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Integrated Eagle/BDS-D Research Resolution Of Behavior Representation Methods Of CCTT SAF And ModSAF Interim Report: Behavior Representation Integration Techniques

Clark R. Karr
Mikel D. Petty

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Behavior Representation Integration Techniques

Interim Report
Integrated Eagle/BDS-D
Research Resolution of Behavior Representation Methods of CCTT SAF and ModSAF

Interim Report

Behavior Representation Integration Techniques

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Table of Contents

0. Executive Summary .................................................................................. 1

1. Purpose ..................................................................................................... 2

2. Background ............................................................................................... 2

   2.1 CCTT SAF and ModSAF ..................................................................... 2

   2.2 Research Plan and Report Structure .................................................... 2

3. CIS General Information .......................................................................... 3

   3.1 Sources ............................................................................................... 3

   3.2 Elements of a CIS .............................................................................. 3

   3.3 Complexity ........................................................................................ 4

4. Differences Between CCTT SAF and ModSAF ..................................... 5

   4.1 Command and Control Hierarchy ......................................................... 5

   4.2 CGF Services ..................................................................................... 5

   4.3 Task Management .............................................................................. 6

      4.3.1 Task Scheduling (Priorities and Hierarchy) .............................. 6

      4.3.2 Task Execution (Ticking and Task Transitions) .................... 6

   4.4 Reactive Behaviors .......................................................................... 6

   4.5 CCTT SAF FSMs vs. ModSAF AAFSMs .......................................... 7

   4.6 Environment and Terrain .................................................................. 7

      4.6.1 Environment ............................................................................ 8

      4.6.2 Terrain .................................................................................... 8

   4.7 Non-DIS Network Communication .................................................... 8

   4.8 Code Sharing ................................................................................... 8

   4.9 Crew-level behaviors ....................................................................... 9

   4.10 Conclusions of Differences Between CCTT SAF and ModSAF .......... 9

5. Prototype Implementation ....................................................................... 9

   5.1 B0025 Conduct Hasty Occupation of a Battle Position ................... 10

      5.1.1 CIS Description ....................................................................... 10

      5.1.2 IST Approach .......................................................................... 11

      5.1.3 Implementation Evaluation ...................................................... 18

   5.2 HVY-0022 Assault an Enemy Position ............................................. 19

      5.2.1 CIS Description ....................................................................... 19

      5.2.2 IST Approach .......................................................................... 20

      5.2.3 Implementation Evaluation ...................................................... 26

6. Lessons Learned ..................................................................................... 27

7. Conclusion ................................................................................................ 28

8. Acknowledgment ...................................................................................... 28
9. References ................................................................. 28

10. Appendices ............................................................... 31

10.1 CIS Outline of Content ................................................. 31
    10.1.1 SECTION A. IDENTIFYING AND ADMINISTRATIVE DATA .......... 31
    10.1.2 SECTION B. DOCTRINAL FRAMEWORK FOR CIS ....................... 31
    10.1.3 SECTION C. ACTIONS TAKEN ............................................... 31
    10.1.4 SECTION D. CHANGES IN CIS STATUS .................................. 32
    10.1.5 SECTION E. BATTLEFIELD OPERATING SYSTEMS (BOS) COORDINATION .... 32

10.2 CIS: B0025 – Conduct Hasty Occupation of Battle Position .......... 33

10.3 CIS: HVY-0022 – Assault an Enemy Position .......................... 40
0. Executive Summary
As CGF systems have matured over the last ten years, they have been applied to solving increasingly difficult problems. The analysis community would like to use CGF systems that portray battlefield effects at the individual vehicle level. For credible analysis, CGF behaviors must be derived from military doctrine and should be traceable back to that doctrine. Unfortunately, this is not the case with current ModSAF behaviors. To be useful in these situations, ModSAF’s behavioral limitations must be addressed.

The CCTT SAF program has undertaken a large knowledge engineering effort to produce realistic CGF behaviors. Part of this effort transforms military doctrine into Combat Instruction Sets (CISs), a natural language description of tactical behavior. Because they are based on CISs, CCTT SAF behaviors are traceable to military doctrine.

This project’s goal is to research methods of incorporating these CISs into ModSAF. This has consisted of several phases of work. The first phase was to research CISs to understand their structure and complexity. Next, IST enumerated differences between CCTT SAF and ModSAF that could affect CIS integration. Then CCTT SAF code and corresponding documents were used to provide more insight into the CCTT SAF environment and its implementation of selected CISs. Lastly, two prototype CISs were implemented in ModSAF. This proof of concept successfully illustrated the feasibility of incorporating traceable behaviors in ModSAF.

By examining the CATT-Task database, IST found that a core group of CISs are frequently used by other CISs. This core group of CISs is a good starting point for future CIS integration. More examination of the CATT-Task database is necessary to fully enumerate this list. IST determined that many of the more than one hundred enumerated issues between the two CGF systems will only slightly influence the resulting behaviors. Some of the more important issues (e.g., terrain) should eventually be addressed by the ModSAF development community. The CIS prototypes helped formalize the design process for the implementation of CISs in ModSAF by revealing areas that could be automated and highlighting design characteristics of ModSAF.
1. Purpose
The analysis community needs CGF systems with realistic behaviors. For credible analysis, CGF behaviors must be derived from and traceable back to military doctrine. This is not the case with current ModSAF behaviors. ModSAF behaviors are derived from military doctrine (Smith 1996), but are not strictly bound to it. ModSAF behaviors are often missing many details of military doctrine. To be useful, ModSAF’s behavioral limitations must be addressed.

CCTT SAF behaviors are based on Combat Instruction Sets (CISs), a natural language description of military doctrine (Ourston et al. 1995). CCTT SAF behaviors are closely bound to military doctrine and include more details from the doctrine than ModSAF’s behaviors. One way to improve ModSAF’s usefulness to the analysis community is to integrate CISs into ModSAF. This integration will lead to realistic interactions of forces between the two systems, or behavior interoperability.

The U.S. Army TRADOC Analysis Center (TRAC) asked IST to determine the feasibility of integrating the behaviors embedded in CCTT SAF within the structure of ModSAF. This approach recognizes that the CCTT SAF and ModSAF architectures are similar enough to make this a reasonable goal. By integrating CISs into ModSAF, progress can be made on a variety of ModSAF problems, including using ModSAF for analysis, using ModSAF to support Command Forces, and using ModSAF in conjunction with CCTT SAF.

2. Background
Before outlining the issues behind adding CISs to ModSAF, some background information is necessary to describe the CGF systems involved and IST’s research plan.

2.1 CCTT SAF and ModSAF
CCTT SAF was designed as a training tool for U.S. Army Companies, Teams, and Platoons that use unit-level U.S. Army Training and Evaluation Program (ARTEP) Mission Training Plans (MTPs) in the Distributed Interactive Simulation (DIS) environment (Mastaglio and Goodwin 1995). Because CCTT SAF’s design focuses on producing a fielded product for training, it is not meant to serve as a research tool for Computer Generated Forces (CGF) development.

ModSAF is intended to be a modularly designed DIS environment for CGF development. It attempts to provide a working environment for exploring new CGF concepts and extending DIS (Courtemanche and Ceranowicz 1995). ModSAF provides an environment suitable for research (e.g., new vehicles, weapons systems, and modules can be added and removed with minimal effort), and is readily accessible to the research community.

CCTT SAF provides the more realistic environment for trainees of the two CGF systems. ModSAF provides a better development environment for CGF concepts than CCTT SAF.

2.2 Research Plan and Report Structure
This project’s goal is to research methods of incorporating CISs into ModSAF. The research plan is outlined next, with references to other sections in this report that provide details about each topic. IST’s research focused on several behavior integration issues. IST first researched CISs to understand their structure and complexity (Section 3). Next, IST found differences between CCTT SAF and ModSAF that could influence behavior interoperability (Section 4). Two prototype CISs were implemented in ModSAF as a proof of concept (Section 5). Lessons learned from the implementation of the prototypes can be found in Section 6. Section 10 provides more background information that was used in IST’s research.

IST has implemented two out of eight planned CISs for this project. The effort of this project will now be directed to finishing the remaining CISs and using this development to fuel the creation of automatic tools to assist in future CIS development.
3. CIS General Information

IST studied Combat Instruction Sets (CISs) before implementing a prototype behavior. CISs are designed to allow someone unfamiliar with military doctrine to understand the actions taken by a unit executing a behavior. CCTT SAF uses CISs descriptions found in the CATT-Task Database to produce doctrinally correct actions for each behavior. The CATT-Task database combines training data from task manuals, soldier manuals, subject matter experts, and training studies into one source (Wright 1994). CCTT SAF has implemented 153 CISs (Marshall 1996) of the approximately 800 CISs in the CATT-Task database.

This section will document the source for CISs, describe some general elements of a CIS, and give an indication of the complexity of implementing CISs.

3.1 Sources

BLUFOR\(^1\) CISs are derived from U.S. Army Training and Evaluation Program (ARTEP) Mission Training Plans (MTPs). Because they were derived from U.S. doctrine, BLUFOR CISs contain more detailed information than their OPFOR counterparts. They are denoted by Bxxxx where the number xxxx corresponds to the unit type. For example, CISs for Tank Platoons are numbered 0001 through 0100 and Attack Helicopter Companies are numbered from 1401 to 1500 (McEnany et al. 1993).

OPFOR CISs are derived from U.S. Army Training and Doctrine Command (TRADOC) OPFOR Heavy Guide (Mellies 1995) and other doctrinal references. They are denoted by Sxxxx or HVY-xxxx in the CATT-Task database (Ourston et al. 1995). The number xxxx here is similar to the BLUFOR CIS. See Section 10.1 for more details about CIS contents.

3.2 Elements of a CIS

A CIS contains a behavior description, a sequence of actions to be taken in the behavior, initial conditions, input data, terminating conditions, and situational interrupts. In the Actions to be Taken section of the CIS, each action in a BLUFOR behavior is grouped into move, shoot, observe, or communicate based on the nature of the action. OPFOR CISs only list the actions in their order of execution. Initial conditions detail necessary information for the behavior to execute. Terminating conditions outline reasons for behavior completion and what actions to take when the behavior has finished. Situational interrupts describe reactive behaviors that could interrupt the behavior. See Section 10.2 for an example of the CIS structure.

---

\(^1\) BLUFOR refers to U.S. Forces and OPFOR refers to Opposing Forces.
3.3 Complexity

One measure of implementation complexity is the relationship between CISs. In general, IST determined that each CIS requires other CISs as part of its specification. Therefore, the complete implementation of one CIS requires implementation of many other CISs. For the purposes of this project, IST has limited the problem by substituting existing ModSAF behaviors for the supporting CISs. To illustrate, consider the CIS B0021 Conduct Tactical Road March. Table 1 illustrates the CISs required as part of B0021’s specification.

