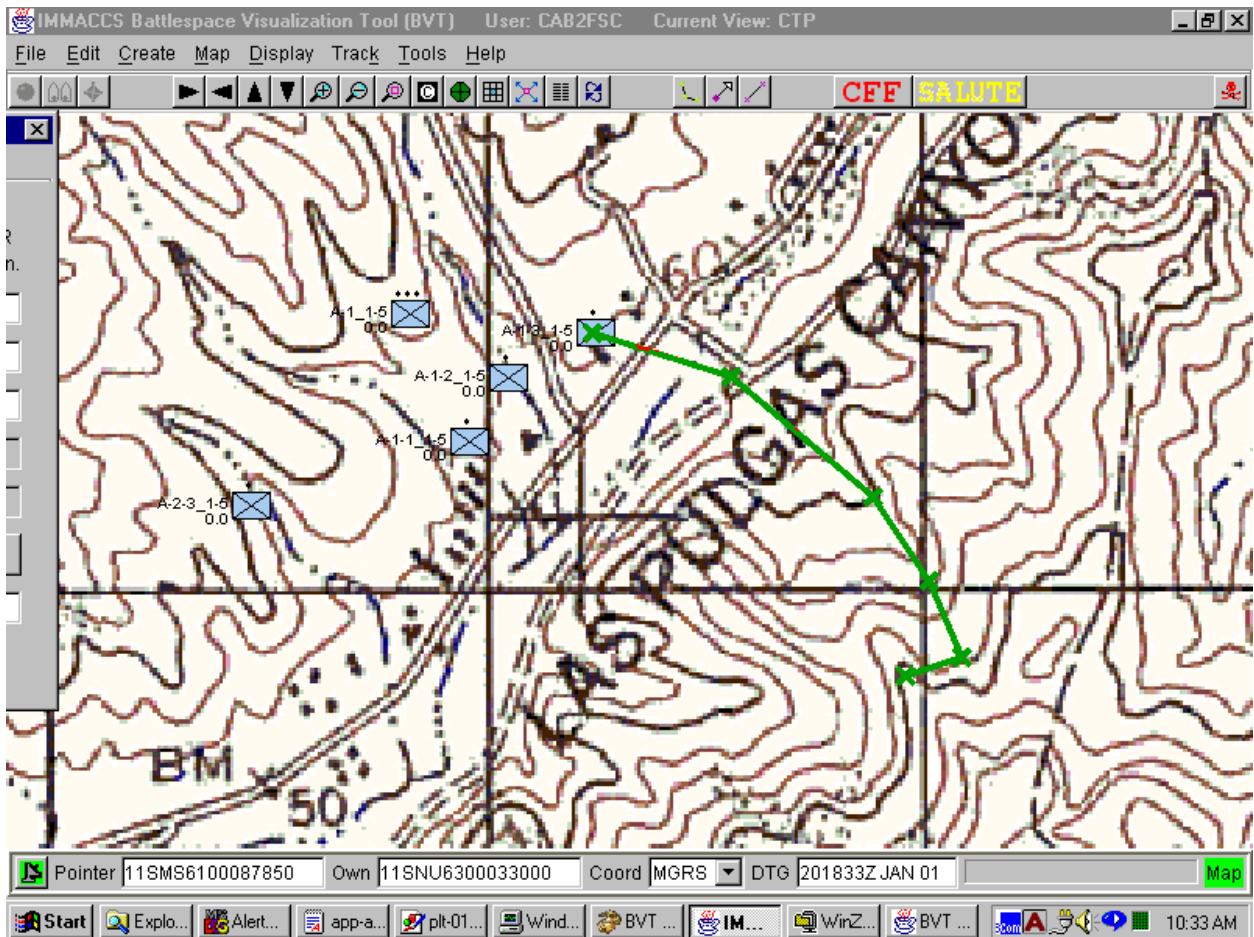
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h. **Providing small unit leaders (e.g., squad leaders) with map displays of their immediate area.** An example is shown below. Note the adjacent platoon. Note also that the squad leader's display is tailored to his needs.