<table>
<thead>
<tr>
<th>CIS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B0001</td>
<td>Execute Column Formation</td>
</tr>
<tr>
<td>B0002</td>
<td>Execute Staggered Column Formation</td>
</tr>
<tr>
<td>B0007</td>
<td>Execute Coil Formation</td>
</tr>
<tr>
<td>B0008</td>
<td>Execute Herringbone Formation</td>
</tr>
<tr>
<td>B0009</td>
<td>Execute Action Drill (Front)</td>
</tr>
<tr>
<td>B010</td>
<td>Execute Action Drill (Right)</td>
</tr>
<tr>
<td>B011</td>
<td>Execute Action Drill (Left)</td>
</tr>
<tr>
<td>B012</td>
<td>Execute Action Drill (Rear)</td>
</tr>
<tr>
<td>B013</td>
<td>React to Indirect Fires</td>
</tr>
<tr>
<td>B014</td>
<td>Execute Contact Drill</td>
</tr>
<tr>
<td>B015</td>
<td>Execute Traveling</td>
</tr>
<tr>
<td>B016</td>
<td>Execute Bounding Overwatch</td>
</tr>
<tr>
<td>B017</td>
<td>Execute Traveling Overwatch</td>
</tr>
<tr>
<td>B018</td>
<td>Perform Assembly Area Activities</td>
</tr>
<tr>
<td>B019</td>
<td>Take Active Air Defense Measures While Moving</td>
</tr>
<tr>
<td>B020</td>
<td>Take Active Air Defense Measures While Stationary</td>
</tr>
<tr>
<td>B022</td>
<td>Execute Actions on Contact</td>
</tr>
<tr>
<td>B024</td>
<td>Perform an Attack by Fire</td>
</tr>
<tr>
<td>B025</td>
<td>Conduct Hasty Occupation of Battle Position</td>
</tr>
<tr>
<td>B026</td>
<td>Occupy a Platoon Battle Position</td>
</tr>
<tr>
<td>B029</td>
<td>Consolidate and Reorganize</td>
</tr>
<tr>
<td>B030</td>
<td>Perform Platoon Fire and Movement</td>
</tr>
<tr>
<td>B031</td>
<td>Assault an Enemy Position</td>
</tr>
<tr>
<td>B032</td>
<td>Execute Platoon Defensive Mission</td>
</tr>
<tr>
<td>B033</td>
<td>React to Dismounted Attack</td>
</tr>
<tr>
<td>B034</td>
<td>Displace to Subsequent Battle Position</td>
</tr>
<tr>
<td>B036</td>
<td>Take Actions at Obstacle</td>
</tr>
<tr>
<td>B041</td>
<td>Perform Resupply Operations</td>
</tr>
<tr>
<td>B042</td>
<td>Perform Maintenance Operations</td>
</tr>
<tr>
<td>B043</td>
<td>Establish an Observation Post</td>
</tr>
</tbody>
</table>

Table 1 – CISs needed for B0021

Although this list may appear lengthy, most of these behaviors are also used by other tasks. From a cursory examination of the CATT-Task database, the CISs highlighted in gray from Table 1 represent elements of a core group of CISs for CIS integration. More examination of the CATT-Task database is necessary to fully enumerate this list.
4. Differences Between CCTT SAF and ModSAF

IST investigated the feasibility of implementing CISs in ModSAF. Because CCTT SAF uses CISs for their behaviors, adding CISs to ModSAF would improve the interoperability between these two CGF systems. Differences between the underlying architecture of these two systems could impact the behavioral interoperability between CCTT SAF and ModSAF. Over one hundred issues were found that could impact behavior interoperability. These issues can be grouped into the following categories:

- Command and Control Hierarchy
- CGF Services
- Task Management
- Reactive Behaviors
- CCTT SAF FSMs vs. ModSAF AAFSMs
- Environment and Terrain
- Non-DIS Network Communication
- Code Sharing
- Crew Level Behaviors

This section examines some differences between CCTT SAF and ModSAF that affects behavior integration.

4.1 Command and Control Hierarchy

CCTT SAF uses a “ghost” controller associated with a platoon as the platoon leader. The ghost controller is associated with a simulated entity, but it is not a simulated entity itself: it does not have a physical model, take damage, or interact with other entities in the battlefield. When its associated vehicle is destroyed, the ghost controller is assigned to another vehicle. All information gathered is maintained and the task continues (Marshall 1996). A platoon leader in ModSAF is assigned to a particular vehicle in the platoon. If this vehicle is destroyed, ModSAF restarts the entire task with the role of platoon leader assigned to a new vehicle. All previous knowledge that this task has acquired since the task was initialized is lost (Rajput and Karr 1995). Note that neither system completely reflects what occurs in real life. In the real world, the new platoon leader should have some of the knowledge that the previous one had, but it would take time to assimilate information that the previous platoon leader gathered.

The two systems also handle communication between subordinates and commanders differently. In CCTT SAF, superiors send orders to subordinates in the SAF Entity Object Database (SEOD) (Horan 1994). ModSAF does not have the concept of orders, rather it has superiors start tasks for subordinates using procedure calls. For example, in CCTT SAF a superior would issue commands to a subordinate using orders in the SEOD, while in ModSAF a similar action would be performed with function calls (e.g., spawn_this_task_for_this_subordinate).

4.2 CGF Services

Even with identical behavioral logic and supporting data at a given echelon level, behaviors can produce different results because of dissimilar underlying services. Some examples of these underlying CGF Services are terrain reasoning, weapon system modeling (e.g., assessing, enemy detection, and targeting), physical modeling (e.g., hull and turret), and sensor modeling (e.g., visual, infrared, radar).

Routing and searching for covered and concealed positions require terrain analysis. While CCTT SAF’s dynamic and static obstacle avoidance algorithms are based on existing ModSAF algorithms, there are differences. For example, IDA* was used in CCTT SAF for planning road routes instead of A*, which is used in ModSAF (Campbell et al. 1995). Further research is necessary to determine the extent of the differences between the CGFs in other CGF services (e.g., other areas of terrain reasoning, weapons system modeling, physical modeling, and sensor modeling).

Differences in these underlying behaviors could be perceived as the distinct methods individual soldiers would use were they executing one of these tasks (e.g., two drivers may choose two different routes through the same forest to reach the same destination).
4.3 Task Management

Execution of a scenario consists of coordinating and executing a series of behaviors. Given that a set of behaviors from two CGF systems are identical, differences in task management can affect overall behavior and scenario outcome. Currently, IST lacks information about CCTT SAF’s task management methodology. Because of this, only general issues that affect behavior interoperability of two CGF systems will be addressed here.

4.3.1 Task Scheduling (Priorities and Hierarchy)

For two CGFs to have interoperable behaviors, their task scheduling mechanisms must be similar. CCTT SAF and ModSAF use ring queues to manage time based and priority based task scheduling. Tasks in CGF Services, among other things, are grouped into schedule rings based on the number of times per second that they need to be executed, e.g., all tasks that need to be executed 15 times per second are assigned to the 67 millisecond ring. As vehicles and units are created, several CGF Service tasks (e.g., routing, assessing) associated with vehicles or units are initialized and assigned to their proper rings. The rate at which all CGF Service tasks are executed in both CGF systems should be similar for behavioral interoperability between the CGF systems.

4.3.2 Task Execution (Ticking and Task Transitions)

Execution of a scenario involves the coordination and execution of a sequence of behaviors. Transitions between behaviors can be automatic, triggered by a Control Measure, or require operator intervention. There are ModSAF behaviors that do not automatically transition to a subsequent behavior when they complete (e.g., Hasty Occupy Position), while other behaviors do automatically transition (e.g., Road March). Knowledge of CCTT SAF’s handling of task transitions would allow more insight into how interoperable a sequence of behaviors could be in comparison to a similar sequence in ModSAF.

A ‘wrapper’ is code that executes before or after a user specified behavior. Any wrapper placed around behaviors in CCTT SAF must be identical to those in ModSAF for a sequence of behaviors to act similarly. ModSAF requires a preparatory task, a preliminary task executed before the actual behavior, for each behavior (HALT is most commonly used). The advantage to using a preparatory task is that each behavior starts from a known condition. The disadvantage is that certain sequences of tasks exhibit odd behavior. For example, sequential move tasks will not keep a vehicle in continuous movement. The second move (as well as the first) starts from a halted state, i.e., the vehicles stop between each move task. If CCTT SAF handles this differently, a behavior in CCTT SAF would act differently than its equivalent in ModSAF.

The tick rate is the maximum frequency that a task is executed. As a simulation becomes busy, the time required to execute tasks in a ring queue can exceed the assigned time for the ring, compromising simulation fidelity and the "real-timeness" of the system (Smith and Swarts 1990). Symptoms of a busy simulation are movement and behavior degradation (Vrablik and Richardson 1994). Behavioral inconsistencies may arise because CGF system A may assign more items to a given ring than system B. As the number of items on a ring increases, it will become more difficult for those items scheduled on a ring to complete on time.

4.4 Reactive Behaviors

CCTT SAF supports more reactive behaviors than ModSAF, and ModSAF behaviors may not correspond to CIS definitions. Consequently, the full implementation of a CIS will require the addition of reactive behaviors in ModSAF as well as modifications of existing ModSAF reactive behaviors.

For some behaviors, CCTT SAF incorporates the code for a reactive task into the code for a non-reactive task. For example, in the OPFOR Assault an Enemy Position, CCTT SAF will execute code to breach an obstacle inside the Assault an Enemy Position task instead of calling a standard Breach Obstacle task. ModSAF transitions to a reactive task by starting the appropriate task. The limitation of CCTT SAF’s approach is that every behavior needing Breach Obstacle must incorporate all the code for Breach Obstacle again. An advantage to doing this is that Breach Obstacle could be tailored to a specific behavior, i.e. an assault Breach Obstacle may need to be different from a traveling Breach Obstacle. Although this presents no behavioral interoperability difficulties, having redundant code presents software maintenance problems.
<table>
<thead>
<tr>
<th>Issue</th>
<th>ModSAF</th>
<th>CCTT SAF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambush (OPFOR)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Consolidate and Reorganize</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Execute Appropriate Action Drill</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Execute Contact Drill</td>
<td>Yes*</td>
<td>Yes</td>
</tr>
<tr>
<td>React to Indirect Fire</td>
<td>Yes*</td>
<td>Yes</td>
</tr>
<tr>
<td>React to Terrain</td>
<td>Yes*</td>
<td>Yes</td>
</tr>
<tr>
<td>Recon Drills (OPFOR)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Take Actions At Obstacle</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Take Active Air Defense while</td>
<td>Yes*</td>
<td>Yes</td>
</tr>
<tr>
<td>Moving/Stationary</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Modifications necessary for CCTT SAF compatibility

Table 2 - Reactive Behaviors

Table 2 illustrates some sample reactive behaviors and whether they are supported in the two CGF systems.

### 4.5 CCTT SAF FSMs vs. ModSAF AAFSMs

Finite State Machines (FSMs) are often used to describe behaviors. An FSM consists of states and transitions. Each state in an FSM corresponds to either a function or a low-level FSM. Transition conditions associated with each state make up the criteria for entering another state (Smith and Petty 1992). Note that CCTT SAF and ModSAF implement different variations of FSM structures. CCTT SAF and ModSAF have several implementation differences in their FSM structures that could affect either the way that a behavior is executed or the ease of implementing a behavior. These differences are exhibited in the implementation language, preprocessing steps, and task parameter changes.

CCTT SAF’s FSMs, written in Ada, contain all the details that link FSMs into the CCTT SAF. On the other hand, ModSAF FSMs, written in C-like syntax (Asynchronous Augmented Finite State Machine or AAFSM format), must go through a preprocessing stage before they become C code. This abstracts out details of FSM linkage to the system and thereby accelerates behavior development.

CCTT SAF does not respond to changes in an input to a behavior once the task is running, restricting the operator from responding to changes in orders. ModSAF’s AAFSM format explicitly allows this change of parameters. For example, if a FRAGO updates a phase line’s position, then the operator may move it and the task will respond to this change, instead of having the operator reissue the task with the new parameters.

### 4.6 Environment and Terrain

Environmental elements may affect behaviors (e.g., smoke, rain, fog, snow, etc.). These will cause a degradation in various behaviors due to reduced sensory input, reduced traction, and reduced trafficability. A CGF system’s behavior is limited by the fidelity of its terrain. High fidelity terrain provides more covered and concealed positions and objects for entities to interact with (e.g., log cribs, tank ditches, DI berms, etc.) than lower fidelity terrain.

Because they represent the operating environment for entities, environment and terrain differences can play an important role in affecting unit behaviors. In general, CCTT SAF has more detailed environment features and terrain than ModSAF.
4.6.1 Environment
Less support for environmental factors will cause the two CGFs to react differently. This affects behaviors by increasing sensor degradation and reducing trafficability.

CCTT SAF and ModSAF support sensor degradation due to rain, fog, and haze. Trafficability in CCTT SAF is reduced due to rain soaking the ground (if the rain floods an area, vehicles will route around it, and traction is reduced on rained soaked terrain). ModSAF does not currently support rain soaked terrain. By ModSAF ignoring the impact of weather on routing (e.g., avoiding muddy terrain), its behaviors will not be interoperable with CCTT SAF.

4.6.2 Terrain
The terrain database representation in CCTT SAF has varying polygonal facets of 60, 120, and 240 meters. This is multi-level terrain, providing trafficability both over a bridge and through the water beneath it (Pope et al. 1995). ModSAF’s terrain database has polygonal facets of 125m and there are no multi-level terrain features (Braudaway et al. 1995). Forests in CCTT SAF are represented as tree aggregates, each of which can be broken up into its respective trees (Pope et al. 1995). Forests are represented as canopies in ModSAF with no information about individual trees contained inside the forest (Braudaway et al. 1995). CCTT SAF’s terrain database contains up to 10,000 destroyable 3D features. The terrain also contains many relocatable objects (those that can be moved around the terrain) in the form of log cribs, tank ditches, DI berms, etc. (Pope et al. 1995). There are few destroyable or relocatable objects in ModSAF (e.g., ModSAF has AVL vehicles) (Braudaway et al. 1995).

CCTT SAF’s varying polygonal facets and support of closer grid posts allow for more accurate terrain representation. This terrain format allows vehicles in high traffic areas to have more terrain objects (trees, buildings, water, etc.) to interact with than ModSAF’s terrain format provides. The CCTT SAF’s use of tree aggregates allows an entity or unit routing through a forest to be able to use the trees for concealed positions and to have its route affected by more obstacles (in the form of trees). Relocatable and destroyable objects provide a more realistic environment for the entity. An entity may take advantage of a relocatable object for concealed positions or face obstacles because of destroyed objects.

4.7 Non-DIS Network Communication
Both ModSAF and CCTT SAF have defined their own network protocols as an extension to DIS. CCTT SAF extends DIS by using the SAF Entity Object Database (SEOD) and ModSAF has the Persistent Object Database (POD). SEOD contains entity information, command graphics, task information, orders, and reports (Shen 1996). Although similar, the POD does not store orders or reports (Smith 1990).

4.8 Code Sharing
CCTT SAF has separate behaviors for each force for a majority of the CISs (see Figure 1), but it also has common behaviors for both forces (e.g., Platoon Execute Traveling). This represents a trade-off between code maintainability and the need for separate behaviors. ModSAF uses the same behaviors for BLUFOR and OPFOR vehicles. This is a problem for behaviors that execute a given behavior differently. For example, Assault an Enemy Position for a Tank Platoon is executed differently for each force. The BLUFOR CIS for Assault an Enemy Position specifies CGF operator intervention and calls for moving to the Objective using covered and concealed routes. Conversely, the OPFOR behavior requires neither operator intervention nor moving to the Objective using covered and concealed routes. Because a CIS is tailored to either BLUFOR or OPFOR behaviors, a mechanism must be introduced to provide separate behaviors for BLUFOR and OPFOR in ModSAF. One solution to this problem is to augment ModSAF’s task filtering mechanism to distinguish tasks by force.
Two other similar areas of concern for code sharing are sharing behaviors across unit types and across echelons. In CCTT SAF two units of different types but at the same echelon level may use the same body of code. For example, in OPFOR Assault an Enemy Position both a tank platoon and a motorized rifle platoon will execute the same body of code, but a tank company executes different code. In ModSAF, behavior code is shared between unit types, and to some extent, between echelons.

4.9 Crew-level behaviors

CCTT SAF has implemented behaviors down to the crew level. This is largely a naming convention for low-level vehicle responsibilities consisting of the Weapons Crew (e.g., target assessment), Maintenance Crew, Driver (e.g., routing), and Resupply Crew. The Crew-level behaviors in CCTT SAF order the Driver to move to a certain location, while ModSAF starts a task for a subordinate vehicle to travel to a certain location. Consequently, for implementation of behaviors in ModSAF, a design decision to either implement Crew-level behavior or use existing ModSAF functionality must be made.

4.10 Conclusions of Differences Between CCTT SAF and ModSAF

Although important, many of the differences between the two systems can be disregarded for this project to allow implementations of CISs in ModSAF. For the purposes of this project, ModSAF has similar functionality to CCTT SAF (e.g., ModSAF has its own CGF Services, command and control hierarchy, reactive behaviors, etc.). Because there are differences, many of these issues need to be addressed by IST or the CGF community.

5. Prototype Implementation

After a survey of the CATT-Task database, IST chose eight CISs to implement in ModSAF (see Table 3). These were chosen to get a sampling of behaviors that are simple, complex, BLUFOR, OPFOR, in ModSAF, not in ModSAF, for a Company, and for a Platoon.

<table>
<thead>
<tr>
<th>BLUFOR</th>
<th>Status</th>
<th>OPFOR</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduct Hasty Occupation of Battle Position (B0025)</td>
<td>Done</td>
<td>Traveling (HVY-0028)</td>
<td></td>
</tr>
<tr>
<td>Execute Actions on Contact (B0022)</td>
<td></td>
<td>Assault an Enemy Position (HVY-0022)</td>
<td></td>
</tr>
<tr>
<td>Consolidate and Reorganize (B0029)</td>
<td></td>
<td>Execute Evasive Actions (HVY-0029)</td>
<td></td>
</tr>
<tr>
<td>Company Perform Tactical Movement (B1101)</td>
<td></td>
<td>Company Occupy A Defensive Strong Point (HVY-0117)</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 – Selected CISs

As a precursor to automated approaches and as a proof of concept, IST manually added two CISs to ModSAF (shown in gray in Table 3). These CISs are implemented to some degree in the current CCTT SAF. The complete CIS descriptions can be found in Appendices 10.2 and 10.3.
This process began by analyzing the CIS definition in the CATT-Task database, and constructing flow diagrams and a list of inputs and outputs required by the CIS. The CCTT SAF code was then analyzed and compared to the CIS definition. Necessary components for the CIS were sought in ModSAF. A ModSAF implementation was designed using this gathered information. Necessary underlying code in ModSAF was used in the design. The design was then implemented and tested.

This section provides a description of the CISs used for this project, lists other behaviors they might need, and gives an overview of the design process used to implement Conduct Hasty Occupation of a Battle Position and Assault an Enemy Position in ModSAF.

5.1 B0025 Conduct Hasty Occupation of a Battle Position
This section presents a description of Conduct Hasty Occupation of a Battle Position, outlines IST’s approach to implementing Conduct Hasty Occupation of a Battle Position in ModSAF, and evaluates IST’s CIS implementation.

5.1.1 CIS Description
IST chose to implement B0025 because it was similar to an existing ModSAF behavior (Hasty Occupy Position). In Conduct Hasty Occupation of a Battle Position, a U.S. Platoon moves toward and occupies a Battle Position (CATT-Task Database). A description of this CIS as given in the CATT-Task database appears in Figure 3.

The platoon is conducting offensive or defensive operations and has received an order to conduct a hasty occupation of a battle position (BP). The platoon moves to and occupies the BP, orients itself properly on the likely direction/avenue of enemy attack and/or assigned engagement area (EA), ensures survivability of the platoon and its fighting position, and is prepared to defend the BP by the time specified in the order (ARTEP 17-237-10-MTP, pp. 5-112 to 5-114; FM 17-15, pp. 4-20, 4-4 and 4-5, 4-10 to 4-16).

BP An advantageous location, selected on the basis of terrain and weapon systems, from which a unit defends or attacks. Platoon BPs and their direct-fire orientation are designated in the Operations Order (FM 17-15, p. 2-8).

EA An area designated along enemy avenue(s) of approach in which the commander intends to destroy the enemy force with massed fires. It can be identified by prominent terrain features or by Target Reference Points at the corners (FM 71-2, p. 4-22).

Figure 3 – Conduct Hasty Occupation of a Battle Position

Figure 3 shows the sequence of actions that a Tank Platoon should follow in the Conduct Hasty Occupation of a Battle Position:

1. Routes to the center of the Battle Position.
2. Locates covered and concealed positions.
3. Moves to and occupies the Battle Position.

5.1.1.1 Supporting CISs for B0025
Conduct Hasty Occupy Battle Position uses other CISs for situational interrupts. The situational interrupts required for this CIS are listed below.