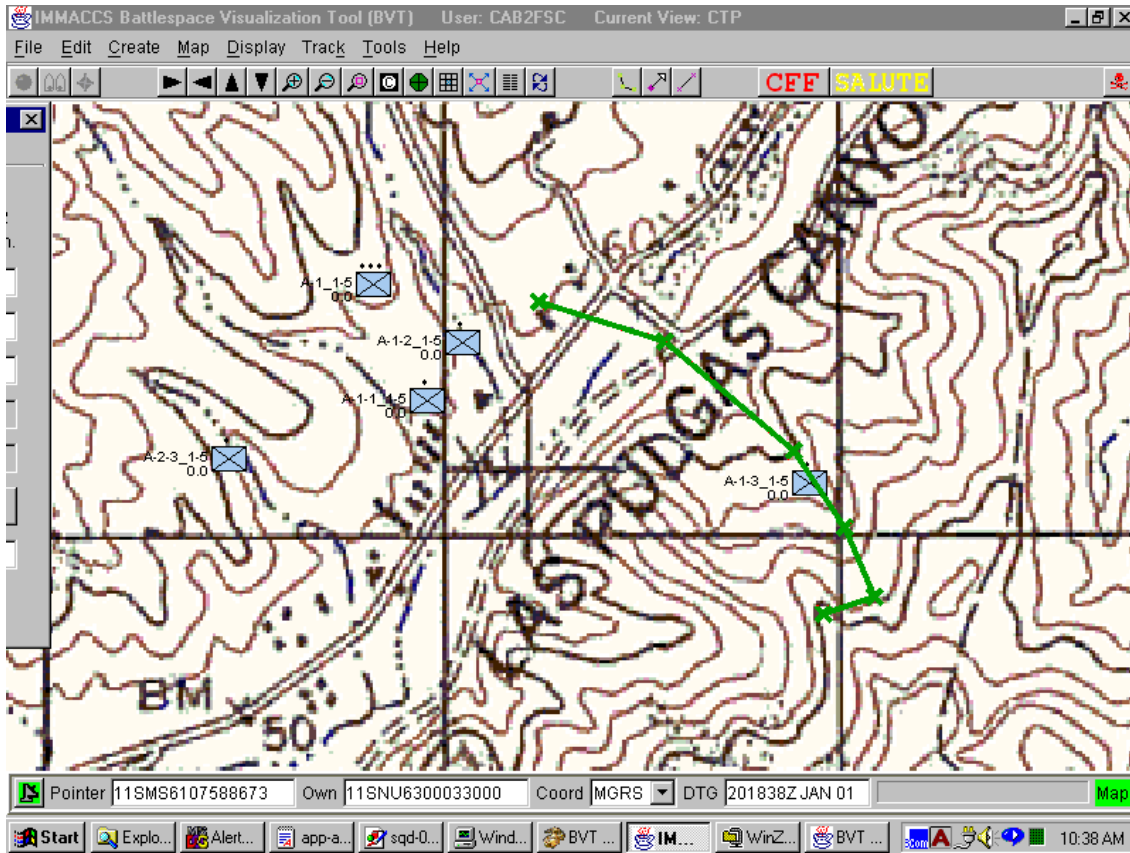
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- i. **Providing small unit leaders with overlay operations orders.** An example is shown below. The green line indicates the route the squad is to take. (Technically, the line depicting the route in this BVT display is called a route, not an overlay, but the effect for the new user is the same.)



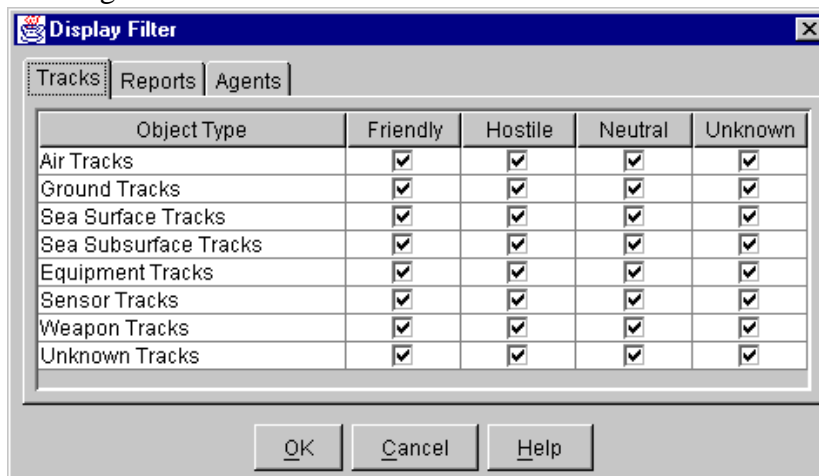
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j. **Monitoring the progress of a unit.** In the example image below, a squad's location is shown against a map as it follows a designated route. Using IMMACCS and WARNET, this image can be shared by other squad leaders, the platoon leader and those whose BVT viewing area includes the squad's position.