Situational Interrupts:

<table>
<thead>
<tr>
<th>B0013</th>
<th>React to Indirect Fires</th>
</tr>
</thead>
<tbody>
<tr>
<td>B0020</td>
<td>Take Active Air Defense While Stationary</td>
</tr>
<tr>
<td>B0022</td>
<td>Execute Actions on Contact</td>
</tr>
</tbody>
</table>
These three CISs represent actions to be taken by the Platoon executing a Hasty Occupy. React to Indirect Fires occurs when the Platoon encounters indirect fire. Take Active Air Defense While Stationary is used to respond to air threats. Execute Actions on Contact provides instructions to follow when opposing ground forces are encountered.

5.1.2 IST Approach
For this prototype, IST explored the CIS, examined the corresponding CCTT SAF code, looked at the existing ModSAF code for a similar behavior, and constructed a diagram for the IST implementation.

5.1.2.1 CIS Task Description
IST first reviewed the CIS definition. The Actions to be Taken section (see Section 10.1.3) of the CIS definition outlines the procedure a unit follows when executing a CIS. IST researchers created a flow diagram from the high level actions in this section (see Figure 4).

Figure 4 – CIS Description of B0025
The boxes in the left column are the high level actions, and those to the right provide more details of the action. Dashed boxes represent actions that the CIS deems unnecessary for simulation. Actions from top to bottom represent the sequential order of actions that occur in the task. From the description, a platoon executing BOO25 would arrive at the Battle Position. Individual vehicles of the platoon would move into a turret down position, move into primary fighting positions, move into turret-down positions, and then continue to improve their positions.

5.1.2.2 CCTT SAF Code

The next step in IST's analysis of this CIS was to examine CCTT SAF code. IST researchers created FSM state diagrams from CCTT SAF behavior code. The state diagram provides an overview of the sequence of actions in the CCTT SAF implementation of BOO25, including transition timing. See Figure 5 for the state diagram for CIS BOO25.

![State Diagram](image)

**Start**
- Calculate the center of Battle Position.
- Start Traveling task to center of Battle Position.
- Transition to Moving.

**Moving**
- If distance from platoon to center of Battle Position is less than 500m, then transition to Halt_Position

**Halt_Position**
- Search for C&C Positions.
- When all vehicles have found their C&C positions, then send orders for individual vehicles to travel to their turret down position.
- Transition to Execute_Orders.

**Execute_Orders**
- If all the vehicles have reported reaching their turret down positions, then wait 5 minutes and then transition to Turret_Down.

**Turret_Down**
- Distribute orders to move to hull down position.
- Transition to Hull_Down.

**Hull_Down**
- If all vehicles have reported reaching their hull down position, then issue progress report stating that the position is occupied.
- Transition to End.

**End**

**Figure 5 - CCTT SAF Implementation of B0025**

Figure 5 shows the actions of the CCTT SAF Hasty Occupation of a Battle Position. Each of the boxes represents a state in the CCTT SAF code. Transitions between states are represented with arrows.
5.1.2.3 Similar Existing ModSAF Behavior

A similar behavior to Conduct a Hasty Occupation of a Battle Position existing in ModSAF is Hasty Occupy Position. A state diagram for Hasty Occupy Position appears in Figure 6.

![State Diagram of Hasty Occupy Position](image)

**Figure 6** – ModSAF’s Hasty Occupy Position

Figure 6 shows the actions of the Hasty Occupy Position. Each of the boxes represents a state in the ModSAF code. Transitions between states are represented with arrows. This ModSAF behavior was analyzed to determine the modifications necessary to implement CIS B0025 in ModSAF. Note that in Figure 5 the platoon moves as a unit to the center of the Battle Position, the vehicles move independent to their hidden positions, and then the individual vehicles move their primary fighting positions. In Figure 6 however, vehicles of the platoon move independently to their primary fighting positions. Section 5.1.3.1 contains more information about differences between ModSAF’s Hasty Occupy Position and CIS B0025.
5.1.2.4 IST Implementation

Using the information gathered from Figure 4, Figure 5, and Figure 6, IST developed an implementation plan for adding Conduct Hasty Occupation of a Battle Position to ModSAF. These three diagrams were merged into a final implementation guide (see Figure 7).

![Figure 7 - Conduct Hasty Occupation of Battle Position FSM Diagram]

The content of each state from Figure 7 is outlined in more detail below.

**init_state**
Calculate the center of the Battle Position and route the platoon to the center of the Battle Position. Transition to moving_to_bp_center.

**Step 1:**
Calculate the center of the Battle Position.

- **Input:**
  Battle Position

- **Output:**
  Battle Position center in (X,Y) format

**Note:**
This will not take into account Battle Position lines that are made up of road segments.

**Approach:**
1) Find the minimum and maximum X & Y values of the Battle Position structure.
2) Set the Battle Position center X value equal to the average of the maximum and minimum X values.
3) Set the Battle Position center Y value equal to the average of the maximum and minimum Y values.
4) Place the Battle Position center in the platoon’s overlay in the PO database.

**moving_to_bp_center**
Calculate distance between unit center and BP center. If distance is within threshold, stop the traveling task, and transition to preparing_for_search.

**preparing_for_search**
Break up the BP line into segments and determine which vehicles will occupy which segment. Initialize the search for C&C positions. Transition to searching_for_positions.

**searching_for_positions**
Confirm that all vehicles are done searching for C&C positions. If done, start moving to hidden positions and transition to moving_to_positions.

**moving_to_positions**
If all vehicles are done moving to hidden positions, start move tasks to primary fighting positions. Transition to at_positions.

**at_positions**
Wait here.
Step 2:
Start a unit traveling task for the entire platoon in column formation from their current location to the Battle Position center.

**Inputs:**
Battle Position center, vehicle PO id, vehicle spacing, speed, formation

**Approach:**
1) Setup the unit traveling subtask parameters.
2) Start unit traveling task.

Step 3:
Transition to `moving_to_bp_center`.

**moving_to_bp_center**
Calculate the distance between the platoon's center of the mass and the Battle Position center. If this distance is within a certain threshold, stop the traveling task and transition to `preparing_for_search`.

**Step 1:**
Verify the platoon's center of mass is within stopping distance of the Battle Position center.

**Inputs:**
Battle Position center, PO vehicle ids, stopping distance, center of mass, current unit center of mass

**Output:**
Are we near the Battle Position center?

**Approach:**
1) If the distance between the center of mass of the unit and the Battle Position center is less than the stopping distance, then transition to `preparing_for_search`.

**preparing_for_search**
Break up Battle Position line into segments and determine which vehicles will occupy which segments. Initialize search for covered and concealed positions and transition to `searching_for_positions`.

**Step 1:**
Assign each vehicle a segment on the line.

**Inputs:**
Battle Position line, number of vehicles

**Output:**
a segment of the line assigned to each vehicle

**Approach:**
1) Divide the Battle Position line into semi-equal sections based on the number of vehicles present in the unit. Each unit covers a single segment of the line. In the event of vehicle loss, the segments are recalculated and reassigned to each surviving vehicle.

**Step 2:**
Initialize search for covered and concealed positions.

**Step 3:**
Transition to `searching_for_positions`.
searching_for_positions
If all vehicles are done searching for covered and concealed positions, then start individually moving vehicles to their hidden positions and transition to moving_to_positions.

Step 1:
Find each vehicles hull-down and turret down positions.

Inputs:
vehicles PO entries, Battle Position line

Output:
primary (required), alternate, and hidden firing positions

Approach:
1) Use standard ModSAF algorithms to find hull & turret down points in the area.
2) Assign the hidden, primary, and alternate firing positions from the hull and turret down positions using standard ModSAF methods.
3) Place the hidden, primary and alternate firing positions in each vehicles overlay.
4) When the searches are complete, start individual move tasks to hidden positions.
5) When the vehicles have reached their hidden positions, wait for five minutes.
6) After five minutes in hidden positions, start move tasks for the individual vehicles to their primary fighting positions.

Step 2:
Transition to moving_to_positions.

moving_to_positions
If all vehicles are done moving to their hidden positions, then start moving the vehicles to their primary fighting positions and transition to at_positions.

Inputs:
vehicle PO entries

Step 1:
When each vehicle has reached its initial position, transition to at_positions.

at_positions
The vehicles are at their positions.

Inputs:
vehicle PO entries

Step 1:
Maintain position and monitor incoming fire.

Step 2:
If accurate fire is detected by an individual vehicle, start an individual move task to a different fighting position for the vehicle.
5.1.3 Implementation Evaluation

IST evaluated its implementation of Conduct Hasty Occupation of a Battle Position against CCTT SAF’s implementation to determine the differences between the two. IST enumerated difficulties that were encountered in implementing this CIS in ModSAF. Finally, to emphasize the need for CISs in ModSAF, IST compared its CIS implementation to a similar behavior in ModSAF (Hasty Occupy Position).

5.1.3.1 Differences Between CCTT SAF and ModSAF Implementations

The three main differences between CCTT SAF and ModSAF Conduct Hasty Occupation of a Battle Position are the use of CGF support services, use of supporting CISs, and parameter updates.

CCTT SAF uses supporting CGF Services from CCTT SAF (e.g., CCTT SAF’s target acquisition, CCTT SAF’s covered and concealed location search). IST’s implementation uses ModSAF’s supporting CGF Services (e.g., ModSAF’s target acquisition, ModSAF’s covered and concealed location search).

CCTT SAF’s CIS implementations are built using supporting CIS implementations (e.g., Execute Traveling, React to Indirect Fires). IST’s implementation of the CIS uses ModSAF supporting behaviors (e.g., unit traveling, react to indirect fire).

CCTT SAF does not have the capability to easily change behavior parameters. ModSAF supports updating a behavior based on parameter changes (e.g., when the Battle Position changes, vehicles adjust their positions to occupy the new position without restarting the task). This feature was used in the ModSAF implementation.

5.1.3.2 ModSAF Implementation Difficulties

Two main difficulties were encountered when implementing this CIS in ModSAF: supporting tasks did not behave as expected and occasionally this CIS did not restart properly after being suspended.

ModSAF’s supporting tasks occasionally do not behave as expected. Periodically, vehicles traveling in the unit would get out of formation, occasionally stopping to let the rear platoon vehicle pass the third vehicle. Although some amount of flexibility is expected in formation maintenance, our SME deemed this inappropriate.

Occasionally this CIS does not restart properly after being suspended. Tasks are suspended in ModSAF when a scenario is saved and reloaded. For unknown reasons, the CIS does not restart properly if it is saved and restarted after the vehicles in the platoon have reached and occupied their Battle Positions. The existing ModSAF Hasty Occupy Position also has this problem, so this restart problem appears to be an artifact of using an existing ModSAF behavior as a starting point.