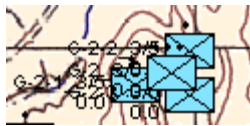
k. **Focusing map display.** The BVT includes a number of features for focusing an information display.

(1) Filtering. The interface is shown below.



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(2) Aggregating Based on Command Relationships. The image on the left shows the location of a platoon leader and his squad leaders. The image on the right is the display of the same unit after the BVT aggregation feature has been used to simplify the display. This is possible because the BVT includes a feature (the Force Administrator) for recording command relationships. Once the relationships between a platoon leader and his squad leaders have been recorded in IMMAGCS with the BVT, the display can be simplified with a few simple actions using a mouse.

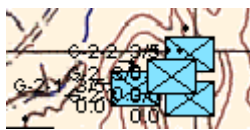


Icons without aggregation

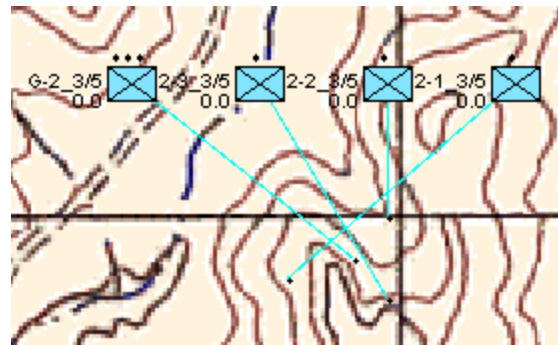


After aggregation

(3) Declutter. The image on the left shows a display cluttered with the icons for a platoon leader and his squad leaders. The image to the right shows the unit after the BVT declutter feature is turned on.



Icons without declutter



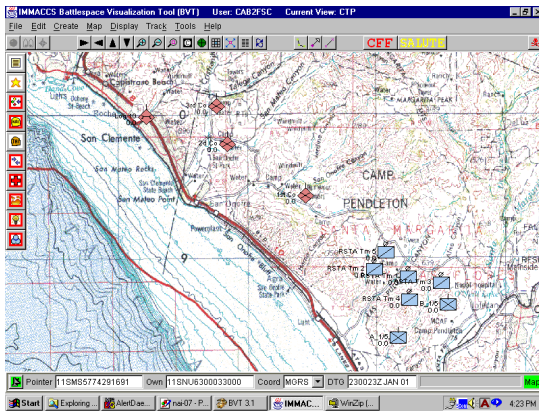
After declutter

(4) Hiding Icons. If A BVT user does not want to represent a specific unit on the screen, the icon representing the unit can be hidden. The icon will not be visible, but the unit's information will remain in the database and can be made to reappear on the BVT map when it is necessary to know the unit's location.

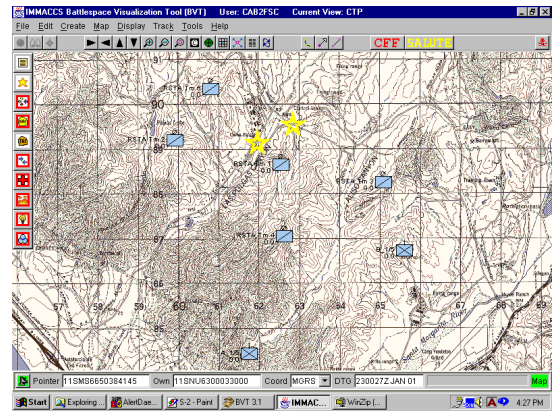
Note: When the features above are used, they affect only the BVT on which they are used.

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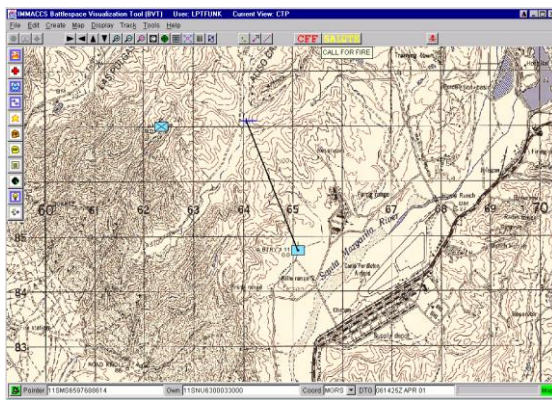
(5) Using these features to focus a map display, company commanders, platoon leaders, and squad leaders can tailor their BVT view to meet their needs. At a battalion or higher headquarters, where more information is received than any single member can monitor and understand, the BVT can be used to divide the information between staff sections. The images below show such displays. (Some readers will be struck by the similarity of the display below to the four heads-up displays shown earlier in this paper. The reason for this division of information is the susceptibility of people to information overload.)



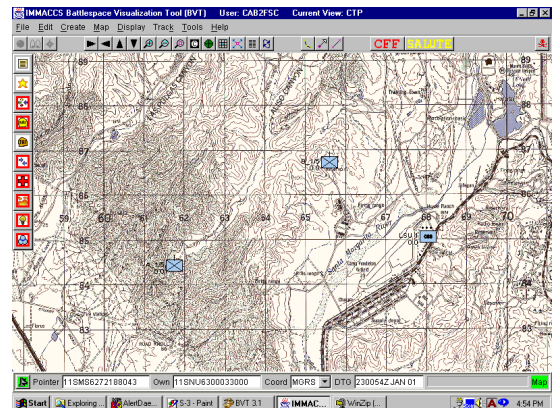