5.1.3.3 Difference From Existing ModSAF Behavior

The Conduct Hasty Occupation of a Battle Position CIS was built using ModSAF’s Hasty Occupy Position task as a base. Obviously if the original task followed the CIS definition, no work would have been necessary. It should be noted that much of ModSAF’s original task was similar to the CIS definition. Two main differences between the CIS prototype and the existing ModSAF behavior are the use of the CIS for only one unit type and the movement toward the Battle Position.

ModSAF’s Hasty Occupy task can be used by both homogeneous and mixed units (e.g., DI-IFV platoons). This CIS is specifically written for a BLUFOR tank platoon. All references to mixed unit tasks were removed and replaced with non-mixed unit equivalent tasks. Although the mixed tasks would have accomplished the same result, they were essentially wrappers for non-mixed tasks, and therefore unneeded for these purposes.

At the beginning of ModSAF’s Hasty Occupy Position, each vehicle finds a primary fighting position, an alternate fighting position, and hidden positions. The vehicles then move individually to their primary fighting positions. In IST’s CIS implementation, the center of the Battle Position is calculated. The platoon moves in column formation to
this location. After the platoon arrives, individual vehicles search for covered and concealed positions. When all vehicles have located their positions, the vehicles individually move to their hidden positions. After waiting in their hidden positions for a delay of five minutes (this represents the time needed for vehicles to fill out range cards and verify sectors of fire), the vehicles move to their primary fighting positions.

5.2 HVY-0022 Assault an Enemy Position
This section presents a description of Assault an Enemy Position, describes IST’s approach to implementing CISs in ModSAF, and evaluates IST’s CIS implementation.

5.2.1 CIS Description
Assault an Enemy Position was chosen to complement Conduct Hasty Occupation of a Battle Position, because this OPFOR task usually attacks an occupying force. In Assault an Enemy Position, an OPFOR platoon moves toward an Objective while attacking the enemy (CATT-Task Database). A description of this CIS as given in the CATT-Task database appears in Figure 8.

Assaulting an enemy position is a component part of the attack. It begins when the platoon moves into combat formation (normally platoon line but can also be in a wedge, echelon right, or echelon left) just prior to crossing the Line of Attack. This action may also be used as an immediate action drill during a movement CIS or any time that the platoon may be ordered to assault and destroy enemy forces. The platoon continues assaulting by firing at the enemy forces and moving forward over the enemy positions until the objective line is reached and the enemy is destroyed or captured. The platoon then moves into firing positions and prepares to repel enemy counterattacks, to continue the attack, or to establish temporary defensive positions. The platoon frontage for the assault may be up to 300 meters. This is also the point that the platoon may revert to the higher level CIS (ATTACK FROM THE MARCH (HVY-0008), NIGHT ATTACK (HVY-0024), or ATTACK FROM POSITIONS IN CONTACT (HVY-0026)).

Figure 8 – OPFOR Assault an Enemy Position
Figure 8 shows the sequence of actions that the Platoon should follow in the Assault an Enemy Position:

1. Moves into line formation before crossing the Line of Attack.
2. Continues assaulting by firing on enemy forces and moving over enemy positions.
3. Travels to objective line while firing.
4. Prepares to repel counterattacks by establishing temporary defensive positions.

5.2.1.1 Supporting CISs for HVY-0022
Assault an Enemy Position uses other CISs for situational interrupts. The situational interrupts required for this CIS are listed below.

<table>
<thead>
<tr>
<th>CIS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVY-0023</td>
<td>Take Air Defense Measures</td>
</tr>
<tr>
<td>HVY-0013</td>
<td>Actions When Under Incoming Indirect Fire</td>
</tr>
</tbody>
</table>

These two CISs represent actions to be taken by the Platoon executing an Assault an Enemy Position. Actions When Under Incoming Indirect Fire occurs when the Platoon encounters indirect fire. Take Air Defense Measures is used to respond to air threats.
5.2.2 IST Approach
For this prototype IST explored the CIS, examined the corresponding CCTT SAF code, looked at the existing ModSAF code for a similar behavior, and constructed a diagram for the IST implementation.

5.2.2.1 CIS Task Description
IST first reviewed the CIS definition. The Actions to be Taken section (see Section 10.1.3) of the CIS definition outlines the procedure a unit follows when executing a CIS. IST researchers created a flow diagram from the high level actions in this section (see Figure 9).

![Diagram of CIS Task Description of HVY-0022](image)

Figure 9 – CIS Task Description of HVY-0022

The boxes are the high level actions for this behavior. The actions for the CIS begin at the first box (Execute Combat Formation CIS) in the upper left corner of Figure 9 and follow the arrows sequentially. A platoon executing HVY-0022 first moves into line formation before crossing the Line of Attack, engages enemy vehicles on the move and destroys targets, continues to assault through the enemy's position until the objective is reached, and reports crossing the Line of Attack and seizure of the Objective.
5.2.2.2 CCTT SAF Code

The next step in IST's analysis of this CIS was to examine CCTT SAF code. IST researchers created FSM state diagrams from CCTT SAF behavior code. The state diagram provides an overview of the sequence of actions that occurs in Assault an Enemy Position, including when transitions between states occur. See Figure 10 for a simplified state diagram of CCTT SAF's CIS HVY-0022.

![State Diagram](image-url)

**Figure 10 – Simplified CCTT SAF Implementation of HVY-0022**

Figure 10 outlines the actions of the CCTT SAF Assault an Enemy Position. Each of the boxes represents a state in the CCTT SAF code. Transitions between states are represented with arrows. The dotted box around the Assaulting state indicates that this state does not exist in the CCTT SAF code. The dotted line illustrates an assumed transition from the Assaulting state based on comments in the CCTT SAF code. Notice that the Take_ACTIONS_at_Obstacle state explicitly deals with obstacles instead of using another behavior (e.g., HVY-0009 Take Actions at an Obstacle).

5.2.2.3 Similar Existing ModSAF Behavior

By examining existing ModSAF behaviors, IST selected Assault as a similar behavior to CIS HVY-0022. A state diagram for Assault appears in Figure 11.
Figure 11 shows the actions of the Assault. Each of the boxes represents a state in the ModSAF code. Transitions between states are represented with arrows. The platoon moves toward the objective line while firing. Once the objective line is crossed, the platoon can occupy a position just past Assault Objective. Notice that a platoon executing the behavior described in Figure 10 reports when crossing the Line of Attack, Safe Distance Line, and the Objective, but in Figure 11, a platoon only reports when seizing the Objective. Section 5.2.3.1 contains more information about differences between CIS HVY-0022 and ModSAF’s Assault.
5.2.2.4 IST Implementation

After reviewing the CIS definition and the CCTT SAF code for the OPFOR Tank Platoon Assault an Enemy Position, IST developed flow diagrams that explained both the CIS definition and the CCTT SAF implementation of CIS HVY-0022. These two state diagrams were merged into a final implementation guide (see Figure 12).

![Flow Diagram](image)

The content of each state from Figure 12 is outlined in more detail below.
**init_state**

Calculate the center of the Line of Attack. Project the center past the line, route the platoon to the projected center, and transition to moving_to_line_of_attack.

**Step 1:**
Set fire permission to free for the platoon.

**Step 2:**
Set fire method to volley for the platoon.

**Step 3:**
Start a unit_targeter task.

**Step 4:**
Start a unit travel task in line formation for the platoon to the LOA.

Inputs: vehicle PO entries, LOA, platoon center of mass

**Approach:**
1) Compute the center of the LOA.
2) Project a route point past the LOA.
   a) Get the maximum and minimum points of the LOA.
   b) Get the platoon center of mass.
   c) Create a unit vector based on the unit's current direction.
   d) Set magnitude = (loa_max[X] - loa_min[X]) + (loa_max[Y] - loa_min[Y])
   f) Store the projected point in the PO database.
3) Start a unit traveling task for the platoon in line formation to the projected point.
4) Transition to moving_to_line_of_attack.

**moving_to_line_of_attack**

If the platoon has crossed the Line of Attack, then send a radio message stating this, calculate the center of the Safe Distance Line, project the center past the Safe Distance Line, route the platoon to the projected center, and transition to moving_to_safe_dist_line.

**Inputs:**
vehicle PO entries, SDL, LOA, platoon center of mass

**Step 1:**
Confirm that the platoon's center of mass has crossed the LOA.

**Step 2:**
If past the LOA, start a unit traveling task to the SDL projected center in line formation.

Inputs: vehicle PO entries, LOA, SDL, platoon center of mass

**Approach:**
1) Compute the center of the SDL.
2) Project a route point past the SDL.
   a) Get the max and min points of the SDL.
   b) Get the platoon center of mass.
   c) Create a unit vector based on the unit's current direction.
   d) Set magnitude = (safe_distance_line_max[X] - safe_distance_line_min[X]) + (safe_distance_line_max[Y] - safe_distance_line_min[Y]).
e) Projected point = center_of_safe_distance_line[X] + vector[X]*magnitude,
f) Store the projected point in the PO database.

3) Start a unit travel task for the platoon in line formation to the projected point.
4) Transition to moving_to_safe_distance_line.

**moving_to_safe_dist_line**
If the platoon has crossed the Safe Distance Line, then send a radio message stating this, calculate the center of the Objective Line, project the center past the Objective Line, route the platoon to the projected center, and transition to moving_to_objective.

**Inputs:**
vehicle PO entries, SDL, Objective Line

**Step 1:**
Confirm that the platoon’s center of mass has crossed the SDL.

**Step 2:**
If past the SDL, start a unit travel task in line formation for the platoon to the Objective Line.

**Inputs:** vehicle PO entries, LOA, safe distance line, platoon center of mass

**Approach:**
1) Compute the center of the Objective Line.
2) Project a route point past the Objective Line.
   a) Get the max and min points of the Objective Line.
   b) Get the platoon center of mass.
   c) Create a unit vector based on the units current direction.
   d) Set magnitude = (max_objective_line[X] - min_objective_line[X]) + (max_objective_line[Y] - min_objective_line[Y]).
   e) Projected point = center_of_objective_line[X] + unit_vector[X]*magnitude,
center_of_objective_line[Y] + unit_vector[Y]*magnitude.
   f) Store the projected point in the PO database.
3) Start a unit travel task in line formation for the platoon to the projected point.
4) Transition to moving_to_objective.

**moving_to_objective**
If the platoon has crossed the Objective Line, then send a radio message stating this. If the user selected secure objective, then start an Occupy Position task using the Objective Line as the Battle Position, otherwise transition to END.