S-2



S-3



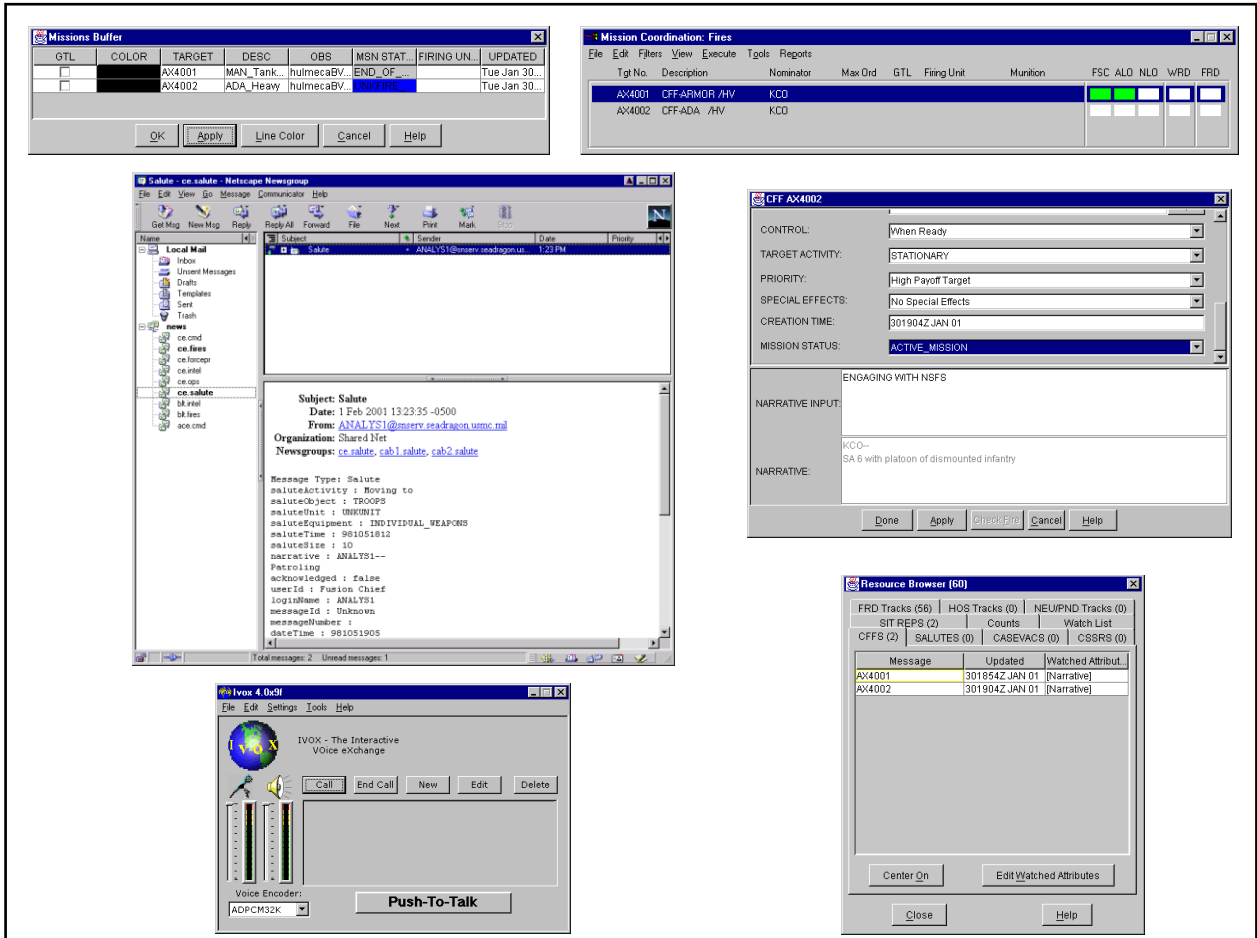
FSC



S-4

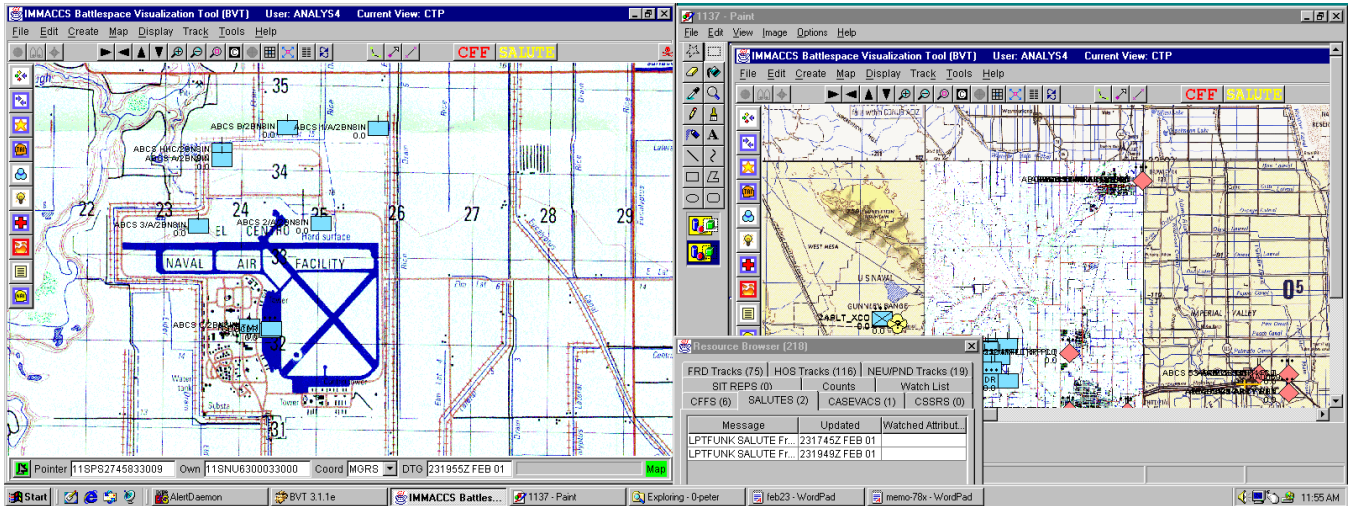
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1. **Task organized information displays.** The IMMMACCS and Microsoft software in use on computers in battalion and higher headquarters can display information in many forms. It would be impossible to have an effective information display if all the software available was used in all the possible ways. However, effective information displays can be developed by carefully selecting and organizing the displays based on the tasks to be performed by the BVT user. The image below shows a few of the non-map windows that can be opened in IMMMACCS.