**Inputs:**
vehicle PO entries, Objective Line

**Step 1:**
Confirm that the platoon’s center of mass has crossed the Objective Line.

**Step 2:**
If crossed and the user has selected to secure the objective area, start an occupy position task, with the Objective Line as the Battle Position, and wait for further orders.
5.2.3 Implementation Evaluation
IST evaluated its implementation of Assault an Enemy Position against CCTT SAF’s implementation to determine the differences between the two. IST enumerated any difficulties that were encountered in implementing this CIS in ModSAF. Finally, to emphasize the need for CISs in ModSAF, IST compared its CIS implementation to a similar behavior in ModSAF (Assault).

5.2.3.1 Differences Between CCTT SAF and ModSAF Implementations
Five main differences between CCTT SAF and ModSAF implementations of Assault an Enemy Position are the use of parameter updates (see Section 5.1.3.1), use CGF Services and supporting CISs (see Section 5.1.3.1), IST assumptions for missing CCTT SAF code, reactive code in a non-reactive task, and CCTT SAF’s use of this code for multiple unit types.

CCTT SAF’s implementation of OPFOR Tank Platoon Assault an Enemy Position was incomplete at the time of this writing. CCTT SAF’s FSM transitions to a state (Assaulting), that does not exist in the code. From reading the CIS definition and consulting with IST’s SME, the Assaulting state was determined to contain a movement task toward the Objective in line formation, with free fire permission for all vehicles in the platoon.

CCTT SAF’s implementation explicitly takes action if a minefield is encountered. ModSAF considers minefields as indirect fire. When encountered, ModSAF starts a reaction to indirect fire that can start a breach minefield task if the platoon is equipped with a plow. ModSAF’s minefield reaction was used in place of CCTT SAF’s explicit instructions for breaching a minefield.

CCTT SAF uses the Assault an Enemy Position for tank platoons and motorized rifle platoons. IST’s implementation is only for tank platoons. CCTT SAF’s implementation dismounts and mounts infantry at appropriate times, but IST’s implementation is not meant for use with platoons that contain infantry. Therefore, no code for infantry in CCTT SAF’s implementation was considered for IST’s implementation.

5.2.3.2 ModSAF Implementation Difficulties
The CIS definition calls for a radio message to be sent after the platoon crosses a phase line (LOA, SDL, Objective Line). IST used a ModSAF crossline function to check this. Travel tasks are generated from the platoon’s current location to the center of its next phase line. This is fine for a phase line made of only two points (Figure 13), but not for a phase line with multiple, nonlinear segments (Figure 14).

![Figure 13 - Phase Line with Only Two Points](image)

The center of the line in this case is not on the line. To ensure the unit crosses the line, the center is projected past the line, along the direction from the unit to the center of the line (Figure 15).

![Figure 14 - Phase Line with Multiple Nonlinear Segments](image)
This ensures the unit will cross the phase line.

5.2.3.3 Differences From Existing ModSAF Behavior

Four main differences between the CIS prototype and the existing ModSAF behavior are: the use of the CIS for only one unit type, the use of the CIS for only OPFOR units, the use of radio communications in the CIS prototype, and the location Battle Position line for a concluding occupy position task.

ModSAF’s nearest behavior to Assault an Enemy Position is the Assault task. The Assault task is used for both mixed and homogeneous units. The CIS is explicitly a tank platoon task, so any calls to mixed level routines were replaced with non-mixed level routines (see the above discussion in section 5.1.3.3).

This CIS is explicitly an OPFOR task. For completeness, the ModSAF taskframe.rdr file was modified to allow only OPFOR vehicles to use it. This is done by setting a bit mask for the task that corresponds to the type of unit that should use it.

ModSAF’s Assault does not account for important phase lines that are required for the Assault an Enemy Position Task. The CIS definition calls for a Line of Attack (from which the assault will begin), a Safe Distance Line (which, when crossed, the platoon should notify supporting artillery fire to shift from attacking the Objective Line to deeper enemy positions), and an Objective Line (which is what the platoon is assaulting). ModSAF’s Assault does have an Objective Line, but not the others. 1ST’s CIS implementation added these phase lines, along with appropriate actions to occur after each is crossed.

ModSAF’s ending phase of the Assault transitions to an occupy position task. The Assault creates a Battle Position a configurable distance from the Objective Line perpendicular to the platoon’s direction. IST instead used the Objective Line as the Battle Position. IST decided on this approach because it provided more flexibility on the orientation, length, and shape of the Battle Position.

6. Lessons Learned

Many of the issues uncovered initially in this project have been addressed with the implementation of these CIs. Some of these key issues include:

- Can behaviors for specific alignments be implemented in ModSAF?
- How different are ModSAF behaviors and CCTT SAF CIS based behaviors?
- Can CISs be implemented in ModSAF?
- Can this process be automated?
Behaviors for specific alignments (OPFOR Hasty Occupation of a Battle Position, and a different BLUFOR Hasty Occupation of a Battle Position) can be incorporated into ModSAF. Behaviors for separate alignments were added to ModSAF in separate libraries in the normal ModSAF fashion. Each behavior was then restricted in use to members of the alignment for whom the task was designed (i.e., only BLUFOR vehicles could execute a BLUFOR defined CIS).

ModSAF behaviors seem to have much of the functionality required by CISs, but seem to lack many of the CIS details. This is probably due to ModSAF's use of one behavior for many types of units and vehicles (e.g., tank platoons use the same behavior as mixed Dismounted Infantry/Infantry Fighting Vehicle platoons). Refer to Sections 5.1.3.1 and 5.2.3.1 for a discussion of differences between CCTT SAF and ModSAF CIS implementations.

CISs can be implemented in ModSAF. IST implemented two CISs in ModSAF based on the CIS definition and the CCTT SAF code. These CISs rely on ModSAF behaviors such as unit traveling, but do perform the tasks called for in the definition.

Much of the process to implement a CIS (at least for the first prototypes) is repetitive and can be automated. For example, creating state diagrams from CIS definitions and CCTT SAF code, library duplication, and inserting CIS definitions in source code to closely tie the definition to the code could be automated. Methods to automate this process will be examined further by IST.

7. Conclusion
This project has demonstrated the feasibility of adding CISs to ModSAF. This paper has illustrated the process that was used to add two CISs to ModSAF and has documented some of the general issues that impact behaviors. IST determined that many of the enumerated issues can be overcome (by IST or the CGF community). CIS prototype implementations helped reveal processes used in CIS implementation that could be automated. By examining the CATT-Task database, IST found that a core group of CISs are frequently used by other CISs. More examination of the CATT-Task database is necessary to fully enumerate this list, but this core group of CISs represents a starting point for CIS integration.

8. Acknowledgment
This research was sponsored by the U.S. Army Simulation, Training, and Instrumentation Command and by the U.S. Army TRADOC Analysis Center as part of the Integrated Eagle/BDS-D Project, contract number N61339-92-K-0002. That support is gratefully acknowledged.

9. References


10. Appendices
The appendices contain more detailed information about CIS content. Appendix 10.1 gives an overview of the CIS layout. Appendices 10.2 and 10.3 supply a complete CATT-Task description for the prototype CISs.

10.1 CIS Outline of Content
Figure 16 illustrates the basic outline of a CIS. Examples of CISs follow in Appendices 10.2 and 10.3.

<table>
<thead>
<tr>
<th>SECTION A. IDENTIFYING AND ADMINISTRATIVE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CIS ID #:</td>
</tr>
<tr>
<td>2. DATE PREPARED OR UPDATED:</td>
</tr>
<tr>
<td>3. CIS TITLE:</td>
</tr>
<tr>
<td>4. TYPE UNIT:</td>
</tr>
<tr>
<td>5. RELEVANT ENTITIES/PLATFORMS:</td>
</tr>
<tr>
<td>6. NAME OF PREPARER:</td>
</tr>
<tr>
<td>7. APPROVING GOVERNMENT AGENCY:</td>
</tr>
<tr>
<td>8. DATE APPROVED:</td>
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<tr>
<td>9. NAME APPROVING OFFICIAL:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SECTION B. DOCTRINAL FRAMEWORK FOR CIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. REFERENCES:</td>
</tr>
<tr>
<td>2. ARTEP TASK AND NUMBER:</td>
</tr>
<tr>
<td>3. GENERAL DESCRIPTION OF TASK:</td>
</tr>
<tr>
<td>4. ARTEP SUBTASKS AND STANDARDS:</td>
</tr>
<tr>
<td>5. INITIAL CONDITIONS:</td>
</tr>
<tr>
<td>6. INPUT DATA:</td>
</tr>
<tr>
<td>7. NOTES:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SECTION C. ACTIONS TAKEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SEQUENCE OF ACTIONS:</td>
</tr>
<tr>
<td>2. TIME-DEPENDENT ACTIONS/RESULTS:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SECTION D. CHANGES IN CIS STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SITUATIONAL INTERRUPTS:</td>
</tr>
<tr>
<td>2. TERMINATING CONDITIONS:</td>
</tr>
</tbody>
</table>

| SECTION E. BATTLEFIELD OPERATING SYSTEMS (BOS) COORDINATION: |

Figure 16 – CIS Outline

10.1.1 SECTION A. IDENTIFYING AND ADMINISTRATIVE DATA
Section A provides information that identifies the CIS by its Bxxxx or HVY-xxxx number and its name. It also provides other administrative details describing the CIS, including information documenting the approval of the CIS (Ourston et al. 1995).

10.1.2 SECTION B. DOCTRINAL FRAMEWORK FOR CIS
Section B gives a general description of the task, provides appropriate reference material, ARTEP subtasks and standards (where appropriate), initial conditions, and input data.

10.1.3 SECTION C. ACTIONS TAKEN
From a behavior implementation standpoint, the bulk of the CISs information falls in Section C. For BLUFOR CISs, each of the actions are described in the order they appear in the ARTEP documentation. They are broken up into move, search/observe, shoot, and communicate. References to various documents are in provided in parenthesis along with the various subtasks. This section also enumerates any time-dependent actions (Ourston et al. 1995).
For BLUFOR CISs, the ARTEP subtasks and standards are denoted by a code which describes the nature of the task from a CGF standpoint (See Table 4) (Ourston et al. 1995).

29
<table>
<thead>
<tr>
<th>D</th>
<th>(Decision) Decision required by either the CGF operator or CGF software</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>(Visual) Event that would normally be seen on the battlefield and would affect how an observer perceives the execution of the task</td>
</tr>
<tr>
<td>I</td>
<td>(Information) Needed information that leads to an action by software or the CGF operator or the process of seeking such information</td>
</tr>
<tr>
<td>N</td>
<td>(Not Needed) Not needed to provide a realistic CGF</td>
</tr>
</tbody>
</table>

Table 4 – Task Type

Events that are denoted by N will be marked as OMITTED in Section C (McEnany et al. 1993).

10.1.4 SECTION D. CHANGES IN CIS STATUS
Any event that causes the CIS to either end or transition to another behavior should be documented in this section. For example, Take Active Air Defense While Stationary (or Moving) and React to Indirect Fires are example of behaviors that are triggered by situational interrupts (Ourston et al. 1995).