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The image below is an example of organizing a display based on the tasks to be performed by the display's user, possibly an operations officer in this case.



m. An **electronic operations log** can be kept that uses hyperlinks in a Microsoft Word document to connect individual log entries with images created by BVT screen saves. This will reduce log notations because the log will include maps illustrating the specific details of a reported situation. Here is a sample log.

LOG

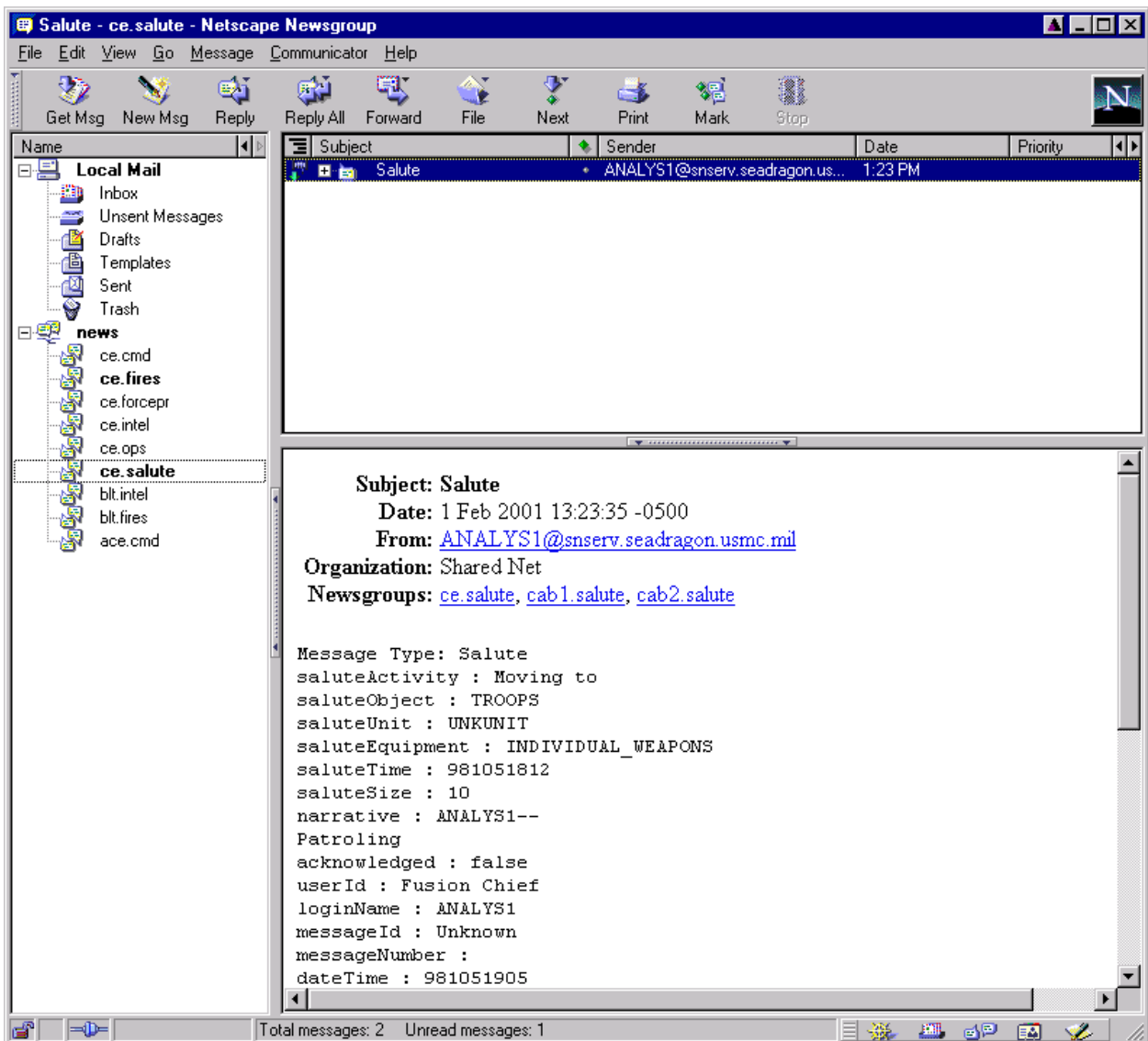
- 0830 Opened Log.
- 1013 [Situation](#) in MCTSSA area as units prepare to move.
- 1017 [Movement](#) of units at MCTSSA.
- 1023 [“Sizeable enemy force”](#) reported.
- 1025 [Jedi9](#) moved.
- 1033 [2ASLT_XCO](#) leaving MCTSSA.
- 1034 [2ASLT_XCO](#) moves further.
- 1050 [Enemy squad](#) appeared.