10.1.5 SECTION E. BATTLEFIELD OPERATING SYSTEMS (BOS) COORDINATION
Section E provides information for autonomous behavior coordination. This section would be titled COORDINATION for an OPFOR CIS (Ourston et al. 1995).
10.2 CIS: B0025 – Conduct Hasty Occupation of Battle Position

CCTT SEMI-AUTOMATED FORCES (SAF)

COMBAT INSTRUCTION SET (CIS)

SECTION A. IDENTIFYING AND ADMINISTRATIVE DATA

1. CIS ID #: B0025
2. DATE PREPARED OR UPDATED: 9/28/93

3. CIS TITLE: CONDUCT HASTY OCCUPATION OF A BATTLE POSITION
4. TYPE UNIT: Tank Platoon

5. RELEVANT ENTITIES/PLATFORMS: Tank, M1A1/M1A2

7. APPROVING GOVERNMENT AGENCY:
8. DATE APPROVED:
9. NAME OF APPROVING OFFICIAL:

SECTION B. DOCTRINAL FRAMEWORK FOR CIS

1. REFERENCES:
   ARTEP 17-237-10-MTP; FM 17-15; FM 17-12-1; FM 101-5-1; STP 17-19EK4-SM; FKSM 17-15-3

2. ARTEP TASK AND NUMBER:
   Conduct Hasty Occupation of a Battle Position (17-3-0227)

3. GENERAL DESCRIPTION OF TASK:
   The platoon is conducting offensive or defensive operations and has received an order to conduct a hasty occupation of a battle position (BP). The platoon moves to and occupies the BP, orients itself properly on the likely direction/avenue of enemy attack and/or assigned engagement area (EA), ensures survivability of the platoon and its fighting position, and is prepared to defend the BP by the time specified in the order. (ARTEP 17-237-10-MTP, pp. 5-112 to 5-114; FM 17-15, pp. 4-20, 4-4 and 4-5, 4-10 to 4-16)

4. ARTEP SUBTASKS AND STANDARDS: (ARTEP 17-237-10-MTP, pp. 5-112 to 5-114)
   1. The platoon arrives at the BP: a. Enters BP from flank or rear (V) b. Keeps all weapons oriented in direction of last known or expected Threat contact (V)
   2. Platoon moves into turret-down positions: Positions all vehicles within limits of BP (V)

   2An advantageous location, selected on the basis of terrain and weapon systems, from which a unit defends or attacks. Platoon BPs and their direct-fire orientation are designated in the OPORD. (FM 17-15, p. 2-8)

   3An area designated along an enemy avenue(s) of approach in which the commander intends to destroy the enemy force with massed fires. It can be identified by prominent terrain features or by TRPs at the corners. (FM 71-2, p. 4-22)
3. PL designates defensive control measures: a. Points out each tank's primary firing position (I) b. Points out limits of company team EA (I) c. Points out target reference points (TRPs)\(^4\) (I) d. Indicates sectors of fire\(^5\) (I) e. Designates routes out of BP to subsequent BP or assembly area (AA), if applicable (D)

4. Platoon moves into its primary fighting positions: a. Each tank moves simultaneously into hull-down position on PL's order (V) b. PL reports establishment of BP to company team commander (I)

5. Each TC ensures his tank can place effective direct fires into the appropriate sector(s) of fire from hull-down position: Individual tank positions are adjusted, as necessary, to be able to fight effectively and survive (V)

6. Each tank moves to turret-down position and continuously scans its sector of fire: a. Each TC moves his tank back to turret-down which affords survivability but still permits gunner to scan sector (turret-down optics-up) (V) b. TCs and gunners continuously scan sector for Threat targets and alert the platoon to any Threat contact (V)

7. Platoon continues to improve the position: PL directs the additional steps of a deliberate occupation as time permits (N)

5. INITIAL CONDITIONS:

a. Platoon is part of company team conducting any form of operation which requires hasty occupation of BP.

b. Platoon may be using any formation or movement technique when approaching BP, but will normally move into column or staggered column formation moving along a single route (preferably covered and concealed) as it moves into or onto BP. (IDT judgment)

c. There are at least 3 tanks available in the platoon. (IDT judgment)

d. Engineer support is not available for this CIS. (FM 17-15, p. 4-12)

e. Platoon has received at least a FRAGO to conduct hasty occupation of BP including locations, positions, and control measures discussed in Section B.6 below. (FM 17-15, p. 4-12)

f. Threat contact is not expected before the "defend NLT" time specified in OPORD/FRAGO.

6. INPUT DATA:

a. Specify route(s) or general direction of approach into BP, location and limits of BP, and BP locations of the other platoons of the company team, if applicable (use overlay or OPORD/FRAGO).

b. Specify likely enemy avenue or direction of approach (use overlay or OPORD/FRAGO).

c. Specify assigned company team or platoon sectors of fire, EAs, and TRPs (use overlay).

d. Specify a primary, one alternate, and one supplementary fighting position for each tank and routes between the positions (use overlay or more detailed schematic diagram).\(^6\)

---

\(^4\)An easily recognizable point on the ground (terrain feature or manmade object) used for identifying and locating enemy targets and controlling direct and indirect fires. (FM 17-15, p. 2-13; FM 17-12-1, p. G-20)

\(^5\)An area that is required to be covered by the fire of a weapon system or a unit. (FM 101-5-1, p. 1-64)

\(^6\)Primary and alternate firing positions are oriented on the same enemy avenue of approach and platoon sector of fire. The alternate position allows a tank to move and reengage the enemy after the TC determines he is receiving accurate
e. Specify what the platoon is to accomplish (mission) at the BP and its subsequent actions. BP missions are normally: (1) destroy a specified-size enemy force, (2) control key terrain or block an avenue of approach, (3) hold till the enemy achieves a specified break point, or (4) assist in other tasks such as passage of lines. Actions to be taken after the mission is accomplished or is no longer feasible include disengage and move to a subsequent BP. The default action is "Defend the BP until ___ hours, then withdraw to subsequent BP # ___" (use overlay or OPORD/FRAGO). (FM 17-15, p. 4-5; IDT judgment)

f. Specify the "defend NLT" time.

7. NOTES:

a. This CIS includes many of the actions that must be taken for CIS #B0026, Occupy a Platoon BP.

b. See Figure 1 for a depiction of 3 platoon BPs (2 tank, 1 BFV) within the confines of a company team BP. Figure 2 shows the use of covered routes when moving between firing positions or otherwise maneuvering on the BP. See Figure 3 for a depiction of primary, alternate and supplementary firing positions. Figure 4 shows a concealed firing position (hull-down and turret-down).

antitank fire in his primary firing position. The distance between the primary and alternate firing positions is normally 75-100 meters, but actual distance may vary based on METT-T. The supplementary firing position is oriented on a different avenue of approach and sector of fire to enable the platoon to fight a 360° battle, if required. (FM 17-15, p. 4-12 to 4-14)
c. Ideally, platoon BPs should be 400 to 700 meters wide to allow for multiple firing positions, but actual distances are based on the factors of METT-T (see again Figure 3). (FM 17-15, p. 4-12)

d. Refer to Appendix A, Tank Platoon Default Parameters.

SECTION C. ACTIONS TO BE TAKEN

1. SEQUENCE OF ACTIONS:

1. The platoon arrives at the BP:

a. Enters BP from flank or rear (V)

   MOVE:
(1) Platoon enters BP using single entry point (default) from rear (default) or flank and using column (default) or staggered column formation. (ARTEP 17-237-10-MTP, p. 5-112; FM 17-15, p. 4-20; IDT judgment)

(2) Covered and concealed routes are used when moving into, in or on, and out of the BP. (FM 17-15, p. 4-12)

b. Keeps all weapons oriented in direction of last known or expected Threat contact (V)

SEARCH/OBSERVE:

(1) Platoon keeps weapons and frontal armor oriented in direction of last known or expected enemy contact (default) or in the normal direction for that particular formation. (ARTEP 17-237-10-MTP, p. 5-112; FM 17-15, p. 4-20; IDT judgment)

(2) During and after occupation of hasty BP, all tanks orient gun tubes and weapons in general direction of enemy and likely avenues of approach to BP. Figure 1 shows likely direction of enemy approach toward 3 platoon BPs. Tanks maintain constant observation to front (generally from 10 o'clock to 2 o'clock, but this may vary based on factors of METT-T) using unaided vision, optics, and night/reduced visibility devices. (ARTEP 17-237-10-MTP, p. 5-112; IDT judgment)

2. Platoon moves into turret-down positions: Positions all vehicles within limits of BP (V)

MOVE:

- Once in or on BP, tanks break out of formation (an RP may be used) and move individually to turret-down posture in their prearranged primary fighting positions on opposite side of BP (i.e., side nearest enemy). The primary fighting positions are generally on line, about 75-100 meters apart, with good fields of fire toward likely enemy avenue(s) of approach and platoon EA(s). Each tank can assume both hull-down and turret-down postures in its primary fighting position. (ARTEP 17-237-10-MTP, p. 5-112; FM 17-15, pp. 4-12 to 4-14; IDT judgment)

- Platoon does not position tanks outside limits of BP without coordinating with company team commander. (FM 17-15, pp. 4-5 and 4-6)

3. PL designates defensive control measures:

a. Points out each tank's primary firing position (I), and

b. Points out limits of company team EA (I), and

c. Points out target reference points (TRPs) (I), and

d. Indicates sectors of fire (I)

These are input data. See B.6 above.

e. Designates routes out of BP to subsequent BP or AA, if applicable (D)

This is an input element in CIS #B0034, Displace to Subsequent BP.