n. **Creating electronic briefings.** High-quality, timely briefings can be created using Microsoft PowerPoint and the BVT screen saves created for an electronic log. The PowerPoint presentations can be used at (1) the daily briefing (often given at 2000) for a commander and his staff, (2) meetings with visitors, and (3) watch changes.

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o. **Preparing map reports for higher and supporting commanders.** This capability is more important than it may appear. As the amount of information available to all levels increases while the number of truly important pieces remains the same, it is more and more difficult to identify or create the few important pieces of information.. Higher and supporting commanders will need assistance to understand the situations of their subordinates and those they are supporting. As the available information increases, it becomes more unreasonable to expect a superior to understand a subordinate's situation just because the superior commander has access to several hundreds or thousands of pieces of information on the subordinate's situation. If OODA loops are to be kept short, subordinates must be prepared to provide their superiors with maps that show only the few important pieces of information necessary for the superior to understand the situation. With IMMACCS, such maps can be created.

p. **Providing Discussion Groups.** IMMACCS includes news groups, electronic forums through which those with common concerns can communicate. The image below lists examples of the news groups that might be available.



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q. **Interacting with and between small units.** When supported by WARNET, information entered into IMMACCS can be disseminated to all nodes as soon as the data entry is completed (i.e., saved). Higher headquarters, of course, has information that the small units neither need nor are interested in. There is information at higher headquarters, however, that should be shared with anyone whose mission has caused him to create a map display that includes that information. Examples include reports that a bridge has been destroyed or repaired or that road has been mined or cleared.

There is also a need for information collected by the small units to be shared with other small units (examples again include bridges destroyed or roads mined). IMMACCS and WARNET provide means to do this.

This potential can only be realized, however, if positive measures are taken to avoid information overload. Information priorities must be established and promulgated, and then adjusted as a situation develops. While the concepts for identifying information requirements are old, their application for small unit information sharing through IMMACCS is new.

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CHAPTER 4

IMMACCS AND WARNET

401. A Layman's View of IMMACCS

a. Introduction. Because IMMACCS is a software system, its functions and parts have been given names that only a programmer could love. This paragraph explains the basic parts and functions of IMMACCS using layman's terms and the technical terms. While it would be desirable from the perspective of Marines not familiar with the technical software names to give IMMACCS parts and functions names familiar to Marines, it is too late to do that. The language of computer programming is too well established to be reinvented by Marines.

b. The backbone of IMMACCS is named **Shared Net**. Of all Shared Net's functions, the two most important are to:

(1) Maintain a database called the **Object Instance Store (OIS)**. It is in the OIS where all records of specific objects on a battlefield such as individual friendly units and hostile units are stored. If an icon appears on a BVT display, it almost always has a record (called an object) in the OIS.

(2) Disseminate information throughout IMMACCS. Shared Net performs the communications tasks once done by messengers who carried yellow pieces of paper from a company commander to a platoon leader.

c. If someone goes to the S-2's office, he or she can get pamphlets explaining the important characteristics of various pieces of enemy equipment. These books are written and distributed because Marines who understand the capabilities of enemy equipment can select positions and take actions to minimize an enemy's capabilities. Similarly, the capabilities of various types or classes of objects (as opposed to specific or individual objects) have been created and compiled in an **Object Library**. The capabilities are recorded as a list of attributes for each object in the Object Library. The objects and attributes selected for recording in the object library are those that are important in military operations, characteristics such as the speed and weight of a T-72 tank and how deep a stream the T-72 can ford. These attributes provide the information needed by the software to create information of tactical value such as whether an enemy force can cross a particular bridge or ford a particular stream. Once the attributes are entered into the computer system, the calculations required to answer tactical questions related to objects in the object library are done far faster by a computer than by a person. When software developers say that IMMACCS creates knowledge, they are referring to this capability to create information of tactical importance.

d. **Agents** are software routines that create the important information or knowledge based on the detailed attributes for each type of object. Some agents so far incorporated into

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IMMACCS provide warnings when incoming reports place hostile forces in NAIs and TAIs or within a specified radius of a DP. Other agents warn when SALUTE reports or fire missions are received. Some agents warn when hostile forces come within a certain distance of a friendly unit or when fires have been called on the reported location of a friendly unit.

e. The **BVT** provides a visual interface with which to look at map displays of data contained in or being process by IMMACCS. The BVT also provides a means to create specific NAIs, TAIs, or DPs; to create overlays and routes; and to submit or view SALUTE reports and calls for fire. The BVT is also used to enter or update information.

f. It is important to understand the nature of **Object-Oriented software**. This software works with (as the layman can guess) objects. What this really means is that the data and software used in object-oriented programs such as IMMACCS are divided into small pieces (called objects). A particular operation by object-oriented software will use only those objects that are relevant. All the software objects need not be used together.

The use of objects is a ‘non-continuous’ approach. When someone does an operation with IMMACCS, it does not run through a long predetermined sequence of software actions that use most of the software objects. Rather, if a report is received indicating that a hostile unit has entered an NAI, the NIA agent runs and activates the NAI agent icon. If a new enemy unit is reported, the appropriate icon appears in the appropriate place.

The “non-continuous” nature of object-oriented software is important because as MCDP 1, *Warfighting*, notes, warfare is also a non-continuous activity. Object-oriented software, thus, has a better potential to create more realistic representations of military operations than do earlier types of software.

402. **WARNET** is the communications system created to (1) exploit wireless technology and (2) move information throughout a MAGTF, thereby exploiting IMMACCS’ potential to improve situational awareness and abbreviate commanders’ OODA loops. This communications capability is important because it helps commanders to maintain the initiative when it depends on rapid information processing.

WARNET has nodes on the ground and in the air. Because of the volume of information generated by modern sensors and military operations, WARNET uses software to control the flow of information between its nodes. Also because of the volume of information and the availability of different communications technologies, WARNET has three levels of communications which must be coordinated.

Thus, while WARNET includes many technological advances, it still requires fine-tuning and consideration of factors such as the limitations of line-of-sight communications.

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CHAPTER 5

CONCLUSION

501. IMMACCS and WARNET are similar to other command and control tools such as telephones, radios, and acetate overlays. All of these tools have the potential to improve commanders' ability to form superior situational awareness, thereby facilitating mission accomplishment. Thorough planning and training are required for any command and control tool to improve decision making, whether the tool is a telephone, radio, acetate overlay, or IMMACCS and WARNET.

As in all areas of warfare and at all times in history, the imagination, creativity, perseverance, and initiative of those on the ground will be more important than any command and control tools.

For the squad leaders, platoon leaders, and company commanders, IMMACCS and WARNET hold the promise of helping to answer the following questions about their immediate area:

Where am I?

Where are you?

Where are they?

For battalion and higher headquarters, IMMACCS and WARNET hold the promise of providing better information displays. Because of the limited capability of people to absorb information, it will still be necessary for different staff sections to monitor different categories of information. However, using IMMACCS and WARNET, each staff section will have better information because:

- a. Displays will show only the information important to its user;
- b. Users will have immediate access to supplementary information through map icons;
- c. Software will automatically update information; and
- d. Software (agents) will automatically create and display new and important information.