4. Platoon moves into its primary fighting positions:

a. Each tank moves simultaneously into hull-down position on PL's order (V)

MOVE:

(1) After 5-minute delay (simulates orientation on control measures) in turret-down positions, tanks move simultaneously up into hull-down posture in their primary fighting positions and complete
their orientation on the position from which they will fight. (ARTEP 17-237-10-MTP, pp. 5-112 and 5-113; FM 17-15, p. 4-20; IDT judgment)

(2) Normal speed within BP during preparation phase is about 10-20 kmph. However, when moving between primary, alternate and supplementary firing positions during an engagement, drivers must move rapidly into, out of and between firing positions. (FM 17-15, p. 4-14; IDT judgment)

b. PL reports establishment of BP to company team commander (I)

COMMUNICATE:

PL reports establishment of hasty BP to company team commander as soon as platoon tanks have assumed primary fighting (hull-down) positions. (ARTEP 17-237-10-MTP, p. 5-113; FM 17-15, p. 4-20)

5. Each TC ensures his tank can place effective direct fires into the appropriate sector(s) of fire from hull-down position: Individual tank positions are adjusted, as necessary, to be able to fight effectively and survive (V)

MOVE:

Positions may be adjusted, if necessary, to ensure each tank can fight effectively and survive; however, adjustments will be no greater than 10 meters from the initial position. (ARTEP 17-237-10-MTP, p. 5-113; IDT judgment)

6. Each tank moves to turret-down position and continuously scans its sector of fire:

a. Each TC moves his tank back to turret-down which affords survivability but still permits gunner to scan sector (turret-down optics-up) (V)

MOVE:

After completing orientation in hull-down posture (see 4.a above), tanks move back into turret-down posture and remain there. This provides greater protection while still allowing scanning/observation of assigned sector. (ARTEP 17-237-10-MTP, p. 5-113)

b. TCs and gunners continuously scan sector for Threat targets and alert platoon to any Threat contact (V)

SEARCH/OBSERVE:

(1) Each tank continuously scans its sector of fire throughout this CIS. (ARTEP 17-237-10-MTP, p. 5-113; FM 17-15, pp. 4-15 and 4-16)

(2) Tank crews maintain 360° ground and air security through observation. (FM 17-12-1, p. 12-99)

COMMUNICATE:

(3) PL reports enemy sightings to company team commander as they occur using SPOTREP format. (FM 17-15, p. A-12)

(4) PL requests indirect fire support for targets of opportunity outside range of direct-fire weapons. (FM 17-15, P. 4-21; IDT judgment)

SHOOT:

(5) Tanks may engage targets during this CIS; however, most shooting will normally take place in CISs subsequent to this, such as Attack by Fire

(6) or Execute Platoon Defensive Mission, after this CIS has been completed. (IDT judgment)

(7) Tanks are prepared to fire weapons within sectors of fire, into EAs or on TRPs.
(8) Tanks may use long-range fires (2 to 3 km). These allow the platoon to hit the enemy at extended ranges, but are not as accurate and may reveal platoon's positions. Tanks normally (default) engage enemy at ranges between 1,500 and 2,000 meters, depending on factors of METT-T, especially visibility conditions. (FM 17-15, pp. 4-20 to 4-22)

(9) Platoon employs long-range indirect fires when enemy is seen at distances outside direct-fire weapons range. Indirect fire is requested by PL using company team command or FIST radio net (see 6.b(4) above). (FM 17-15, pp. 4-21 and 4-19)

7. OMITTED

2. TIME-DEPENDENT ACTIONS/RESULTS:

a. If platoon is in hasty BP for more than 1 hour, the following improvements are assumed: improved defensive range cards and defensive fire plan (translates to 10% increase in direct and indirect fire hit accuracy and response speed), establishment of wire communications (translates into 20% better communication and fire control), and setting up physical security alarms (translates into 30% better warning of infiltration). (FM 17-15, p. 4-16; IDT judgment)

b. If platoon is in hasty BP for more than 3 hours, the following additional improvements are assumed: camouflage nets are set up (translates into 25% less chance of being detected by enemy ground forces; 40% less chance by enemy air forces), and movement between positions is rehearsed (results in 10% increase in speed when changing positions). (FM 17-15, p. 4-16; FKSM 17-15-3, p. 20; IDT judgment)

SECTION D. CHANGES IN CIS STATUS

1. SITUATIONAL INTERRUPTS:

a. Contact with OPFOR armed with tanks and/or ATGMs and within effective range, Execute Actions on Contact (CIS #B0022). (FM 17-15, p. 3-18)

b. Platoon receives indirect fire, execute CIS #B0013, React to Indirect Fires. (FM 17-15, p. 3-21)

c. Platoon is subjected to air attack, execute CIS #B0020, Take Active AD Measures while Stationary. (FM 17-15, pp. 3-21 to 3-23)

2. TERMINATING CONDITIONS:

a. Directed change of mission.

b. Platoon has completed its assigned mission at BP (see Section B.6.e) and is prepared to initiate the next CIS (such as Displace to Subsequent Battle Position, Attack by Fire, or Execute Platoon Defensive Mission) in accordance with commander's order or plan.

SECTION E. BATTLEFIELD OPERATING SYSTEMS (BOS) CHECKLIST

1. MANEUVER:

2. FIRE SUPPORT:

3. AIR DEFENSE:

4. COMMAND AND CONTROL:

5. INTELLIGENCE:

6. MOBILITY/COUNTERMOBILITY/SURVIVABILITY:

7. COMBAT SERVICE SUPPORT:
10.3 CIS: HVY-0022 – Assault an Enemy Position

CCTT SEMI-AUTOMATED FORCES (SAF)

COMBAT INSTRUCTION SET (CIS)

SECTION A. IDENTIFYING AND ADMINISTRATIVE DATA


3. CIS TITLE: ASSAULT AN ENEMY POSITION

4. TYPE UNIT: Tank Platoon

1. RELEVANT ENTITIES/PLATFORMS:

a. COMPOSITION: Three Tank Sections (one tank each)

b. ENTITIES BY TYPE: T-62, T-72, T-64, T-80

c. ATTACHMENTS/DETACHMENTS: Possible attachments include one or more motorized rifle squads

6. PREPARED BY: Thomas O’Keefe PHONE NO.: (303) 773-6900

7. APPROVING GOVERNMENT AGENCY: CAC-Threats, Fort Leavenworth, KS

8. DATE APPROVED: 24 May 1994

9. NAME OF APPROVING OFFICIAL: CPT Johnny R. Bullington

SECTION B. DOCTRINAL FRAMEWORK FOR CIS

1. REFERENCES:


2. GENERAL DESCRIPTION OF TASK:

Assaulting an enemy position is a component part of the attack. It begins when the platoon moves into combat formation (normally platoon line but can also be in a wedge, echelon right, or echelon left) just prior to crossing the Line of Attack. This action may also be used as an immediate action drill during a movement CIS or any time that the platoon may be ordered to assault and destroy enemy forces. The platoon continues assaulting by firing at the enemy forces and moving forward over the enemy positions until the objective line is reached and the enemy is destroyed or captured. The platoon then moves into firing positions and prepares to repel enemy counterattacks, to continue the attack, or to establish temporary defensive positions. The platoon frontage for the assault may be up to 300 meters. This is also the point that the platoon may revert to the higher level CIS (ATTACK FROM THE MARCH (HVY-0008), NIGHT ATTACK (HVY-0024), or ATTACK FROM POSITIONS IN CONTACT (HVY-0026)).
3. INITIAL CONDITIONS:

Platoon is moving in some formation or has deployed from firing positions.

4. INPUT DATA:

a. Line of Attack
b. Platoon objective (normally the enemy in emplacements or other strong point fortifications) and objective line.
c. General direction of continuation of attack.
d. Safe Distance Line

5. NOTES:

a. This CIS is very similar to the Motorized Rifle Platoon CIS, ASSAULT AN ENEMY POSITION.
b. This CIS is a component part of the CISs, ATTACK FROM THE MARCH, NIGHT ATTACK, and ATTACK FROM DIRECT CONTACT WITH THE ENEMY. It may also be used from a traveling or road march action when an enemy force has been encountered (See Appendix D, Situational Interrupt Matrix).

SECTION C. ACTIONS TO BE TAKEN

1. SEQUENCE OF ACTIONS:

a. When in an attack CIS, the platoon executes a combat formation CIS prior to crossing the Line of Attack (default formation is Line Formation).

   The Line of Attack may be up to 600 meters from the enemy FEBA.

   Tanks will orient guns forward and focus observation in designated sectors. The left flank tank will be responsible for the sector from 8 o’clock to 12 o’clock, the center tank will be responsible for the sector from 10 o’clock to 2 o’clock, and the right flank tank will be responsible for the sector from 12 o’clock to 4 o’clock.

   Platoon leader will also track action in adjacent platoon sectors.

   Platoon assault combat formation: default speed is 10 km/h; default spacing is 100 meters between tanks.

b. Platoon executes appropriate scheme of maneuver as it moves forward toward enemy FEBA. The scheme of maneuver used by a platoon assaulting an enemy position is a frontal attack. This is the case even if the company or higher level unit is executing an envelopment or flanking maneuver.

c. Tanks maintain approximate speed, interval and formation during the assault.

d. Tank commanders control individual tank fire and movement in accordance with platoon commander’s direction.

e. Tanks engage on the move and destroy targets designated by the platoon leader and fire independently on targets of opportunity appearing in the platoon sector. Priority of fire is against enemy tank and anti-tank weapons (see Appendix A for firing parameters).
f. During an attack on an enemy position (ATTACK FROM THE MARCH, NIGHT ATTACK, or ATTACK FROM POSITIONS IN CONTACT CISs) if a minefield is encountered, tanks will attempt to go around it. If this is not possible, the tanks will be prepared for it and have at least one plow in the platoon. This tank will drive through the minefield, creating a path for the other tanks to follow.

g. The tank that has the plow attached will move forward into the minefield. The platoon commander will order the platoon to execute COLUMN FORMATION CIS. The tank with the plow will become the lead tank in the platoon. The second and third tanks will move into formation behind the new lead tank and follow it through the minefield at an interval of 50 meters.

h. Once the tanks have cleared the minefield, they will immediately resume the combat formation (usually LINE FORMATION).

i. As the platoon approaches the Safe Distance Line (approximately 200 meters in front of enemy FEBA), friendly supporting fires are shifted into the depth of the enemy positions on the battalion commander’s order.

j. The platoon continues to assault through the enemy’s positions, destroying and/or capturing enemy personnel and equipment until the objective line is reached. If this CIS is being executed as a part of another CIS (ATTACK FROM THE MARCH, ATTACK FROM POSITIONS IN CONTACT, or NIGHT ATTACK), it will revert to that CIS at this time.

k. Once enemy forces are destroyed or captured, the platoon immediately prepares to repel enemy counterattacks, continue the attack, conduct a pursuit, or occupy temporary defensive positions.

l. Platoon leader will report:

   Crossing Line of Attack.
   Seizure of objective.
   Destruction or capture of enemy forces and equipment.
   Serious friendly losses.
   Other events which preclude accomplishment of mission.

2. TIME DEPENDENT ACTIONS/RESULTS:

SECTION D. CHANGES IN CIS STATUS

1. SITUATIONAL INTERRUPTS:

   a. See Appendix D, Situational Interrupt Matrix

   b. If platoon is attacked by enemy air, execute TAKE AIR DEFENSE MEASURES CIS.

   c. If platoon is receiving incoming indirect fire, execute ACTIONS ON INCOMING ARTILLERY FIRE CIS.

2. TERMINATING CONDITIONS:

   a. Platoon reaches objective line

   b. Enemy forces have been destroyed or captured.
c. Orders from higher headquarters directing change of mission.

d. Platoon is destroyed.

SECTION E. COORDINATION: