Application of Feature-Oriented Domain Analysis to the Army Movement Control Domain

Sholom G. Cohen
Jay L. Stanley, Jr.
A. Spencer Peterson
Robert W. Krut, Jr.

June 1992

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Software Engineering Institute
Carnegie Mellon University
Pittsburgh, Pennsylvania 15213

This report was prepared for the

SEI Joint Program Office
HQ ESC/AXS
5 Eglin Street
Hanscom AFB, MA 01731-2116

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(signature on file)

Thomas R. Miller, Lt Col, USAF
SEI Joint Program Office

This work is sponsored by the U.S. Department of Defense.

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Application of Feature-Oriented Domain Analysis to the Army Movement Control Domain

Abstract: This report documents an analysis of the army movement control domain performed by the Software Engineering Institute (SEI) and a team of movement control experts from the Army. This report includes common terminology and requirements extracted from Army doctrine, experts in the field, and movement control systems. The report also describes the potential for prototyping of systems using domain analysis products and the tool support needed.

1.   Introduction

Movement control plays a major role in the delivery and sustainment of combat forces.The successful deployment of these forces often determines the outcome of campaigns, major operations, battles, and engagements. Movement control has been defined in [FM 55-10] as:

> *"The planning, routing, scheduling, control, coordination, and in-transit visibility of personnel, units, equipment, and supplies moving over lines of communication and the commitment of allocated transportation assets according to command planning directives."*

Therefore, movement control involves synchronizing and integrating logistics, movement information, and programs that span the three levels of war: strategic, operational, and tactical. Movement control balances requirements against capabilities and allocates resources based on the combat commander's priorities.

1.1. Audience for this Report

The information contained in this document is organized in a manner that provides clear insight into the movement control domain. Its intended audience need not be experts in the area of movement control. The report addresses the needs of a variety of readers and:

- Is intended for developers interested in the requirements for army movement control application software.

- Provides an understanding of the application of a specific domain analysis method.

- Is directed towards individuals generally interested in the application of a domain analysis method.

- Provides an example of the application of a specific domain analysis method in the command and control area.

Although the movement control analysis spanned strategic, operational, and tactical levels of warfare, the primary focus was on the operational and tactical levels. More specifically, the products resulting from the domain analysis will be targeted for users at the corps level of command and below. This is because the organizations participating and showing significant interest in this work are working in these focus areas with the movement control domain.

1.2. Purpose of Analysis

The products resulting from the domain analysis provide a common basis for communicating user needs to implementors of movement control applications. In addition to providing domain analysis products, the purpose of the analysis was also to validate the SEI Feature-Oriented Domain Analysis method (FODA) presented in [SEI90a] and provide an approach for future domain analysis.

1.2.1. Develop Products to Support Software Implementation

The Army Tactical Command and Control System (ATCCS) consists of five battlefield functional areas (BFAs). The BFAs are Air Defense, Combat Service Support, Field Artillery, Intelligence, and Maneuver Control. These BFAs share common application requirements such as movement control. The domain analysis was intended to produce products that support the implementation of related movement control software applications within the BFAs and other army systems.

1.2.2. Validating the Method

During the feasibility study, FODA was applied to the window manager domain. The window manager domain was scoped for limited size and selected because it was well documented. The next step in validating the method was to apply FODA to a more challenging domain. The ATCCS movement control domain was selected as representative of a larger, more complex, and less well-documented domain.

1.2.3. Provide Approach for Using FODA in Other Domains

Following successful application of FODA within the movement control domain, the method can be applied to other software application domains. These applications may be used for ATCCS and other Army projects. Domain analysis has the potential for saving time, effort, and expense by promoting effective software reuse. Therefore, the FODA methodology will serve long-term reuse objectives.

1.3. Report Overview

This report summarizes the method and the sources used during the analysis. The report provides a summary of the products that are given in detail in the appendices (bound as a separate volume). The report contains a description of the use of the products in building a move-

ment control application, as well as a summary of lessons learned. The following is a summary of the remaining sections of this report:

Section 2: Overview of the Method - provides a short review of the FODA method. This review concentrates on how the method was applied during the first two phases of the movement control domain analysis and how we plan to perform the third and final phase of the method for this domain.

Section 3: Technical Approach - provides insight on information gathered from domain experts, documentation, and systems. Other topics addressed within this section are tools used to aid model development, special training, and results of the workshop conducted for the purpose of gathering domain requirements and validating interim results.

Section 4: Movement Control Domain Analysis Review - provides a concise view of the products of the domain analysis and discuss how each adds to an understanding of the movement control domain. This section also describes validation of the model against existing systems.

Section 5: Application of the Domain Model in System Development - shows an extended example of how the domain model products are used in the construction, usage, and validation of a prototyping tool for modeling movement control systems.

Section 6: Conclusion - addresses two primary topics: lessons learned and recommendations for future research. Lessons learned addresses pertinent information that will be used to refine the methodology. Recommendations for future research focuses on future directions for the current project.

2. Overview of Feature-Oriented Domain Analysis Method

The SEI domain analysis of movement control identified, collected, organized, and represented the relevant information in the movement control domain. This analysis studied existing systems and their development histories, underlying theory, emerging technology within the domain, and captured knowledge from domain experts. In performing this domain analysis, the SEI used the FODA method. This method supports the discovery, analysis, and documentation of commonality and differences within a domain.

FODA defines a process for domain analysis and establishes specific products for later use. Three basic phases characterize the FODA process:

1. *Context Analysis*: defining the extent (or bounds) of a domain for analysis.

2. *Domain Modeling*: providing a description of the problem space in the domain that is addressed by software.

3. *Architecture Modeling*: creating the software architecture(s) for implementing solutions to the problems in the domain.

The application of the FODA during each of the phases is described in detail in Sections 2.1-2.3.

During the analysis there are a variety of participants who must provide information, develop domain analysis products, and review the results. The FODA report describes three groups of participants in the domain analysis process. They are the:

1. *Sources*. These participants provide information needed during the analysis. They may be further characterized as:

    - *End users*. The personnel that use systems in the domain. These participants know how the systems they use operate, understand where the systems fit in a larger flow of control, and what capabilities are missing from current systems.

    - *Domain experts*. The personnel that provide information about systems in the domain.

2. *Producers.* These participants gather the information, perform the analysis, and produce the products. They are familiar with the FODA method and applying it to gather and organize domain knowledge.

3. *Consumers* - These participants use the domain analysis products. They may be further characterized as:

    - *End users*. The same as in *Sources* above.

    - *Requirements analyst*s. The specifiers of new systems in the domain.

- *Software designers*. The personnel designing new systems in the domain.

The participants in an analysis may not play unique roles, i.e., the requirements analyst who has worked on the specifications of several systems in the domain may be one of the domain experts. There is a clear distinction, however, among the roles of consumers of domain analysis. The role categories of consumers map easily onto the roles of various Army organizations that take part in the software acquisition process [ACAM86]. This process is affected by the interactions among the organizations performing the domain analysis and the users of the analysis. Two important organization types that are part of the acquisition process are:

1. *Combat Developer*. This is the Army term for the user representative in the acquisitions process. The combat developer is a key source of domain expertise, as he is familiar with requirements for a related set of software systems. Capturing commonality at this level is critical in forming the domain model. The combat developer also is a user of the domain model, utilizing the model as the basis for requirements elicitation and specification.

2. *Material Developer*. The material developer works with the combat developer in identifying and specifying system requirements. The material developer has two primary roles:

    a. *Acquisition agent.* Generally, this role is performed by the Program Executive Officer (PEO) and specific Product Managers (PMs) for individual systems. For development of reusable software, the material developer will serve as the key acquisition agent and must be an active participant in the domain analysis.

    b. *Implementor.* The contractor or an internal development organization is the actual developer of the domain model and architecture. The model developer or a separate implementor may also be users of the models, building a system based on the models or using all or parts of the models in system development, reusable component development, and training.

An overview of each of the phases within the FODA process and the relationships between their products and their consumers is given in the following sections. This discussion of FODA is given in light of its application to the movement control domain.

2.1. Context Analysis

Context analysis defines the scope of a domain that is likely to yield useful domain products. During the context analysis for this domain, the relationships between the movement control domain and the elements external to it were established and analyzed for variability. The kinds of variability to be accounted for are, for example, when applications in the domain have different data requirements and/or operating environments. The results of the context analysis, along with other factors such as availability of domain expertise, domain data, and project constraints, were used to limit the scope the domain. Sections 3.1and 3.2 describe the information

resources used to perform our analysis of the movement control domain. The context analysis for the movement control domain is documented in detail in a previous SEI report [SEI91a].

The product resulting from the context analysis is the *context model*. This model includes a structure diagram and a context diagram. The structure diagram for this domain is an informal block diagram in which the movement control domain is placed relative to higher, lower, and peer-level domains, all within a general view of the domain's applicability. Higher level domains are those of which the domain under analysis is a part of or to which it applies. For example, movement control is only one of several domains in the Army command and control domain. Lower level domains (or subdomains) are those within the scope of the domain under analysis, but which are well understood. Examples of these lower level domains for movement control are User Interfaces and Common Message Services. Any other relevant domains (i.e., peer domains) must also be included in the diagram.

The movement control context diagram is a data flow diagram showing data flows between a generalized application within the domain and the other entities and abstractions with which it communicates. One thing that differentiates the use of data flow diagrams in domain analysis from other typical uses is that the variability of the data flows across the domain boundary must be accounted for with either a set of diagrams or text describing the differences.

These products provide the domain analysis participants, mentioned at the beginning of this section, with a common understanding of:

- The scope of the domain
- The inputs/outputs
- Stored data requirements (at a high level) for the domain

Section 4.2 discusses the products of the context analysis and their use in more detail.

2.2. Domain Modeling

Domain modeling identifies the commonalities and differences that characterize the applications within the domain. The domain model documented in Section 4.3 of this report applies to the scope of movement control established during the context analysis and refined in Section 4.1. The domain modeling phase consist of three major activities. A brief description of each activity and its results is given below.

1. *Entity-Relationship* (ER) *Modeling* captures and defines the domain knowledge and data requirements that are essential for implementing applications in the domain. The movement control domain is rich in data requirements including data to characterize unit and orders information (see Section 4.3.1). Domain knowledge typically is information that is deeply embedded in the software and is often difficult to trace. Those who maintain or reuse software need this information in order to understand the problems the domain addresses.

The ER model is used primarily by the requirements analyst and the software designer to ensure that the proper data abstractions and decompositions are used in the development of the system. The ER model also defines data that is assumed to come from external sources.

2. *Feature Analysis* captures the end user's understanding of the general capabilities of applications in a domain. For the movement control domain, the commonalities and differences of interest to end users among related movement systems were designated as features and are depicted in the *feature model*. These features, which describe the context of domain applications, the needed operations and their attributes, and representation variations are important results because the feature model generalizes and parameterizes the other models produced in this domain analysis.

   The feature model is the chief means of communication between the end users (in movement control, the combat developer organizations) and the developers (i.e., the material developers and implementor) of new applications. The movement features are meaningful to the end users and can assist the requirements analysts in the derivation of a system specification that will provide the desired movement control capabilities. Previously, combat developers have had difficulty specifying their needs. The feature model provides them with a complete and consistent view of the movement control domain. The combat developer will select features and the requirements analyst can validate them for completeness and consistency. The domain modeling tool (see Section 3.4.1) allows prototyping of the selected features by the software designer during the software development process for a new system in the domain.

3. *Functional Analysis* identifies the control and data flow commonalities and differences of the applications in a domain. This activity abstracts and then structures the common functions found in the domain and the sequencing of those actions into a model. Common features and ER model entities form the basis for the abstract functional model. The control and data flow of an individual application can be instantiated or derived from the functional model with appropriate adaptation. The functional model for the movement control domain is described in detail in Section 4.3.3.

   The functional model is the foundation upon which the software designer begins the process of understanding how to provide the features and make use of the entities selected.

The domain modeling process also produces an extensive *Domain Dictionary* (Appendix G) of terms and/or abbreviations that are used in describing the features and entities in movement control, and a textual description of the features and entities themselves. If multiple terms are used to convey an equivalent concept, each is listed in the dictionary with the most frequently used term identified as the primary term with the needed definitions(s) and the other terms referring back to the primary.

The domain dictionary has been found to be one of the most useful products of a domain analysis. The dictionary helps to alleviate a great deal of miscommunication because it provides the users of the domain information with a central location to look for terms and abbreviations

that are completely new to them, or for definitions of terms that are used differently or in a very specific way within the domain.

The resources used during the domain modeling phase of this analysis are described further in Chapter 3. The products of this effort, i.e., the ER model, feature model, functional model, and domain dictionary are included in various sections of Chapter 4 and/or as appendices to this report.

2.3. Architectural Modeling

Architectural modeling provides a software solution for applications in the domain. An architectural model (also known as a design reference model) is developed in this phase and detailed design and component construction can be done from this model. This architectural model is a high-level design for applications in a domain. It focuses on identifying concurrent processes and domain-oriented common modules, and on allocating the features, functions, and data objects defined in the domain models to the processes and modules.

The FODA report describes the use of DARTS methodology [GOMAA84] for the architectural modeling. For the movement control domain, the architectural model will be based on the *structural modeling* method. This method is based upon work performed by the Software Architecture Engineering (SAE) project at the SEI on projects that have developed software architectures.

In the structural modeling approach, the architecture is based upon the repeated use of a set of software structures. The consistent use of structures throughout the architecture is called the Object Connection Update (OCU) paradigm, documented in [SEI88]. The OCU concepts and techniques have been refined into the structural modeling process, which was initially defined in [SEI90b] and is currently being used on several external projects under the supervision of the SAE Project. A more detailed description of the method is currently being developed by the projects

The OCU paradigm can be described briefly by defining the terms as they are used in connection with the paradigm.

Object A software implementation of a real-world entity, either a physical object or a logical object that is to be treated as if it were real (an organization). Given the attributes of the object and its operational state, an object maps the relevant effects of its environment onto itself. The implementation isolates individual effects and is unaware of its connections to other objects. The implementation of a object may be a composition of other objects.

Connection The mechanism for transferring state information between objects. Processing a connection involves reading the state of some objects on the connection and broadcasting to others.

Update   The gating and processing of a connection or other input to derive a new output and/or internal state of an object.

A complete system is comprised of three levels of software component activities:

1. The executive, which handles the coordination of objects, the connections between them, and the ordering of updates.

2. The system, which organizes a set of related objects into a more meaningful whole. It provides internal coordination for its objects and interfaces them to other systems.

3. The object, which encapsulates and manages the information about a single entity, including the attributes and state information.

These three levels map well onto various aspects of the ER and functional models developed during the domain modeling process. The executive component is derived from the functional model and defines the independent activities that share information and synchronize with one another. The systems components are derived from the detailed behavioral states and the activities they control. Finally, the objects are derived from examination of the ER model and the data and operations needed by the activities.

2.4. Applying the Results of Domain Analysis

FODA defines a method for performing domain analysis and describes the products of an analysis. The application of the domain analysis method within the Army domain has helped refine the method and establish ways of applying the products.

Figure 2-1 shows the three components of the domain model: the feature model, the entity relationship model, and the functional model. A combat developer works with the domain analyst and these products define requirements for a system. The three steps in the process are:

1. The combat developer and domain analyst use the feature model as a vehicle for communicating system needs. The domain analyst will turn these needs into a selection of features. In addition, composition rules among features will automatically add specific features to the new system.

2. The domain analyst uses the entity relationship model to explain the *objects* that compose a system. This helps the combat developer understand the data requirements as well as other systems and data structures with which the system must interoperate.

3. The functional model is then used to describe commonality and differences in data and control flow resulting from differing combinations of features.

The product of feature selection is the definition of capabilities of the system under development as shown in Figure 2-1.
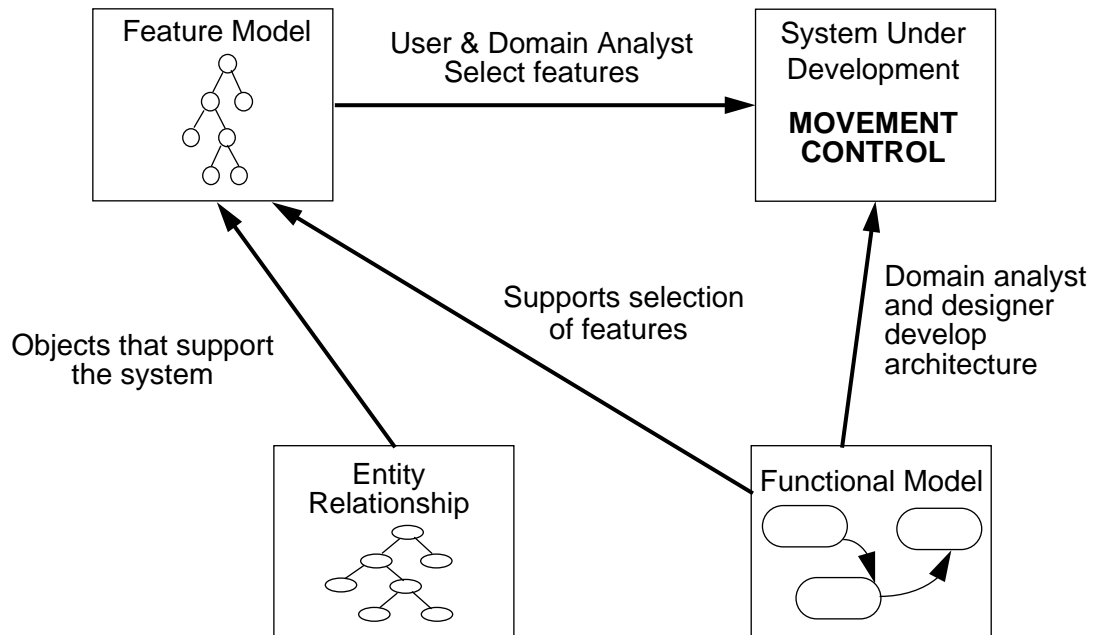
Figure 2-1 Use of Domain Model in System Development

The functional model supports feature selection as well as architectural development. Feature selection will parameterize the functional model, establishing the dynamics of interacting system capabilities. A combat developer will utilize this information in making choices that will affect both system control and operations. For example, a choice of features may affect the sequence of operations or eliminate those operations altogether. Another important aspect of this model is the definition of data flow resulting from these operations. The system dynamics necessary to meet the desired system capabilities may depend on specific feature selections.

When implementing the desired features, the domain analyst and software designer will work jointly to establish the software architecture. The functional model defines data exported by specific activities as well as those required for input by other activities. The model also shows the control necessary to start an activity to effect the data flow. The architectural structure described in Section 2.3 is a direct product of this type of interaction. The detailed realization of all data flows and the control necessary to accomplish them is a key component of software design. Using the feature model, the software designer engineers a general architecture that supports implementation of common features that can also be parameterized for tailorability for meeting optional and alternative features.

This application of the domain analysis products feeds into a life-cycle view of *model-based software development*. This process is illustrated in Figure 2-2. Under this development approach, models exist to help in both *setting* the problem and in *solving* the problem. Domain

analysis and its products are the model base for understanding the user needs and obtaining requirements. Architectural models provide a structure for building a solution. Finally, implementation models provide components, software generator tools, and software composition tools to support production of the deliverable software products. Where the models are inadequate for understanding the problem space and producing a solution, the life cycle must include unprecedented development. In addition to filling the gaps in existing models, unprecedented development will lead to refinement of existing models or to the realization that the existing models are no longer adequate.
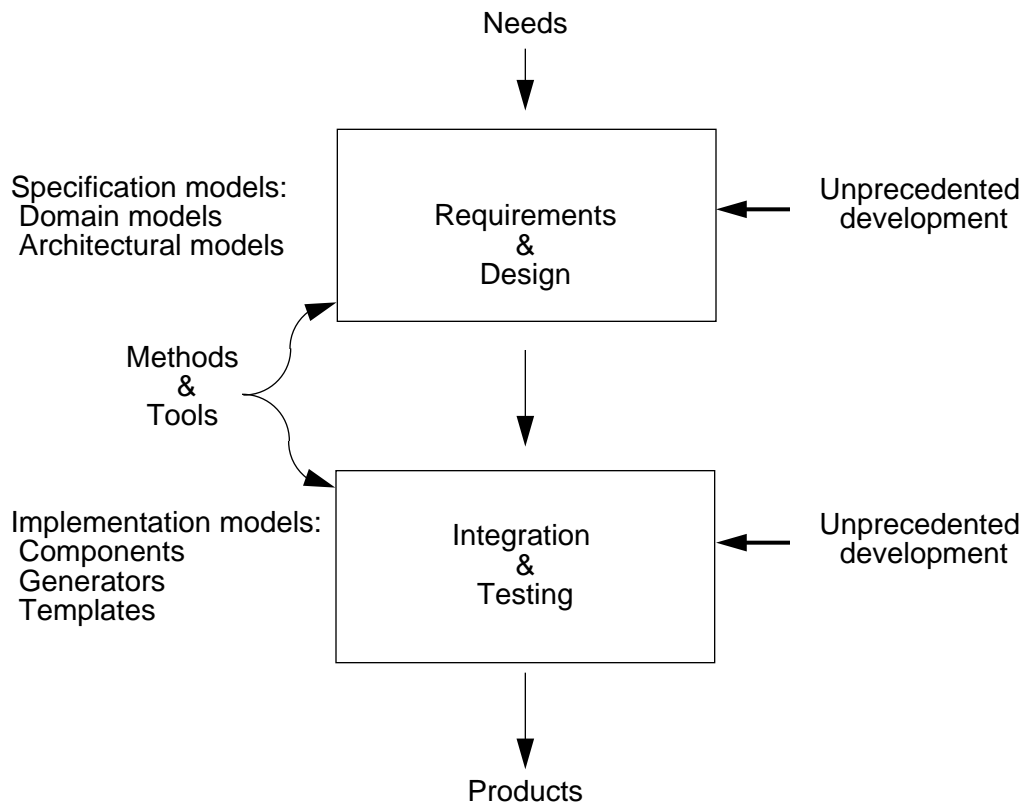
Figure 2-2 Domain Analysis and Model-Based Development

The life-cycle model also shows the importance of methods and tools. While general tool support is necessary for configuration management and other general software engineering activities, specialized model-based tools and methods will support specification and implementation activities. For domain analysis, these tools will provide functionality to:

- Document the domain model

- Support feature selection for model-based specification

- Perform prototyping to animate specifications

Chapter 5 of this report describes the use of a domain analysis tool supporting these functions.

3.   Technical Approach

The following sections contain sources and summaries information gathered during the analysis. The section also describes the tools and techniques used by the analyst during the effort.

3.1. Domain Expert Discussion

An important step in domain analysis is understanding the customer (user/developer) community. During the Army Movement Control Domain Analysis Project, the customer community was examined to identify key components of the army acquisition process. This examination revealed three primary components:

1. *Production.* Converts raw material into the intermediate goods required by the combat system. Within the production system, there are two major subcomponents:

   - *Training and Doctrine Command (TRADOC).* Responsibilities of TRADOC are to produce training, doctrine, tactics, and techniques for combat operations. TRADOC is also the user representative in the research, development, and acquisition process of weapon systems. TRADOC conducts all combat developments that are not specifically designated to other Army commands and agencies.

   - *Army Materiel Command (AMC).* Produces weapon systems and other related weapons materiel and supports the systems after fielding. The Army Materiel Command performs assigned materiel and related functions for research and development, development test and evaluation, acquisition, and logistics support of materiel systems as required by the Army.

2. *Combat.* Converts the Army's intermediate products, obtained from the production subsystem, into combat-ready forces.

3. *Integration/Coordination.* Decides what is to be produced or accomplished by the whole system and makes sure that the system performs as expected [ACAM86].

TRADOC and AMC share the responsibility of research, development, and acquisition. Due to this, TRADOC combat developers and AMC materiel developers played a significant role in the development of the domain model.

During the early stages (context analysis phase and domain modeling phase) the thrust of the analysis was identifying system requirements. Therefore, the domain analysis relied heavily on the combat developers and the user representative during materiel acquisition for domain expertise (see Figure 3-1).

As the analysis progresses into the later stages of the domain modeling process, more interest is placed on converting the user requirements to a common software system architecture. The

materiel developers now play a more significant role in the domain analysis. Figure 3-1 illustrates the typical developer involvement during domain analysis.
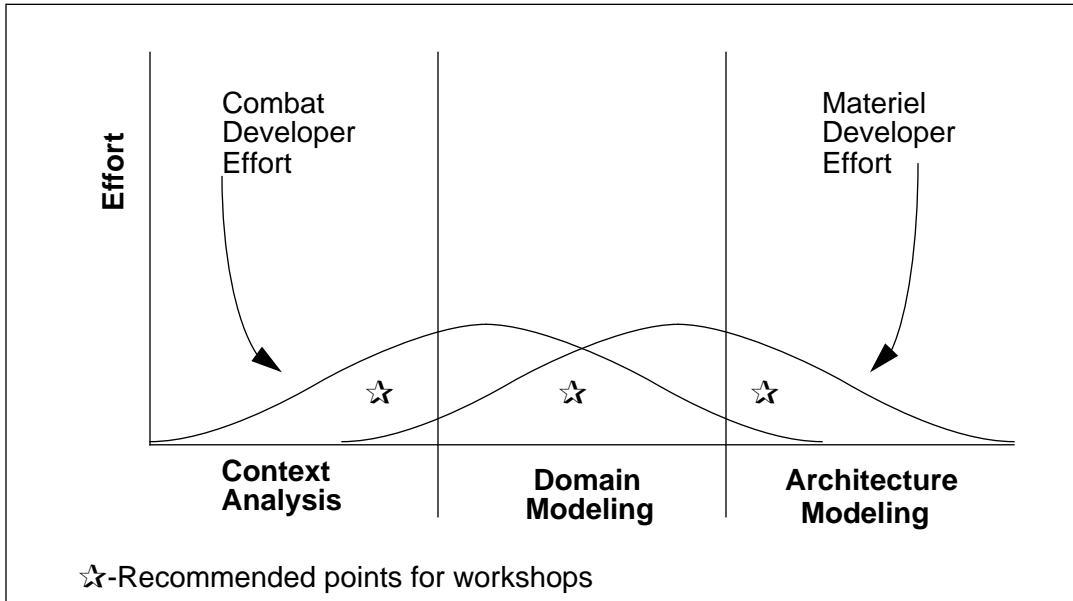
Figure 3-1 Developer Effort During Domain Analysis

The domain workshop is necessary for obtaining domain information and validation of existing domain analysis products. The participants in the workshop will include domain experts from TRADOC and AMC. As illustrated by the figure, there are three appropriate times for conducting a domain analysis workshop:

1. *Prior to the transition into the Domain Modeling Phase.* As a result of the preliminary scoping process, the domain analyst understands enough of the terminology and issues to ask intelligent questions associated with scoping the domain and building the model skeleton.

2. *Midway through the Domain Modeling Phase.* At this point, the most knowledgable and articulate of the combat developer domain experts have been identified, the preliminary domain model is developed, and it can be used as a focal point of feature discussion. Materiel developer domain experts can begin orientation into the domain.

3. *Shortly after the transition to the Architecture Modeling Phase.* Materiel developers understand the issues surrounding the domain, a few of the implementation issues have been discussed, and the first draft of the system architecture has been completed and can be used as the focal point for uncovering unknown implementation problems.

The next section discusses the finding of the workshop conducted during this project.

3.2. Domain Modeling Workshop

An Army movement control workshop brought together experts from the U.S. Army along with domain developers from the SEI, industry, and academia. The workshop proved to be an effective means for:

- Discussions of commonalities among movement control systems.

- New and evolving system requirements.

- Underlying theory of movement control.

The effectiveness of the workshop is dependent on two major factors:

1. *Timing of the Workshop.* The domain analyst should be reasonably familiar with the domain before scheduling the workshop. This timing of the workshop allows:

   - Identification and invitation of the most important domain experts.

   - Review of draft versions of the entity relationship and feature models. During the workshop, the interaction between the different various models and the use of the FODA method could be demonstrated. This aspect of the workshop provides a forum for the domain analysts to articulate their current understanding of the domain. Use of the models also provides a mechanism for the domain experts to establish common terminology, discuss additional features, and identify issues that require further domain analysis.

2. *Control of Discussion.* There are several critical factors which must be considered during open discussions:

   - Because the participants are from diverse backgrounds, each participant understands the system from a slightly different point of view. Control of the discussion requires extracting the commonality that exists between the different points of view. The domain analyst must then restate these characteristics in a manner that can be agreed upon by the experts.

   - The discussion must focus on key characteristics of the domain. Because the participants are experts in the domain, there is a tendency for them to sidetrack and elaborate on the relatively unimportant issues. Knowledge of the domain at this point in the analysis enables the participants to maintain proper focus on the appropriate issues within the domain.

3.3. Sources of Domain Information

The domain analysis relied on domain experts in movement control, systems that performed movement control functions and Army doctrine, for domain information. The following subsections document these sources of information.

3.3.1. Domain Experts Involved with the Project

The domain analysis obtained expert knowledge from the U.S. Army labs, schools, and development organizations. Domain experts are listed in Table 1.

3.3.2. System Discussion

There are relatively few software systems with movement control features. This was one of the primary differences between this analysis and that of the feasibility study [SEI90a]. During the feasibility study, a large percentage of the window manager software features could be viewed directly from the screen. The lack of example systems within the movement control domain increased the work of the domain analyst. Instead of having working systems from which to extract features and other domain information, the analyst was forced to uncover the information from requirements documents, doctrine, and discussions with domain experts.

However, there were a few computer based systems discovered that exhibited limited movement control capability. The vast majority, though, were limited to the convoy planning aspects of movement control. Others were in the early stages of development and were merely prototypes arising from the concept exploration phase of development.

Table 2 contains a list of systems analyzed during the domain analysis process. Table 3 contains a list of the documentation associated with the reviewed systems.

3.3.3. Army Doctrine

Table 4 provides a list of key Army documents that contributed to the understanding of the domain.

Organization	Name	Contribution to the SEI	Benefits from Domain Analysis
U.S. Army Field Artillery School System: AFATDS	• Major John Garhart	• Source for unit movement control requirements • Provided more insight into the AFATDS movement control module	• Exposure to work in related systems (DAMMS-R, ALBE-GIS, etc.) • Clear picture of common movement control requirements
Magnovox Electronic Systems Company System: AFATDS	• Eric Deets • Scott Black • David Burgdorf	• Source for unit movement control requirements • Provided more insight into the AFATDS movement control module	• Exposure to work in related systems • Clear picture of common movement control requirements • Facilitates development of reusable movement control software

Table 1 List of Domain Experts

Organization	Name	Contribution to the SEI	Benefits from Domain Analysis
U.S. Army CECOM System: CASS	• Bruce Gray • Mike Fragale	• Provide information about the ATCCS/CASS layer	• Understanding of the domain analysis methodology • Knowledge of how the technologies can be used in subsequent CASS efforts
Combined Arms Command Future Battle Lab	• Capt. Jim Shufelt	• Provided insight into the new AirLand Operations concept	• Assurance that the systems that will be developed from the domain analysis process will be able to change to meet the new fighting doctrine
Carnegie Mellon University System: TPFDS	• Steven Roth	• Insight into strategic level movement control characteristics • Demonstration of the CMU TIPFDS prototype	• Exposure to the movement control methodology

Table 1 List of Domain Experts - Continued

Organization	Name	Contribution to the SEI	Benefits from Domain Analysis
U.S. Army Combined Arms Support Command System: CSSCS	• Richard H. Silva	• General understanding of the CSSCS requirements	• Understanding of the full Army movement control model • Clear picture of interface issues and information exchanged between CSSCS and DAMMS-R
Carnegie Group, Inc. System: KBLPS	• Ivan Johnson • Vivien Robinson • Bruno Levy • Victor Saks	• General understanding of the KBLPS	• Provided requirements for the transportation aspects of the KBLPS prototype
U.S. Army Waterways Experiment Station System: ALBE-GIS	• David Horner	• Provided understanding about the GIS for ATCCS	• Provided insight into the Tactical Decision Aids that will be built into the ALBE-GIS
U.S. Army Transportation School	• Capt. Mike Boyle	• Provide information on current practices in movement control • Provide lessons learned from Desert Storm	• Opened up communication channels between Transportation School and developers of DAMMS-R

Table 1 List of Domain Experts - Continued

Organization	Name	Contribution to the SEI	Benefits from Domain Analysis
U.S. Army Combined Arms Support Command System: DAMMS-R	• Tom Snodgrass • William L. Cope	• Source for logistical and unit movement control requirements for DAMMS-R	• Exposure to other movement control systems and GIS alternatives • Clear understanding of the movement control domain requirements which will be used in the development of DAMMS-R
COMARCO/IBS System: DAMMS-R	• William H. Anckaitis • Christopher R. Valentine	• Source for logistical and unit movement control requirements	• Exposure to work in related systems • Broader perspective on Army movement control domain requirements • Facilitation of the development of clear and concise Army requirements documents • Expose issues of typical user interface
Loral Command and Control Systems System: MCS	• Jim Frahm • Leonard Courson • Jim Standlee • James Aucoin	• Provide insight into MCS functionality	• Exposure to work in related systems

Table 1 List of Domain Experts - Continued

System	Description
Department of the Army Movement Management System - Redesign DAMMS-R	The overall objective of DAMMS-R is to provide a reliable, survivable, and responsive information processing capability in support of physical distribution management, movements control, transportation operations, and transportation services in overseas theaters in peace or war. These objectives include capabilities for movement programming, *highway traffic regulating,* cargo forecasting, shipment tracing, holding and diversion, in-transit visibility, fleet and intermodal asset accountability, *monitoring and controlling* of containers, *unit and other specified movements,* load planning, *convoy planning, and recording PDN characteristics.*
Advanced Field Artillery Tactical Data System AFATDS	The Movement Control subsystem within AFATDS consists of three major functional categories: *Internal FA Coordination,* which include the initiation of movement requirements and determining the time, location, and routes for a move *(convoy planning); Movement Request,* which includes preparation of movement request and reports and resolution of route conflicts *(highway regulation);* and *External FS Coordination,* which validates and coordinates movement requests between AFATDS and MCS.
Transportation Coordinator Automated Command and Control Information Management System TCACCIS	TCACCIS provides individual units with a *convoy planning* tool for use by reserve units within the continental U.S. It provides some support for *highway regulation* but lacks a deconfliction capability.

Table 2 List of Systems

System	Description
Condensed Army Mobility Module System CAMMS	CAMMS is a software package designed to make mobility predictions of various kinds for use in tactical applications. It contains functionality to provide the following capabilities that are movement control related: current and historical weather effects, cross-country mobility predictions, *on-road mobility predictions*, foot soldier mobility predictions, maneuver damage predictions, *interactive route evaluation*, and *route network evaluation*.
Mobilization Movement Control System MOBCON	MOBCON provides various movement control capabilities for use in the planning and execution of Active Army or Army Reserve unit movements within the U.S. at the state or national level. It provides the following movement control capabilities: *convoy planning* (units must submit movement input data via paper forms) and *highway regulation* (route deconfliction).

Table 2 List of Systems - Continued

Document	Description
ATCCS System Developement Master Plan, Annex A - Current Configuration	This document describes the current configuration of the C^2 systems for each of the five BFAs in ATCCS. It also addresses the CHS and communications programs.
ATCCS System Specification	This document establishes the performance, design, development, and test requirements for ATCCS.
Common ATCCS Support Software (CASS) System/Segment Specification	This document establishes the functional, performance, security, and verification requirements for the CASS.
Segment Specification for the Maneuver Control System (MCS), Segment 11	This document establishes the requirements for Segment 11 of the Maneuver Control System (MCS.)
Computer Program Development Spec. for the Movement Control CPCI, AFATDS	This document establishes the requirements for design, test, performance, and qualification of the computer program identified as the MC CPCI of AFATDS.
Combat Service Support Control System (CSSCS), Segment 3, Functional Reqs.	This document present the requisite functional capabilities of Segment 3 of CSSCS and serves as the basis for Segment 3 design and development.

Table 3 List of System Documents

Document	Description
Functional Description for DAMMS-R, Volume 1	This document is written to provide system requirements to be satisfied, information on performance requirements, and a basis for system testing and maintenance.
DAMMS-R Comparability Analysis Study	This document reflects the result of evaluating candidate systems (fielded or under development) which appeared to meet requirements of 4 subsystems within DAMMS-R.

Table 3 List of System Documents - Continued

Document	Description
FM 5-33: Terrain Analysis	This field manual prescribes basic doctrine and is intended to serve as a primary source of the most current information on terrain analysis procedures.
FM 5-36: Route Reconnaissance and Classification	This field manual describes the fundamentals of route reconnaissance and methods for reconnoitering and classifying routes for military use.
FM 6-20: Fire Support in the AirLand Battle	This field manual establishes the principles of fire support and describes the fire support system in terms of its major components, functions, and required products.
FM 6-20-1: Field Artillery Cannon Battalion	This field manual describes how cannon battalions are organized and how they operate to support the combined arms team.
FM-34-1: Intelligence and Electronics Warfare Operations	This manual expands doctrine contained in FM 100-5. It delineates the IEW mission, the role of IEW in combat, and the principles governing its operations and sustainment.
FM 34-3: Intelligence Analysis	This manual describes the processes, procedures, and techniques used to produce intelligence. It focuses on intelligence production at corp level and below.

Table 4 List of Field Manuals

Document	Description
FM 35-25: Corps Intelligence and Electronic Warfare Operations	This manual provides Army doctrine for corps IEW operations and presents tactics and techniques for accomplishing the four IEW tasks.
FM 55-2: Division Transportation Operations	This manual provides doctrinal guidance concerning organization and functions of division transportation operations in an oversea wartime environment.
FM 55-10: Movement Control in a Theater of Operations	This manual shows how transportation movement resources or modes are managed and controlled in an oversea theater.
FM 55-15: Transportation Reference Data	This manual includes the characteristics of transportation equipment and facilities, and methods for estimating capabilities and requirements for movement.
FM 55-30: Army Motor Transport Units and Operations	This manual is devoted to the movement of cargo by trucks. It covers applicable command and task units. It explains the different types and methods of hauls.
FM 55-60: Army Terminal Operations	This manual is directed to Army terminal operations in a theater of operations. It contains procedures and techniques for planning and executing these operations.
FM 100-5: Operations	This is the Army's keystone warfighting manual. It explains how Army forces plan and conduct campaigns, major operations, and engagements.

Table 4 List of Field Manuals - Continued

Document	Description
FM 100-10: Combat Service Support	This manual depicts the Army CSS organizations and describes how they support commanders by manning, arming, fueling, fixing, and moving their forces.
FM 100-15: Corps Operations	This manual addresses the conduct of corps combat operations and the integration and coordination of combat units and the various support elements.
FM 101-5: Staff Organizations and Operations	This manual prescribes basic doctrine for staff organization and operations. It contains information about the content and format of combat plans and orders.
FM 101-5-1: Operational Terms and Symbols	This manual is the dictionary of operational terms and military symbols. Definitions and terms here agree with those in JCS Pub. 1 and AR 310-25.
FM 101-10-1: Staff Officers' Field Manual - Organizational, Technical & Logistic Data	This manual contains the Table of Organization and Equipment for various kinds of units. It also has data for supply usage and movement planning for these units.
AR 310-25: Dictionary of United States Army Terms	This publication, which defines Army terminlogy, is a supplement to JCS Pub. 1 and contains defintions not found in JCS Pub. 1.
JCS Pub. 1: Department of Defense Dictionary of Military and Associated Terms	This publication supplements standard English language dictionaries with a source of standard terminology for military use.

Table 4 List of Field Manuals - Continued

3.4. Tool Support for Domain Analysis

The FODA feasibility study [SEI90a] determined the need for tools to support both the process of domain analysis and the process by which the products of the domain analysis support software development. The initial intention of the feasibility study was to perform the analysis using manual techniques. As the amount of information needed to describe the domain grew, the manual technique became more complex. To handle the volume and complexity of information gathered during the domain analysis, a set of manual and independent semiautomated methods were used. These tools provided:

- Cross-checking and consistency
- Reusability of data

Representing the results of a domain analysis process is primarily a task of representing a large amount of knowledge. The domain analyst should provide facilities so that the user can access that knowledge quickly and easily. The goal of domain analysis tool support should be to offer an integrated environment for collecting and retrieving the domain model and architectures. The set of manual and independent semiautomated methods used during the feasibility study did not meet that goal. Therefore, the FODA feasibility study recommended that subsequent domain analysis studies investigate integrating tool support into the domain analysis method and produce requirements for specific domain analysis support tools. This recommendation was addressed during the application of FODA to the Army Movement Control Domain.

The following section discusses the tool currently being examined during the Movement Control Domain Analysis. The tool is 001^{TM}, (written "zero zero one," but pronounced "double-oh one") created by Hamilton Technologies, Inc. (HTI) [HAMIL86], [MURPH90]. 001 provides the modeler the ability to:

- Integrate entities, features, and functions into a consistent model.
- Map selected features to a system under development.
- Generate code for system prototyping.

The intent of the next section is not to provide an in-depth introduction to 001 but rather to introduce the components of the 001tool set and to explain how they are employed to support the FODA method. The in-depth languages and syntax are documented in the 001 Tool Suite System Reference Manual [OO1SRM].

This section concludes with a brief discussion of the other tools used to support this study.

3.4.1. Hamilton Technologies, Inc. (HTI) 001

001 has been designed, developed, and used for the rapid development of systems. The 001 technology embodies many aspects of a "Development Before The Fact Approach" [HAMIL86] which assures that a system is developed with built-in quality and productivity. The 001 tech-

nology is based on a set of axioms [HAMIL86] that guarantee consistency and logical completeness of the resulting system design.

3.4.1.1. The 001 Tool Suite

The 001 Tool Suite is an integrated family of automated software tools designed to improve the system development process. The tool suite automates the application of the 001 philosophy to fully integrate data structures, object design, and functional performance.

The 001 Tool Suite [OO1SRM] consists of the following components:

- The 001 AXES language
- A textual editor
- A graphics Map Editor (MapE)
- An Analyzer
- A Resource Allocation Tool (RAT)
  - A function-oriented RAT
  - A type-oriented RAT
- A Systems Management Interface (FACE).
- An Object Map editor (OMap)

The 001 AXES language provides a means of integrating cross-checking and consistency with reuse of data and features. The language includes an object type decomposition via a Type Map (TMap) and functional decomposition via a set of Functional Maps (FMaps). The TMap defines the possible objects and states that an object may have and FMaps are used to define, integrate, and control the transformation of objects from one state to another state.

Both the graphical and textual editors are used to construct an 001 AXES definition. The graphical map editor is used to graphically construct and edit FMaps, TMaps, and the Road-Map (the hierarchy which provides an index to the system of FMaps and TMaps). The textual editor is used to create textual definitions of FMaps or TMaps, or to access the textual version of the graphical definitions maintained by MapE.

The graphical TMap consists of a set of trees. Each tree represents the decomposition of an object. The syntax of a TMap provides four abstract types to represent the decomposition of an object into its component objects. These are the *TupleOf*, *OneOf*, *OsetOf*, and *TreeOf* abstract types.

- The *TupleOf* abstract type identifies an object as consisting of one to a specified number of component objects.
- The *OneOf* abstract type identifies an object as being one of its component objects (i.e.,the object instance may be represented by one and only one of its components objects).

- The *OsetOf* abstract type represents an object as being an ordered set of its component objects. This is similar to the construct of a circular doubly linked list available in some programming languages.

- The *TreeOf* abstract type is used to represent an arbitrary tree structure with an object at each node.

In the graphical FMaps, the 001 user specifies a particular functionality as a tree of functions, with each function specifying its inputs and outputs. In addition, with each function there is an associated control structure specifying constraints on the way that data (inputs and outputs) may flow between the functions that make up that functions' decomposition.

The Analyzer performs the syntax and semantic analysis on partial or completed definitions produced by either the textual editor or MapE. The Analyzer checks to ensure that all parts of the definition are internally consistent and checks all interfaces for correctness and completeness.

After the Analyzer completes the syntax and semantic analysis, the RAT generates operational code.

- The functional RAT generates a target language source code program from successfully analyzed definitions. It insures that the implementation maintains the integrity of its 001AXES definition. It eliminates error-prone hand-coding, permits simulation, and makes rapid prototyping possible.

- The type RAT generates abstract type templates used by the functional RAT. These type templates define the allowed primitive operations on each type.

The System Management Interface is designed to allow easy access to all of the capabilities of 001 and a wide variety of general purpose commands to be executed.

An OMap can be thought of as the runtime instance of data that has been created and organized according to the constraints provided by a particular TMap. The OMap editor is a tool that allows the user to readily access such data and manipulate it in a variety of powerful ways. For example, the Omap editor can be used as a default-form user interface for the system during execution.

3.4.1.2. Use of 001

The analysis of the Movement Control Domain used TMaps to model both the entity-relationships and features of the FODA method. The relationships between entities on the entity-relationship diagram are transformed into the relationships between object entities on a TMap, as seen in Figure 4-4, by representing the "is-a" and "consists-of" relationships with the TupleOf abstract type. The "has" relationship is represented with the OsetOf abstract type.

The feature diagram is transformed into the TMap representation, seen in Figures 4-4 through 4-7, by modeling optional features as leaf node objects of type boolean (or literal), the alternatives as a OneOf abstract type, and mandatory as a TupleOf abstract type. Since a TMap follows the same tree structure as a feature diagram, the concept of "reachability" defined in the FODA feasibility study is maintained within a TMap.

The Fmaps in 001 AXES are used to define the behavior of the system in terms of functional decomposition, control structures, and the flow of data. This information supplements the control and activity information previously represented by STATEMATE statecharts and activity-charts in the FODA feasibility study.

3.4.1.3. Analysis of 001

The main objective of using 001 was to determine the feasibility of incorporating all of the models of FODA into a single tool. The model may then be executed to demonstrate the effectiveness of the method and the ability to specify a system from the model.

In 001, it was possible to convolve the features, entity-relationship, and functional models together with FMaps and TMaps. The combining of Tmaps and Fmaps allows:

- Visualization of the FODA models.

- Consistency checking across the models.

- Implementation of a prototype system, parameterized by features.

Once these FMaps and Tmaps were generated and successfully analyzed for syntax and semantic errors, the model was turned into code by the RAT. The type RAT generated a system of object type templates for the domain from the TMap and the functional RAT generated the source code from the integration of the type templates and the FMaps. The code was compiled and executed for prototyping models of a movement control system. This use of 001 is explained in Chapter 5.

The 001 Tool Suite supported the FODA method by enabling a system to be created based on a set of commonalities among similar systems (the FODA model) and the selection of a set of features to be incorporated into the newly defined system.This application of FODA creates an executable prototype of the system with the desired set of features. The user of the prototype may change the performance of the prototype through a selection of different features.

The examination of 001 will continue by looking at the the kinds of user interfaces that 001 can be used with. Currently, a model is executed by selecting the features desired via the OMap editor during execution. However, primitives within the 001 AXES Language enable the model developer to access a graphical user interface (such as Motif) within 001 for the selection of features. This graphical interface would create an environment around 001 where the user could select features and enter object data for model execution without an in-depth knowledge of the 001 Tool Suite or the OMap editor.

During this analysis of the movement control domain, the FODA method still relied on STATEMATE to provide the high-level perspective of functionality and behavior. Further exploration of 001 will include studying 001 Fmaps and RoadMaps as an expression form to be used as an alternative to STATEMATE when expressing high-level perspectives of functionality and behavior. Given our work with 001 to date, we see that although the RoadMap provides some of the high-level functional understanding of the system being modeled, a user of the model cannot easily understand the behavior of the system because of the semantics and

syntax of FMaps. Having expressions of the functional and behavioral perspectives that are understandable in 001 is desirable, as the result would be unambiguous protrayal of intent and full integration with the entity-relationship and feature definition side of the problem currently expressed in Tmaps.

3.4.2. Use of STATEMATE for Movement Control Analysis

The use of STATEMATE in this analysis was the same as that described in the FODA feasibility study. STATEMATE Statecharts and Activitycharts were used to represent the high-level functional model. Changes from STATEMATE Version 2.5 to Version 3.0 are reflected in the charts. In STATEMATE Version 3.0, the issues of decluttering the charts and the visibility or scope of the elements within a chart are addressed. These changes and their impact on the process of modeling a system are documented in a separate report [SEI91b].

3.4.3. Info Mode Under the GNU Emacs Editor

The movement control domain analysis used *Info*, a documentation tool, to capture much of the information about a domain: the features descriptions, the entities and relationships descriptions, and the terminology dictionary. These pieces of information are related to one another in ways that paper documents cannot easily capture. Thus, the creation of a file of the domain information formatted for use in Info mode under GNU Emacs [STALL87] allows for the navigation through these collections of textual information in a useful way.

GNU is the name of a set of (virtually) free software packages available for use on computers that run the UNIX operating system. GNU is *not* public domain software, but its copyright permits its users to modify and/or redistribute it almost without restriction. GNU Emacs is a powerful editor that has the ability to support various modes of operations:

- Normal text editing and use of various document description language (T_EX and Nroff for example).

- Program code development and formatting (C and Lisp are supported).

- Support for various utilities available for use within the editor (Mail and Shell).

Info is one of the utility modes. It provides a powerful facility for navigating among many pieces of text that are related to one another in some way(s), something like a primitive form of hypertext. The *Help* facility for Emacs is written for use in this mode.

Appendix C describes the basic information on how to format a file for use within Info mode and a summary of how to navigate in an Info file.

4. Movement Control Domain Analysis Review

This chapter presents the products of the context analysis and domain modeling phases of the movement control domain analysis. The product presentations are intended to give the reader an overview of:

- The style and content of the products.

- The knowledge of the domain represented by the products.

Many of the products are too large to be discussed in detail in the body of this report. In each case, the section describing that product will refer the reader to the appropriate appendix for more information on that product. This is to allow the reader to get a high-level understanding of the domain as portrayed in the products.

4.1. Refinement of the Movement Control Domain Scope

The purpose of the context analysis phase of domain analysis is to establish the scope of the proposed domain. In order to understand the scope of a domain, we must first have a basic knowledge about the higher level domain(s) of which the target domain is a part. Also, an understanding of the domain's users and related applications is useful in knowing how the target domain interfaces with its peers.

This Context Analysis report [SEI91a] details the results of the context analysis for movement control. The domain modeling phase has addressed most of the issues raised in Section 3.2 of that report. Several of the issues that produced notable changes to the perceived context for movement control, or changed the context analysis products as they were previously published, are summarized below:

- The usage of movement control software extends beyond the movement of units in the battlefield. Such software is also needed for *logistical* movement, which is the movement of supplies and equipment to support and sustain the units in combat. The considerations of logistical movement require the ability to view the assets available for performing that movement. Organic assets (those intrinsic to the unit) are used with unit movement. Logistical movement requires knowledge about common user assets so that an appropriate selection can be made. Most of the functionality is equivalent to that needed for unit movement, so that inclusion of logistical movement does not greatly expand the functionality to be incorporated into the domain model. Even at the level of strategic movement where large groups of men and materiel of all types are moved over great distances, the basic features and entities are applicable.

- A large amount of the movement conducted on the battlefield is not planned and scheduled in the time frame of generation and promulgation of an Operational Plan or Order (OPLAN or OPORD). Section 3.2.1.d of the Context Analysis report discusses the issues of timing. Most of the movement that occurs on the battlefield is in response to commanders

receiving new missions from their superiors.

Based upon the mission, the commander perceives a need to move to a new position and informs his superior of this intent via a movement request. The higher echelon staff approves the movement after assuring that it does not conflict with other current or planned movements or actions. The planning for a unit's movement is normally done by the unit, not some staff person higher up the chain of command.

- The *context* features affect many of the operations features, more so than was reported in the Context Analysis report. Section 4.3.2.2 describes the coupling of these two sets of features.

- Movement feasibility or estimation of movement capability is an issue that was only dealt with at a cursory level during the domain modeling phase. Although this issue is important at the higher echelons of command for strategic planning, the project consciously decided to focus its effort on movement control within ATCCS, which is a tactical movement system. In such systems, feasibility is implicitly determined by the unit actually planning its move. The domain model contains features that incorporate the concept of movement feasibility, but this feature is not analyzed to the same extent as other areas within the domain.

The next section will establish the placement of movement control software within the software structure of ATCCS and its constituent nodes and show the refined context diagram for the movement control domain.

4.2. Context Analysis Products

Movement Control is a software application common to the ATCCS BFAs. The products of context analysis place the movement control domain within the overall ATCCS structure and establish a common pattern for movement control operations.

4.2.1. The ATCCS Development Strategy

The ATCCS software development is implemented using a hierarchy of layers as seen in Figure 4-1. The figure is in the form of a structure diagram that is described in Section 2.1. The four primary layers of ATCCS are the hardware layer, Common Off-The-Shelf (COTS) layer, Common ATCCS Support Software (CASS) layer, and the Command and Control Applications layer.

Layers 1 and 2 of the figure show the Common Hardware and Software (CHS) suites which provide a powerful operating environment for each computer that is part of ATCCS. The two layers provide low-level interoperability to allow networking of the computers running the BFA software on each node. Layer 1, the hardware layer, consists of common hardware components. Components within this layer include central processing units, printer devices, communication devices, and display devices.

Layer 2, the COTS layer, consists of commercial software, already built and tested, which can be tailored to provide software services to the BFAs. Examples within this layer are operating system (UNIX), database management software, graphics support, communication drivers, etc.

The line between Layer 2 and Layer 3 symbolizes the standard interfaces to packages such as the UNIX operating system, the Structured Query Language (SQL) for relational databases, and graphics packages like the X Windows System. Packages such as these provide a high degree of software portability as the hardware platforms evolve over time.

Command & Control Applications Software (Layer 4)	BFA-Unique Applications	Common Applications Software - Force Level Control (FLC) - System Management - Movement Control

Applications-Layer Reuse Library

Common ATCCS Support Software (CASS) (Layer 3)

Workstation Management	Data Management	Common Message Services	Network Management	Standing Request for Information (SRI) Services
Machine Interface Toolkit	Computer Communications	Inter-Software Communications	Security	

Real-Time Services

System Support Software (COTS) (Layer 2)

Commercial Off-The-Shelf Software
- Operating System(UNIX)
- DBMS (SQL)
- Graphics Support
- Spreadsheets
- Word Processing
- Ada Bindings
- Communication Drivers

Hardware (Layer 1)

CHS Based Computer Systems

Computers	Printer	Communications Interface Units
Displays	Tape	Disks

Figure 4-1 The Movement Control Structure Diagram

Layer 3 shows the CASS, which provides many common services such as message handling and system and data managers. This layer provides for higher maintainability and extensibility of the ATCCS software. The CASS layer provides common interfaces to the application software in the applications layer from the COTS and hardware services. The major thrust of CASS is to "shield" the application software from changes within the COTS or hardware layers. The CASS layer consists of several classifications of services, database management services, display services, communication services, operating system services, etc. Each of the ser-

vices within the CASS layer contains various objects. These objects provide the lower level computational routines and data structures needed to support the application software. The dotted line between Layers 3 and 4 denotes that the CASS software is an integral part of the ATCCS systems, as opposed to the COTS applications in Layer 2 which are not developed and maintained by ATCCS.

Layer 4, the Applications layer, consists of software that provides common C^3I functionality, as well as unique services to the five BFA systems being developed (AFATDS, ASAS, CSSCS, FAAD, and MCS). Although each of these five systems are targeted for a specific functional area, they share common application requirements, some of which are Target Damage Assessment, Resupply Operations, Order of Battle, and Movement Control. The recognition of these common applications within the ATCCS systems prompted the designers of the ATCCS architecture to add a common application section within this layer.

The layered architecture described above is one where the bottom layers are at low levels of abstraction and the upper layers depend upon the use of appropriate interfaces into the lower level to achieve their functionality. Such architectures are becoming common in building software. The OSI communications architecture [YOUNG89] and the X Window System [ZIMM80] are highly visible examples. Layered architectures are one way of removing extraneous (outside of the domain's scope) functionality from consideration during the domain analysis so that the focus is on the specific needs of the selected domain.

4.2.2. Context Diagram

Movement control is concerned with the movement of battlefield assets in support of tactical objectives. As noted in Section 2.3.1 of the Context Analysis report [SEI91a], movement control plays a role in each of the three key operations (plan, direct, execute) within a C^2 system, and these key operations carry over into the context diagram shown in Figure 4-2.

- Movement control receives inputs as *commander's guidance* during the **Planning** function, checks the requests against the *constraints and options* data, and generates the *movement estimate*.

- Alternately, a unit may receive a *movement requirement* due to operational considerations. The unit plans it's movement resulting in a *movement request*.

- The movement request is matched against actions occurring on the battlefield by the area commander's staff, using information available from the *operational considerations* flow.

- Finally, movement control generates *orders* using the **Direct** function as output to the **Execute** function. The orders also are *stored* so that their *status* (for example, in progress, completed, or canceled) can be requested or updated via the *movement status* inputs from **Position Reports**.

The computation of movement feasibility (the resources needed, routes to be followed, etc.) requires that two types of information be available:

1. *Static* data: Information about the terrain over which movement is to occur (roads, mountains, rivers, bridges, etc.), measures of unit sizes and payload capacities, and information about tactical considerations that limit or constrain movement options.

2. *Dynamic* data: Current information about the weather, terrain, or road conditions (the effects of weather or combat actions), the availability of transportation assets, and data on friendly and enemy units (locations, sizes, etc.).

Most of this data is produced or maintained by operations outside the scope of the movement control domain. For example, all data about weather, terrain, and the disposition of friendly and enemy forces is obtained directly from intelligence.
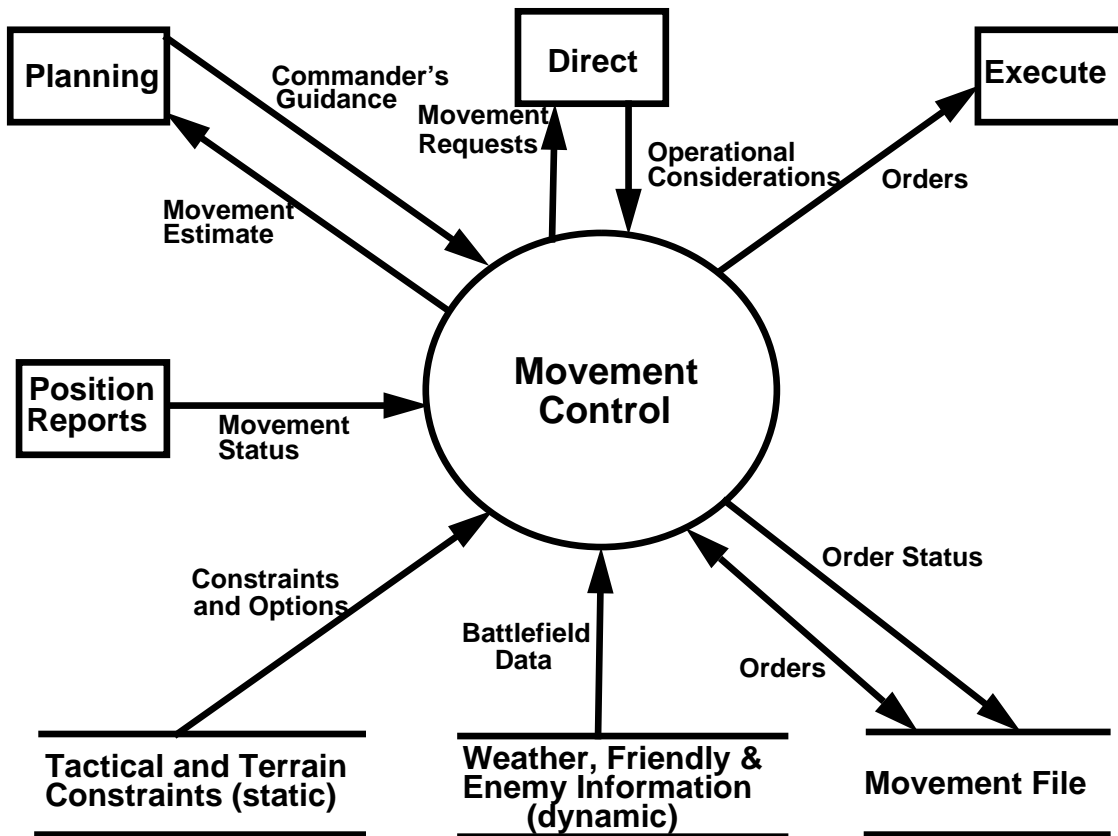
Figure 4-2 The Movement Control Context Diagram

4.3. Domain Modeling Products

Two important results of the domain modeling process are the modeling of the entities and features of the domain. The next two sections present the highlights of these models using the 001TMap notation as described previously in Section 3.4.1 of this report[1]. The third section describes the functional model using STATEMATE as described in Section 3.5.2. Lastly, the

[1] Due to limitations within 001, the entity or feature names appearing on the TMap may be shortened versions of the equivalent name appearing in this chapter for discussion purposes.

domain dictionary is described. Each of the products is fully detailed in one or more appendices as indicated in Table 5.

Model	Reference
Entity Relationship data	Appendix - D
Feature data	Appendix - E
Feature Catalog	Appendix - F
Functional Model	Section 4.3.3.
Domain Dictionary	Appendix - G
Domain Acronyms	Appendix - H

Table 5 List of Domain Model Products and Report Appendices

4.3.1. Entity Relationship Model

The ER model, depicted in Figure 4-3, presents system entities and relationships between them. The information contained in the ER model is largely derived from Army doctrine[FM 101-5]. The road movement table, defined by the field manual, pertains to commands issued by the commander to units regarding movement between specified locations. The commands contain an enumeration of vehicles, organized as a convoy, the routes the convoy is to follow, and the schedule for carrying out the movement.

The figure uses the entity relationship notation seen in [SEI90a] and shows that the majority of relationships are associated with three kinds of entities:

1. *Commander*. The person making decisions about how missions are to be accomplished.

2. *Units*. The combat or support organizations a commander has available for accomplishing missions.

3. *Orders*. The mechanism by which the commander communicates his decisions to units for implementation. A particularly important kind of order is the *Movement* (Mvmt) *Order*. Generating a movement order requires dealing with *Transportation*, *Routes*, and *Schedules* at various points in the process.

This high-level representation of the ER model is sufficient for an overview of the entities in the domain. An ER modeling tool would be required in order to manipulate detailed ER data, maintaining completeness and consistency. No modeling tools that support the FODA approach to ER modeling, which combines ER modeling with semantic data modeling, were found at the time of the domain analysis (see Section 5.2 of [SEI90a] for further information). The 001 tool does, however, provide support for semantic data models in its Tmaps, which

constitute the bulk of the information that needs to be captured in the FODA ER model. The 001 tool still lacks a means for depicting information on relationships between entities in the semantic network. The 001 graphic notation is therefore supplemented with textual information as detailed in Appendix D.
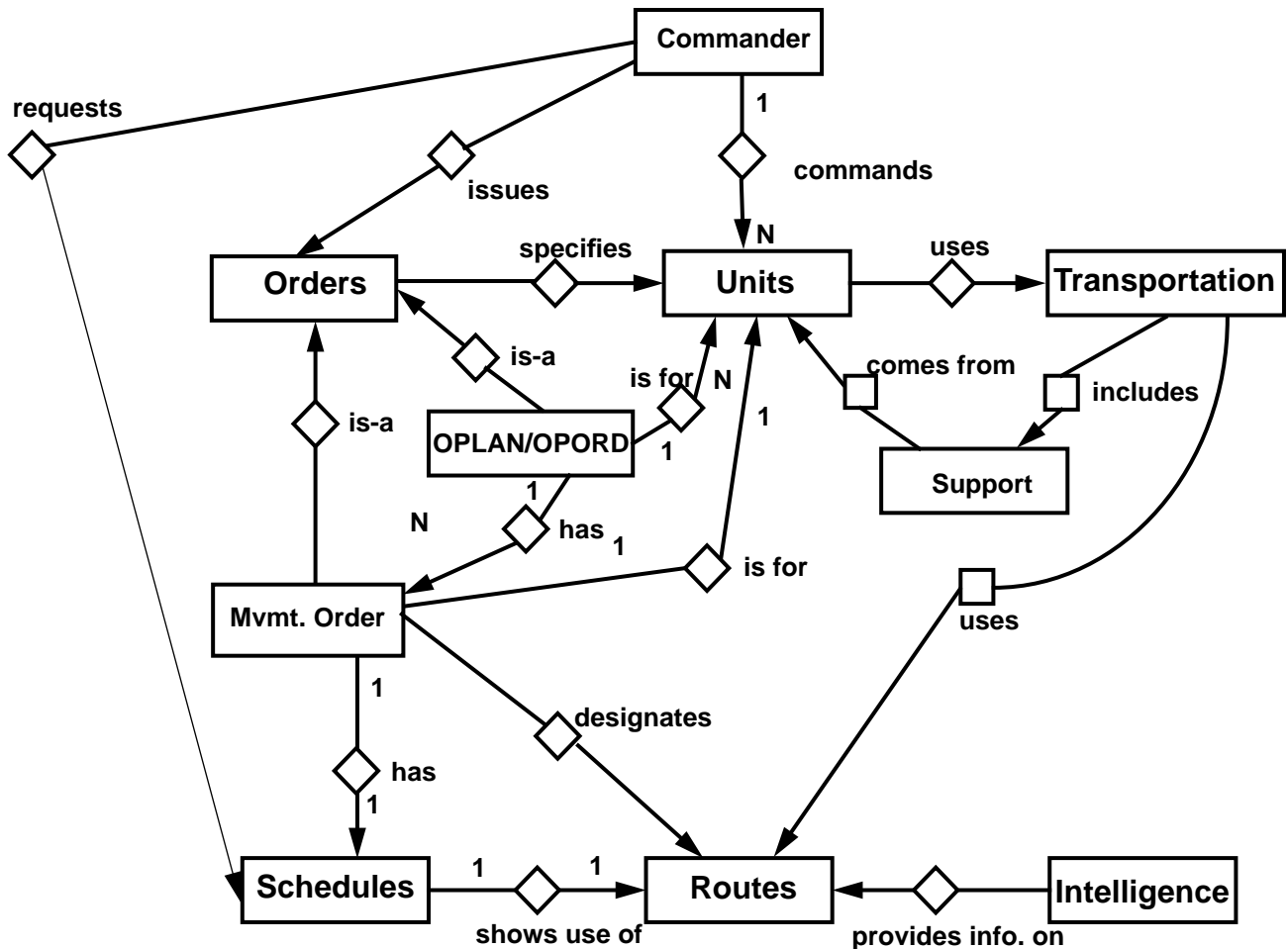
Figure 4-3 Entity Relationship Model

The top level of information found in the movement control ER model is portrayed in Figure 4-4 using the 001 syntax. The figure shows that the movement control domain consists of the six following types of information:

1. *Orders*. The entities that are sent and received by various command echelons to communicate information about the movement control process (e.g., Operational Orders).

2. *Transportation*. The entities that represent the vehicles that will carry the unit or material from its current to its future location.

3. *Schedules*. The entities that provide a time base coordination of present and future use of transportation infrastructure.

4. *Distribution Plans*. The entities that represent the plans of the commander and his movement control staff to control the use of important transportation infrastructure to best accomplish the overall mission.

5. *Intelligence*. The entities that represent the knowledge of the battlefield state; most importantly, the information about the transportation infrastructure and status.

6. *Task Force*. The entities that represent the units or sets of units needing to move or requiring the movement of various materials.
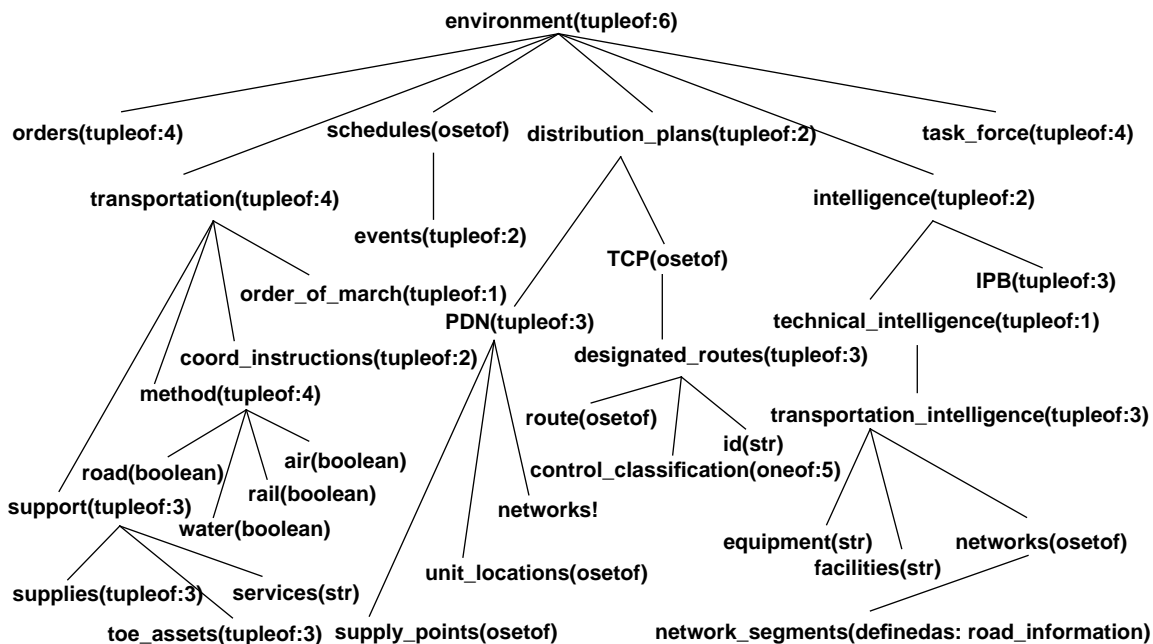
Figure 4-4 001 Representation of Top-Level Entities

Important aspects of the movement control problem are captured in the *Transportation*, *Distribution Plans*, and *Intelligence* entities. *Intelligence* comes in two forms that are relevant to movement control: technical intelligence and Intelligence Preparation of the Battlefield (IPB). There are several categories of technical intelligence; however, the most important to the movement control domain is transportation intelligence, which is information about the equipment, facilities, and networks available for use in meeting transportation needs in a theater of operations. The road network is particularly important as the vast majority of movement within a theater is performed on roads. IPB is "a systematic and continuous process of analyzing the enemy, weather, and terrain in a specific geographical area."[FM 34-1] IPB has three parts of its process that provide information relevant to movement control:

1. *Terrain analysis*. Gathers and analyzes information pertinent to how the geography of the theater area will affect operations. For movement control, this involves the checking and updating of terrain (including roads, bridges, tunnels, etc.) data collected by the Defense Mapping Agency.

2. *Weather analysis.* Plays an important role in understanding the usability of parts of the road network and thus, the capability of the network to sustain planned movements.

3. *Threat evaluation.* Seeks to predict the actions of the enemy forces and their consequences. For movement control, this may mean the rerouting of convoys around areas where fighting may occur as well as moving friendly units in those areas.

Distribution Plans are the entities that define roads and other aspects of the transportation infrastructure (e.g., rail lines, supply points, etc.) movement control within the theater area. The *Physical Distribution Network* (PDN) is used primarily by logistics personnel to visualize where the combat units are, where the supplies they will need are, and the paths between the two. The *Traffic Control Plan* (TCP) is constructed by the command responsible for movement control in a particular area. It designates specific routes, most of which are expected to carry a high traffic load, and places controls and monitors on those routes to enforce compliance.

Transportation is organized information about a movement, consisting of four entities:

1. *Support.* The need for other units to provide supplies (food, water, fuel, etc.), TOE assets (assignable equipment or personnel of any kind), or other services for a particular movement.

2. *Method.* Selecting the network and associated equipment for carrying out a movement. During the analysis the focus was on road movement, although most of the information (and most of the feature model) is applicable to the other three modes of transportation. At the theater level, a significant portion of planning distribution patterns involves mode determinations of various unit and logistical movements.

3. *Coordinating Instructions.* Information about aspects of a movement that the moving entity needs to know about measures taken to help assure the safety of the movement.

4. *Order of March.* Information about the characteristics and organization of the vehicles in a convoy to be used in performing a movement.

Each of the three entities: Intelligence, Distribution Plans, and Transportation, describe the data used as inputs to the process of planning individual movements. Intelligence provides the movement planner with data on potential paths (segments and terrain), the Distribution Plans augment this path information with data on controlling the usage of important road segments, and Transportation provides information on the potential kinds of Support that may be requested. Transportation also provides entities for storing some of the important products of the movement planning process, the Method selected, the Coordinating Instructions needed, and the Order of March to be followed.

Appendix D gives the complete graphical depiction of the ER model as seen in the 001 Tmap and gives a textual description of each entity given in the ER model.

4.3.2. Feature Model

The window manager feature model was portrayed in the FODA report using both a textual description and graphical representation in the form of an And/Or diagram. The textual description used in this report follows that of the FODA report. The format is only slightly changed for inclusion into a file for use in the GNU Emacs Info mode (see Appendix C for a discussion of this tool). The graphical notation was modified to incorporate the 001 T-map notation. A description of the use of the 001 notation for describing the basic relationships between features (mandatory, alternative, and optional) is given below.

Feature Type   001 Notation in Graphical Representation

Mandatory   The *feature_name***(tupleof:X)** notation is used for parent features where X is the number of child features; feature_name' signifies a leaf feature.

Alternative   The *feature_name***(oneof: X)** notation is used for parent features where X is the number of alternate children.

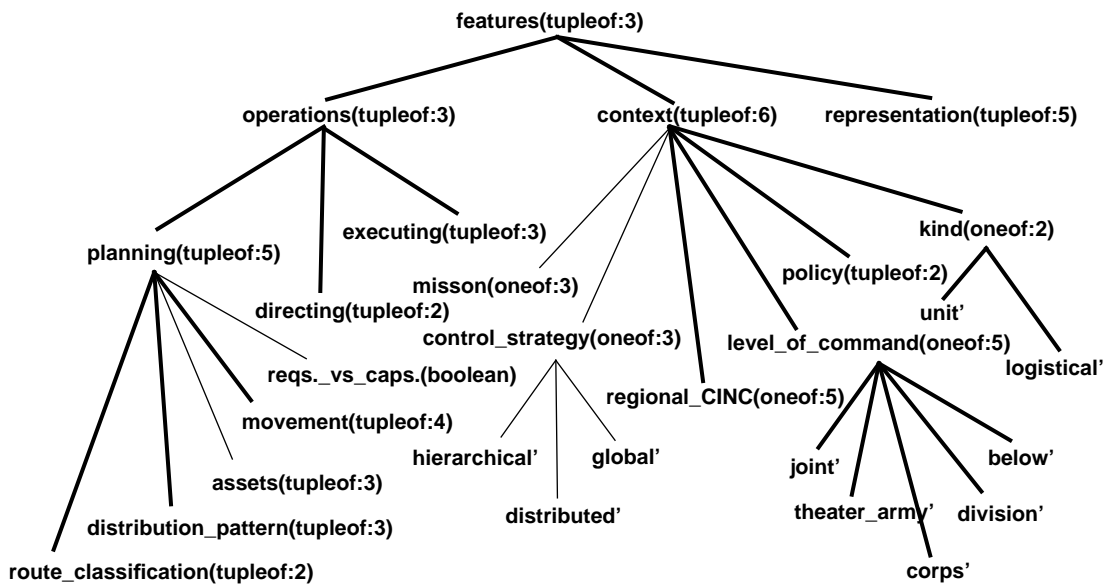**Optional**   Optional leaf features are denoted by the **(boolean)** notation after the name.

Figure 4-5 The Top-Level Feature Model

As shown in Figure 4-5, there are three main groups of features within the movement control domain:

1. *Operations*. Those features that describe the functional characteristics of movement; the services that a system must provide.

2. *Context*. Those features that describe the overall mission or usage patterns of a system; the description of the class(es) of users for a system.

3. *Representation*. Those features that describe how information is viewed by the user or produced for another system; what sorts of input and output capabilities are available.

Each of these groups of features is described in more detail in the following paragraphs.
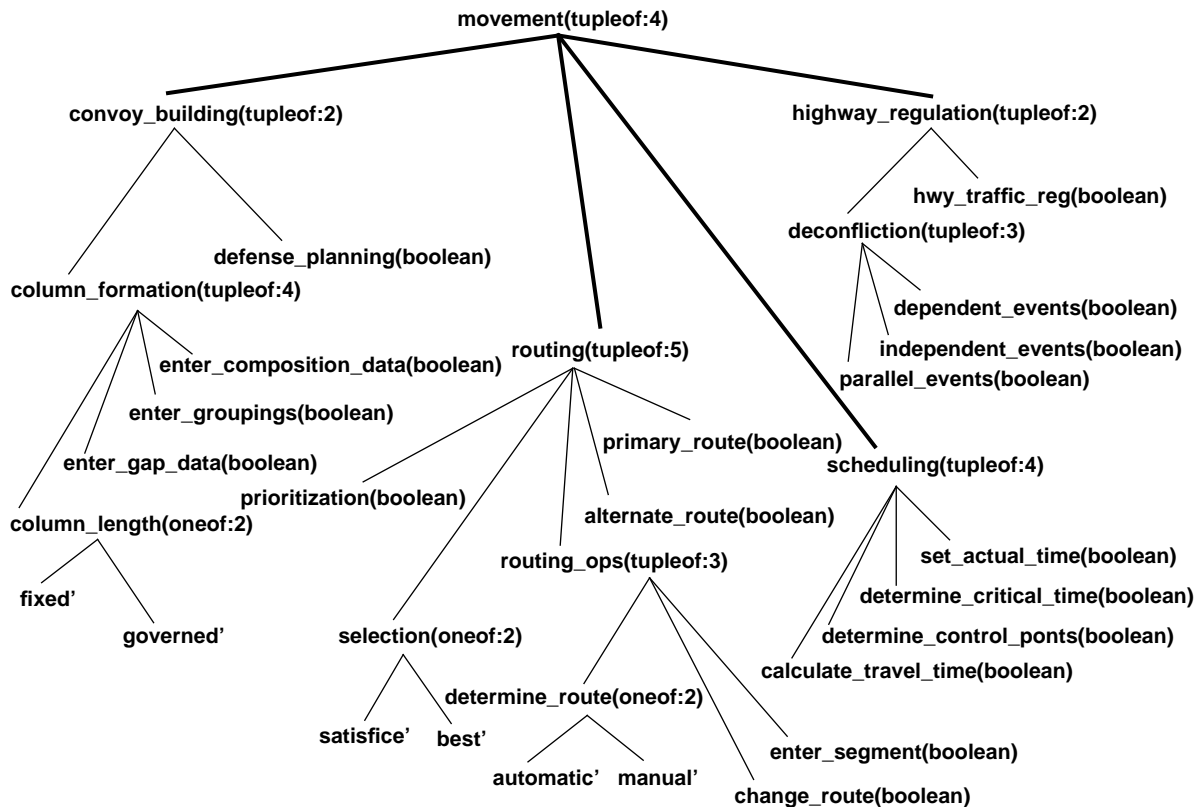
4.3.2.1. Operational Features

The operational features fall in three major categories:

1. *Planning*. Those features that describe the process of preparing for future assigned or assumed movements.

2. *Directing*. Those features that describe the operations needed to transition the results of Planning into forms of communication that convey information governing actions, i.e., orders.

3. *Executing*. Those features that describe operations that take place when a movement is occurring.

The Planning features are the most important as they denote the features that are seen as the essential elements of movement control. The Planning feature is decomposed into five sub-features:

1. *Route Classification.* Those features that allow for determining the suitability and capacity of a road or set of roads for use by various kind of vehicles.

2. *Distribution Pattern*. Those features that characterize the ability to view movement requirements at an aggregate level and allocate road or other means of transportation to the continued coverage of those requirements. Much of this problem involves the ongoing relocation of materiel from its arrival into the theater area through supply points to units using the materiel.

3. *Assets*. Those features that allow movement planners to consider different usage characteristics for the vehicles, networks, and equipment to be employed in movement.

4. *Movement*. Those features that characterize the functionality of the most important and frequently performed processes in movement control, the planning of individual moves. The decomposition of these features is depicted in Figure 4-6 below.

5. *Balance Capabilities versus Requirements*. A feature that allows command personnel the ability to determine whether or not the transportation system can support the requirements of a plan.

The features under `movement` describe the essence categories of movement functionality. `Highway_regulation` is shown as a single feature broken in two sub-features, `traffic_- control` and `deconfliction`. `Traffic_control` is the physical regulation and control of designated routes, performed by military police or civil authorities. `Deconfliction` is the coordination of all movement within a specified network to ensure that no two sets of vehicles will occupy the same space at the same time. `Deconfliction` is an important part of a comprehensive movement control solution because it is necessary to keep moves from interfering with one another and to track the utilization of key routes within the network.

Figure 4-6 The Detailed Operational Features of Movement

The process of planning a convoy requires three `operational_features`: `convoy_- building`, `routing`, and `scheduling`. `Convoy_building` has two sub-features, `de- fense_planning` and `column_formation`. The `column_formation` feature, a major part of the convoy planning process, supports `convoy_building` through the four following features:

1. `Enter_Composition_Data`. This is data about the number and types of vehicles to be made part of the convoy being formulated.

2. `Enter_Groupings`. This is data about the placement of the vehicles and various groups of vehicles within the convoy. Army movement doctrine requires that specific rules must be followed in the organization of vehicles into convoys. [FM 101-5] provides a detailed description of this doctrine.

3. `Enter_Gap_Data`. This is data about spacings between vehicles and groups in the convoy for safety, security, and other considerations.

4. `Column_Length`. After data about the vehicles, groupings, and gaps is obtained, length is determined so that the amount of road space needed by the convoy is known. This information is used by `scheduling`.

`Routing` is the determination of a viable path from one location to another. Three of the five sub-features under `Routing` pertain to the flexibility of this feature's implementation: its ability to consider multiple routes and to use the priority system to enable or eliminate the use of various segments that are restricted by other movement control organizations. The two features of interest are the `Determine_Route` feature under `Routing_Ops` and the `Selection` feature.

1. `Determine_Route`. Most systems still require the `manual` entry of routing information, even if this is just pointing and clicking on path segments on a display map. However, some systems allow for `automatic` routing where the user need only specify the start and end (release) points desired and a usable path between those points will be generated.

2. `Selection`. The `selection` feature is a control over the amount of processing that the system may perform in path selection. In `satisfice` selection, the computations stop when one viable path has been encountered or verified. In `best` selection, the system will perform a more exhaustive search, seeking the optimal path based upon user defined characteristics such as path length or road type.

`Scheduling` is the determination of the time span during which the movement will occur. This feature includes operations to set the times the convoy will occupy various parts of the road space as identified by the `routing` operations. The `scheduling` feature will include operations and information that are well understood from the scheduling domain. This information correlates to the four sub-features:

1. `Set_Actual_Time`. This feature allows for scheduling a series of events to occur in a specified time sequencing in `relative` time and later, for setting the true start time for the sequence and compute the rest of `absolute` or real times.

2. `Determine_Critical_Time`. This feature allows for the designation of the single time from which other times in the schedule are based, either the time of the first or last event.

3. `Determine_Control_Points`. This feature allow for entry of time delays for stops at various point along the route for resting, re-fueling, etc. This is time lost in activities that do not contribute to progress in the schedule.

4. `Calculate_Travel_Time`. Complete the schedule, computing results as needed.

Routing and scheduling are two interrelated domains that have been the subject of much research, including work on solutions to notoriously difficult problems in computer science such as the Traveling Salesman Problem. The difficulties of the movement control routing and scheduling problem stem from the need to be responsive to *dynamic* demands, because many movements are generated as a result of changing battlefield conditions. Yet most routing and scheduling algorithms require a *static* (prearranged) set of movements to be accomplished, and attempt to provide as optimal a set of paths and schedules as possible [BODIN81]. Addition of a new movement requirement may yield a completely different solution. However, one of the unwritten axioms of movement control is to not change the route or schedule of approved movements. The need to cope with continuous requirements for new movements without disrupting the current set of approved movements presents a problem for `tactical` or `operational` movement control that is not solvable using standard techniques. These techniques are applicable to `strategic` movement as the planning time frame allows for a more complete set of movement requirements to be generated.

4.3.2.2. Context Features

The context features, shown in Figure 4-7, provide a means of describing the users of movement control systems and the missions they will perform. During the domain modeling process, these features provide the primary means of understanding what movement operations are needed by various echelons of command and how operations are affected by the overall situation.
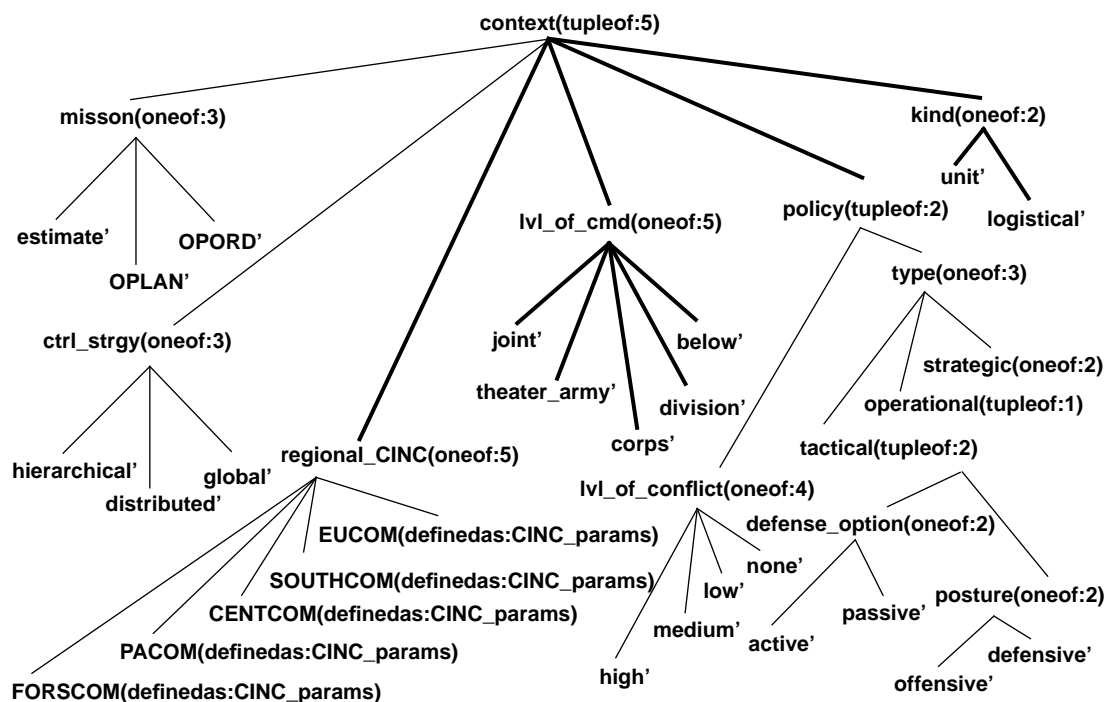


Figure 4-7 The Context Features

The six top-level context features are:

1. The `mission` feature defines the accuracy requirements needed for the forthcoming calculations. Early planning and feasibility computations do not need the completeness and accuracy of data that final orders require.

2. The `control_strategy` feature defines the echelons and systems using movement control software. Selection among the given alternatives affects the resulting software structure. How the structure is affected is explained in more detail later in the description of the functional model, Section 4.3.3.

3. The `regional_CINC` feature defines information and parameters for the domain that are specific to a given region or location, such as the use of metric measurements in Europe versus English measurements in the United States, or differing message formats used for compatibility with host nations or other preexisting systems.

4. The `level_of_command_feature` defines the distinctions in various aspects of movement control that occur at the different echelons of command. The scope and scale of the movement problem is considerably different at joint commands (such as NATO) than at a brigade headquarters coordinating its subordinate units.

5. The `policy` feature defines most of the situational attributes that affect movement control. For `tactical` movement, the `posture` and `defense_option` features define changes in operations that Army doctrine implies should hold in various situations.

6. The `kind` feature provides a mechanism to keep a clear distinction between the differences in `unit` and `logistical` movement as seen during the context analysis phase and its results.

4.3.2.3. Representation Features

The representation features describe the mechanisms available for getting information to and from the user of a system. For movement control, there are five potential ways to represent data as shown in Figure 4-8 below.
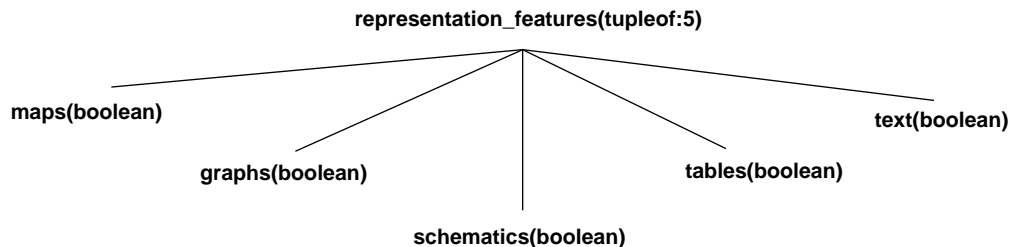
Figure 4-8 The Representation Features

1. `Maps`. This feature requires that several important capabilities be present in the underlying services of the computer systems on which movement control software is to be run:

- A mechanism for storing and retrieving geographic information including location, terrain data, named entities, and much more.

- A graphical display environment powerful enough to provide unique shadings, colorations, outlines, etc., to allow the display of many varied types of data in distinct forms.

- A mathematical package to support the analysis of geographic data.

2. `Graphs`. This feature allows the user to view the timetable for one or more movements using bars to represent the passage of units over portions of a route. This timetable is called a movement graph and is used by movement control personnel to visualize a movement or the usage of a high traffic route by multiple convoys.

3. `Schematics`. Another graphical representation option which allows users to build a complex graph of paths between points and the flow capacities and quantities along those paths. Various schematics are used in the process of distribution planning.

4. `Tables`. An alternative to graphs as a method for viewing a timetable for one or more movements. Similar to Text below, but more powerful because a mechanism for formatting data is implied.

5. `Text`. Any representation (ASCII or other) that allows use of alphanumeric characters and other symbols used in typewritten or intercomputer communications.

Appendix E shows the complete feature model for the movement control domain in the 001 Tmap graphical form and gives a textual description of each feature in the model. Appendix F contains the features catalog that shows what features are used in the systems analyzed during the domain modeling phase.

4.3.3. Functional Model

Movement control is one component of a complete tactical command and control system. These command and control systems are characterized by the need to:

- Monitor the battlefield state.

- Compare that state to a desired state based on long-term goals.

- Direct actions to change state.

- Execute actions that actually change state.

The process runs continuously. The context analysis produced a process control loop to show the relationship among these control steps and system states.

While process control models an ideal view of command and control, the functional model within the FODA method models actual systems and data requirements. The important aspects of the functional model are:

- High-level activities that characterize the domain.

- Control structures that model the behavior of the systems in the domain.

- Information structures that are common to those systems.

The FODA method uses STATEMATE activity and state charts to document the functional model.

The features within the domain define commonality and differences among activities, control, and data. The functional model utilizes these features as the basis for common activities and control and to parameterize control structures which result in different patterns of behavior. This approach allows the functional model to highlight commonality at a higher level and isolate mission details particular to a given system. These details are captured primarily in the context features and the selections among optional/alternative operational features. Mission details determine which operations are ultimately performed in an individual system and the specific data produced or consumed by these operations.

The STATEMATE representation of the functional model provides a form for expressing movement control operations, executive control, and data requirements. This representation is documented in a hierarchy of activity and state charts. Activity charts show the operations within movement control and their information flows, and Statecharts show the behavior of these activities according to particular mission characteristics (context features and optional/alternative operations).

4.3.3.1. Movement Control as Part of Command and Control

The highest level activity chart places movement control within the context of a command and control system. Figure 4-9 shows the interaction of movement control with both Army intelligence and operations. (These activities are labelled movement_control_activities, trans_intell_act, and operations_activities in Figure 4-9.) The relationships among these three activities could be extended to a complete command and control system, including domains parallel to movement control such as force level control or fire support planning. The same interrelationships with intelligence and operations would exist for these other domains.

Movement control must have intelligence and operations information to carry out movement activities. The information flows shown on the activity chart (battlefield_data, operations data, and cmdrs_guidance) describe the data exported by intelligence and operations activities and imported by movement control. These flows are also shown on the context diagram of Figure 4-2. The contents and structure of this information is derived from the entity relationship model. Use of the entity relationship model to structure the data will permit commonality between movement control systems and other related applications. Provided the appropriate information flows exist, the movement control activities are not dependent on any particular implementation of either intelligence or operations. Movement control sees only the data they export and the data movement control returns to them.
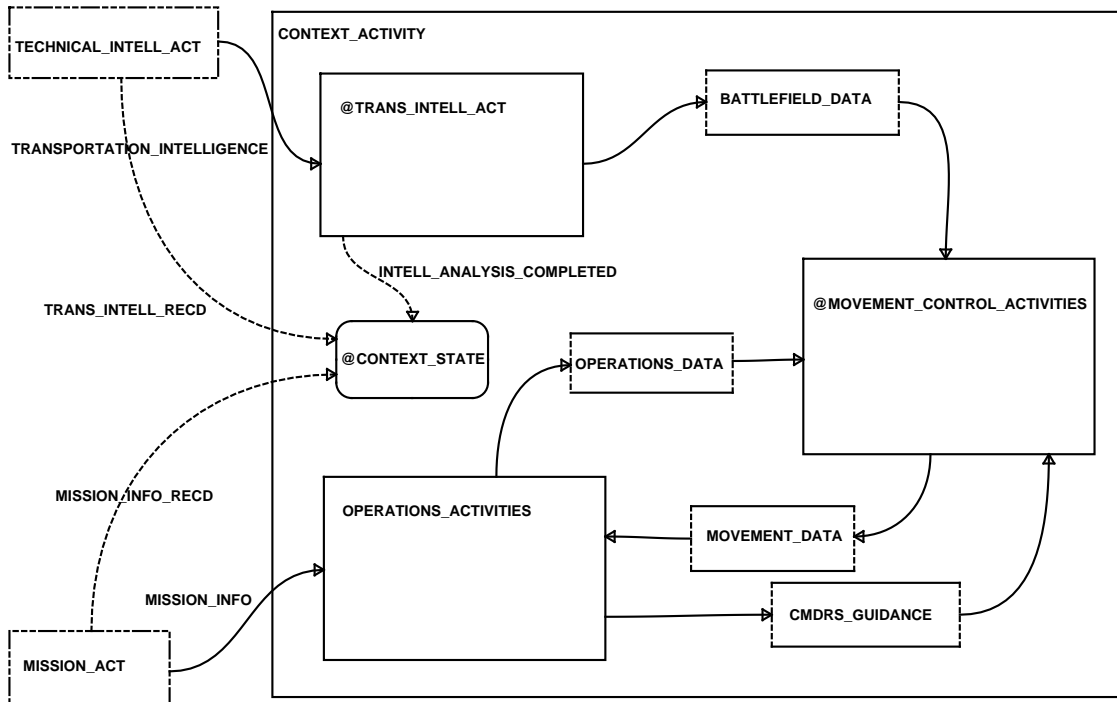
Figure 4-9 Movement Control Activity Chart

The box labeled context_state controls the behavior of intelligence, operations, and movement control activities. Figure 4-10 shows the state chart that represents context_state. The form of this chart indicates that each of the three active states: intelligence_behavior, operations_behavior, and movement_control_behavior are running in parallel. These states, in turn, control the parallel behavior of the intelligence, operations, and movement_control activities in Figure 4-9.

This parallelism supports the common structure within the command and control system. Actual Army staff operations must proceed in parallel with appropriate sharing of information. Automated command and control systems must support this concept of operations. Movement control operations are driven by specific staff functions (e.g., the issuing of an order or the receipt of new intelligence information). The chart shows the initiation of movement_control_behavior in response to a change in battlefield state indicated by integrate_intell or mission_order_issued. In fact, this parallel structure also applies to other subsystems within a command and control system. Mission orders and intelligence will affect their operations, as well.
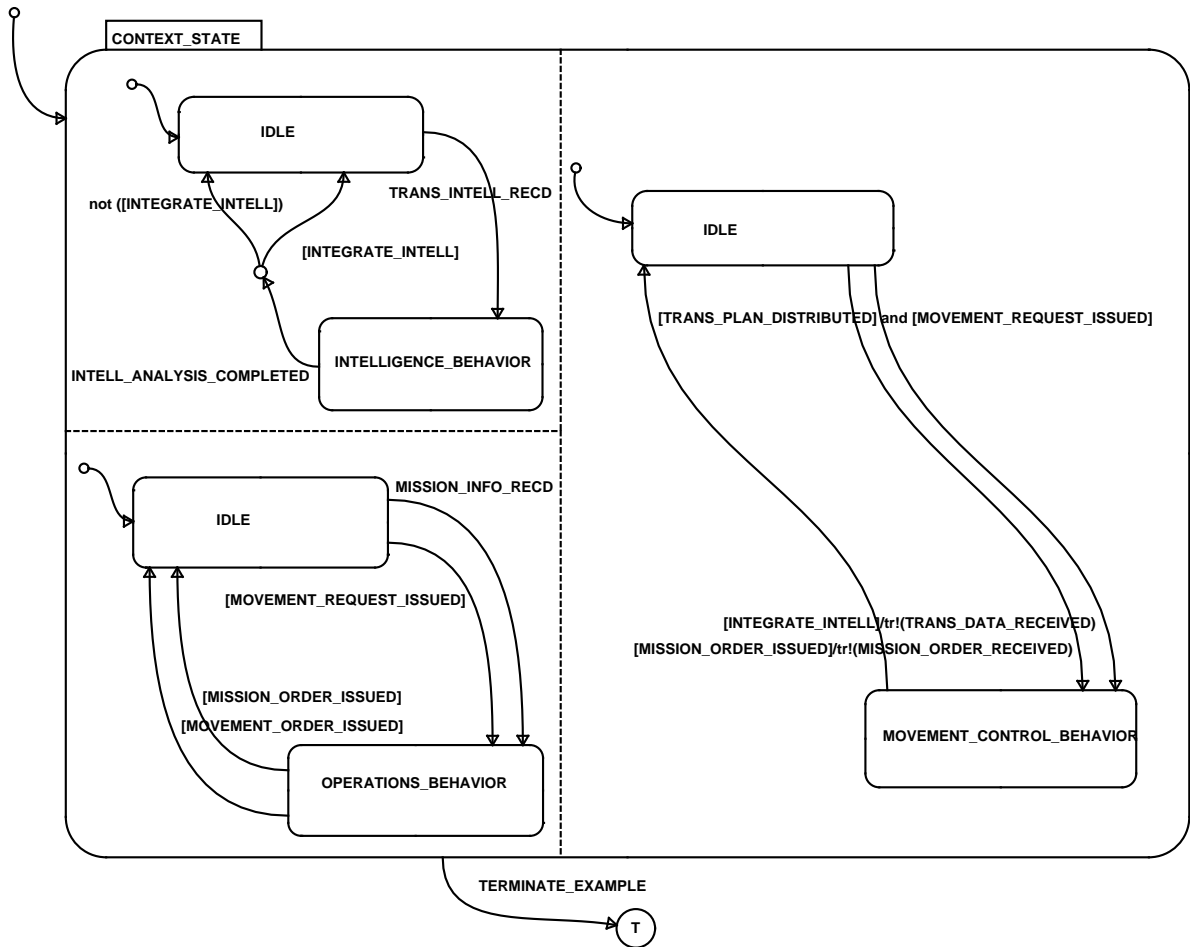
Figure 4-10 Behavior of a Command and Control System

4.3.3.2. Common Intelligence and Movement Control Activities

Each of the activities within Figure 4-9 may be decomposed into lower level activities. For example, the decomposition of intelligence activities and behavior is based on Army doctrine [FM 34-3]. While the detailed operations within each activity of this chart will vary depending on the specific intelligence system, the pattern of activities and their interactions will be repeated from system to system. This common activity structure is illustrated in Figure 4-11.

The domain analysis also revealed the common structure for movement control activities shown in Figure 4-12. These activities are derived from the operational features and the study of commonality among related movement control systems. The activities of this chart perform operations defined by specific features:

- Highway_regulating implements `highway_regulation` operations.

- Deconflicting_route implements the `deconfliction` feature.
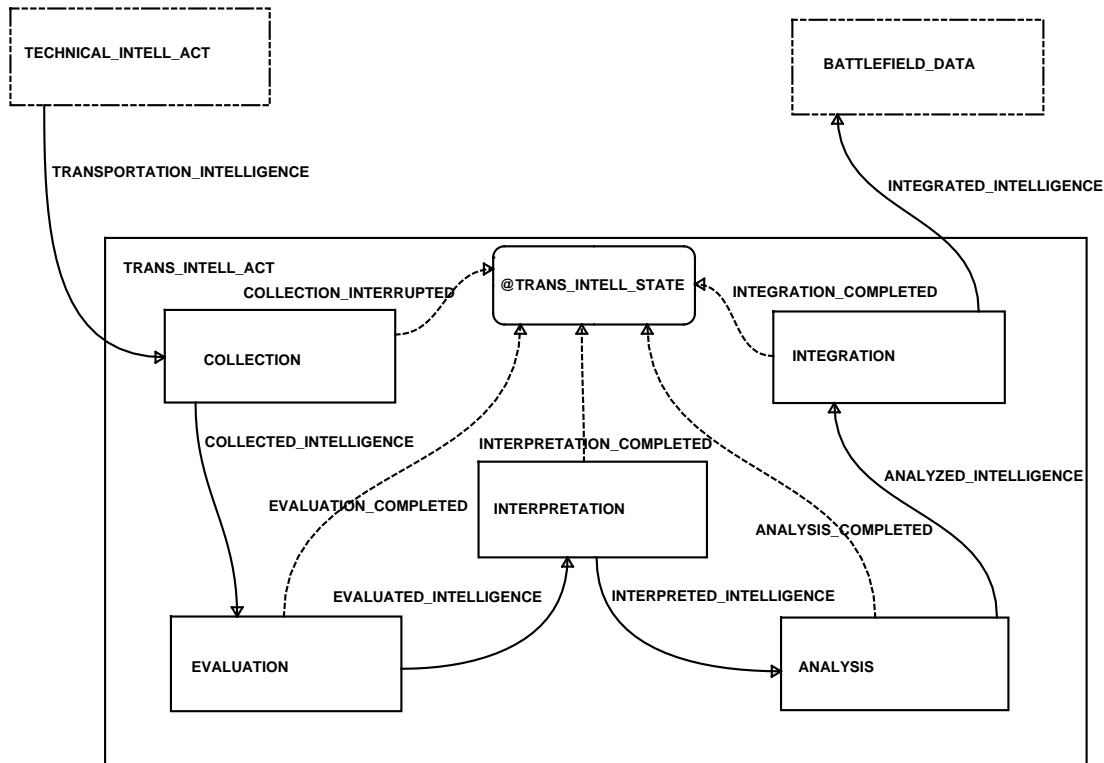
Figure 4-11 Common Intelligence Activities

- Convoy_planning is an aggregate of three features: `convoy_control`, `column_formation`, and `asset`.

The control and internals of these activities will vary depending upon the selection of other features. For example, the selection of the `unit` context feature may mean that convoy_planning will not include `asset`. Control will also vary depending upon the selection among the `control_strategy` features. Section 4.4.2. addresses variability within this control activity.

The functional model does not decompose the operations_activities. The structure of this activity will vary depending on the specific command and control system. The domain analysis only looks at the movement control component of command and control for ATCCS and other related systems requiring movement control. The data passed between activities also exhibits a common structure. Each of the three activities produces and/or uses data created by the other three. As long as this data interface is adhered to, modification of the internal operations of any activity will not affect the others. For example, if convoy_planning is for a `unit` move it will not perform selection of transportation assets. For `logistical` moves, convoy planning must include selection of assets. However, the data convoy_planning exports, consisting of order_of_march and schedules entities, will not change. Section 5.3 will explore this concept as it applies to two actual movement control systems.
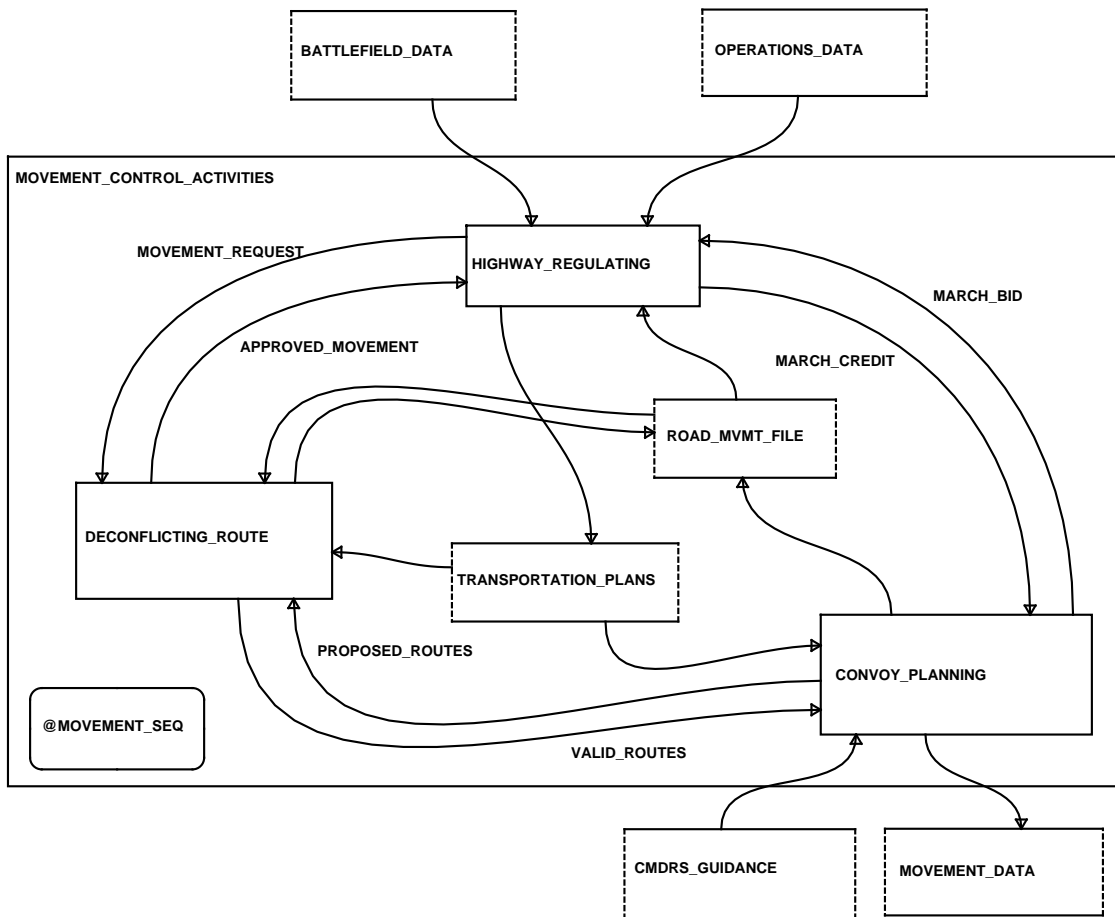
Figure 4-12 Common Movement Control Activity Structure

4.3.4. Domain Dictionary

As stated in Section 2.2., the domain dictionary plays an important role in alleviating misunderstandings among the various groups involved in a domain analysis and between subsequent users of its results. The Army has specific meanings for terms both directly related to movement and for terms used to define organizational levels and structures that are pertinent in understanding movement in military terms. For example:

coil   An arrangement of vehicles forming a circle.

This meaning for a common word in the English language is not part of most dictionaries. Alternately, the term movement control is taken from an Army manual [FM 55-10]. Its meaning is more specific and precise than any definition that is derivable from combining the ordinary meanings of these two words.

movement control   The planning, routing, scheduling, control, and in-transit visibility of personnel, units, equipment, and supplies moving over lines of communication in accordance with the directives of command planning. It is a continuum involving the synchronization and integration of movement information and programs spanning the strategic, operational, and tactical levels of war. Movement control is guided by a system of balancing requirements against capabilities and allocating resources based on the combat commander's priorities.

The complete listing of the Movement Control Domain Terminology is given in Appendix G.

The Army movement control domain is also rich in acronyms and abbreviations. They play an important role in military communications because their usage can be a significant factor in shrinking the size of messages sent and received between units and in documents generated for widespread use. An example of such an acronym is:

ATCCS   Army Tactical Command and Control System

The complete list of movement control domain acronyms is given in Appendix H.

4.4. Validation of the Domain Model

Validation of the domain model products is an important step in the domain analysis process. In order to validate the domain model, it must be possible to specify preexisting or proposed systems using the domain model products. Systems used as inputs in the domain modeling process may be used for validation; but preferably the model developers will test a system not used for developing the model for validation. The features and the functional model are particularly important as they form the basis for the architectural modeling phase. The following two sections discuss the methods used in validating the features and functional model for the movement control domain.

4.4.1. Validation of the Features for Movement Control

Validation of the features was performed by a simple empirical approach that was also used during the feasibility study to validate the window manager features. The representation of the features as seen in Figure 4-5 through Figure 4-8 may be highlighted for those features that are present in each of the two systems analyzed in the greatest detail, AFATDS and DAMMS-R. These systems have significantly different (i.e., non-overlapping) context features that modify more closely related operational features. See Section 3.3 for further information on these two systems.
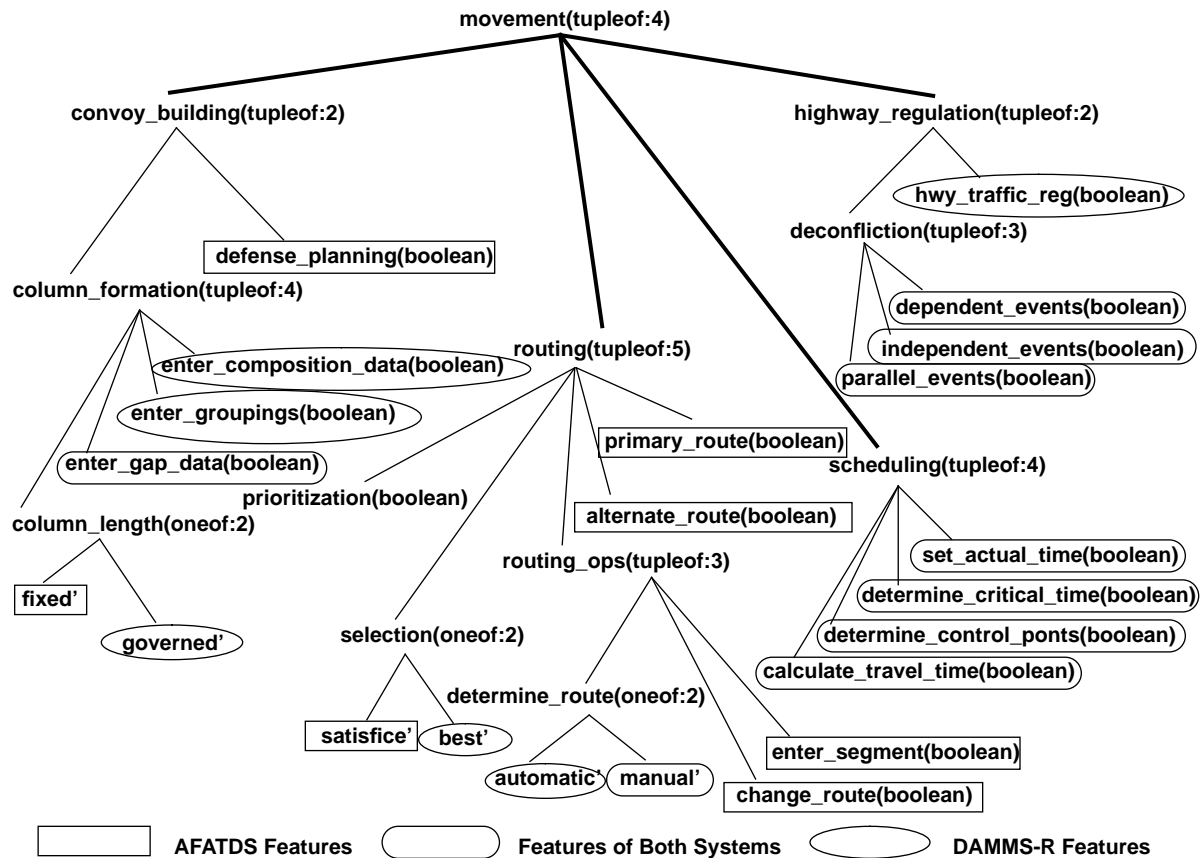
Figure 4-13 Detailed Operational Features for AFATDS and DAMMS-R

Within the scope of the domain analysis, the features highlighted should completely represent the capabilities of the corresponding system or the features are incomplete. A comprehensive feature model is needed to describe a domain with systems that are widely divergent (few features in common) or extremely similar (differing in only a few low-level features). Figure 4-13 and Figure 4-14 highlight the appropriate features of the AFATDS and DAMMS-R systems from the detailed movement operational features (Figure 4-6) and the context features (Figure 4-7).

An even more useful validation of the feature model is to see if it can be used to describe the functionality of a movement control system that was not analyzed during the domain modeling process. The Reserve Component Automation System (RCAS) is to be used by the Army Reserve to support decision making for "all commanders, staff, and functional mangers responsible for Reserve Component Forces." [OO1SRM]. RCAS will support planning and execution of mobilization of reserve units and will also perform routine administrative tasks. The mobilization process consists of bringing together personnel, supplies, and equipment to carry out a specific mission. An important requirement of RCAS in executing mobilization is a process RCAS refers to as "movement execution."
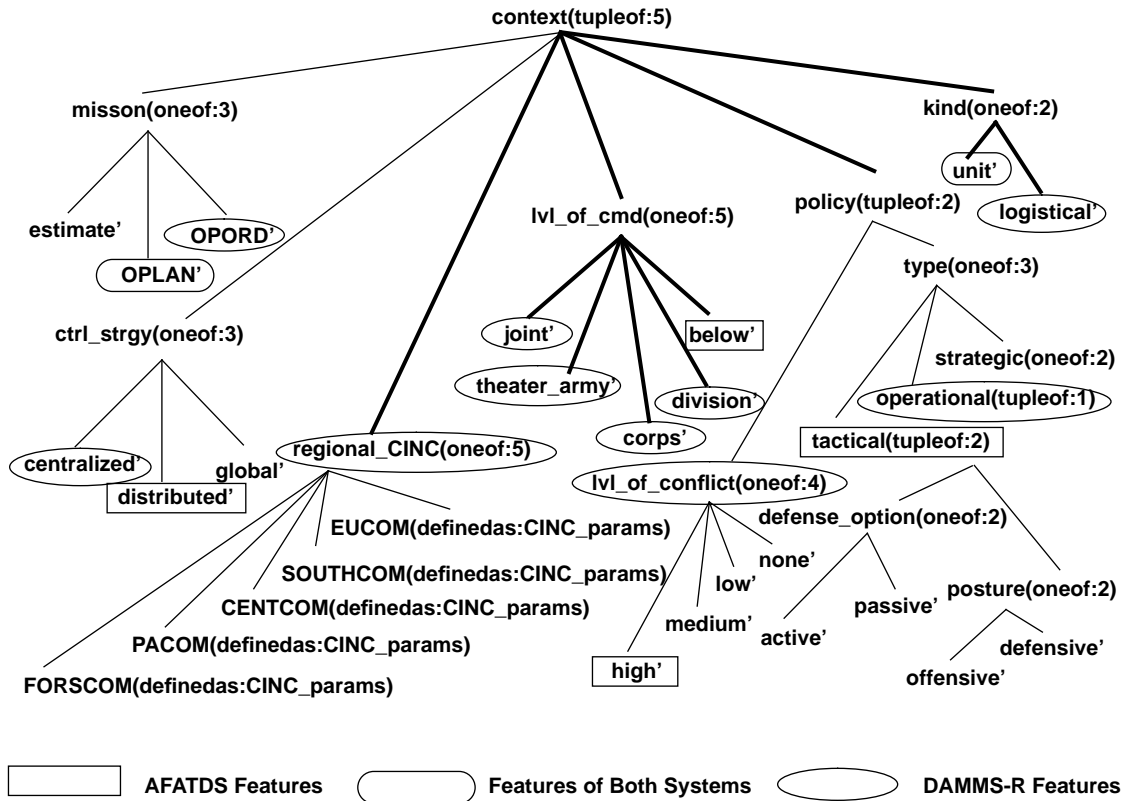
Figure 4-14 Context Features for AFATDS and DAMMS-R

The domain model validation examined this requirement to determine the matching of RCAS needs to features provided in the domain model. Movement control functionality proved to be a vital part of RCAS and serves to validate the model.Figure 4-15 and Figure 4-16 represent the feature mappings of the detailed operational features and the context features, respectively, for the RCAS movement control functionality as described in [OO1SRM]. This comparison reveals two points of validation:

1. The domain model can serve as a reference model for RCAS requirements.

2. The requirements for RCAS very closely parallel those of DAMMS-R.

The information in the domain model (entities, features, and functions) can be used by RCAS developers in their specification activities as they move from function descriptions at a high level to specification. Moreover, following the lead of DAMMS-R, it may be possible to achieve a significant level of reuse between the systems. In this perspective, the domain model and the specifics of DAMMS-R can support for the development of a new system. This is the primary goal of the domain analysis activity.
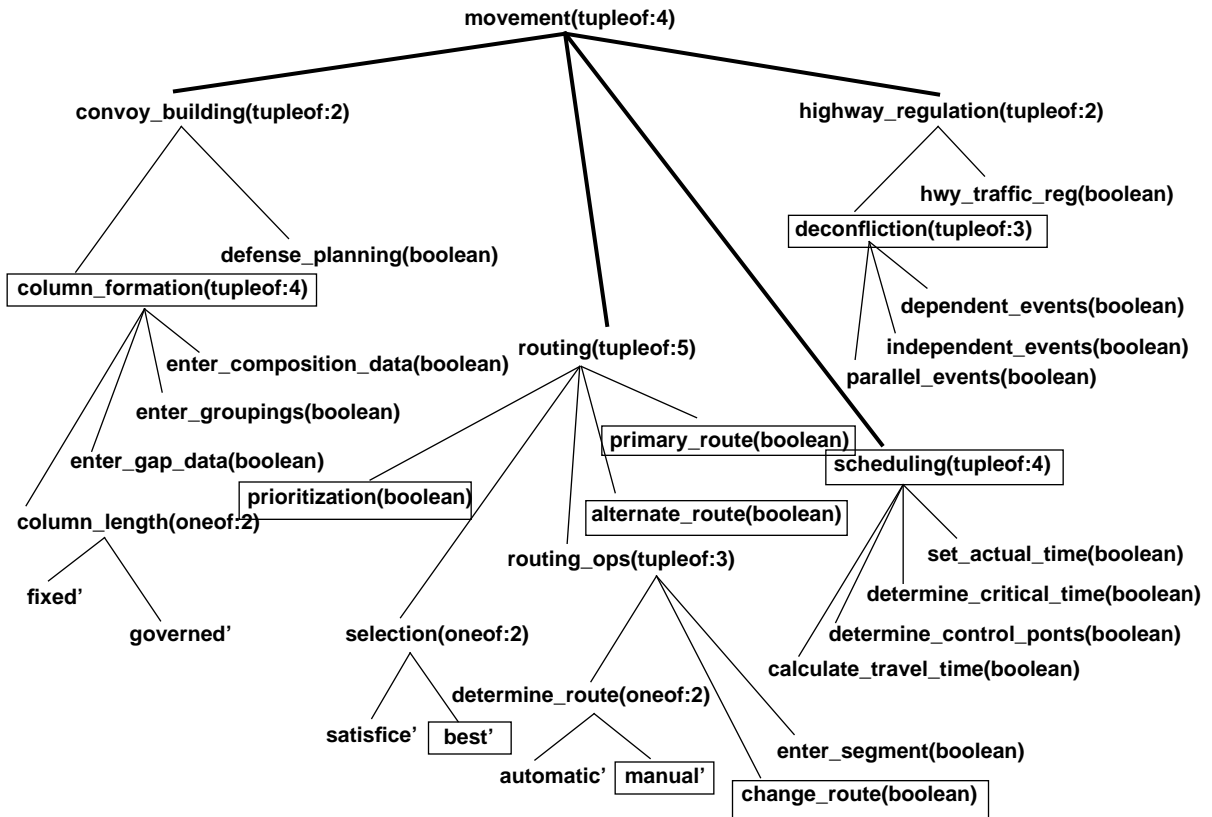
Figure 4-15 Detailed Operational Features for RCAS
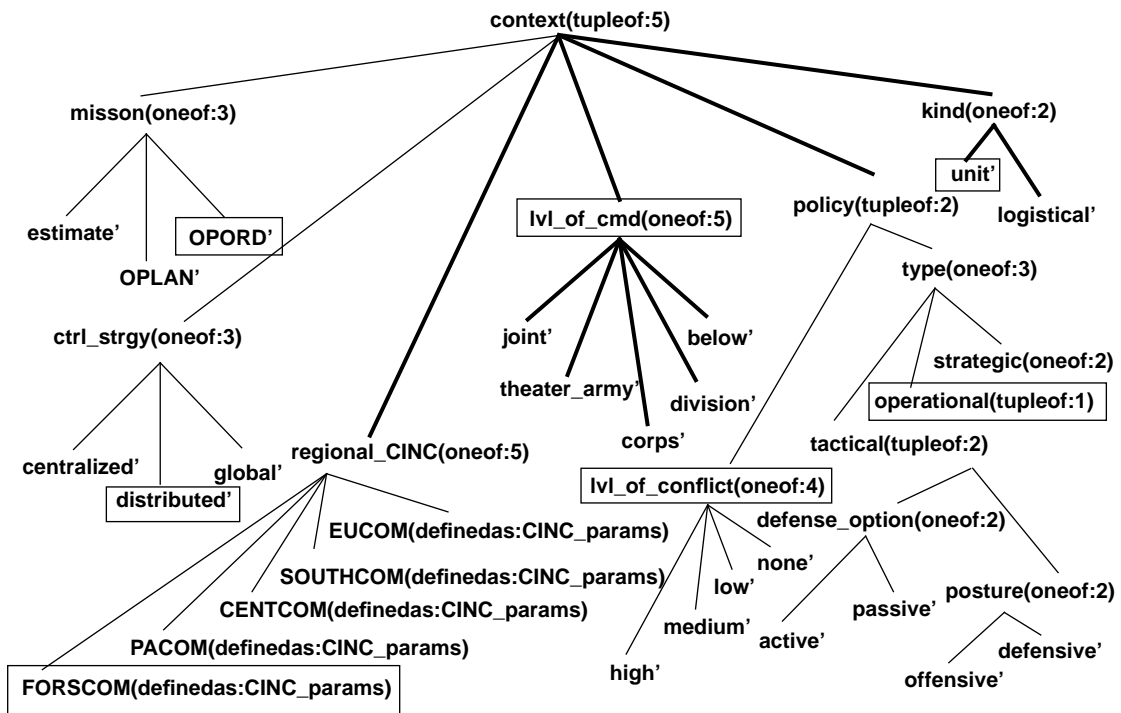

Figure 4-16 Context Features for RCAS

4.4.2. Validation of the Functional Model

Both AFATDS and DAMMS-R share the common functional model presented in Section 4.3.3. These two systems differ, however, in the behavior of their movement_control_activities. This difference is a result of the selection of different `control_strategy` features. As Figure 4-18 shows, AFATDS follows a `distributed control_strategy` while DAMMS-R uses `centralized`. The individual control activities for each `control_strategy` alternative demonstrate the commonality of operations, with differences in specific implementation.

The behavior shown in Figure 4-17 follows the `centralized control_strategy` of DAMMS-R. Within this context, there are three parallel sets of states:

1. Developing_trans_plans controls highway_regulating activities.

2. Deconflicting controls deconflicting_route.

3. Planning_convoy and the other states at the bottom of the figure control convoy_planning activities.

These parallel states will proceed regardless of the internal operations of the activities they control.

For the specific movement_control_activities of AFATDS (Figure 4-18), deconflicting is not a separate state. This is characteristic of `distributed` systems where the entire convoy_planning activity is performed by the unit doing the move. This unit must have the information needed to carry out its own planning because it may be moving under actual combat conditions. This is reflected in the parallelism between developing_trans_plans and planning_convoy on the chart. These states reflect the parallel nature of information gathering and operations planning that is conducted in a combat unit. However, the unit cannot rely on control from a central command to deconflict its move. This activity must be integral to the convoy_planning activity.

4.4.3. Results of Domain Model Validation

The use of actual systems to validate the domain model demonstrates its success in capturing commonality and establishing factors that result in differences among systems. The common structure of the functional model, down to the level of movement_control_activity behavior, shows the activities and control that result from mandatory features. The differing behavior within the movement_control activity shows the effect of different context features to allow for different classes of users and system missions, as well as the differing behaviors among options and alternatives.
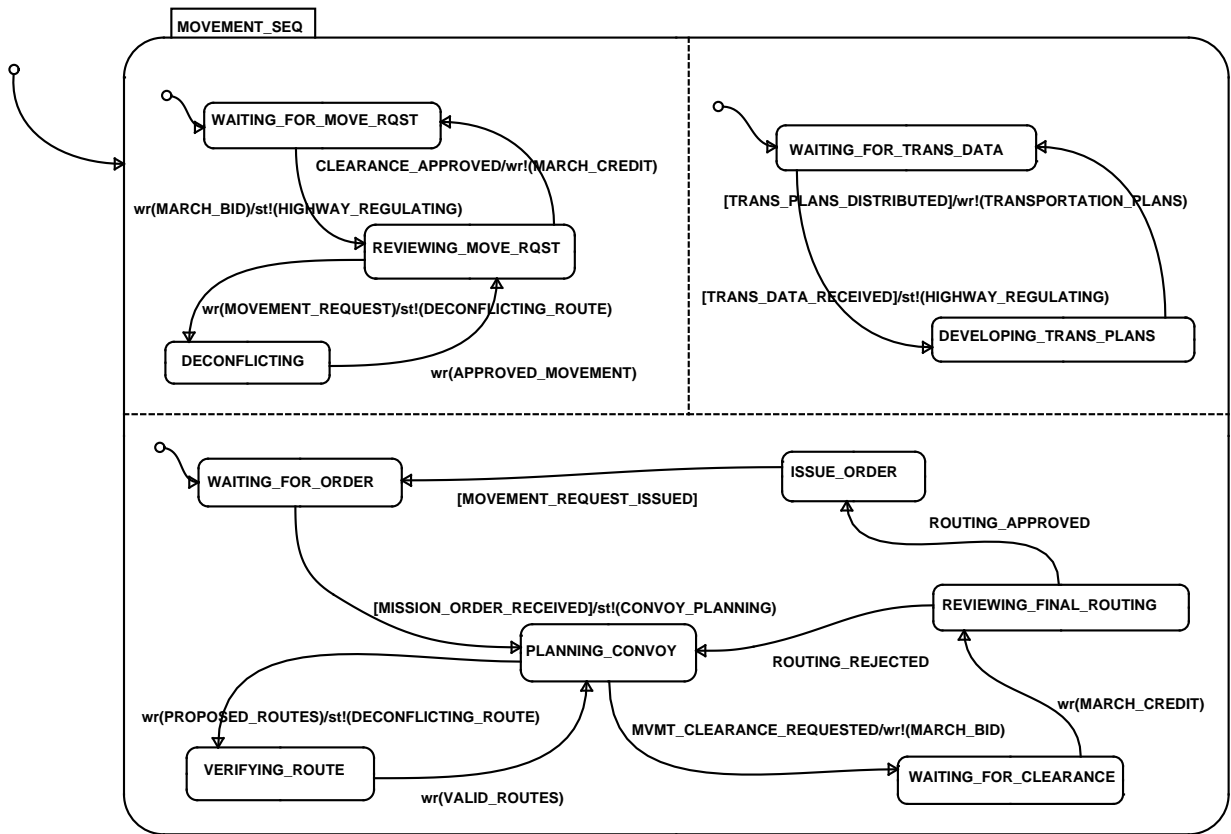
Figure 4-17 Behavior of DAMMS-R Movement_Control_Activities

The next step in validating the domain model is to demonstrate its effectiveness in supporting the development of a new movement control system. Chapter 5 of the report describes the process of using the domain model to build a system and perform prototype testing.
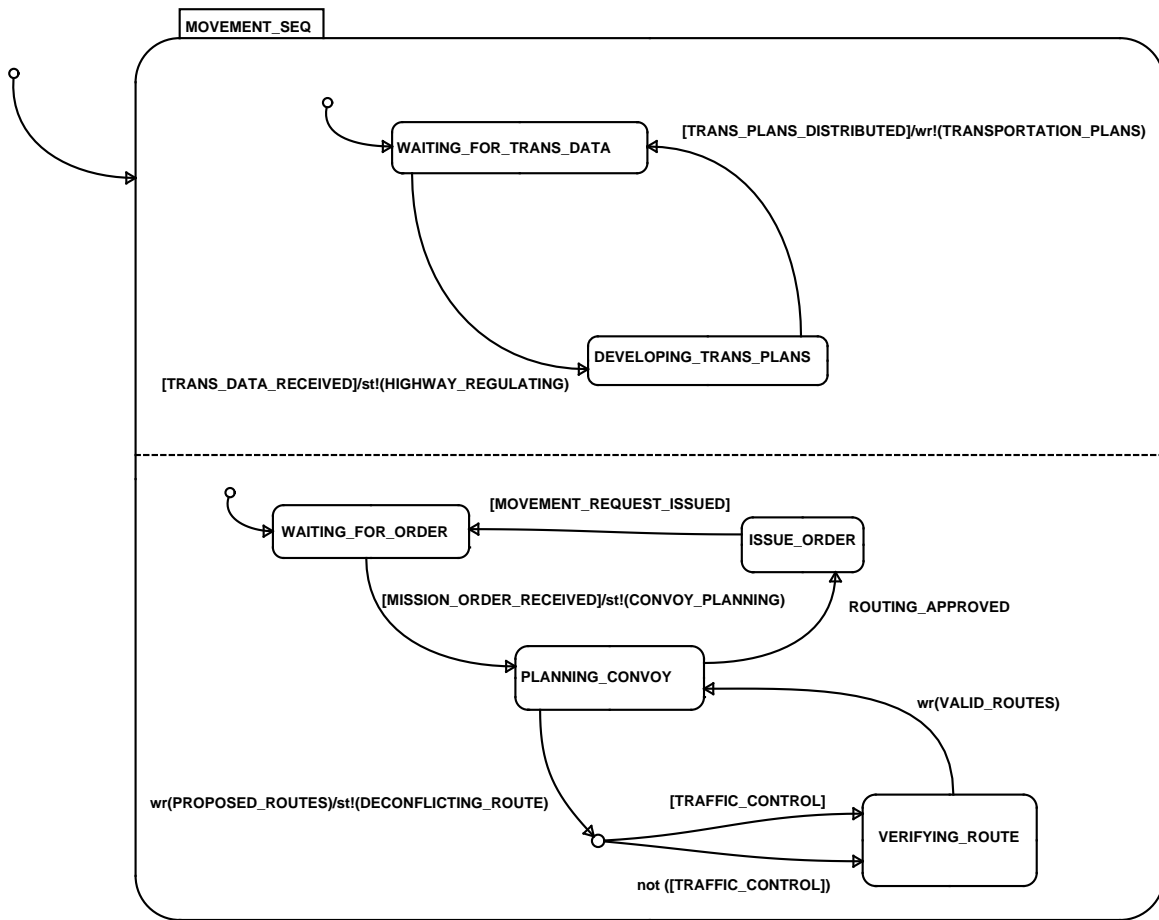
Figure 4-18 Behavior of AFATDS Movement_Control_Activities

5. Application of the Domain Model in System Development

The domain model presented in Chapter 4 forms the basis for software development of a movement control system. By integrating access to the domain model products (the feature, ER, and functional models), the domain modeling tool built using 001 can provide a prototyping capability for movement control. This prototyping system is called the SEI Movement Control Prototyper, or *MoveCon*. The remainder of this chapter will discuss the rationale for building the system, the approach taken in its development, and the use of the system as a means for prototyping various models of movement control systems.

5.1. The Domain Model and Prototyper Capability

A domain modeling tool can be used in the early stages of the software development process to support end users in specifying requirements for new systems. This tool must provide the three views of the FODA domain model. While the information constrained in the model provides enough information to build a system, automatic prototyping gives the user the ability to animate the specification built from a selection of features. Simulation through STATEMATE gives a conceptual animation of the system specification. The simulator approach is not, however, directly tied to the domain model. The functional model in STATEMATE is not integrated with the other views of the domain model. Without integration, it is not possible to test consistency and completeness across modules.

To meet this need for integration, the domain modeling tool must support both domain model creation and model-based prototyping (see Figure 5-1). Using the domain modeling tool, the domain analyst documents the domain model and implements a prototyping capability (labeled Domain Model Prototyper in the figure). The prototyper, as its name implies, allows implementation of a working model of the system under development based on a selection of features. The fidelity of the prototype is a function of:

- The completeness of the domain model (how many of the features within the domain been captured in the model).

- The implementation of code generating capability in the prototyper for those features.

As the domain model matures, more features will be captured in the domain model and, as prototyping verifies parts of the model, the prototyping capability will be increased.

The loops within the figure show the pattern of development of both the model and the prototyper to validate the model. The outermost loop shows the evolution of the model. As the domain analyst captures more domain information, the model is expanded or changed to reflect new domain information. In parallel with domain model development, the domain analyst will construct a working model of the domain via the prototyper. A selection of features captured in the domain model will be built into the prototyper to allow both validation of the domain mod-

el (does the model capture the common features of systems in the domain) and prototyping of a system under development.
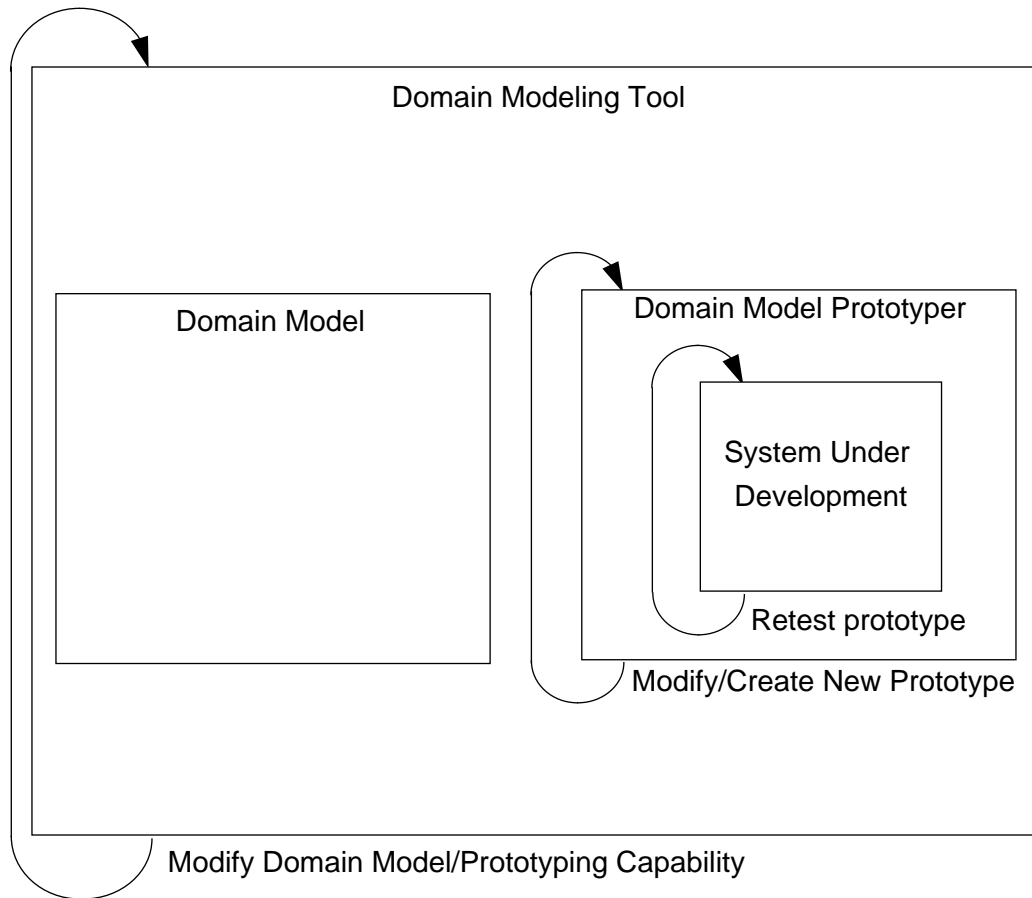
Figure 5-1 Domain Modeling Tool Capability

The loops attached to the prototyper show the ability of the domain modeling tool to test new system capability.

- Given an existing domain model, the prototyper allows selection of features to implement a prototype for a system under development. The user of the prototyper may change features selected for the system to build a new or modified version.

- The prototype may be successively tested. Errors may be traced to incorrect selection of features for the system under development or to incorrect implementation of the features within the prototyper.

The prototyper supports both the domain model developer and user:

- The developer gets feedback on the correctness and completeness of the model.

- The user gets a sense of the capabilities for a new system and the effect of selecting alternative or optional features.

The prototyper directly support the notion of the *binding time* of features, as described in the FODA report:

- *Compile time*. The features implemented in the prototyper that cannot be changed without modifying the domain model or the prototype.

- *Load time*. The features that can be changed whenever the prototyper is used to build a new prototype system or to modify an existing system.

- *Runtime*.The features that can be selected during execution of the system.

The next section describes the use of this approach in building MoveCon, a movement control system prototyper.

5.2. The Movement Control Prototyper (MoveCon)

MoveCon is a prototyping system for implementing those portions of the movement control domain model dealing with convoy planning. The features in the models shown in Figure 5-2 and Figure 5-3 are those available to the user through MoveCon. These features would be included inside the domain model prototyper box of Figure 5-1.

The Army has a need for tools to automate portions of convoy planning both for creating convoys and for determining an appropriate route and schedule for those convoys. In many cases, this function is still performed manually on paper. Several of the steps involved are potentially time-consuming and/or error prone. For example, a combat developer may recognize the need for a new subsystem to automate convoy planning. The three main capabilities of this convoy planning tool are:

1. Selecting vehicles, grouping them as needed into a march column, and providing adequate spacing between vehicles and groups as required.

2. Verifying that one or more selected routes is a valid path of segments from a start point to a release point and that the vehicles in the march column can pass all points on a proposed route. If the vehicles cannot travel the entire route, the route must be rejected.

3. Scheduling the use of the selected routes by calculating the passing and travel times over each segment of the route.
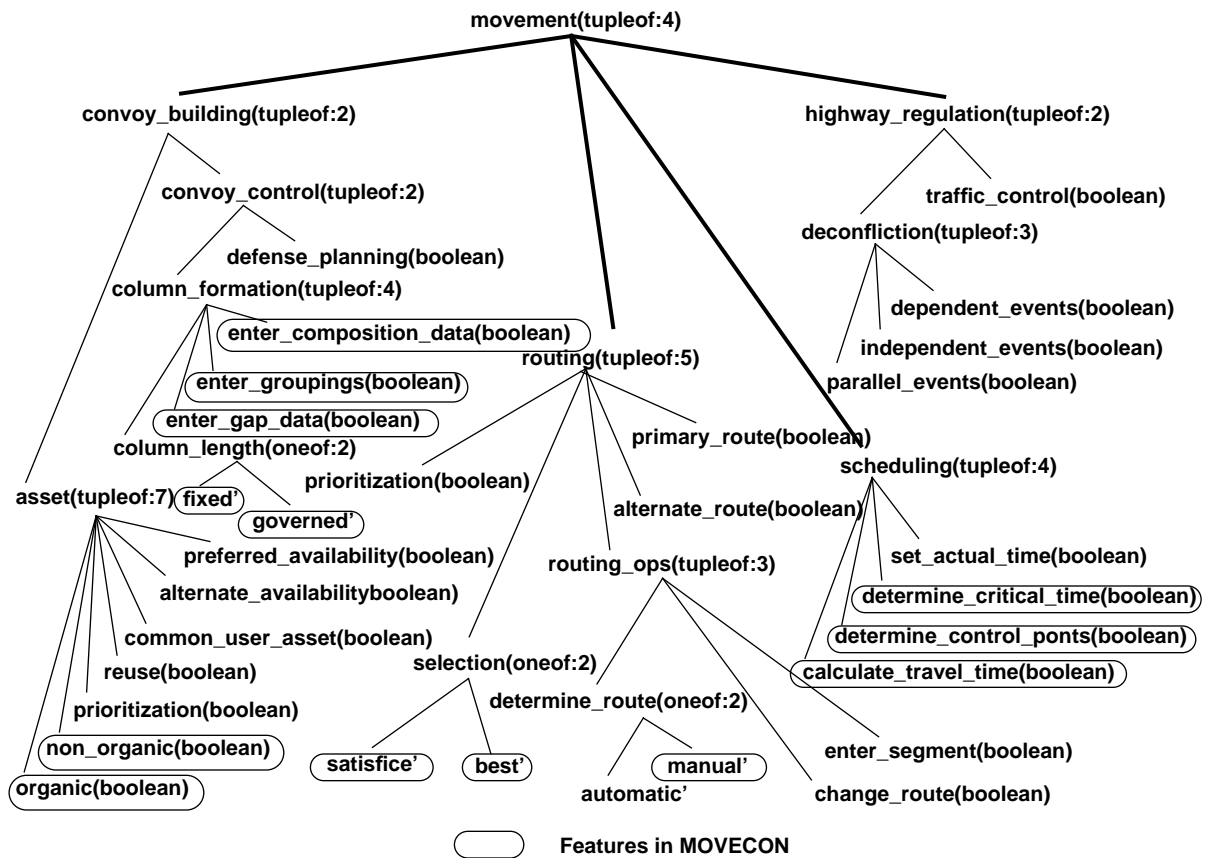
Figure 5-2 The Operational Features Modeled in MoveCon

With minor variations, these three elements (the number and types of vehicles in a convoy, the proposed route, and a schedule for its use) are the essential pieces of information needed by existing or proposed systems. For example, they would support:

- Formulating a Movement Request for AFATDS or the equivalent Convoy Clearance Request for DAMMS-R.

- Performing the convoy planning operations of stand-alone, PC-based systems examined during the domain analysis.
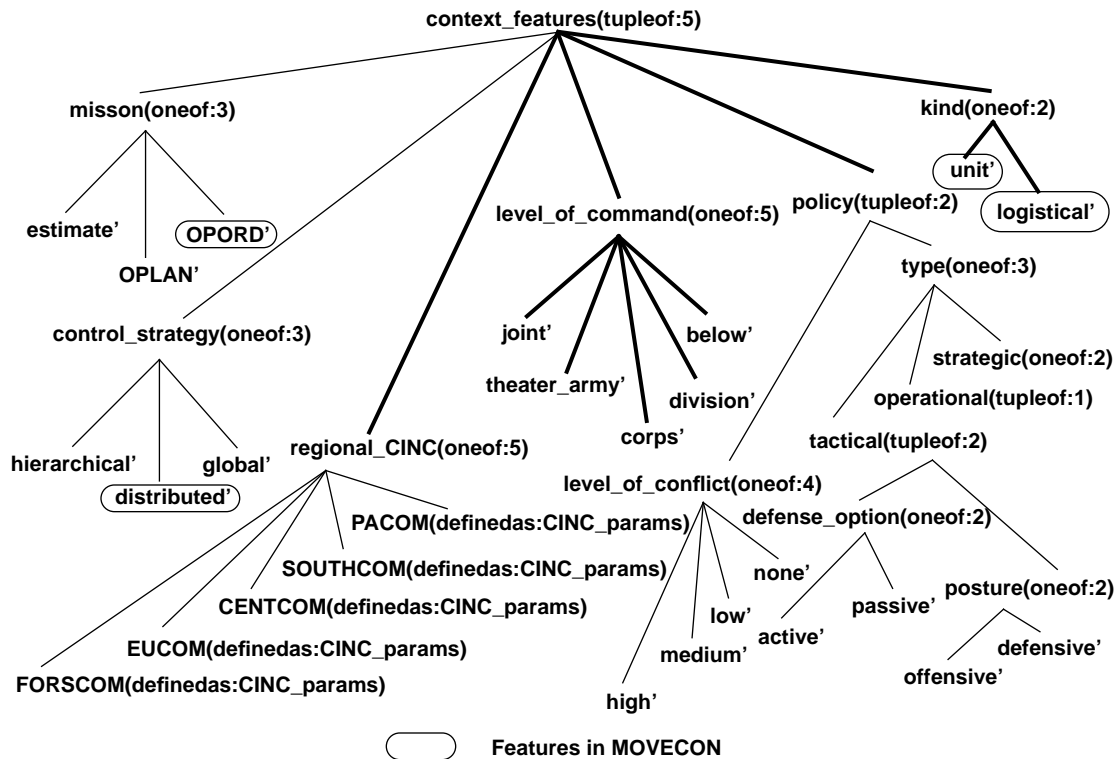
Figure 5-3 The Context Features Modeled in MoveCon

The combat developer can test the system generated by MoveCon as he would any software system. Test data could include convoy composition, route selection, or scheduling constraints. Through successive runs of the prototyper, the combat developer can refine the capabilities of the desired system. These refinements require modifying the prototype system under development, as shown in Figure 5-1, or creating a new prototype. The combat developer may also provide feedback on the prototyping capability to modify the model or the prototyper if the needed capabilities are not part of MoveCon.

5.3. Scenarios to Validate MoveCon

The prototyper has been used to build two convoy planner systems. Figure 5-4 shows the scenarios that exist for each system. Scenario 1 is a simple planner, handling only `unit moves`. Because of the `unit` feature, the composition rules automatically provide both `organic asset` and `governed` columns. Other features of the system for Scenario 1 are not currently selectable in MoveCon. They may be considered *compile-time* features.

Scenario 2 offers more capabilities to the user. During runtime, the user may select either of the alternatives for the `kind` feature. This indicates that for successive convoy building operations, the user of the system can build either `unit` or `logistical` convoys. The runtime

capability for the `kind` feature automatically provides runtime selection for `assets` and `column_length`. Through composition rules, these capabilities must be provided if `logistical` is selected.
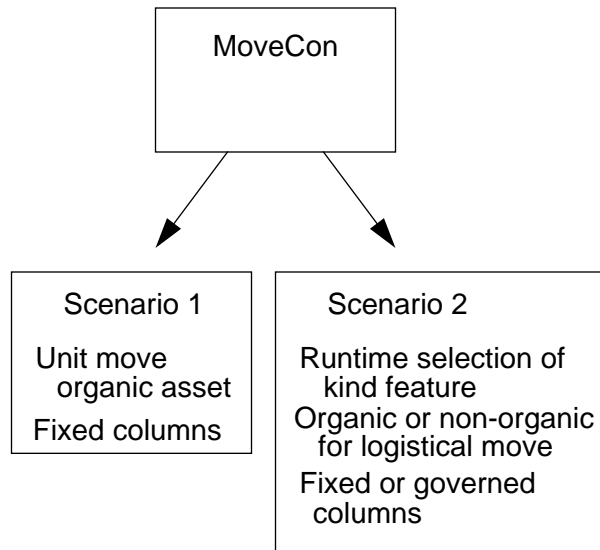
Figure 5-4 Scenarios for Testing the Prototyper

Figure 5-5 and Figure 5-6 show the selection of features for each scenario. Although the features differ in only three places, the resulting differences between the two systems is significant. In Scenario 1, the user has the ability to route and schedule a unit but cannot change unit composition. The vehicles composing the convoy are those of the unit itself and do not change for individual moves. For the second scenario, however, the user has the ability to build the convoy for assets belonging to other units. These non-organic assets will differ depending on the requirements for each move.

Appendix I contains a list of sample vehicle data for both the unit and logistical movement scenarios and a sample road network for building routes.
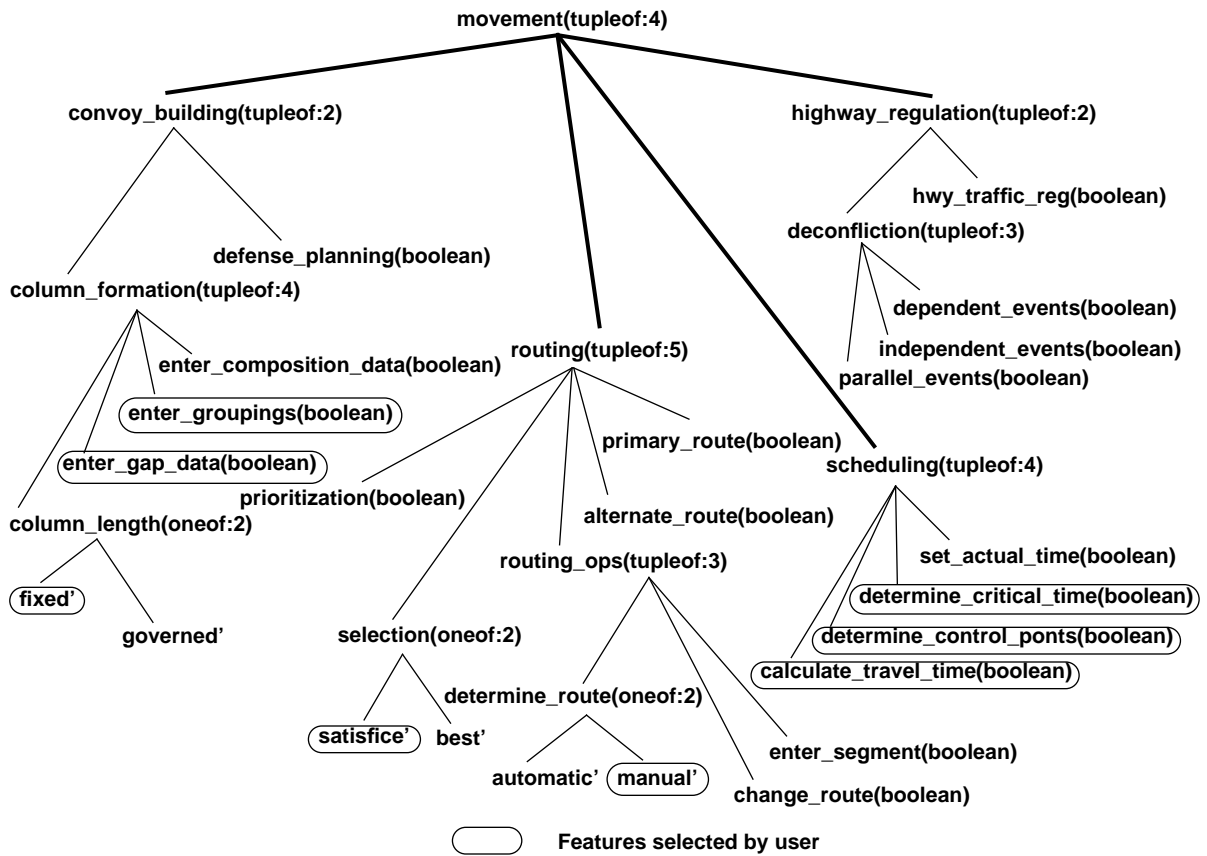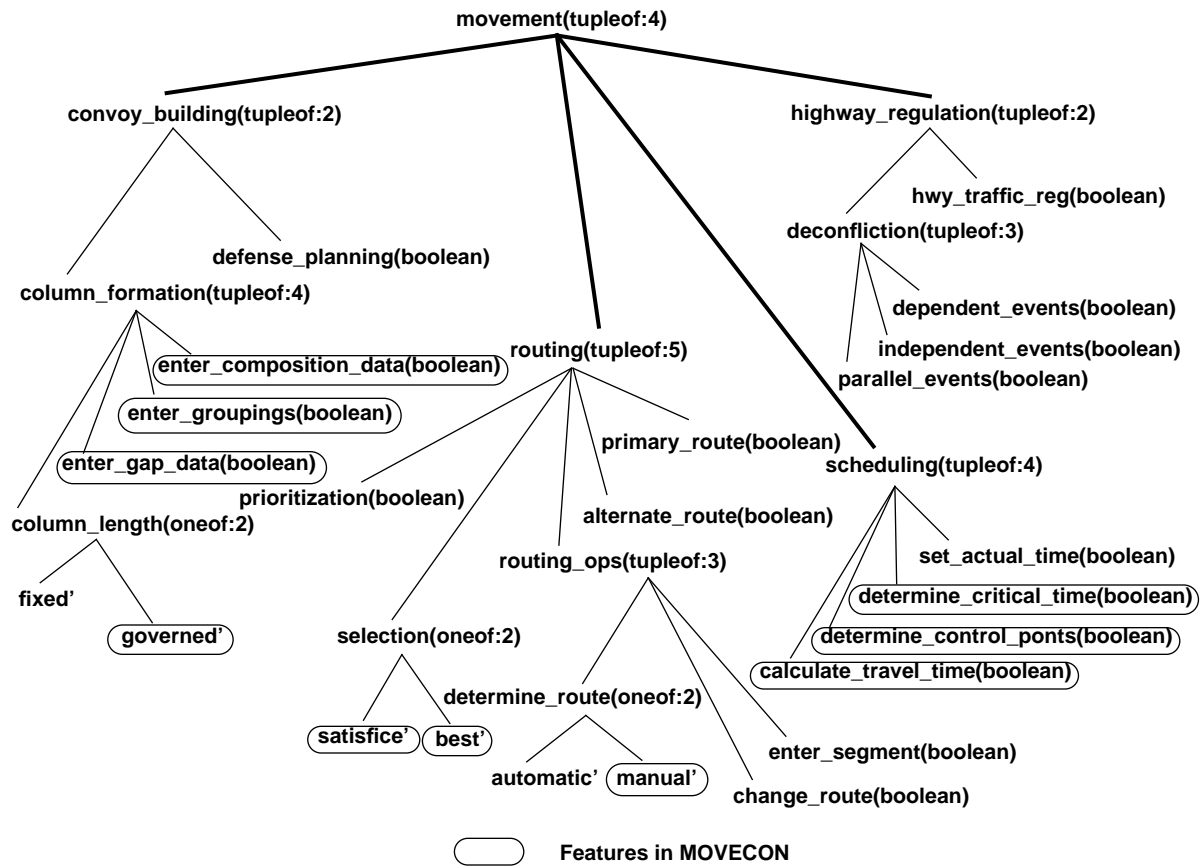
Figure 5-5 Feature Selection for Scenario 1

Figure 5-6 Feature Selection for Scenario 2

6. Conclusion

6.1. Lessons Learned

The primary purpose of the Army Movement Control domain analysis was to apply the FODA method within a realistic MCCR domain. An important aspect of this analysis, which differs from that performed under the feasibility study, is that commonality among related systems within the domain was neither well-understood nor well-documented. Domain expertise for movement control did not exist among the domain analysts before the analysis and there was no in-house experience upon which to draw. In addition, before the analysis began there was not an immediately available user of the domain results. In order to obtain confirmation of the model and sample use, a specific user had to be identified.

These factors led to several valuable lessons learned that may be useful to others performing domain analysis.

6.1.1. Clear Definition of Users

As part of context analysis, a domain analyst must identify all users of the domain model. Users could include:

- The combat developers or other system specifiers.

- Software designers or developers.

- Other software systems with which the class of systems under analysis must operate.

- Other domain analysts.

Given this range of users of the domain model, the model must address a range of needs including requirements elicitation, software product implementation, and system interfacing. Representatives of each of the user groups must be involved in the development and review of the model and order to assure its usability.

6.1.2. Early Identification of Domain Experts

During context analysis, the domain analyst must identify the appropriate domain experts and other sources of information. For the movement control domain, this includes combat developers from several Army TRADOC organizations concerned with movement as well as specific Army manuals and procedures. Learning from the domain experts, the domain analysts become "experts" as well, but are constantly measuring their knowledge against the true domain expertise. Attendance at training courses within the domain is also an appropriate means of building in-house expertise. Effectively working with domain experts is the best means to achieve adoption of the domain model by potential users.

6.1.3. Need for Enactment of Model

During the feasibility study, Statemate simulation was used to demonstrate the capabilities of a system specified using feature selection. This was effective in a simple domain (window managers), where potential users have a good idea of how such systems work. For the movement control domain, potential users must be convinced that the model can be effectively used to specify a new system. The use of a modeling tool that can both capture the domain model and produce prototype code to simulate a system based on feature selection is one approach that can secure user acceptance.

6.1.4. Establishing a Community of Interest

During later stages of the analysis, it is very useful to bring together domain experts from different organizations for joint activities. These meetings can be organized around discussions of the domain model, its application, or their own work in progress. For example, it was discovered during this domain analysis that groups as diverse as university researchers, an AI firm, and the Army Transportation School have a significant overlap of interest. The domain analysis process brought them together to share their interests. Once a domain model is in place, it is necessary to maintain contact with all current and potential users of the model to assure its successful application and evolution.

6.1.5. Establishing Domain Expert Support

A domain analysis effort must have formalized support agreements established between domain analysts. During the movement control analysis, participation from domain experts came through selling the idea and hoping experts would become interested enough to work with the analyst.   Although the group managed to elicit adequate support to build the model, the process was time-consuming and should not be used for subsequent efforts. In the future, once experts are identified, a memorandum of understanding should be developed between the two parties that solidifies the domain expert involvement throughout the project.

6.2. Recommendations for Future Research

6.2.1. Observations Leading to Research Recommendation

Within the Army there seems to be a lack of communication among developers of related software systems. Little detailed information is exchanged from command to command. This means that related software systems that perform primarily the same operations are often developed independently. Domain analysis helps improve communication. Through analysis of the specific domain for which the software is targeted, information about related systems is exposed.

The development of the Department of the Army Movement Management System (DAMMS-R) illustrates the benefits of improved communication among developers. DAMMS-R is being developed to support movement management, transportation operations, and common user transportation asset control functions within any theater of operations. Movement control plays

a significant role in the operation of the DAMMS-R software. After taking a closer look at the requirements for DAMMS-R, it was determined that the DAMMS-R requirements and movement control requirements for the ATCCS system are very similar. Recognizing these similarities, the domain analysts orchestrated interaction between the interested parties for both systems. As a result, the possibility of a joint development effort was discovered. The domain analysis effort is now attempting to provide products to both the DAMMS-R and ATCCS projects.

The domain analysis also discovered that the ALBE-GIS, part of the Geographical Information System for the ATCCS system, provides tactical decision aids (TDA) that may support movement control. This means that part of the movement control software may already exist.

Without analyzing the software domain prior to development, these reuse opportunities would have probably been overlooked.

6.2.2. Proposed Directions

The Army should apply the movement control domain model and SEI software architecture technology to implement movement control software for ATCCS. This software will interface with the common ATCCS support software (CASS) architectures. Software development will use the domain model and analysis method together with proven methods used by the SEI Software Architecture Engineering Project.

The task will be done jointly with interested Army parties who have participated in the analysis. The project will also receive domain information from several ongoing prototyping efforts (Army Transportation School, Carnegie Group, AFATDS) that are not currently developed on the CASS configuration. The capabilities of these prototypes will help refine the movement control domain model and will be reflected in the movement control architecture.

This task will also support the CASS group in determining effective methods for applying the results of the domain analysis in the creation of reusable software. The SEI will look at the implications of designing movement control packages for reuse in Ada.

The products produced from this work will be:

- A fully developed movement control domain model with automated tool support.

- An architecture to support development of reusable movement control software.

- Various reusable Ada packages which will serve as examples for CASS and guidelines for implementing reusable software with Ada 9X.

Domain analysis tutorial
Domain model-based Ada package
Ada reuse handbook
Domain analysis handbook

Table 6 Tentative Schedule for Future Research

6.2.3. Premise for Research Recommendations

It is recommended that responsible Army organizations support these proposed directions. Both the method and system developers can receive the benefits of a joint effort.

- Refinement of the FODA method by incorporating SAE work.

- Joint development of two major Army systems needing primarily the same capability.

- Application of FODA to new domains.

Joint support means that the Army would receive a movement control software architecture, reusable components, and the technology associated with the development. This software could be used on subsequent software developments as a by-product of ongoing research, without the need for initiating a new development.There are three primary benefits associated with this joint interaction:

1. Since both systems primarily use the same software, a joint development venture will be more cost effective for both commands, leading to overall savings for the Army.

2. Since DAMMS-R interfaces with ATCCS, many of the problems normally associated with software interoperability and interfacing can be avoided.

3. If these systems are developed from a common software approach, the user interfaces will be similar. For example, soldiers who are trained to interact with movement control software (regardless of the systems incorporating the common application) can be taught from this standard interface.

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REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
Unclassified	None

2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT
N/A	Approved for Public Release
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	Distribution Unlimited
N/A	

4. PERFORMING ORGANIZATION REPORT NUMBER(S	5. MONITORING ORGANIZATION REPORT NUMBER(S)
CMU/SEI-91-TR-28	ESD-TR-91-28

6a. NAME OF PERFORMING ORGANIZATION	6b. OFFICE SYMBOL (if applicable)	7a. NAME OF MONITORING ORGANIZATION
Software Engineering Institute	SEI	SEI Joint Program Office

6c. ADDRESS (City, State and ZIP Code)	7b. ADDRESS (City, State and ZIP Code)
Carnegie Mellon University Pittsburgh PA 15213	ESD/AVS Hanscom Air Force Base, MA 01731

8a. NAME OFFUNDING/SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (if applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
SEI Joint Program Office	ESD/AVS	F1962890C0003

8c. ADDRESS (City, State and ZIP Code)	10. SOURCE OF FUNDING NOS.			
Carnegie Mellon University Pittsburgh PA 15213	PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.
	63756E	N/A	N/A	N/A

11. TITLE (Include Security Classification)
Application of Feature-Oriented Domain Analysis to the Army Movement Control Domain

12. PERSONAL AUTHOR(S)
Sholom G. Cohen, Jay L. Stanley, Jr., A. Spencer Peterson, and Robert W. Krut, Jr.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Yr., Mo., Day)	15. PAGE COUNT
Final	FROM TO	June 1992	75

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse of necessary and identify by block number)
FIELD	GROUP	SUB. GR.	common Army terminology and requirements
			domain analysis tool support
			movement control

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report documents an analysis of the army movement control domain performed by the Software Engineering Institute (SEI) and a team of movement control experts from the Army. This report includes common terminology and requirements extracted from Army doctrine, experts in the field, and movement control systems. The report also describes the potential for prototyping of systems using domain analysis products and the tool support needed.

(please turn over)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
UNCLASSIFIED/UNLIMITED SAME AS RPTDTIC USERS ■	Unclassified, Unlimited Distribution

22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE NUMBER (Include Area Code)	22c. OFFICE SYMBOL
John S. Herman, Capt, USAF	(412) 268-7631	ESD/AVS (SEI)

DD FORM 1473, 83 APR   EDITION of 1 JAN 73 IS OBSOLETE

ABSTRACT —continued from page one, block 19

ABSTRACT —continued from page one, block 19

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Sholom G. Cohen
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Feature-Oriented Domain Analysis

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, Pennsylvania 15213

This report was prepared for the

SEI Joint Program Office
HQ ESC/AXS
5 Eglin Street
Hanscom AFB, MA 01731-2116

The ideas and findings in this report should not be construed as an official DoD position. It is published in the interest of scientific and technical information exchange.

FOR THE COMMANDER

(signature on file)

Thomas R. Miller, Lt Col, USAF
SEI Joint Program Office

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Appendix A. Movement Control Workshop Report

Abstract: The Army Movement Control Workshop was held at the Software Engineering Institute (SEI) on July 9–10, 1991. The purpose of the workshop was to bring domain experts from the Army together with the SEI, Industry, and Academia to discuss related systems, system requirements, and related problems in the area of movement control. The following is a summary of the workshop findings.

A.1. Working Group 1: Doctrine and Modeling

Working Group 1, Session 1 (7/9/91, 3:30p.m.–5:00p.m.)

A.1.1. Goals
The five goals of this session were to:

1. Familiarize the workshop participants with SEI movement control work.

2. Review the proposed FODA project's discussion topics.

3. Retract inappropriate topics.

4. Add pertinent new topics.

5. Prioritize topics.

Each of these goals is elaborated in the paragraphs below.

A.1.1.1. Familiarize the participants with FODA project's work
In accomplishing the first goal, the SEI participants presented a general description of the type of information features and entity relationship models capture. The group also discussed the interaction between these models, and an overview of the Movement Control Models developed at the SEI.

The entity-relationship model generated little discussion, the group agreed that the model captured the information needed for the vast majority of functionality within the movement control domain.

The features model, on the other hand, generated a great deal of discussion and questions. It was decided that the model would serve as a focal point for any subsequent discussions. The model also served as a mechanism for capturing new system requirements.

A.1.1.2. Review the proposed FODA project's discussion topics
The six SEI proposed topics were:

1. Scope of movement control and where each developer fits?

2. What aspects of the movement planning cycle should the software support?

3. What is the time frame for performing movement planning?

4. What commonality exists among the models of movement control embodied in existing systems (KBLPS, TPFD, CASCOM, SEI, AFATDS, etc.)?

5. What effects would the Air Land operation have on movement control?

6. What other related work, e.g., electronic maps, is relevant to the domain?

Participants were presented this list and an explanation of the topics. The rational for the selection of these topics was also provided.

A.1.1.3. Retract inappropriate topics

Only one topic was retracted, which was Topic 4: "What commonality exists among the models of movement control embodies existing system?" The group extracted this topic because the participants felt more suited for discussing characteristics of a movement control system, not system to system commonality. The group also felt commonality issues were more appropriate for the participants within Group 2.

A.1.1.4. Add pertinent new topics

There were two new topics added to the list:

1. "Balancing Requirements versus Capabilities"

2. "How do the various movement control (sub)systems to be fielded (AFATDS, MCS, DAMMS-R) fit within the levels of command in a theater of operations?"

Balancing requirements with capabilities means that within any given theater of operation, there are a limited number of transportation capabilities available for moving supplies and personal within that theater. More often than not, move requirements exceed the capability of the transportation assets. The focus of this topic will be whether this problem is within the scope of the movement control domain. If so, what are the issues surrounding a solution to this problem?

How do the various movement control (sub)systems fit within the levels of command in a given theater of operation? This new topic is concerned with which command structures (Theater, Corp, Division, etc.) are best suited for a particular software system and what type of interaction would be needed in order to provide a consistent picture of the transportation system.

Per collaboration with the other working group, the feature 'In-transit Visibility' was suggested as a topic for discussion within this working group.

A.1.1.5. Prioritize topics

The prioritizing process consisted of weighting the importance of each of the topics and listing them according to their importance. The purpose for this was to ensure that the most important issues were addressed in lieu of the workshop timing constraints.

The group felt that the order prescribed by the SEI was appropriate and the new topics were added accordingly. Listed below are the resulting six discussion topics to be addressed in Session 2.

1. What is the scope of movement control and where does each developer fit?

   • Establishing Main Supply Routes

   • Position determination

   • Loading of vehicles

   • Balancing Requirements versus Capabilities

   • In-Transit Visibility

2. What aspects of the movement planning cycle should the software support?

3. What is the time frame for performing movement planning?

4. What effects would the Air Land Operation have on movement control?

5. What other related work, e.g., electronic maps, is relevant to the domain?

6. How do the various movement control (sub)systems fit within the various levels of command?

A.2. Working Group 1, Session 2 (7/10/91, 8:30a.m.–3:30p.m.)

A.2.1. Scope of movement control

A.2.1.1. Establishing Main Supply Routes

This was determined to be an important part of movement control as viewed at the theater and corps level. MSRs are determined using each mode of transportation, based upon supply requirements obtained from requirements schematics, and the transportation capabilities obtained from mode schematics. A movement program is compiled listing all of the planned movements needed prior to the start of, and during, the operation. From the movement program, movement control software will generate main supply routes (Chapter 6 of [FM 55-15] describes this process in some detail).

A.2.1.2. Position determination

There were two points of view for this topic:

1. According to Major Garhart, tactical units are given a general position (oval) by their commander. Within this general area, the tactical units are given the authority to position their assets. Exact position determination within this general area would be based on elevation, slopes, and other terrain characteristics. It was determined that the selection of these general areas

(ovals) is outside the scope of movement control. This was the responsibility of task force commanders and their superiors. But support of selection of exact positions within this oval would be a useful characteristic of movement control software.

2. From the logistician's point of view, Captain Boyle indicated that position determination or site selection was an important aspect of movement control. Site selection is the determination of logistics supply points within a given theater. The factors involved with the selection of these sites are: location of units receiving the supplies, location of the supplies, terrain characteristics, and availability of a transportation infrastructures.

After subsequent discussions it was determined that these were in fact similar processes, governed by a different set of rules, and that this was an important characteristic of movement control.

A.2.1.3.   Loading of vehicles

Loading of vehicles has been automated only in a few specific instances; in particular, the Air Force has implemented a load planning system for its airlift operations for Army and Marine units. ALPS (Air Load Planning System) and CALMMS (Common Air Load Movement Management System) systems require large amounts of information about the size and weight of equipment. Such a system is essential in the proper planning and execution of airlift movements given the relatively high cost of aircraft usage.

Load planning systems for surface cargo are being proposed but may not be widely used for various reasons:

- For unit movements, the unit's transportation officer/NCO has a predetermined load plan for each vehicle in a convoy. The equipment being moved is almost a constant.

- For logistical movements, the amount and types of cargo to be moved and the destinations are so varied that load planning is a complex problem.

Currently under consideration is the institutionalization of standardized shipping containers. This would simplify the problem and make a software solution more viable.

The group agreed that load planning software lies within the scope of movement control. But when considering the effort involved with developing such a feature, load planning software was not considered to be a critical characteristic and would probably be an optional feature.

A.2.1.4.   Balancing Requirements vs.Capabilities

Based on preliminary evaluation of the transportation system used in Desert Shield/Storm, balancing requirements with capabilities was not done effectively during this campaign. One factor that contributed to this was allotting units transportation assets that were not fully utilized much of the time. To gain perspective, a typical scenario might be that Battalion A has a requirement to move men/material and Battalion B has the transportation capabilities necessary to accomplish this task, but is reluctant to release these assets for fear of losing those assets entirely.

A proposed solution is to develop a centralized transportation broker, who would distribute these capabilities more effectively. The development of movement control software which would support this brokerage process would definitely be a high-priority consideration for movement control software.

One of the primary requirements that would be generated as a result of this feature would be *in-transit visibility*, which leads to the next discussion topic.

A.2.1.5.   In-transit Visibility

The idea of centralizing the control of transportation assets brings one to the natural conclusion that in order to accomplish this task, a complete accounting of all the critical transportation assets must be provided. This is one aspect of in-transit visibility.

Another aspect is keeping track of where the cargo and personal are located within the transportation system. Major Garhart mentioned that as units are being deployed, they are typically separated into groups. One group might be responsible for preparing equipment for transport, another might be responsible for delivering that equipment, and yet another might proceed directly to the tactical assembly area. A critical piece of information for the commanders is where those units are and when they will be reassembled.

This is another important feature for movement control software.

A.2.2. Aspects of the planning cycle needing software support

The attendees concluded that the three aspects described above are useful features of a robust movement control system. Simulation capabilities would be particularly useful in course of action planning and analysis. What-if analysis is useful in performing the initial estimate necessary to ensure the gross feasibility of a planned concept of operations. Operations planning results in the detailed movement program, and the ability to control and schedule movements according to established priorities.

A.2.3. Time frame for movement planning

The time frame for movement at various levels of command is a definite factor in movement control. The time scale increases as the level of command rises due to the size of the units involved, the complexity of interaction with subordinate and lateral units, and the need for increased host nation support and coordination. Theater and corps commands must accommodate a planning cycle that looks ahead weeks in advance in many cases, whereas the brigade and battalion commander can measure their planning time frame in terms of hours.

A.2.4. Effects of AirLand Operations on movement control

The new AirLand Operations doctrine could have an impact on the way movement control is accomplished. The current doctrine assumes a linear battlefield with fairly fixed regions of control for each command echelon. The new doctrine allows for a more fluid battlefield. This will change standard operating procedures. The corp will exercise more direct control over forces.

The primary effects on a movement control system will be in the areas of deconfliction and defense-on-move options. Since the corp will exercise more control over a larger geographic region and more transportation assets, the amount of information that will have to be disseminated at any given time will increase. Deconfliction algorithms targeted for corp will have to be more robust. At the battalion level, movement control agents will be operating in less secure environments near combat operations and they will be more concerned in protecting themselves in the event of an unexpected enemy attack.

A.2.5. Other related work relevant to the domain

David Horner presented the Waterways Experiment Station's (WES) work on TerraCAMMS (Terrain and Condensed Army Mobility Model System). According to Mr. Horner, Terra-CAMMS is much more than just an electronic map. The 'Terra' portion of the system provides a graphical display of Terrain characteristics while the CAMMS portion of the system provides Tactical Decision Aids (TDA) to the user of the system. Some of the TDAs are:

- Mobility information, how certain vehicles interact with certain types of terrain characteristics.

- Route Classification information, such as bridge classification, road width, and height restrictions.

- Line of site information, at certain elevations one can determine radar signal ranges.

The system was designed in order to easily provide interfaces to procedures and functions within TerraCAMMS for specific user application.

One concern that several participants had coming into this workshop was what type of standardized mapping capability would be selected for the ATTCS systems. Mr. Horner mentioned that the personnel at the WES met with General Harmon, Program Executive Officer-Command and Control Systems (PEO-CCS), a week before the Movement Control Workshop. General Harmon stated in that meeting that TerraCAMMS would be the Geographical Information System (GIS) for the ATCCS systems.

From preliminary discussions with WES, the TerraCAMMS possibly contains many of the lower level features required for a movement control system.

Just a note to illuminate any confusion. ALBE-GIS (Air Land Battle Environment - Graphical Information System) and TerraCAMMS are different names for the same system.

A.2.6. Movement control's fit within levels of command

Within a theater, AFATDS and other systems for various BFAs coordinate movement for their units for internal needs but all tactical movements are also coordinated with MCS at the brigade level and below. This is because MCS is the system that the tactical commander and his immediate staff have access to, and he is the final authority on all movement within his area of operations. At higher levels of command, the Division, Corps, and Theater/Joint commands

also have specific movement control organizations that schedule operational movements and coordinate the use of controlled routes within their zones through the use of the DAMMS-R software.

A.2.7. Pertinent discussions outside of given scope

The *kind* of movement (unit or logistical) was determined to be a modifying feature rather than an operational feature and hence was moved to the appropriate diagram.

Several changes were made to the *types* of movement feature, particularly under the *tactical* (*maneuver*) sub-feature.

A point was raised that most of the sub-features listed under Planning were applicable on a smaller scale during execution of movement control. The Operational Features diagram will be modified to reflect a 'copy' (not depicted graphically) of the Planning feature/sub-features under Adjust.

Numerous items were renamed to more closely fit the attendees' experiences and knowledge. A modified feature model and the features descriptions are available in Appendix E of this report.

A.3. Working Group 2: Validation and Transition

Working Group 2, Session 1 (7/9/91, 3:30p.m.–5:00p.m.)

A.3.1. Representation

Mr. Cohen inquired as to the range of representations that could be used to represent a development, such as DAMMS-R: Whether several types of tools could provide information to support all the users? The following responses were made to Mr. Cohen's inquiry:

- Mr. Black felt that there are actually too many aspects of a development to look at and that you may need several different representations to understand the domain.

- Mr. Cope, of DAMMS-R, expressed the view that too many representations only confuse the final product. Mr. Valentine said that DAMMMS-R had gone back to the basics of data flow diagrams to represent their convoy planner.

- Mr. Johnson suggested a tool like Teamwork may be used to represent these basic data flow diagrams.

- It was suggested that an object-oriented development may possibly express the information in a common way.

- It was felt, however, that a key question to representing the information was how you would be presenting the product to an agency.

- Mr. Valentine felt that a demonstration of the prototype software would enable the customer to pick and choose what they desire from the system.

A.3.2. Reuse Issues

The representation discussion quickly progressed to a discussion of common versus unique tailoring of software. The questions asked and comments made were:

- How is the software provided and is it reusable? Would this become part of a working, reusable library?

  Mr. Black, Mr. Silva, Mr. Valentine, and Mr. Johnson didn't feel that any of the software would be reusable. They felt that there were too many approaches, clients, and systems to have a realistic reuse library.

- Were software products being written with reuse, libraries, and modularity in mind? Who was going to maintain the libraries?

  Mr. Black felt that changes to user interfaces and databases prohibit reuse and that people were not really learning to write code to be reused. Mr. Johnson stated that his organization encouraged reuse within house. But, Mr. Johnson also cited proprietary rights as a problems with reuse libraries. Mr. Fragale discussed the topics of configuration management and the awareness of the reusable modules. Mr. Fragale also suggested that the Army may have a centralized database in the future; however, Mr. Silva did not feel that the database would be visible to all the possible users.

A.3.3. Topics for Session 2

The working group decided to discuss their representation and reuse issues using the following topics as an outline:

1. Who are movement control users?

    - ATCCS (AFATDS, CSSCS, MCS)

    - CASCOM (DAMMS-R)

    - ACCIS

    - Others

2. What are their needs?

    - Movement capabilities

    - Logistics capabilities

    - Course-of-action planning

    - In-transit visibility

3. How to deliver capabilities - Representations?

    - Abstract models

    - English text

    - Object/package libraries

- Prototypes

- Data dictionary (element definitions, standard abbreviations and terminology, and entity relationship information)

- Control/data flow

4. How to get from Abstract Representation to Production System?

- Refining prototype through customization

- Use of model as basis of development

- Building from package or object libraries

- Marketing stand-alone system

5. What are barriers to common solutions?

- Standard languages

- Reusable software (rewrite interface, rewrite application)

- GFE and proprietary core

- Common versus unique tailoring

A.4. Working Group 2, Session 2 (7/10/91, 8:30a.m.–3:30p.m.)

A.4.1. Catalog of Systems and Features

The second meeting of the working group began with Mr. Valentine providing an in-depth description of the convoy planner and highway regulation functions of the DAMMS-R project. This included the procedures for planning and requesting a move; the responsible groups within the theater, corps, and divisions; the concept of road networks; and the act of deconfliction.

Mr. Valentine, Mr. Silva, and Mr. Black attempted to identify the similarities and differences between the movement concepts of the DAMMS-R, CSSCS, and AFATDS systems. For example, DAMMS-R is concerned with a road network that is defined in the Traffic Circulation Plan (TCP) and the controlled Main Supply Routes (MSR) of the Highway Regulation Plan (HRP), whereas the AFATDS system is only concerned with tactical routes for unit movement. The DAMMS-R system will perform deconfliction by identifying a conflict and attempting to resolve it, the AFATDS system will only detect a conflict, and the CSSCS system will only establish a set of priorities if a conflict exists. Table 1 lists the similarities and differences of the highway regulation and convoy planning functions of DAMMS-R, AFATDS, and CSSCS as well as those for the systems developed by the Carnegie Group (CGI) and Martin Marietta (SAFORS).

Mr. Valentine and Mr. Silva agreed that the contents of convoys will eventually need to be supplied to both DAMMS-R and AFATDS. CSSCS currently has in-transit visibility on certain control items within supply and transportation units and DAMMS-R uses a container transportation

control number (TCN) to follow a container, but there is nothing in place to follow the contents of the container.

A.4.2. Transition

The final discussion for the working group dealt with getting a model/prototype to production system. The key point is the ability to communicate the information that must be exchanged between developers and users. Mr. Silva felt that the information should be provided to the staff planners and concept planners rather than the users. Mr. Johnson felt that the ability to demonstrate various levels of functionality in prototype form is a very important part of product introduction. In addition, he felt that the ability to estimate where the product will be, at a given time, in reference to the willingness of an end users acceptance to the product, is very important. The group felt that it is impossible to predict the end users openness to a product or prototype. Mr. Johnson felt that in the early stages of the product, developers should limit the number of diverse inputs to avoid ballooning of the requirements.

System Users

System Users	DAMMS-R	AFATDS	CGI	CSSCS	SAFORS
Road Network & Status	TCP	Tactical	TCP	MSR	Tactical
Required Receipt & Approval	✓	Manual	Implicit in Plan	Coordinate via Cmd & DAMMS-R	✓
Deconfliction	✓	Detection	Implicit in Plan	Coordinate via Cmd & DAMMS-R	✓
Monitoring	✓	✓	--	✓	✓
Convoy Planning					
Convoy Building	✓	Partial	✓	--	Partial
Routing	✓	✓	✓	--	Partial
Schedule	✓	✓	✓	--	Partial
Request	✓	✓	Implicit	--	Partial

Table 1 Common System Features

A.4.3. Summary

The group developed a high-level catalog of common features (Table 1), that also showed key differences among the related systems. The group also defined key areas where joint efforts can lead to common solutions. These efforts apply to software to support movement control as well as other Army systems The areas needing common solutions include:

- Graphic Information Systems and a common binding for movement related applications.

- Army organization representation.

- User interface standards.

- Vehicle classification and characteristics.

- Standard terminology.

The group also determined several steps necessary to assure smooth transition from abstraction to production:

- A clear statement of requirements for a system. Commonality and reusability are not a substitute for formal agreement between developer and customer.

- Feeding back results to identify gaps in the abstract model.

- Using new solicitations as a basis for improving the model and assuring its applicability in an evolving domain.

- Knowing the infrastructure of customer organizations.

- Attending briefings, seminars, etc., to assure knowledge of marketplace.

- Developing the ability to pull new technology into the development organization and push new ideas into the community.

Appendix B.   Transportation School Training

Abstract: The information contained in this section is a summary of a two-week block of instruction entitled "Transportation in a Theater of Operations." The course is geared for the armies Captains and Majors who will assume the responsibility of transportation-related issues during peacetime and in war.

B.1.   Movement Management Organizations

B.1.1. Definitions

- **Transportation Management.** The performance of command and/or staff functions related to planning, coordination, evaluation, and analysis of all aspects of water, rail, highway, and air transportation systems; development of transportation policies and doctrine; assessment of capabilities in terms of current and projected transportation requirements; allocation and monitoring the use of transportation resources in accordance with established priorities; and preparation of contingency transportation plans.(AR 310-25)

- **Traffic Management**. The direction, control, and supervision of all functions incident to the procurement and use of freight and passenger transportation services.

- **Movement Control.** The planning, routing, scheduling, control, and in-transit visibility of personnel, units equipment, and supplies moving over lines of communication in accordance with the directives of command planning. It is a continuum involving the synchronization and integration of movement information and programs spanning the strategic, operational, and tactical levels of war. Movement control is guided by a system of balancing requirements against capabilities and allocating resources based on the combat commanders priorities.

- **Movement Requirement**. The request to transport personnel or material that has been approved by the appropriate commander.

- **Movement Capability**. The sum total of the capabilities of the shipping and receiving agencies and the transport services.

- **Movement Program**. A command directive prepared by the transportation movements elements and issued in the names of the commander.

- **Throughput Distribution**. The shipment of supplies from point of origin as far forward into the combat zone as possible, bypassing intermediate supply activities.

B.1.2. Principles

The four principles of movement control operations are:

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1. **Control of Movements will be Centralized at the Highest Level**. Exercised by the commander charged with supplying logistical support and who is in a position to see the complete transportation system.

2. **Fluid and Flexible.** The transportation system will adapt to continuously changing demands.

3. **Maximum use of Carrying Capacity.** Transportation cannot be stored, full utilization of transportation assets.

4. **Movements will be Regulated**. A movement will *not* be initiated if it is known that any part of the transportation net cannot support the move. Movements will be regulated according to there priorities.

B.1.3. Theater Organization

Communication Zone	Corps	Division	
TA DCSLOG	AC of S TRANS	DTO	FEBA
TAMCA — TRANSCOM	MCC — TRANS Big	MCO — TMT Co	

Strategic		Operational		Tactical
←				→

Levels of War
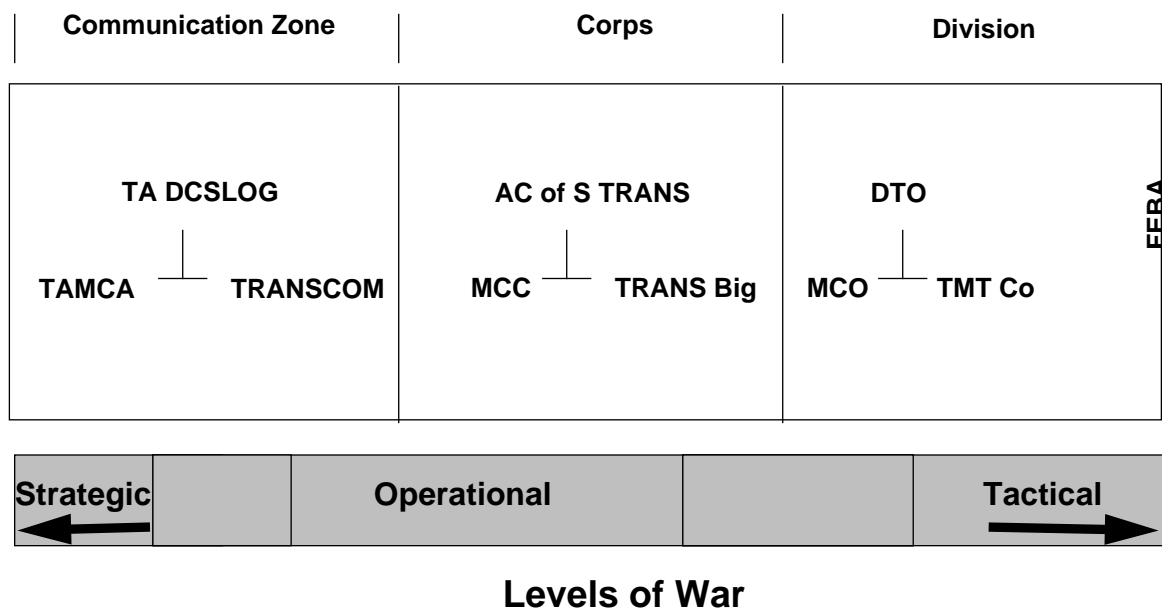
Figure B-1 Generic Theater Organization

1. Communication Zone

   • Supervisors: Theater Army Deputy Chief of Staff Logistics (TA DCSLOG).

   • Coordinators/Controllers: Theater Army Movement Control Agency (TAMCA).

   • Mode Operators: Transportation Command (TRANSCOM).

2. Corps

   • Supervisors: Assistant Chief of Staff Transportation (AC of S Trans).

- Coordinators/Controllers: Movement Control Center (MCC).

- Mode Operators: Transportation Brigade (Trans Bde).

3. Division

- Supervisors: Division Transportation Officer (DTO).

- Coordinators/Controllers: Movement Control Office (MCO).

- Mode Operators: Transportation Motor Transport Company (TMT Co).

B.1.4. Movement Control Teams

These organizations are designed to help accomplish transportation management and transportation control. There five types of Movement Control Teams: Regional, Air Terminal, Highway, Highway Traffic Point Team, and Branch. The TAMCA and MCC provide command and control over the MCTs. The teams are organized with special types of transportation skills and placed at locations where these skills can be fully utilized.

B.2. Host Nation Support

The provision of support (Manpower, Equipment, and Facilities) by a host nation (Korea, UK, Germany, etc.) mainly in the administrative and logistics areas of operations.

B.2.1. Types

- Government Agency

- Host Nation Civilians

- U.S. Contractors and Third Nation

- Host Nation Military Units

- Host Nation Facilities

- Supplies and Equipment

B.2.2. Standardization Agreements (STANAG)

The Standardization agreement is an agreement among several or all of the NATO member nations to adopt like or similar operational, logistical, and administrative procedures. The main advantage of standardization is that the system and documentation requirements in use today would also be good in time of war. The most important transportation standard agreements are listed below.

1. STANAG 2155.

- Road movement and credit

- Mode: Road

2. STANAG 2156.

   • Surface transport request and resupply to surface transport request

   • Mode: Road/Rail/Sea

B.2.3. Summary

At the beginning of Desert Shield the allied forces estimated that the amount of Host Nation Support to be provided by the Saudi government would be on the order of 25%. Prior to Desert Storm the actual figure of Host Nation Support provided by the Saudi's was 75%. With the purposed cutbacks to the military spending in the years to come, the U.S. military will rely heavily on Host Nation Support to provide transportation assets.

B.3. Transportation Intelligence

B.3.1. Definitions

   • **Intelligence**. The product resulting from the collection, processing, integration, analysis, evaluation, and interpretation of available information that concerns one or more aspects of foreign nations or areas of operations that are immediately or potentially significant to military planning and operations.

   • **Technical Intelligence**. Intelligence concerning foreign technological developments and operational capabilities of foreign material that have or may have practical applications for military requirements. It is the end product resulting from the processing and collation of technical information.

   • **Transportation Intelligence**. A facet of technical intelligence, it is the product resulting from the collection, evaluation, interpretation, analysis, and integration of all available information about the air, land, and water transportation systems of foreign areas of operation that are of immediate or potential military significance. This intelligence includes data on the characteristics, condition, development, organization, material operation, maintenance, and construction of transportation system facilities.

B.3.2. Doctrine

   • FM 55-1: Transportation Services in a Theater of Operations.

   • FM 34-1: Intelligence and Electronics warfare operations.

   • FM 34-3: Intelligence Analysis.

   • FM 34-54: Battlefield Technical Intelligence.

B.3.3. Objectives of Transportation Intelligence

   • Determine foreign transportation capabilities and limitations.

   • Provide information from which military countermeasures are developed.

- Permit use of foreign transportation equipment and facilities by U.S. forces.

- Exploit new transportation development for Military needs.

- Provide input on a continuous basis to the overall national integrated technical and scientific intelligence program in consonance with theater policy.

- Provide tactical, operational, and strategic studies on characteristics, capabilities, and limitations of foreign transportation equipment, facilities, and installations.

- Transportation intelligence is always essential to successful military operations. Now, with the development of highly complex weapons systems and the necessity of rapidly deploying our troops to remote areas and then keeping them supplied, technical intelligence has assumed a more critical role in military planning.

B.4. Movement Plans, Programs, and Procedures

B.4.1. Definitions

- **Operational Plan**. A plan for a single or series of operations to be carried out simultaneously or in succession. It is usually based upon stated assumptions and is the form of directive employed by higher authority to permit subordinate commanders to prepare supporting plans and orders.

- **Movement Plan**. A command directive that the TAMCA plans and the division prepares with input from all movement control levels. The plan allots available transportation to support requirements based on tactical priorities that the operational commander sets the supply and movement priorities for unit commanders. The plan provides transportation priorities to resolve competition, traffic, and mode management decisions so that available transportation assets are best used and comply with any Host Nation-imposed restrictions.

- **Movement Program**. An authorized movement program.

B.4.2. Movement Procedures

The seven step procedure for movement planning is:

1. Develop a distribution pattern

2. Determine what must be moved.

3. Determine what transportation resources are available.

4. Balance requirements against the capabilities.

5. Determine shortfalls, critical points, and recommended priorities.

6. Coordinate the plan.

7. Prepare, publish, and distribute the movement program.

B.5. Transportation Movement Release

B.5.1. Force Activity Designator (FAD)

The Force Activity Designator is used for logistics supplies before that are in-transit. It is used to specify a relative priority of one logistic item to another. They are used to map logistics priorities to transportation priorities.

B.5.2. Transportation Priorities

Transportation priorities are use to specify the relative degrees of transportation urgencies from one transported item to another. There are five levels of transportation priorities: TP1, TP2, TP3, 999, and ALOC.

1. **TP1**. If the request for transportation with designation of TP1 is made before 9:00 a.m., the total transit time will be 6 days, otherwise the total transit time is 7 days.

2. **TP2**. If the request for transportation with designation of TP2 is made before 9:00 a.m., the total transit time will be 7 days, otherwise the total transit time is 8 days.

3. **TP3**. The total transit time for a TP3 will be a minimum of 11 days.

4. **999**. The item will be delivered within 24 hours.

5. **ALOC (Air Line of Communication)**. The item will be delivered within 24 hours.

B.5.3. Transportation Movement Release Code (TMR)

The TMR is a unique alpha numeric code that specifies a specific cargo movement or represents usage of a transportation asset directed through movement control channels. Standard TRMs (STRMs) also exist, which are TRM codes that are assigned to recurring moves (i.e., movements of the same supplies to the same locations on a routine basis).

B.5.4. Conclusion

TMRs are a means of tracking transportation assets within a theater of operations. Contained in these TMR's are TPs which provide a means of specifying degrees of urgency. The Transportation Priorities are also used as one of the criteria for selecting a mode of transportation.

B.6. Utilization of Highway Networks

B.6.1. Definitions

- **Highway Traffic Regulations**. The coordination and the actual use of the road network by vehicles, personnel, and animals needed to meet military requirements. It consists of planning, routing, scheduling, and diverting movements on the available road networks in accordance with priorities.

- **Traffic Control**. Includes enforcing traffic laws and regulations, investigating traffic accidents, and directing traffic. It is a function of the Military Police.

- **Highway Regulation Plan**. A staff plan which combines pertinent information from standard operating procedures, directives, regulations, traffic circulation overlays, and staff estimates of the capabilities of the existing road network to handle the traffic that must go over it.

- **Critical Point**. A roadway structure or feature which limits road width, overhead clearance, or vehicle load class as well as any feature which interferes with the meeting or crossing of two or more streams of traffic.

B.6.2. Highway Traffic Division

The Highway Traffics division is a located with the MCA and MCC. It provides Liaison Support to personnel, intelligence, tactics, logistics, and military planning.

- **Functions/Operations**. Provide efficient highway regulation.

  - Planning

  - Routing

  - Scheduling

  - Directing

- **Responsibilities**.

  - Maintenance of a situation map.

  - Adherence to established priorities.

  - Receipt of all requests for highway routing.

  - Issuance of Schedules, Road Movement Tables, Movement Credits, and Traffic Circulation Maps.

  - Coordinate with other Highway Traffic Divisions.

  - Coordination with engineer construction activities.

- Road Maximization Techniques.

  - Balance: Matching vehicle characteristics with those of the roads.

  - Separation: Non-conflicting routes to concurrent movements.

  - Distribution: Spreading traffic over many routes.

B.6.3. Highway Route Classification

The classification of a route takes five parameters into consideration: width, type, class, clearance, and obstructions. More details are provided in [FM 5-36].

1. **Width**. The width of the minimum traveled way along the route.

2. **Type**. There are three alphabetic codes used to designate a route type:

    a. Type 'X' is an all-weather route. This is a route that with reasonable maintenance is passable thought the year to maximum capacity traffic.

    b. Type 'Y' is a limited all-weather route. This is any route that with reasonable maintenance can be kept open in all weather, but is sometimes open to less than maximum capacity traffic.

    c. Type 'Z' is a fair weather route. This is any route that quickly becomes impassable in adverse weather and cannot be kept open by maintenance, short of major construction.

3. **Class**. The military load classification. This is usually a bridge classification, but it could also be a culvert or a weak part of the road surface, such as an embankment.

4. **Clearance**. This indicates the minimum overhead clearance for a particular route. If there is an unlimited overhead clearance, '00' is used.

5. **Obstructions**. Route obstructions are factors which restrict the type, amount, or speed of traffic flow. There are two special types of obstructions which carry their own special character code: Snow Blockage (T) and Flooding (W).

B.6.4. Route Classification Formulas

Route classifications are usually specified with Route Classification Formulas. A typical formula might look like 7.0m/X/50/9.2m/T. This would indicate the route has a minimum width of 7 meters, an all-weather route, a military load classification of 50, an overhead clearance of 9.2 meters, and there is snow blockage somewhere along the route.

B.7.   Modes of Transportation

B.7.1. Types
- Animals
- Road
- Water
- Rail
- Aircraft Fixed Wing
- Aircraft Rotary Wing

B.7.2. Governing Factors
- Transportation Priority (TP)
- Required Delivery Date (RDD)

- Weight and size

- Nature of material

- Cost of transportation

- Distance to be shipped

- Modes of transportation available

B.7.3. Mode Selection Criteria

- **Priority Requirements**. The theater commander determines priorities.

- **Security Requirements**. These include Nuclear, Biological, and Chemical (NBC) considerations, and the security classification of the cargo or movement.

- **Political Requirements.** The types of cargo and anti-U.S. Sentiment.

- **Guidelines**.

  - Allocating capability for the largest shipments the longest distance.

  - Use the full capacity of each mode in relative economy.

B.7.4. Vehicle Classification

Vehicle classification takes the following factors into account: weight/load classification of the vehicle, its height, and its width. This information can be found in [FM 5-36] and [FM 55-15]. Special consideration needs to be exercised when towing vehicles or when loading equipment on top of vehicles.

B.7.5. Convoy Management

B.7.5.1. Definitions

- **Convoy**. Six or more vehicles moving together over the same march route, or ten or more in one hour.

- **March Column**. All vehicles in a convoy.

- **Serial**. A group of vehicles within a march column.

- **March Unit**. A group of vehicles within a serial.

- **Functional Elements**. The Head, Main Body, and Trail are functional elements within a group of vehicles.

- **Road Distance**. Distance from point to point usually expressed in miles or kilometers.

- **Time Distance**. Time required to move from one point to another point at a given rate of speed.

- **Lead**. Linear spacing between heads of elements in a column/serial.

- **Time Lead**. Time measured between the head of one element or vehicle and the head of the next as they pass a given point.

- **Gap**. Space between the rear of one element to the front of the following element.

- **Time Gap**. The time measure between the rear of one element and the front of the next as they move past a given point.

- **Length**. Length of roadway occupied from front to rear

- **Time Length, Pass Time, or Time Space**. The time of a column or element to pass a certain point.

- **Road Clearance Distance**. Total distance that the head of the convoy must travel for the entire column to clear a section of road.

- **Road Clearance Time**. Total time a column or element requires to travel over and clear a section of road.

- **Road Space**. Total length of roadway occupied by a column or element and any space added to the length that may be required for safety or to maintain flexibility.

B.7.5.2. Road Movement Graphs
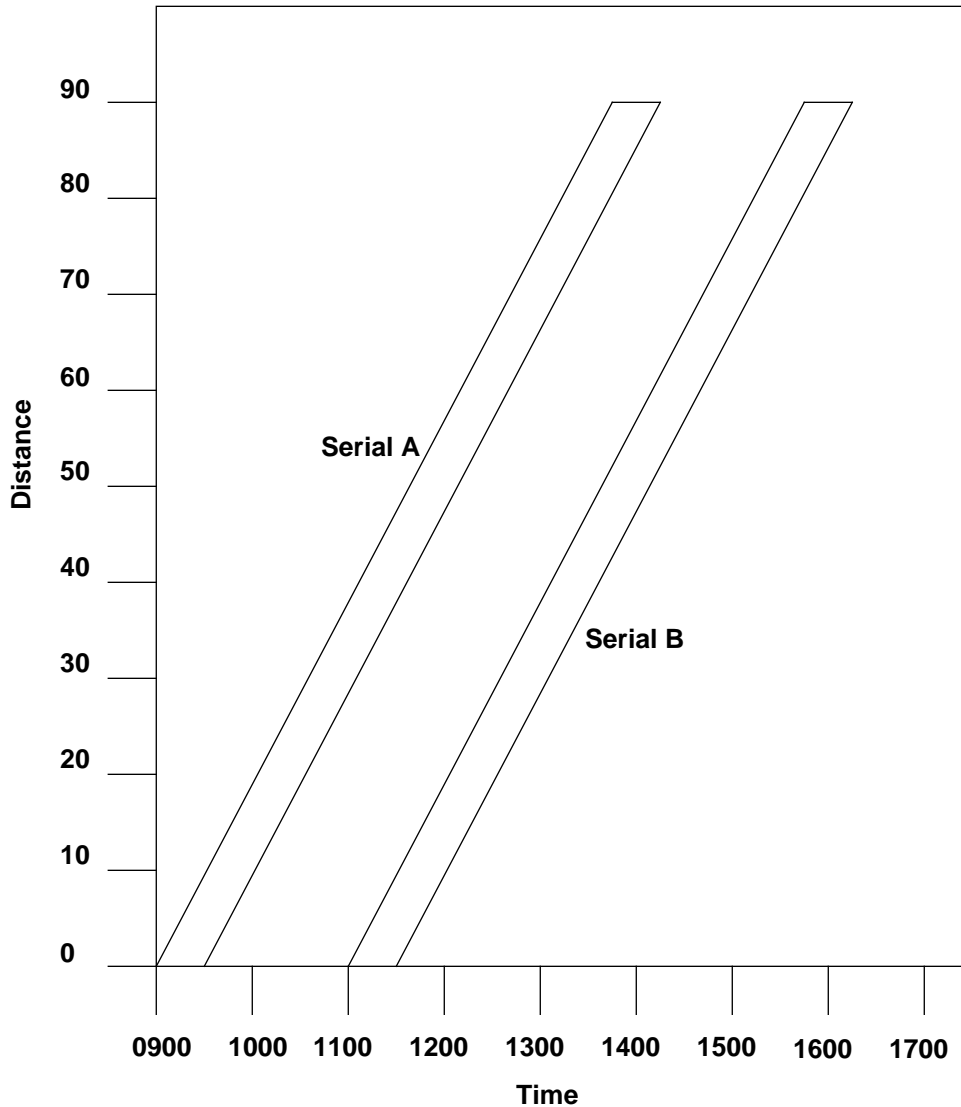
Figure B-2 Road Movement Graph

B.7.5.3. Convoy Organization

Guidelines for vehicle densities within a march unit and the gap distances between march units and serials can be found in [FM 101-5]. Guidelines for convoy speeds over different road classification formulas can also be found in [FM 101-5].

Appendix C.   Using Info Mode in GNU Emacs

C.1.   Formatting a File for Use in Info Mode

All information in an Info file (see [STALL87] for complete information on GNU Emacs) is stored in one of more logical *nodes*. The start of a node is delineated in a file by placing two special characters in succession on an otherwise empty text line. These two characters are unprintable, but they are seen on a screen display as `^_^L` where the `^` stands for use of the 'Control' key. The next important piece of information is the node name. It is delineated by the use of the text symbol `Node:` at the start of a line with a space and then a identifying name that must be **unique** from all other identifying names in the file. Multiple word identifiers, i.e., spaces, are allowed. Other fields that can occur on this line are `Next:` , `Up:` , and `Previous:` . `Next` and `Previous` names refer to sibling nodes at the same conceptual level in a hierarchical structure and `Up` refers to the parent of a node. The top node in the hierarchy is `Top`.

Children of a node are usually created using the *Menu* capability. A menu is created by first signifying the start of a menu. This is done by creating a line with the text `* Menu:` on it. Menu items are designated by separate lines using the form `*<Name>:` where `<Name>` is an identifying name as discussed. The menu list is ended whenever a text line is seen that does not begin in the menu item format. A brief description of the menu item can be entered on the line starting one space after the colon.

The third way to create a reference from one node to another is using the *Note* capability. This capability is used to create the non-hierarchical links between nodes in an Info file. For example, it is used in the domain information files to allow the user to quickly access the definition of a term when it is used in the explanation of a feature or an entity. A note reference can be created anywhere in a textual line (that does not interfere with another Info marker) using the form `*note <Name>::`. Figure C-1 shows a sample node, which contains an example of each of the important usages described above formatted in the basic style used in our domain Info file for movement control.

The last step to perform whenever an Info file is created or modified is to invoke a special operation within Emacs to create a tag table for the nodes in the file. The tag table is a list of internal pointers that Emacs can use to quickly locate nodes within the files. The operation is invoked by typing `<Meta>X Info-tagify`[1]. This operation should be invoked at the end of any editing session when changes have been made because the Info-tagify operation uses the position of the node within as its index and the position of nodes changes as text is entered or deleted.

[1.] <Meta.> refers to the use of the Meta key, which is different depending upon the keyboard in use. The GNU Emacs manual discusses the binding of logical and physical keyboard keys in detail.

```
^_^L
Node: A Node,Next: Node-3, Up: Parent Name, Prev: Node-1

Some text(optional) about the node as desired.

* Menu: One line describing the overall choices.

* Child A:
* Child B:
* Child C: a description of this menu choice is OK here.

See *note Other Node:: for further related information.
```

Figure C-1 File Format for GNU Emacs Info

C.2. Invoking Emacs and Navigating in Info Mode

To use an Info mode file within Emacs, it must be informed where your Info files reside (the default location is where the Emacs Help Info files reside). To do this, a special function to locate and load your Info **dir** file should be incorporated into a **.emacs** file in your home directory. The **.emacs** file is read when Emacs is invoked and serves to initialize your editing session. The **dir** file is a special top-level Info file into which the names for a set of Info files are entered. Thus, a common location can be maintained for accessing information on all domains. Figure C-2 depicts the information to be incorporated into the **.emacs** file.

The domain Info file can be invoked directly by typing `emacs -e da-browser` at the UNIX shell level. The -e option executes the named function at start-up, which puts the user directly into the Info mode under Emacs and reads in the **dir** file to begin the browsing session.

```
;;; Define an alternate Info browser for DA information
(defun da-browser ()
 "Browse through the available information about a domain."
  (set-variable 'Info-directory "<Info directory path>")
  (find-file "<Info directory path>/dir")
  (delete-other-windows)
  (load "info")
  (Info-mode)

;;; Invoke the proper major mode for the Info browser.
(setq auto-mode-alist'(("\\.inf$" . info-mode)))
```

Figure C-2 The "da-browser" Function Text

The commands used to navigate through the Info nodes are listed below. Most are single key entries that execute immediately. Others will require the use of the Return key after entering a name or confirming a selected choice.

Command	Description
n	Go to the Next: node (as seen in the node name line).
p	Go to the Previous: node.
u	Go to the Up: (parent) node.
m	Go to the Menu item pointed to by the current text cursor location. A Return is required to get to this choice.
f	Follow the reference to be named in the bottom command line. The space bar here serves as a name completion mechanism if the first character provide an unambiguous reference to a *note in the current node.
g	Go to the named node to be specified in the bottom command line. The space bar completion will NOT work here.
l	Go to the Last node you were at.
1 up to 5	For any Menu, the first five items can be accessed immediately by typing the appropriate numeric character.
Space bar	Go to the next page of a large Info node.
Delete	Go back to the previous page of a large Info node.
b	Go to the beginning of a node.

Table 2 List of Info Mode Commands

Appendix D.   The Entity-Relationship Model

What the entity-relationship model represents is a set of accepted conventions that most Army movement control system tend to follow—it is not a description of the full functionality of every movement system, which can include ideas not needed in commercial systems supporting movement.

Note: Relationships are represented as links between entity nodes. All names used in the figures to follow are either proper names used in the paragraph identifiers or the Alternate Names which can be found at the end of the entity descriptions, if applicable.

Alternate Name: environment

Figure D-1 Top-Level Entities for Movement Control

D.1.   Orders

Orders are the mechanism by which commanders get their subordinate units to perform functions or achieve objectives.

An order is always addressed to some Unit or Task Force commander. A movement related order usually contains some information about a selected mode of transportation.

Figure D-2 Decomposition of the Orders Entity

See also: *note Units::

      *note Transportation::

Definition: *note order::

D.1.1. Fragmentary Order

A fragmentary order is an abbreviated from of an operation order used to make changes in missions to units and to inform them of changes in the tactical situation. "A fragmentary order (FRAGO) provides pertinent extract from a more detailed order. It ... usually provide timely changes to existing orders. Those elements found in a complete order are omitted when they are not changed..."

Relationships: modifies an Order previously issued

Source: FM 101-5-1 and FM 101-5, p. 7-4

Alternate Name: frag_order

D.1.2. Warning Order

"A warning order gives subordinate units advance notice of a contemplated action or order which is to follow. Its purpose is to help units and their staffs initiate the preparations for execution of a mission by giving them the maximum warning and the essential details of impending operations including planning time available.

The warning order may include:

- Earliest time of move.
- Rendezvous (point) and time for assembly of a group (or task force).
- Regrouping of transport.
- Preliminary moves to assembly area.

The wording must show clearly what the ... recipient ... must act on (immediately) and what is a warning... Every warning order involving movement must state a time before which there is no move. This means a further order must be issued before that time giving actual move timings (a movement order), or extending the time before which there will be no move, or placing the troops at so many hours or minutes to move."

Relationships: is-a Order

Source: FM 101-5, p. 7-4

Alternate Name: warning_order

D.1.3. OPLAN/OPORD

"An operation order (OPORD) gives subordinate commanders the essential information to carry out an operation. When a operation is to be conducted at some future time, the OPORD may be an operation plan (OPLAN), which will be implemented by appropriate instructions..."

The difference between an OPLAN and an OPORD is usually only a matter of how times are used. See Event Times, paragraph D.5.1.1.

Relationships: is-a Order

> has 1 *note Road Movement Annex::

Source: FM 101-5, p. 7-2, G-51

D.1.3.1. Road Movement Annex

A road movement annex is a designated section of an OPORD/OPLAN. It contains the information about the planned movements of units needed to put forces into place at the correct time to accomplish some part of the plan. Pages G-51 and G-52 of FM 101-5 contain a precise outline of the information to be given in the annex for the movements covered by the plan. This outline is identical to that for a road movement order given to a single unit.

Relationships: has N *note Movement Order::

> may contain *note Movement Table::

Source: FM 101-5, p. G-51/52

Alternate Name: rd_mvmt_annex

D.1.4. Movement Order

A movement order is the final step performed by a commander in preparing to have one or more of his subordinate units move from one location to another. It contains all of the information that a unit needs about routes, schedules, support to be provided, etc., for a unit to move without further coordination. A road movement order is a special kind of administrative/logistics order. Its format is identical to that for the *note Road Movement Annex::

Relationships: is-a Order

> contains *note Routes::
>
> > *note Schedules::
>
> may contain *note Movement Table::

See also: *note operation order for road movement::

Source: FM 101-5, p. 7-3, G-19

Alternate Name: mvmt_ord

D.1.4.1. Movement Table

A movement table is an optional appendix to a road movement annex or order. It is a mechanism for displaying the information about one or more road movements in a convenient and

readable form. The chief attribute of a movement table is the layout of the due and clear times for the critical points on the route(s) the unit is using for its move. Related movements are shown on the same table for easy comparison of times so that time constraints are more visible to commanders and logistics personnel. FM 101-5 provides the exact detail of the information to be supplied in a movement table.

Relationships: may be part of *note Movement Order::

*note Road Movement Annex::

Source: FM 101-5, p. G-141/142

Alternate Name: mvmt_table

D.2.   Task Force

A task force is a temporary grouping of units, usually to carry out a specific operation or mission. It has many of the entities and attributes of a unit. However, it has no assets of its own; its assets come from the units that comprise the task force. It also does not have a UIC (see Section D.2.4.3.) due to its temporary nature.

Relationships: has temporary control of N *note Units:

consists of *note Mission::

*note Structure::

*note Status::

Definition: *note Task Force::

Source: FM 101-5-1

Alternate Name: task_force

Figure D-3 Decomposition of the Task Force Entity

D.2.1.   Mission

A mission is the task or objective that a unit is to accomplish. A unit is assigned a generalized mission for which it receives the most appropriate assets and structure for achieving the mis-

sion. During operational planning, the mission is made specific for each instance of a task to be performed or objective to be attained.

A task force is organized with a specific mission already known to the commander formulating the task force. Usually a task force is comprised of many parts of one unit, augmented with other units of various types that have assets that the main unit is lacking.

Definition: see *note mission::

D.2.2. Structure

The structure of a unit designates the allocation of personnel to the various functions within a unit. A unit's overall structure is designated by the appropriate Table of Organization and Equipment for that type of unit in FM 101-10. These tables standardize the structure of the various kinds of combat and support units found in most levels of the Army organizational hierarchy.

Relationships: has 1 *note Commander::

        has N *note Subordinate Units::

Figure D-4 Decomposition of the Structure Entity

D.2.2.1. Headquarters

The location of the personnel assigned to perform the command function of a unit.

D.2.2.1.1. Commander

The chief commissioned officer in charge of a unit, regardless of his rank.

D.2.2.1.2. Staff

The officers designated to assist the commander in the performance of his duties.

Definition: see *note staff::

D.2.2.2. Subordinate Units

The group of units that are subject to the authority or control of an officer.

Alternate Name: subord_units

D.2.3.   Status

The status of a unit involves a description of the state of the personnel, equipment, and supplies that is used to determine the ability of a unit (or task force) to achieve present or future missions. This status information is an important part of the situation reports sent by unit (or task force) commanders to their superiors.

D.2.4.   Units

A unit is an entity that can go into combat or that provides support for combat in some fashion. It exists as a permanent part of the Army command hierarchy.

See also *note Task Force::

Figure D-5 Decomposition of the Unit Entity

D.2.4.1.   Mission

See paragraph D.2.1.

D.2.4.2.   Structure

See paragraph D.2.2.

D.2.4.3. UIC-ent

A six-character alphanumeric code designating a unit that can be allocated to a specific mission.

Alternate Name: uic

D.2.4.4. Status

See paragraph D.2.2.1.1.

D.2.4.5. Assets

Assets are the physical objects that a unit has to work with.

D.2.4.5.1. ASL Assets

These are assets that are consumed or used by the unit's personnel and equipment, which are generally nor reusable after they are used or otherwise disappear.

See also: *note ASL::

Alternate Name: asl_assets

D.2.4.5.1.1. Supplies

Various forms of consumable items form the basis for this abstraction.

The kinds of consumables and their Army designation are listed below.

Ammunition: Class V supplies

Food: Class I supplies

POL: Class III supplies

Relationships: part of *note Support::

D.2.4.5.1.1.1. Ammunition

Ammunition includes bullets, bombs, rockets, grenades, mines, and generally any part of an explosive device listed in the Army Class V Supply group. These parts are generally useless after explosion or detonation occurs. The exceptions are bullet and shell casings.

Source: FM 101-5-1

D.2.4.5.1.1.2. Food

Subsistence items found in the Army Class I Supply group. These include meals ready to eat (MRE), T-rations, and fresh fruits and vegetables.

Source: FM 101-5-1

D.2.4.5.1.1.3. POL

Items found in the Army Class III Supply Group; in particular, the fuels needed to operate the vehicles used to conduct a movement.

Definition: *note POL::

D.2.4.5.1.2.   Usage Rate

This entity is a consumption rate for each of the class of supplies. These rates are used to compute the volume of supples needed to sustain combat so that an adequate supply network can be implemented.

Alternate Name: usage_rate

D.2.4.5.2.   TOE Assets

The TOE assets are those items found within a unit that are not consumed or used by the personnel at a given rate during combat. FM 101-10 lists the class of supply items and the number of people assigned to various functions.

Alternate Name: toe_assets

D.2.4.5.2.1.   Personnel

The body of persons assigned to the unit being moved. The number of persons and the kinds of persons required are given in FM 101-10.

D.2.4.5.2.2.   Equipment

The class of supplies needed by a unit to perform its ongoing mission. These may include Class II (clothes, tools, etc.), Class IV (construction materials), Class VII (weapons), Class VIII (medical materials), and Class IX (repair parts) supplies.

D.2.4.5.2.3.   Vehicles

Vehicles are a part of the Class VII supplies. Depending upon the amount of mobility required by their ongoing mission, a unit may or may not have enough organic vehicles to move itself.

Important attributes of vehicles needed for convoy planning are seen in Figure D-6.

D.2.4.5.3.   Unit Positions

The kinds of positions that are attributes of a unit are listed below.

Current: the present location of a unit.

Planned: one or more future locations/zones.

Alternate Name: unit_positions

D.2.4.5.3.1.   Current

The exact (as precise as possible) location of a unit at last report.

D.2.4.5.3.2. Planned

A set of locations determined by the unit commander or his superior for use in implementing the later stages of a plan. Each position in the set may have a time associated with it for ensuring proper movement coordination.

Figure D-6 Decomposition of the Vehicle Entity

Figure D-7 Decomposition of the Transportation Entity

D.3. Transportation

This entity is a collection of information about how a unit is to conduct its move. The breakdown of transportation information is listed below.

Support: what outside help is needed.

Method: medium of transport to be used.

Coordinating Instructions: information other combat units may need.

Order of March: how to organize the unit(s) for movement.

Other important information directly related to transportation/movement of a unit is given in the description of the *note Routes:: and *note Schedules:: entities.

Alternate Name: trans

D.3.1. Support

The kinds of outside assistance that a unit may need to accomplish a move. Support can include services, supplies, and assets from other units. The units that provide this assistance are combat service support units.

See: *note Services::

*note Supplies::

*note TOE Assets::

D.3.1.1. Services

Services are work performed by personnel not part of the units involved in the move.

D.3.2. Method

Method refers to the medium of transportation used to accomplish a move. The four methods of transportation recognized for Army usage are:

Road: the primary method used in most units in tactical situations.

Water: used mostly for strategic movements, also includes amphibious operations.

Rail: used where available and when time allows for it, economical.

Air: high cost, fast, can support many mission types.

D.3.3. Coordinating Instructions

Information or assistance that other units (not involved in the move directly) need to know to help or not to interfere with the movement.

The kinds of coordinating instructions are listed below.

Security: measures that help to ensure the moving unit's safety.

Control Measures::   measures that minimize interference from other units.

Alternate Name: coord_instr

D.3.3.1.   Security

Security involves taking those measures to ensure the enemy does not hinder the planned movement. Measures that can be taken to provide security during a move include:

Air Support: keeping enemy aircraft away from the route and moving unit.

Defense on Move: how other ground and artillery units protect the movement.

D.3.3.2.   Control Measures

Instructions given to ensure that this movement does not interfere with other operations and vice versa.

Alternate Name: ctrl_meas

D.3.4.   Order Of March

Some details of the important information on how the movement is to be organized and accomplished.

Alternate Name: ord_of_march

D.3.4.1.   Convoy Organization

How the vehicles holding all of the men and equipment to be moved are organized to best accomplish the move under the given circumstances. The organization of a road movement follows a set pattern of generalized vehicle groups.

The information grouped under this entity is listed below.

        Size   whether one or multiple columns are used.

        Density   the spacing between individual vehicles and groups.

        Speed   the rate of travel of the vehicles.

Alternate Name: convoy_org

D.3.4.1.1.   Column

The column consists of all the vehicles involved in a single move over the same route. Large groups of vehicles should be broken into manageable groups where possible, preferably along organizational boundaries. If a column is to be broken into serials, keep a reasonable time gap

---

(15-20 minutes or more) between each serial to allow for other columns to proceed through intersection areas, to allow for halts, etc.

Relationships: has 1 *note Routes::

has 1 *note Schedules::

has N *note Serial::

Source: FM 55-30, FM 55-10

Figure D-8 Decomposition of the Column Entity

D.3.4.1.2.   Serial

A serial consists of elements of a march column moving from one area, over the same route, at the same rate. All of the elements move to the same new area and are grouped under one command.

Relationships: part of *note Column::

has N *note March Unit::

Source: FM 55-30

D.3.4.1.3.   March Unit

A march unit is a small number (usually 7-12) of vehicles that move or halt on command or signal from one commander.

Relationships: part of *note Serial::

has N *note Vehicles::

Definition: See *note march unit::

Alternate Name: march_unit

D.3.4.1.4.   Formation

The formation a column uses is dependent on the time of day during the march and the overall tactical situation. The selection of a formation type affects the gap sizes and speed determinations. The choice of Fixed or Governed column length is also needed.

The three types of column formations are listed below.

Close   High density (40 per KM), low speed (16 KPH)

Open   Medium density (12 per KM), high speed (24 KPH)

Infiltration   Low density (10 or less per hour), variable speed

See feature *note Column Length::

Figure D-9 Decomposition of the Formation Data Entity

D.3.4.1.4.1.   Close

A close formation is used at night, on poorly marked routes, or in congested areas. Its advantages are that full traffic capacity can be used, control is better, and fewer guides, escorts, and route markers are needed. Its disadvantages are that quick dispersion is difficult, the column is easily detected, congestion may occur at the point of arrival, it requires careful scheduling and rigid control to avoid blocking at intersections, and causes driver fatigue.

Source: FM 55-30

D.3.4.1.4.2. Open

An open formation is used during normal daylight conditions. Its advantages are a lesser chance of enemy observation or attack, cargo moves faster, driver fatigue is reduced, fewer accidents occur, and its flexibility. Its disadvantages are that command and control are difficult and proper vehicle spacing is hard to maintain.

Source: FM 55-30

D.3.4.1.4.3. Infiltration

An infiltration formation is used during daylight hours in congested areas or where heavy traffic crosses the intended route. Its advantages are that it provides maximum security and deception, high speeds are possible, other traffic has little effect on individual trucks, and it does not hinder cross traffic. Its disadvantages are that more time is required to complete the move, column control is impossible, drivers can get lost and require specific details, halts are hard to arrange, and orders are not easily changed.

Source: FM 55-30

D.3.4.1.5. Elements

An element is a group of vehicles, each of which performs a particular job within the group. The first three of the element types are part of every column and its internal serials and march units. The last element type is optional.

The four different functional units are listed below.

Head: first vehicle in the order of march.

Main Body: bulk of the vehicles in the column.

Trail: last element where wreckers and other support vehicles are located.

Detached Party: not part of column, guard units.

Source: FM 55-30

D.3.4.1.5.1. Head

The head is the first task vehicle of the column in the order of march. The pace setter rides in this vehicle and sets the pace necessary to meet the schedule. The convoy commander also rides in a vehicle at the head, but he is free to move up and down the column to make adjustments as needed.

Source: FM 55-30

D.3.4.1.5.2. Main Body

The main body of the column follows immediately after the pacesetter. It consists primarily of vehicles carrying troops, equipment, and/or supplies. The main body of a column may be sub-

divided into serial and march units as needed. Each serial or march unit may also be organized into a head, body, and trail. Each head should have its own pacesetter.

Source: FM 55-30

Alternate Name: main_body

D.3.4.1.5.3. Trail

The trail is the last element of a column or lower grouping. Wrecker, maintenance vehicles, and medical support vehicles/teams are located here. The trail element also assists in maintaining march discipline and final clearance at checkpoints.

Source: FM 55-30

D.3.4.1.5.4. Detached Party

Detached parties (advance and follow-up) are not part of the main column. They are detailed to perform special duties such as quartering and reconnaissance. In some tactical situations, advance, flank, or rear guards may be required. Guides, escorts, and patrols may also be needed for heavily traveled routes and at busy intersections.

Source: FM 55-30

Alternate Name: detached_party

D.4. Distribution Plans

See Figure D-10 and the following sections for more information.

Alternate Name: dist_plan

D.4.1. Physical Distribution Network

The Physical Distribution Network (PDN) is the collection of information used to make decisions about movement and supply transportation requirements. It consists of three important kinds of information:

1. The current or potential locations for supplies and transportation support points.
2. The current or planned locations of all combat and support units to be serviced via the network.
3. The links for all modes of transportation connecting points for 1 and 2 above.

Source: FM 55-10

Alternate Name: PDN

Figure D-10 Decomposition of the Distribution Plans Entity

D.4.2. Traffic Circulation Plan

The traffic circulation plan (TCP) is a specific overlay (or addition) to a map for an area of operations. It designates the MSRs and other controlled routes (by classification) for the area, indicates the potential traffic flow on those routes, and indicates where traffic control points are to be expected.

The development of a traffic circulation plan occurs after the Physical Distribution Network (PDN) has been derived by the G3 and G4 planners. The PDN shows all of the transportation flows needed to sustain the supply points designated for the current and planned locations of friendly forces.

After the TCP is completed, the Highway Regulation Plan is formed. It listed the specific classifications for the designated routes on the TCP overlays and other useful information.

Source: FM 101-5 p. G-140, and FM 55-10, Chapter 6

Relationships: refined from *note Physical Distribution Network::

Alternate Name: TCP

D.4.2.1. Routes

A route is a planned path between the designated starting location (or current position) and the desired end location.

Relationships: has 1 *note Control Class:: designation for its usage by vehicles

has 1 *note Schedules:: for a moving unit's column(s) usage

has 1 *note Column::on designated portions of it at any time

has N *note Segments:: roadway between two points of interest

part of a *note Traffic Circulation Plan::

Alternate Name: rt

D.4.2.1.1. Segments

A segment is a significant portion of a route. It is denoted by two points. A segment may be designated for various reasons, such as the path between two important points, dominant feature on or about the roadway involved, etc. Important entities (and relationships) about Segments are listed below.

Checkpoint: a segment has two (the end points) .

Length: a segment has a length (distance in miles or kilometers).

Relationships: part of *note Route::

consists of *note Road Information::

D.4.2.2. Control Class

There are five distinct classifications for routes in an area of operations.

Open: a minimum of control is exercised. No movement credit (such as STANAG 2154) is required. Supervision is normally limited to military police traffic control at critical intersections.

Supervised: requires limited control by the highway traffic headquarters. The military police provide traffic control posts and patrols. Any column of 10 (depending on theater) or more vehicles or any vehicle of large size or weight will require a movement credit. Access to the route may be regulated.

Dispatch: full control is exercised. Priorities are set for use of this type route. A movement credit is required for movement of any vehicle or group of vehicles. Both organizational and area control are required.

Reserve: route set aside for the sole use of a certain unit, specified operation, or type of traffic. If a route is reserved for a certain unit, then the commander decides how much and what kind of control is required.

Prohibited: no traffic is allowed.

Source: FM 55-30, Pages 5-3 and 5-4.

Alternate Name: ctrl_class

D.5. Schedules

A schedule is a set of times, where each time is supposed to indicate the occurrence of something noteworthy (an event). For movement, the key events are the entry and exit of columns into or past critical points.

Relationships:

> has 1 *note Routes:: one Schedule determines the use of one Route
>
> has 1 *note Column:: by one Column during the Schedules time frame
>
> has N *note Events::

D.5.1. Events

An event is a connection between the occurrence of something and the time when it occurs (or should occur).

D.5.1.1. Event Times

An event time is the single moment in measured time, distinct from any other. The important event times for movement are Due times (when the lead vehicle of a column crosses a critical point) and Clear time (when the last vehicle of a column crosses that same critical point).

Figure D-11 Decomposition of the Schedules Entity

How time is expressed is also important. Time can be expressed in two ways. For planning purpose, time is usually measured in *relative* terms, relative to some point in time yet to be

given a specific value. Example are D-Day and H-hour values seen in OPLANs. Times can also be expressed in *absolute* terms where the values is given in clock time form.

Relationships: has 1 *note Checkpoints:: (or Critical Point) associated with it

Alternate Name: event_times

Figure D-12 Decomposition of the Time Entity

D.5.1.2.   Action

A action is something that takes place, a change from a previous condition. The two *types* of action important to movement are Halt (the cessation of movement) or Commence (begin movement).

The *occurence* of an action can be subdivided into two categories, Scheduled (but not yet occurred or past due) and Actual (something occurred, whether Scheduled or not). Any action that occurs not on schedule is a potential for reaction.

D.6.   Intelligence

Intelligence data for movement control covers a broad range of information, is collected from a wide range of sources, and different information is needed at various levels of command in planning movement at the strategic, operational, or tactical level.

See the feature *note Level of Command::

Definition: see *note Intelligence::

Alternate Name: intell

D.6.1.   Technical Intelligence

Technical Intelligence is the raw information about the capabilities of various groups of entities important to military planning. These include data about enemy weapons and vehicles, and an area's capacity to transport various loads and sustain combat. This last category is particularly important to movement planning.

Alternate Name: technical

Figure D-13 Decomposition of the Intelligence Entity

D.6.1.1.   Transportation Intelligence

Transportation intelligence concentrates on information about the capabilities of an area of operations to support movement of friendly forces. This information fall into three major categories: Equipment, Facilities, and Networks. The information about networks is the most crucial to movement control, in particular, the data on roads, their bridges, tunnels, condition, etc.

Alternate Name: transporting

D.6.1.1.1.   Road Information

Data about roads is stored in as much detail as possible, usually at the segment level. There are five pieces of information that are needed to compute the movement capability of a vehicle or group of vehicles.

Load Class: what kind of weight can the road or bridges on it bear.

Minimum Width: how wide can a vehicle be to fit on the roadway or how many lanes are available.

Minimum Height: what is the minimum clearance height of any bridges or tunnels on the roadway.

Weather Restrictions: rated by the letters X, Y, or Z.

> X: road is easily trafficable in all weather conditions .

> Y: road is not good going but usable in inclement weather, lower speeds.

> Z: road becomes impassable in heavy rain and/or snow.

Obstructions: are there any tight radius turns, severe grades, or current existing snow blockage (T) or flooding (W) on the route.

Figure D-14 Decomposition of the Road Information Entity

In addition, there are three additional pieces of information useful in routing and scheduling operations: End Points (described in the Checkpoints paragraph below), Length, and Speed.

Alternate Name: road_info

D.6.1.1.1.1.   Checkpoints

Checkpoints are where turns may need to occur or for other reasons, but they are primarily used to aid in the timing of vehicle passing time so that a schedule can be determined.

Special points that are Checkpoints include:

Start Point   the first checkpoint of a preplanned route.

Release Point   the last checkpoint of a preplanned route.

Critical Point   other specially designated points on a route.

Harbor Area   for halts and other functions.

Refueling Point   for refueling vehicles during an extended movement.

Relationships has 1 *note Location::

　　　　　　has 2 *note Events:: (one Due Time and one Clear Time)

D.6.1.1.1.1.1. Location

A location can be a set of coordinates on a map or an absolute position on the earth using latitude and longitude measurements.

Relationships: part of a *note Check Point::

Figure D-15 Decomposition of the Location Entity

D.6.2.   IPB

Intelligence Preparation of the Battlefield (IPB) is done before battle to assess the operational and tactical situation and to allow the commander to understand the area of operations so that he can most effectively achieve the given mission. Various resulting templates are:

Doctrinal: how enemy will deploy without constraints.

Situation: how enemy will deploy within terrain and weather constraints.

Event: locations where critical events and activities will occur and where critical (high value) targets (HVT) will appear.

Decision Support: decision point and areas of interest keyed to Events.

Definition: see *note IPB::

Source: FM 34-3

D.6.2.1.   Terrain Analysis

G2 has support from attached Engineer Terrain Teams or detachments from the theater Engineer Topographical Battalion. The Defense Mapping Agency is the chief source of terrain information which is available on two scales:

Planning terrain analysis: scale 1:250,000 (inches) [1 inch ~ 4 miles]

Tactical terrain analysis: scale 1:50,000 [1 inch ~ 3/4 mile]

DMA overlays available:

> Vegetation
>
> Surface materials (soils)
>
> Surface Drainage
>
> Surface configuration (topology)
>
> Obstacles
>
> Transportation
>
> Cross-country movement (wet and dry)
>
> Concealment (seasonal)
>
> Groundwater (planning DB only)

FM 5-33 provides process to be used if support is not provided.

The focus of Terrain Analysis for IPB is on OCAKA:

> Observation and fields of fire or Line of Sight.
>
> Concealment (not observable) and cover (protection from fire).
>
> Obstacles: features that stop, impede, or divert movement.
>
> Key terrain: seizure or control provides a marked tactical advantage.
>
> Avenues of approach and mobility corridors: routes that provide above.

Other items of interest include Drop or Landing Zones, Communication and EW Sites, and Main Supply Routes (MSRs).

Important entities derived from terrain analysis are listed below.

Obstacles: problem areas.

Mobility Corridors: the best paths for cross-country movement.

Combined Overlays: Synopsis of information at a higher level derived from several DMA overlays. For example, a terrain/weather overlay showing how weather conditions will affect various kinds of terrain.

Alternate Name: terrain

D.6.2.2.   Weather Analysis

Weather has significant impact on terrain and ability to perform movement. The process begins with climate analysis in the area of operations, which provides climate information in an overall context. The important aspects of weather forecast data are:

Cloud coverage or fog: affects visibility, good for offensive, bad for defense, affects use of air assets.

Wind: windchill, blowing debris, NBC weapons usage.

Temperature: personnel, equipment problems.

Precipitation: state-of-the-ground, mobility.

Alternate Name: weather

D.6.2.3.   Threat Evaluation

This is the understanding of enemy force characteristics such as composition and organization, tactical doctrine, weapons and equipment, and their support systems. The process results in Doctrinal and Situational (via Terrain and Weather data) templates. Important information from the effort includes:

Enemy Positions: where to avoid undefended movement.

Enemy Intentions: including data on their movement patterns and their usage on nuclear, biological, or chemical (NBC) weapons.

Alternate Name: threat

Appendix E.   Features Descriptions

Note: All names used in the figures to follow are either proper names used in the paragraph identifier or the Alternate Names which can be found at the end of the entity descriptions, if applicable.

Figure E-1 Top-Level Features for Movement Control

E.1.   Operations

The major classes of operations for conducting movement are derived by analogy from the standard Army command and control process described in FM 101-5.

Type: mandatory

Source: FM 101-5

Figure E-2 Decomposition of the Operations Feature

E.1.1.   Planning

The commander receives a mission from headquarters or input from other groups and, with assistance from his staff, proceeds to derive a course of action that will accomplish the given mission.

Type: mandatory

Source: FM 101-5

E.1.1.1.   Route Classification

Route classification is performed to assist in planning and executing military movement. The classification is given using a formula that briefly describes a specific route and is used on the route reconnaissance overlay or traffic circulation plan. The formula is made up of a series of numbers and letters that express, in a standardized sequence:

Figure E-3 Decomposition of the Planning Feature

- The route width

- Route type

- Lowest military load classification

- Overhead clearance

- Obstructions to traffic flow

- Special conditions on the route

Type: optional

Source: FM 5-36

Alternate Name: route_class

E.1.1.1.1. Enter Terrain Data

This feature allows the user to enter or modify terrain information. The entered or modified terrain information may cause a need for a route or routes to be reclassified; in particular, a new obstruction may make a route unusable to some vehicles previously allowed on the route.

Type: optional

Source: AFATDS CEP B5 spec.

Alternate Name: terrain_dat

E.1.1.1.2. Mechanism

This feature describes two ways for the route classification information to be entered or derived from existing online data.

Type: mandatory

Source: Movement Control Workshop

E.1.1.1.2.1. Automatic

This feature would allow the system to algorithmically determine or update the classification of any existing or proposed routes by analyzing all of the information about features or obstructions on the route and the surrounding terrain. This feature is not currently performed by any operational movement control software.

Type: alternative

Source: Movement Control Workshop

E.1.1.1.2.2. Manual

This feature allows the user to enter route classification data into the system for use in route selection.

Type: alternative

Source: Movement Control Workshop

E.1.1.2.   Distribution Pattern

This feature addresses the analysis of various kinds of information to order to determine:

- What sizes of movement (especially supplies) will be occurring in the area of operations.

- What roads and other movement networks and facilities exist and what are their capacities.

- In what areas units or supplies should be located for best advantage.

- What mode of transportation should be utilized to implement a required movement.

The traffic circulation and control plans and the designation of Main Supply Routes are two results of this analysis.

Type: mandatory

Source: Movement Control Workshop

Alternate Name: dist_pattern

E.1.1.2.1. Mode Determination

Type: mandatory

Source: Movement Control Workshop

Alternate Name: mode_deter

E.1.1.2.1.1. Large Scale

Large-scale mode determination is performed as part of completing a movement program. It is the process of determining how to ship the various classes of supplies to the designated receiving and distribution sites effectively and economically.

Type: optional

Source: Movement Control Workshop

Alternate Name: large_scale

E.1.1.2.1.2. Small Scale

Small-scale mode determination is performed as part of developing or fulfilling a single movement request. It is the process of determining what mode options are available and/or appropriate for a planned movement of material or of a unit.

Type: mandatory

Source: Movement Control Workshop

Alternate Name: small_scale

E.1.1.2.2. Develop Plan

This feature allows for the completion of specialized movement control related plans, such as the Traffic Circulation Plan and the Highway Regulation Plan.

Type: optional

Source: FM 55-10

Alternate Name: dev_plan

E.1.1.2.3. Site Selection

Site selection is a class of features that allows users to create and modify one or more locations suitable for the organization for use in movement planning.

Type: optional

Source: Movement Control Workshop

Alternate Name: site_sel

E.1.1.2.3.1. Change Position

Allows the user to alter the selected input location manually.

Type: mandatory

Source: AFATDS CEP B5 spec.

Alternate Name: change_pos

E.1.1.2.3.2. Deconflict Position

A candidate location may not be viable due to close proximity to other friendly or potential enemy location or actions. Deconflict Position is a feature that allows for such checks to be made based upon conflict parameters that vary depending on the unit or movement type involved.

Rules: requires Scheduling

Type: optional

Source: AFATDS CEP B5 spec.

Alternate Name: deconflict_pos

E.1.1.2.3.3. Show Planned Positions

For tactical units, in particular Fire Support and Air Defense units, a commander may have preplanned a series of fire locations to be used at various times and circumstances. It is this collection of locations that the user is to view.

Type: optional

Source: AFATDS CEP B5 spec.

Alternate Name: show_plan_pos

E.1.1.2.3.4. Determine Position

The Determine Position feature assists the user in determining the new location for a unit or supply handling point.

Type: mandatory

Source: AFATDS CEP B5 spec.

Alternate Name: deter_pos

E.1.1.3. Assets

Assets are entities that have value which must be ascertained and managed. Assets have a set of utilization characteristics or attributes that are applicable to each of the three types of assets (vehicles, networks, and equipment). Each kind of asset may have different utilization characteristics. For example, a unit may "own" the vehicles it is using to perform a move but must request to use the road space from the command that "owns" (i.e., controls) the desired portion of the road network.

Type: mandatory

Source:

Figure E-4 Decomposition of the Assets Feature

E.1.1.3.1. Classes

This feature captures the need for groups (classes) of assets with different characteristics.

Each of the usage features listed under Vehicles is similarly applicable to the Networks and Equipment asset classes.

Type: mandatory

Source:

E.1.1.3.1.1. Vehicles

This is the determination of vehicles needed to facilitate a move or a series of moves. Usage features primarily involve issues of ownership (who owns or controls the asset's utilization).

Type: mandatory

Source:

E.1.1.3.1.1.1. Organic

This utilization feature incorporates the use of entities that are permanently allocated to the unit (in the case of vehicles or equipment) or under the direct control of the moving unit.

Type: mandatory

Source: AFATDS CEP B5 spec.

E.1.1.3.1.1.2. Non-Organic

This feature incorporates the use of entities that are *not* allocated to the unit, but are provided by a transportation/movement control unit to augment the unit's supply or authorize usage of a route.

Type: optional

Source:

Alternate Name: non_org

E.1.1.3.1.1.2.1. Common User Asset

Common User Assets are transportation vehicles, routes, and equipment set aside by a corps or division that are available to any of its subordinate units to assist in their movements. They are allocated on an as-needed basis to those units requesting movement assistance but are not attached to the moving unit.

Type: optional

Source:

Alternate Name: cmn_usr_asset

E.1.1.3.1.1.2.2. Preferred Availability

The availability of the most appropriate vehicles, routes, and equipment to perform the move. The preference may be due to size, i.e., a few large vehicles make the moving group smaller but may be restricted to certain routes, speed, or other considerations.

Type: mandatory

Source:

Alternate Name: preferred_avail

E.1.1.3.1.1.2.3. Alternative Availability

The availability of vehicles, routes, and equipment that are sufficient to perform the move, but are not the assets most desirable for use. This availability needs to be considered when the preferred assets are not available.

Type: optional

Source:

Alternate Name: alt_avail

E.1.1.3.1.1.3. Reuse

Depending upon the time frame of the movement and other factors, reuse involves transport vehicles making multiple trips to facilitate a move rather than using many vehicles making only one trip each.

Type: optional

Source:

E.1.1.3.1.2. Networks

This is the determination of the available transportation infrastructure assets, i.e., roads, water routes, air lanes, and rail lines that may be used to facilitate a move.

See all of the usage features previously given under Vehicles for the various potential choices.

Type: mandatory

Source:

E.1.1.3.1.3. Equipment

This is the determination of equipment (other than vehicles) needed to facilitate a move. These assets consist mainly of material handling equipment (MHE) needed to load and unload transport vehicles and do not affect movement unless such equipment is needed.

See all of the usage features previously given under Vehicles for the various potential choices.

Type: optional

Source:

E.1.1.3.2. Priorization

This is the notion of assigning a value to the importance (priority) of one movement to others. This priority value is used to resolve contention for resources (assets), including all of those named previously.

Type: optional

Source:

E.1.1.4. Movement

This feature addresses the "how" and "which way(s)" a unit or task force is to be moved. This is where the determination of resources occurs, the resources being the vehicles and equipment needed and the usages of designated routes or paths.

Figure E-5 Decomposition of the Movement Feature

E.1.1.4.1. Convoy Building

Type: mandatory

Source:

Alternate Name: convoy_bldg

Figure E-6 Decomposition of the Convoy Building Feature

E.1.1.4.1.1. Column Formation

This is the process of selecting the vehicles and organizing them into various groups depending on the number and types of vehicles, the route selected, and other considerations.

Alternate Name: column_form

E.1.1.4.1.1.1. Column Length

The Column Length feature controls the distance between vehicles and groups of vehicles in a convoy.

Type: mandatory

Source: FM 55-30, Chapter 5

Alternate Name: c_length

E.1.1.4.1.1.1.1. Fixed

A fixed column uses a prescribed distance between vehicles that is maintained at all rates of speed. This allows the length of the convoy to remain fixed. A fixed column is used in parade formations, for short trips, or when closing the highway to other traffic.

Type: alternative

Source: FM 55-30, Chapter 5

E.1.1.4.1.1.1.2. Governed

A governed column uses its speed to regulate the distance between vehicles. A speedometer multiplier (a factor of 1, 2, 3, or higher) is used to multiply the speedometer reading to arrive at the distance in meters or yard between vehicles. A governed column is used in almost all motor moves on open highways or over poor routes. In areas where road conditions are unreliable, a minimum distance should be set to prevent bunching of vehicles at low speeds.

Type: alternative

Source: FM 55-30, Chapter 5

E.1.1.4.1.1.2. Enter Gap Data

This feature allow the user to enter distance data between each vehicle in a group and between group of vehicles.

Type: optional

Source: FM 55-30, Chapter 5

Alternate Name: gap_data

E.1.1.4.1.1.3. Enter Groupings

This feature allow the user to group the vehicles in his convoy in columns, serials, and march units as needed.

Type: optional

Source: FM 55-30, Chapter 5

Alternate Name: groupings

E.1.1.4.1.1.4. Enter Composition Data

This feature allows the user to enter the vehicle type and other characteristics (height, width, and weight) that are particularly important for each vehicle in the convoy.

Type: optional

Source: FM 55-30, Chapter 5

Alternate Name: comp_data

E.1.1.4.1.2. Defense Planning

Defense planning is considering the effect that the enemy may have upon a proposed movement. This includes selecting a route that the enemy cannot easily intervene upon, organizing the convoy to place guard forces at appropriate locations, requesting and coordinating fire support, and other considerations.

Type: optional

Source: FM 55-30, Chapter 6

Alternate Name: defense_plan

E.1.1.4.2.   Scheduling

This feature addresses the "when" of moving a unit or task force. Scheduling of a movement can be critical because the timing of other movements and the arrival time may be important factors in gaining surprise in an attack or ensuring that momentum is maintained.

Type: mandatory

Rules: requires Routing

requires Convoy Building

Source:

Figure E-7 Decomposition of the Scheduling Feature

E.1.1.4.2.1.   Dependent Events

The ability of a scheduling or deconflicting system to adequately determine that an event has some connection to other events and that a change to such an event in a schedule requires changes to any dependent events.

Type: mandatory

Source:

Alternate Name: dep_events

E.1.1.4.2.2.   Backward Planning

In some situations, the arrival time at the destination is the critical factor in a movement. Backward planning allows the sequence of events to be specified in reverse order so that the last value determined is the start time that will ensure the moving unit(s) arrive at the proper time.

Type: mandatory

Source:

Alternate Name: bkwd_plan

E.1.1.4.2.3. Scheduling Ops

Scheduling options available to the user of the system.

Type: mandatory

Source: AFATDS CEP B5 spec.

Alternate Name: ops

E.1.1.4.2.3.1. Calculate Travel Time

After a convoy has been built, a route selected, a critical time selected, and control points noted, the remainder of the movement schedule can be calculated.

Type: mandatory

Source: AFATDS CEP B5 spec.

Alternate Name: calc_travel_time

E.1.1.4.2.3.2. Determine Control Points

After a route has been determined, the user is allowed to enter data on the durations of rest and refuel stops at appropriate points and to designate his usage of critical points, control (reporting) points, or other indicated points on a traffic control plan.

Type: mandatory

Source: AFATDS CEP B5 spec.

Alternate Name: deter_ctrl_pts

E.1.1.4.2.3.3. Determine Critical Time

This operation allows the user to set either the time of leaving the old location or the time to arrive at the new location as the critical time for scheduling the remainder of a move.

Type: mandatory

Source: AFATDS CEP B5 spec.

Alternate Name: deter_critical_time

E.1.1.4.2.3.4. Set Actual Time

Often a plan or order is issued without stating the true times for movements to occur; the times are given in terms relative to some initial event time. When a message or order is received that

sets the time of start, the 'H-hour', this operation allow the user to enter this time and calculate the true time that other planned movements are to occur.

Type: mandatory

Source: AFATDS CEP B5 spec.

Alternate Name: set_actual_time

E.1.1.4.3. Routing

Routing is the determination of the path between a unit's current position or other designated start point and its ultimate destination or release point.

Type: mandatory

Source:

Figure E-8 Decomposition of the Routing Feature

E.1.1.4.3.1. Selection

The amount of work to select an optimal route may be too time-consuming (computationally intensive). This feature allows route selection to be less than optimal if desired.

E.1.1.4.3.1.1. Best

The best option will find the optimal route for a given starting and ending location. The time to find the best route may be long because many different paths may need to be checked.

Type: alternative

Source:

E.1.1.4.3.1.2. Satisfice

This feature allows the selection process to stop after one route is found that meets the given requirements for load class of vehicles, width, etc. Note: this requires a kind of deconfliction separate from the time space deconfliction performed by a coordinating command.

Type: alternative

Source: AFATDS CEP B5 software

E.1.1.4.3.2. Routing Ops

Source: AFATDS CEP B5 spec.

Alternate Name: routing_ops

E.1.1.4.3.2.1. Change Route

This feature allow the user to modify a route already created.

Type: mandatory

Source: AFATDS CEP B5 spec.

Alternate Name: change_rt

E.1.1.4.3.2.2. Determine Route

Determine Route allows the user to select a path between two points using predefined route segments.

Type: mandatory

Source: AFATDS CEP B5 spec.

Alternate Name: deter_rt

E.1.1.4.3.2.2.1. Auto-Routing

This feature allows the user to let the system select the route based upon a starting and ending location, sufficient information about possible segments that can be used, and the characteristics of the vehicles to be used.

Type: optional

Source: DAMMS-R preliminary requirements

E.1.1.4.3.2.3. Enter Segment

Enter Segment allows the user to add or delete a segment to or from a list of defined route segments.

Type: mandatory

Source: AFATDS CEP B5 spec.

Alternate Name: enter_sgmnt

E.1.1.4.3.3. Alternate Route

One or more paths that are acceptable for movement but are not as desirable as the primary route. One of them is selected and allocated for use if the primary route is unavailable for some reason.

Type: optional

Source:

Alternate Name: alternate_route

E.1.1.4.3.4. Primary Route

This is the preferred path from a starting point to a destination. It may be preferred due to its length (shortest), available cover, or other considerations.

Type: mandatory

Source:

Alternate Name: primary_route

E.1.1.4.4. Highway Regulation

Highway regulation is the centralization of certain functions to one echelon of command so that subordinate commands request and receive approvals for operations that the superior command will be responsible for in terms of command and control.

Type: optional

Alternate Name: hwy_reg

Figure E-9 Decomposition of the Highway Regulation Feature

E.1.1.4.4.1. Highway Traffic Regulation

The coordination and the actual use of the road network by vehicles, personnel, and animals needed to meet military requirements. It consist of planning, routing, scheduling, and diverting movements on the available road networks in accordance with priorities.

Type: optional

Rules: requires Develop Plan

requires Prioritization

Source: FM 55-10

Alternate Name: traffic_control

E.1.1.4.4.2. Deconfliction

The proposed schedule for a moving unit must be compared against the schedules of all other units that may be using the same route (or any part thereof) or that may otherwise interfere with already planned movements. This is the time space deconfliction that must be performed by a designated unit within a specified chain of command.

Type: mandatory

Rules: requires Scheduling

Source: AFATDS CEP B5 spec.

Alternate Name: deconflict

E.1.1.4.4.2.1. Dependent Events

See paragraph E.1.1.4.2.1.

E.1.1.4.4.2.2. Independent Events

The ability of a scheduling system to adequately determine that an event has no connection with some other events and thus, a change to that event in a schedule does not affect any independent events.

Type: mandatory

Source:

Alternate Name: indep_evnt

E.1.1.4.4.2.3. Parallel Events

The ability to schedule and deconflict multiple events that occur at the same point or period in time. These events may be independent (only coincidence is the time relationship) or dependent (these events need to occur together).

Type: mandatory

Source:

Alternate Name: paral_evnt

E.1.1.5.　Balance Requirements vs. Capabilities

This input occurs when the commander is attempting to determine an appropriate course of action based upon the mission as he perceives it, and he needs to know if his transportation assets can support the movement of troops and their sustainment. It occurs at the beginning of mission planning and whenever circumstances change enough that initial type planning is needed.

Type: optional

Rules: requires Mode Determination

Source: Movement Control Workshop, FM 55-10

Alternate Name: req_vs_cap

E.1.2.　Directing

After a course of action has been established by the commander, it is transformed into orders for his subordinate units.

Type: mandatory

Source: FM 100-15

Figure E-10 Decomposition of the Directing Feature

E.1.2.1.　Receive Inputs

The system must be able to receive inputs such as orders requiring movement and the results of requests sent to other agencies for approval.

Type: mandatory

Source:

Alternate Name: inputs

E.1.2.1.1. Host Nation Guidance

This input occurs when the local authorities in a region where the Army is located impose restrictions and/or rules about the use of roads in the area.

Type: optional

Source: Movement Control Workshop, FM 55-10

Alternate Name: host_nat_guid

E.1.2.1.2. Messages

This feature allows for systems to get inputs from interfaces to other systems.

Figure E-11 Decomposition of the Messages Feature

E.1.2.1.2.1. Movement Order

This is the final authority for a unit to proceed with a movement. The receipt of this order presumes that all coordination with lateral and outside organizations has been performed.

Type: optional

Source: AFATDS CEP B5 spec.

Alternate Name: mvmt_order

E.1.2.1.2.2. Movement Request

This message is for a higher echelon unit. It contains the details of a proposed movement by one of its subordinates. Alternately, a superior unit can inform its subordinate of its preliminary approval of a move prior to final coordination and issuance of a movement order.

Type: optional

Rules: requires Movement Order

Source: AFATDS CEP B5 spec.

Alternate Name: mvmt_request

E.1.2.1.2.3. Mvmt. Status Request

A command unit wants to know the current status of movement being performed by the receiving unit.

Type: optional

Rules: requires Movement Status Response

Source: AFATDS CEP B5 spec.

Alternate Name: mvmt_stat_rqst

E.1.2.1.2.4. Mvmt. Status Response

A subordinate unit has reported its current movement status to the appropriate superior.

Type: optional

Source: AFATDS CEP B5 spec.

 Alternate Name: mvmt_stat_rspn

E.1.2.1.2.5. Coordination Request

In the battlefield, maneuver units need to coordinate their movements with lateral commands in other BFAs (fire support, air defense, etc.) and vice versa. This message is from a lateral BFA command requesting concurrence for a movement request.

Type: optional

Rules: requires Coordination Response

Source: AFATDS CEP B5 spec.

Alternate Name: coord_request

E.1.2.1.2.6. Coordination Response

In the battlefield, maneuver units need to coordinate their movements with lateral commands in other BFAs (fire support, air defense, etc.) and vice versa. This message is from a lateral BFA command acknowledging a movement or providing information to alter a movement request.

Type: optional

Source: AFATDS CEP B5 spec.

Alternate Name: coord_response

E.1.2.1.2.7. Other

This feature allows for input messages other than those indicated above.

Type: optional

Source: Movement Control Workshop

E.1.2.2.   Generate Outputs

The ability to format movement information in the ways needed for inclusion into the appropriate sections and annexes (appendices) of an OPLAN or other orders dealing with movement.

 Type: mandatory

Source: Movement Control Workshop

Source: AFATDS CEP B5 spec.

Alternate Name: outputs

E.1.2.2.1. Produce Strip Map

A strip map is a map of a route, showing only the roads or other segments to be used and the immediate surrounding terrain (along with checkpoints and times), which provides the minimal necessary information for a driver to proceed with the movement.

Type: optional

Source: AFATDS CEP B5 spec.

Alternate Name: strip_map

E.1.2.2.2. Replies

This feature allows for the sending of any message needed for movement purposes.

See Messages (Para. E.1.2.1.2.) and its subparagraphs.

Source: Movement Control Workshop

E.1.3. Executing

Here the current situation is monitored. Plans are changed and new orders based upon perceived need are issued.

Type: optional

Rules: require Scheduling

Source: FM 100-15

Figure E-12 Decomposition of the Executing Feature

E.1.3.1.   Monitoring

The commander and staff must monitor the reports coming in about both the situation of his own troops and that of the enemy.

Type: mandatory

Source: FM 100-15

E.1.3.1.1. Check Critical Times

This feature allow the user to check the current time against critical times in the movement file and indicate if a unit has not reported passing a critical point within a given range of the planned time.

Type: optional

Alternate Name: critical_tim

Source: AFATDS CEP B5 spec.

E.1.3.1.2. Show Unit Movement Status

This feature allows the user to view the collected status information of all moving units.

Type: optional

Source: ATATDS CEP B5 spec.

Alternate Name: unit_stat

E.1.3.1.3. Show Moving Units Positions

This features displays the current known location of all units under movement orders.

Type: optional

Source: AFATDS CEP B5 spec.

Alternate Name: unit_pos

E.1.3.2. In-Transit Visibility

This feature allows supply and logistics personnel to ascertain the location of shipments without knowing the transportation method or vehicle used. This is done by integrating data about the location of vehicles with the contents listings of the vehicles.

Type: optional

Source: Movement Control Workshop

Alternate Name: in_transit_vis

E.1.3.3. Adjust

The commander modifies his plans and issue new orders to take advantage of unforeseen enemy actions or to remedy existing or potential problems unaccounted for previously. This adjustment will utilize most of the features as seen under the Planning feature of this feature set.

Type: mandatory

Source: Movement Control Workshop

E.1.3.3.1. Maintain Movement Data

The user must be able to delete old information from movement files and update movement data as updates and new information come in.

Type: mandatory

Source: AFATDS CEP B5 spec.

Alternate Name: maintn_mvmt_dat

E.2.   Context

This set of features relates the objectives of movement to the steps needed to accomplish movement. These features are intended to provide 'context' to the Operations features.

E.2.1. Mission

E.2.1.1. Estimate

An estimate is a guess made about the feasibility of a movement to see if a unit or force can be moved to support a mission or a course of action under consideration by the commander. It involves a quick check of the unit/force's location, status, and the overall situation without doing all of the detailed planning to know exactly how the movement will be performed. It usu-

ally results in a yes or no decision. The feasibility of a movement may be checked by the organization approving a request to move or that issues the order that necessitates a movement. Developing a movement estimate is an important part of developing a course of action.

Figure E-13 Decomposition of the Context Features

This alternative is not currently supported by any automated movement control system.

Type: alternative

Source: Movement Control Workshop

E.2.1.2.   Operational Plan

This feature signifies that a more complete set of calculations be performed to determine the routes, schedules, and mode allocations to be used to implement the movement program for inclusion into OPLANs, etc.

Type: alternative

Source: Movement Control Workshop

Alternate Name: OPLAN

E.2.1.3.   Operational Order

This feature signifies that the complete set of calculations be performed to determine the exact route, schedule, and convoy organization to be used to implement a specific movement for inclusion into OPORDs, movement requests, etc.

Type: alternative

Source: Movement Control Workshop

Alternate Name: OPORD

E.2.2. Control Strategy

This feature describes how movement control is implemented in terms of how organizations participate in the movement process and what effects their decisions can have on others.

Type: mandatory

Source:

Alternate Name: ctrl_strgy

E.2.2.1.   Centralized

In a centralized movement control system, all functionality is placed (with the exception of some limited convoy planning aids) with a single organization that is responsible for coordinating all movement with a region. No unit or logistical movement can take place without this central organization being cognizant of it because no one else has the ability to analyze the effects of a new potential moves on ones already in progress or scheduled.

Type: alternative

Source:

Alternate Name: central

E.2.2.2.   Distributed

In a distributed movement system, various aspects of movement functionality are capable of being handled at multiple sites. A unit planning a move can gain access to currents conditions and plans in order to understand what options (modes, roads, etc.) are available and what cannot be done.

Type: alternative

Source:

Alternate Name: dist

E.2.2.3. Global

In a global movement system, an attempt is made to optimize a large number of unit and materiel movements to achieve the maximum throughput possible in a theater. This kind of system is intended to have cognizance of all movement requirements and capabilities within its scope.

Type: alternative

Source:

E.2.3. Regional CINC

A Regional CINC is a major geographic area of the world in which the Army has a preexisting command structure and set of procedures coordinated with the nations in the region as to certain conditions and constraints upon planned movement in that area. These conditions and constraints will affect movement operations.

The Commander in Chief (CINC) for a region must identify a value for the following location-dependent parameters: name (for the command), convoy size (the number of vehicles that, if traveling together, must request a convoy clearance), measure (whether sizes and weights are measured in English or metric units), and map usage (whether Army grid maps or maps using latitudes and longitudes are to be used to determine locations).

Examples of Regional CINCs are FORSCOM (Force Command, U.S.), EURCOM (European Command), CENTCOM (Central Command), PACOM (Pacific Command) and SOUTHCOM (Southern Command).

Figure E-14 Decomposition of the CINC Parameters Feature

Type: mandatory

Source: Movement Control Workshop

Alternate Name: regional_CINC

E.2.4. Level of Command

The level of command or echelon of forces of the commander planning a movement has a direct influence on the type (scope) of movements he will consider noteworthy.

Type: mandatory

Source: FM 55-10, Chapter 1, Section 2

Alternate Name: lvl_of_cmd

E.2.4.1. Joint

Commands operating in a multinational or multiservice force environment are most concerned with strategic movement.

Type: alternative

Rules: requires Strategic

       mutex-with Tactical

Source: FM 55-10, Chapter 1, Section 2

E.2.4.2. Theater Army

At this high level of command, the emphasis is on strategic movement but some levels of operational movement can be considered.

Type: alternative

Source: FM 55-10, Chapter 1, Section 2

Alternative Name: theater_army

E.2.4.3. Corps

At the corps level, the emphasis is on operational movement. Some inputs are needed into strategic movement and an overview of the tactical movement considerations are needed.

Type: alternative

Source: FM 55-10, Chapter 1, Section 2

E.2.4.4. Division

Divisions are concerned with both operational and tactical movement. Tactical movement is the primary concern due to the need to coordinate the movements of subordinate units on the battlefield.

Type: alternative

Source: FM 55-10, Chapter 1, Section 2

E.2.4.5.   Below

Any movement to be performed by a brigade or lower level unit is in all likelihood tactical in nature.

Type: alternative

Rules: requires Tactical

   mutex-with Strategic

Source: FM 55-10, Chapter 1, Section 2

E.2.5. Policy

E.2.5.1.   Types

Type: mandatory

Source: FM 100-5

E.2.5.1.1. Strategic

Strategic missions and their movements involve transporting a large volume of personnel and equipment into the general area where combat is occurring or will occur. Generally, this entails moving a large number of units from their bases in the United States into the theater of operations, i.e., InterTheater movement. This is a precursor to a unit's ultimate deployment to a specific area.

Type: alternative

Source: FM 55-10, Chapter 1

E.2.5.1.1.1. Deliberate

Deliberate strategic movement is performed when time is not critical and the economical utilization of movement assets is the prime concern.

Type: alternative

Source:

E.2.5.1.1.2. Crisis

Crisis strategic movement occurs when timely relocation of troops and/or equipment from one major land mass to another is needed. Quick response and completion by whatever available means is the guiding force in this situation.

See parallel definition in *note administrative::

Type: alternative

Source:

E.2.5.1.2. Operational

Operational movement involves movement from the debarkation point (ending the strategic movement) into an area of operations appropriate for the units, or from one area of operations to another in the same theater.

Operational movement is commonly referred to as administrative movement. An administrative movement is "one in which troops and vehicles are arranged to expedite their movement and converse time and energy when no enemy interference, except by air, is anticipated.... elements are organized to ... maximize transportation resources. Usually ... planned and organized by the G4..."

Type: alternative

Source: FM 100-15, p. 7-11

E.2.5.1.2.1. Lateral

Movement across the width of the battlefield (for example, relocation of a reserve force or the maneuver of a counterattack force) requires additional attention to planning. Extra considerations include best utilization of transportation, adequacy of the transportation network, weather influences, security, and organization to meet tactical requirements.

Type: optional

Source: FM 100-15

E.2.5.1.3. Tactical

Tactical movement involves the relocation of a force from one location to another within the same area of operations.

"A tactical movement is a movement ... to contact with the enemy or during which contact is anticipated ... In a tactical movement, elements are organized to facilitate combat ... the G3 plans a tactical movement."

Type: alternative

Source: FM 100-15, p. 7-11

E.2.5.1.3.1. Defense Option

Type: mandatory

Source: FM 55-30, Chapter 6

Rules: requires Defense Planning

Alternate Name: defense_option

Figure E-15 Decomposition of the Tactical Feature

E.2.5.1.3.1.1. Active

An active defense during movement uses its guard and advance forces to attempt to destroy any enemy forces it may encounter. If speed is essential or surprise is intended by the moving force, then active defense is inappropriate.

Type: alternative

Source: FM 55-30, Chapter 6

E.2.5.1.3.1.2. Passive

A passive defense during movement places its highest priority on convoy protection and security rather than confrontation with enemy.

Type: alternative

Source: FM 55-30, Chapter 6

E.2.5.1.3.2. Posture

Posture involves the overall intention of the movement and its mission.

Type: mandatory

Source: FM 100-5, Chapters 6 & 8

E.2.5.1.3.2.1. Offensive

An offensive posture assumes that the force is attempting to take control of an area currently held by enemy forces.

Type: alternative

Source: FM 100-5, Chapter 6

E.2.5.1.3.2.2. Defensive

A defensive posture assumes that the force is only attempting to maintain its hold in an area or prevent the enemy from controlling an area important to the friendly force.

Type: alternative

Source: FM 100-5, Chapter 8

E.2.5.1.3.3. Operations Area

The battlefield is divided into three areas for conducting three different classes of operations or mission types.

Type: mandatory

Source: FM 100-15

Alternate Name: op_area

E.2.5.1.3.3.1. Close

The close operations area is that area where "the current battles and engagements of major maneuver units, together with its combat support and combat service support activities presently supporting them" are located.

Type: alternative

Source: FM 100-15, p. 3-0

E.2.5.1.3.3.2. Deep

The deep operations area is that area where "those activities which are directed against enemy forces not currently engaged in close operations, but capable of engaging or influencing future close operations" are located.

Type: alternative

Source: FM 100-15, p. 3-0

E.2.5.1.3.3.3. Rear

The rear operations area is that area where "those activities from the rear boundary" of the operations area "forward to the rear boundaries of committed maneuver units, that assure the freedom of maneuver and continuity of operations, including sustainment and command and control" are located.

Type: alternative

Source: FM 100-15, p. 3-3

E.2.5.1.3.4. Enemy Contact

There are three phases during a tactical movement to contact. Each of them usually occurs in the order specified below.

Type: mandatory

Source: AR310-25, Army Standard Dictionary of Terms

Alternate Name: enemy_contact

E.2.5.1.3.4.1. Remote

In the early stage of a movement to contact, the possibility of contact with enemy forces is remote, thus more emphasis can be placed on economical usage of transportation assets.

Type: mandatory

Source: FM 100-5, Chapter 7

E.2.5.1.3.4.2. Improbable

In the middle stage of a movement to contact, the possibility of contact with enemy forces is improbable but reasonably possible, thus some planning for positioning of an advance guard and other security forces should occur while conducting movement of this kind.

See also *note tactical column::

Type: mandatory

Source: FM 100-5, Chapter 7

Alternate Name: improb

E.2.5.1.3.4.3. Imminent

In the last stage of a movement to contact, meeting enemy resistance is to be expected and anticipated and the moving force must be ready to engage in battle as much as possible.

Type: mandatory

Source: FM 100-5, Chapter 7

E.2.5.2.   Level of Conflict

The scale of effort and armaments to be used in achieving the objectives of an actual or potential conflict between opposing forces in a "political-military confrontation between contending states or groups."

Type: mandatory

Source: FM 100-5, Chapter 1 and JCS Pub. 1, p. 212 (quoted material)

Alternate Name: lvl_of_conflict

E.2.5.2.1. High

All out war where all means of engagement and weaponry are potentially usable, including Nuclear, Biological, and Chemical (NBC) weaponry. Confrontations between opposing forces may extend into land, sea, and air and the battlefield is "likely to be chaotic, intense, and highly destructive."

Type: alternative

Source: FM 100-5, p. 2

E.2.5.2.2. Medium

Warfare where fighting is often intense, but whose scale is below that of High. Medium-level conflict is usually restricted to conventional weaponry.

Type: alternative

Source: FM 100-5

E.2.5.2.3. Low

A state of conflict requiring "special forces composition and organization, rapid deployment, and restraint in the execution of military operations" due to political and economic considerations. At this level, Army forces are typically pitted "against irregular or unconventional forces, enemy special operations forces, and terrorists."

Type: alternative

Definition: see LIC

Source: FM 100-5, p. 4

E.2.5.2.4. None

Normal peacetime contingency or peacekeeping operations. Force is used only in cases of self-defense.

Type: alternative

Source: FM 100-5, p. 4

E.2.6. Kind

This feature is used to determine "what" (in terms of thing) is needed to be moved in order to accomplish a mission.

Type: mandatory

Source: Movement Control Workshop

E.2.6.1. Unit

A unit movement is the relocation of the personnel, equipment, and supplies that constitute it. A unit movement can either be specifically ordered by a superior commander, implied by the mission given to the unit commander, or otherwise indicated by combat conditions. A unit movement is usually planned by the unit itself and is performed by the unit if it already has the appropriate transportation assets or is allocated them.

Type: alternative

Source: Movement Control Workshop

E.2.6.2. Logistical

A logistical sustainment movement is the relocation of supplies and equipment to a requesting unit or to a depot. This kind of movement is planned by the organization in charge of the material or the unit ordered to move the material. The requesting unit only asks that the material be brought to its location or taken from it to some other location. The transportation organization allocates the vehicle resources and plans the route taken and the schedule for the movement.

Type: alternative

Source: Movement Control Workshop

E.3. Representation

The representation features are needed to describe the different forms that movement information may take, both as input to movement functions and various types of output that users need. The representation features do not include the concept of internal message formats (bits and bytes) needed to input or output information between software systems or the particular format of textual output, such as the various formats of road clearances (STANAG 2155, Form 1255, etc.).

Figure E-16 Decomposition of the Representation Feature

E.3.1. Maps

Maps are an integral part of portraying the information needed to make movement decisions. Maps can show existing terrain, roads, the positions of units and supply points, and many oth-

er useful kinds of information. Few software systems, until recently, had maps available on-line to assist in the movement control planning process.

Type: optional (mandatory for most new systems)

Source: ATCCS Map Requirements memorandum [PEOCCS90].

E.3.2. Graphs

Graphs are a useful method for portraying or condensing large amounts of numerical data. For movement control, the road movement graph is an essential output of a highway scheduling system used to show the passing of multiple convoys over the designated critical points in the highway network.

Type: optional

Source: FM 55-10

E.3.3. Schematics

Schematics are used for more effective movement planning and management. Their purpose is to portray total shipping requirements and available transportation capabilities as they relate to the actual distribution system. Schematics are prepared requirements (in tons of supply classes) and each available mode. They show the various shipping and receiving points and the various flows needed between each point.

Type: optional

Source: FM 55-10, Pages 98-99

Alternate Name: schemtcs

E.3.4. Tables

Tables are another useful method for portraying large amounts of numerical data. The road movement table is a listing of the important points on a route and the times for which a convoy is due to arrive and clear each point. This information, along with a map of the roads to be used, is usually given to each driver in a convoy.

Type: optional

Source: FM 55-10

E.3.5. Text

Text is the primary medium through which movement control systems interact with their users. The inputs and outputs are both usually textual forms whose format is dependent on the theater area, as each theater can define its own format and operating procedures for movement.

Type: mandatory

Source: FM 55-10

Appendix F.   Features Catalog

	TCACCIS	DAMMS-R	AFATDS	CAMMS	ALBE-GIS	MOBCOM
Operational Features						
Planning						
Route Classification						
Enter Terrain Data	No	Yes	Yes	Yes	Yes	Highway
Mechanism	N/A	Automatic	Manual	No	Auto/Man	Auto/Man
Distribution Pattern						
Mode Determination	No	Yes	No	No	No	No
Develop Plan	No	Yes	No	No	No	No
Site Selection						
Show Planned Position	No	???	Yes	Yes	Yes	Yes
Deconflict Position	No	???	Yes	No	Planned	Yes
Change Position	No	???	Yes	No	Yes	Yes
Movement						
Convoy Building						
Assets						
Organic	Yes	Yes	Yes	No	Planned	No
Non-Organic	TBD	Yes	No	No	Manual	No
Prioritization	TBD	Yes	No	No	N/A	No
Reuse	TBD	Yes	N/A	No	N/A	No
Common User	TBD	Yes	N/A	No	N/A	No
Preferred Availability	TBD	Yes	N/A	No	N/A	No
Alternative Availability	TBD	Yes	N/A	No	N/A	No
Column Formation						
Composition	Yes	Yes	No	Yes	Yes	Yes
Groupings	Yes	Yes	No	Yes	Yes	Yes
Gap Distance	Yes	Yes	Yes	Yes	Yes	Yes
Length	Yes	Both	Fixed	Yes	Yes	Yes
Scheduling						
Operation						
Set AbsoluteTime	TBD	Yes	Yes	No	TBD	Yes
Determine Critical Time	TBD	Yes	Yes	Yes	Yes	Yes
Determine Control Points	TBD	Yes	Yes	No	Yes	Yes

	TCACCIS	DAMMS-R	AFATDS	CAMMS	ALBE-GIS	MOBCOM
Calculate Travel Time(s)	Yes	Yes	Yes	Yes	Yes	Yes
Backward Planning	TBD	Yes	Yes	Yes	Yes	Yes
Dependent Events	TBD	Yes	Yes	No	Yes	Yes
Routing						
Operations						
Enter Segment	Yes	Yes	Yes	Yes	Yes	Yes
Determine Route	No	Auto	Man	Auto	Auto	Auto
Change Route	No	Yes	Yes	Yes	Yes	Yes
Selection	S/B	S	B	S/B	S/B	
Primary	Yes	Yes	Yes	Yes	Yes	
Alternate	Yes	No	No	TBD	Yes	
Prioritization	Yes	No	No	TBD	Yes	
Highway Regulation						
Traffic Control	Yes	No	No	No	Yes	
Deconfliction						
Parallel Events	Yes	Yes	No	Yes	Yes	
Independent Events	Yes	Yes	No	Yes	Yes	
Dependent Events	Yes	Yes	No	Yes	Yes	
Directing						
Receive Inputs						
Host Nation Guidance	US/EUR	Yes	No	No	Yes	US Only
Req. vs. Cap. Balance	No	Yes	No	No	Yes	No
Messages						
Movement Orders	Yes	Yes	No	Yes	Yes	
Movement Request	Yes	Yes	Yes	No	Yes	Yes
Mvmt Status Request	TBD	???	Yes	No	No	No
Mvmt Status Response	TBD	???	Yes	No	No	No
Coordinate Request	No	No	Yes	Yes	No	No
Coordinate Response	No	Yes	Yes	No	No	No
Other	TBD	No	No	No	No	No
Generate Outputs						
Movement Orders	Yes	Yes	Yes	No	Yes	Yes

	TCACCIS	DAMMS-R	AFATDS	CAMMS	ALBE-GIS	MOBCOM
Movement Request	TBD	Yes	Yes	No	Yes	Yes
Status Request	TBD	???	Yes	No	No	Future
Status Response	TBD	???	Yes	No	No	No
Strip Map	No	Yes	Yes	No	Yes	Yes
Coordinate Request	TBD	Yes	Yes	No	No	No
Coordinate Response	TBD	Yes	Yes	No	No	No
Other	TBD	No	No	No	No	???

Execute

Monitoring

	TCACCIS	DAMMS-R	AFATDS	CAMMS	ALBE-GIS	MOBCOM
Unit Movement Status	No	Yes	Yes	No	No	No
Moving Units Positions	No	Yes	Yes	No	No	No
Check Critical Time	No	Yes	Yes	No	No	No
In-Transit Visibility	**Yes**	**Yes**	**???**	**No**	**No**	**Yes**

Adjust

	TCACCIS	DAMMS-R	AFATDS	CAMMS	ALBE-GIS	MOBCOM
Maintain Movement Data	No	Yes	Yes	No	No	No

Context Features
Mission

	TCACCIS	DAMMS-R	AFATDS	CAMMS	ALBE-GIS	MOBCOM
Estimate	**TBD**	**No**	**No**	**Yes**	**Yes**	**Yes**
OPLAN	**TBD**	**Yes**	**No**	**No**	**Yes**	**Yes**
OPORD	**TBD**	**Yes**	**Yes**	**No**	**Yes**	**Yes**
Regional CINC	**US/EUR**	**Yes**	**N/A**	**N/A**	**Yes**	**US Only**

Level of Command

	TCACCIS	DAMMS-R	AFATDS	CAMMS	ALBE-GIS	MOBCOM
Joint	**No**	**Yes**	**No**	**No**	**TBD**	**Yes**
Theater Army	**No**	**Yes**	**No**	**No**	**Yes**	**Yes**
Corp	**Yes**	**Yes**	**Yes**	**No**	**TBD**	**Yes**
Division	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Below	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**No**

Policy

Types

Strategic

	TCACCIS	DAMMS-R	AFATDS	CAMMS	ALBE-GIS	MOBCOM
Deliberate	TBD	No	No	No	No	Yes
Crisis	TBD	No	No	No	No	Yes

	TCACCIS	DAMMS-R	AFATDS	CAMMS	ALBE-GIS	MOBCOM
Operational		Yes	No	No	TBD	Yes
Lateral	TBD	???	No	No	TBD	Yes
Tactical						
Defense Option	TBD	No	???	No	No	No
Posture	TBD	No	???	No	No	No
Level of Conflict						
High	Yes	Yes	No	Yes	Yes	
Medium	Yes	Yes	No	Yes	Yes	
Low	Yes	Yes	No	Yes	Yes	
None	Yes	No	No	Yes	Yes	
Kind						
Unit	Yes	Yes	Yes	N/A	Yes	Yes
Logistical	Yes	Yes	No	N/A	No	Yes
Representations						
Maps		**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Graphs		**Yes**	**No**	**No**	**Yes**	**No**
Schematics		**Yes**	**No**	**No**	**No**	**No**
Tables		**Yes**	**Yes**	**No**	**Yes**	**Yes**
Text		**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Appendix G.   Movement Control Terminology Dictionary

Except where noted in the Source: field, the terms and definitions in this dictionary are drawn verbatim from authoritative Army documents, most notably AR 310-25 (Dictionary of Army Terms) and FM 101-5-1 (Operational Terms and Symbols).

abatis
A vehicular obstacle constructed by felling trees 1-2 meters above the ground on both sides of the road so that they fall, interlocked, toward the expected direction of enemy approach. The trees should remain attached to the stumps, be at a 45-degree angle to the roadway, and the obstacle itself should be at least 75 meters in depth to be most effective.

administrative unit
Unit organically able to do its own interior management. It may be both administrative and tactical.

advance by bounds
Move forward in a series of separate advances, usually from cover to cover or from one point of observation to the next.

advance by echelon
Advance by separate elements of a command moving at different times.

advance depot
Supply point in the forward part of the communications zone of a theater of operations, ahead of the intermediate and base depots.

advance detachment
The leading element of an advance guard. It is set out from the advance guard.

advance guard
The security element operating to the front of a moving force.

advance officer
An officer designated by the commander to precede the column by a distance sufficient to reconnoiter the route of march and to select alternate routes or detours if required; to instruct and place guides and route markers, where appropriate; to notify authorities of approach of column and receive instructions or changes to instructions at highway regulation points. This officer may also command the advance party.

advance party
A security element of an advance guard. It is sent out from, and precedes, the advance guard support on the march. It sends forward and is preceded by the advance guard point.

air assault   Operations in which air assault forces (combat, combat support [CS], and combat service support [CSS]), using the firepower, mobility, and total integration of helicopter assets in their ground and air roles, maneuver on the battlefield under the control of the ground or air maneuver commander to engage and destroy enemy forces.

airborne operation

An operation involving the movement of combat forces and their logistic support into an objective area by air.

airborne units   Units organized, equipped, and trained primarily for making assault landings from the air.

airhead   1. A designated area in a hostile or threatened territory which, when secured, permits the delivery (airdropped or airlanded) of forces and supplies and provides maneuver space for operations. Normally it is the area seized in the assault phase of an airborne or air assault operation.

2. A designated location in an area of operations used as a base for supply and evacuation by air.

See also beachhead and bridgehead

alternate position

The position given to a weapon or unit to be occupied when the primary position becomes untenable or unsuitable for carrying its task. The alternate position is so located that the weapon or unit can continue to fulfill its original task.

area of influence

A geographical area wherein the commander is directly capable of influencing operations by maneuver or fire support systems normally under his command or control.

area of interest   That area of concern to the commander, including the area of influence, areas adjacent thereto, and extending into enemy territory to the objectives of current or planned operations. This area also includes areas occupied by enemy forces who could jeopardize the accomplishment of the mission.

area of operations

That portion of an area of conflict necessary to conduct military operations. Areas of operations are geographical areas assigned to commanders for which they have responsibility and in which they have authority to conduct military operations.

area of responsibility

A defined area of land in which responsibility is specifically assigned to the commander of the area for the development and maintenance of installations, control of movement, and the conduct of tactical operations involving troops under his control along with parallel authority to exercise these functions.

armor

A fighting combined arms team consisting of tanks and armored cavalry reconnaissance/security units, supported on the battlefield by Army aviation, a flexible and rapid communications network, and a mobile logistics system, all trained and equipped for mounted ground combat.

armor group

A field army unit designed to exercise command control and supervision of one or more separate tanks, armored infantry, and armored cavalry battalions, assigned to a corps or field army.

armor sweep

A raid or other limited attack without terrain objective by a rapidly moving armor unit through or across enemy controlled territory. An armor sweep may be conducted for reconnaissance in force, destruction or capture of personnel or material, or to harass or disrupt enemy plans and operations.

armored cavalry

Combat units characterized by a high degree of mobility, firepower, shock action, and multiple flexible communications. The units are especially designed to execute reconnaissance, security, combat, or economy of force operations utilizing organic surface and air mode of transport.

armored infantry

A field Army unit designed to close and destroy the enemy by fire and maneuver, to repel hostile assault in close combat, and to provide support for tanks.

army

The largest administrative unit of the forces consisting of two or more Army corps and supporting troops; field army.

asset

A useful or valuable quality or thing (soldiers, machines, arms, and ammunition are common Army assets).

Source: American Heritage Dictionary (with SEI annotation)

avenue of approach

An air or ground route of an attacking force of a given size leading to its objective or to key terrain in its path.

basic load

For other than ammunition, basic loads are supplies kept by using units for use in combat. The quantity of each item of supply in the basic load is related to the number of days in combat the unit may be sustained without resupply.

For ammunition, it is that quantity of nonnuclear ammunition authorized and required to be on hand in a unit to meet combat needs until resupply can be accomplished. The basic load for ammunition is specified by the theater army and is expressed in rounds, units, or units of weight as appropriate.

basic tactical unit

Fundamental unit capable of carrying out an independent tactical mission, such as a rifle company in the infantry or a battery in artillery.

battalion

Unit composed of a headquarters and two or more companies or batteries. It may be part of a regiment and be charged with tactical functions only, or it may be a separate unit and be charged with both administrative and tactical functions.

battery

The basic tactical artillery unit, corresponding to the company in the infantry.

Source: American Heritage Dictionary

battle position

Position on which the main effort of the defense is concentrated. A battle position is made up of defensive sectors that support one another.

beachhead

A designated area on a hostile shore which, when secured, ensures the continuous landing of troops and material, and provides maneuver space requisite for subsequent projected operations ashore. The beachhead is the physical objective of an amphibious operation.

See also airhead and bridgehead

bound

1. Single movement, usually from one covered and concealed position to another by dismounted troops or combat vehicles.

2. Distance covered in one movement by a unit which is advancing by bounds.

See also advance by bounds

boundary   A control measure normally drawn along identifiable terrain features and used to delineate areas of tactical responsibility for subordinate units. Within their boundaries, units may maneuver within the overall plan without close coordination with neighboring units unless otherwise restricted. Direct fire may also be placed across boundaries on clearly identified enemy targets without prior coordination, provided friendly forces are not endangered. Indirect fire also may be used after prior coordination.

Lateral boundaries are used to control combat operation of adjacent units.

Rear boundaries are established to facilitate command and control.

bridgehead   1. An area of ground held or to be gained on the enemy's side of an obstacle.

2. In river crossing operations, an area on the enemy's side of the water obstacle that is large enough to accommodate the majority of the crossing force, has adequate terrain to permit defense of the crossing sites, and provides a base for continuing the attack. As a minimum, ground must be secured which eliminates direct and observed indirect fires on the crossing site.

See also airhead and beachhead

brigade   1. A unit consisting of a variable number of combat battalions.

2. Formerly, a unit of the Army composed of two or more regiments commanded by a brigadier general.

Source: America Heritage Dictionary

brigade support area

A designated area in which combat service support (CSS) elements from division support command (DISCOM) and corps support command (COSCOM) provide logistic support to a brigade. It normally is located 20 to 25 kilometers behind the forward edge of the battle area (FEBA).

checkpoint   A predetermined point on the ground used as a means of coordinating friendly movement. Checkpoints are not used as reference points in reporting enemy locations.

close air support

Air action against hostile targets that are in close proximity to friendly forces and that requires detailed integration of each air mission with the fire and movement of those forces.

coil   An arrangement of vehicles forming a circle.

column formation

An arrangement of vehicles or dismounted troops which (1) provides good security and permits maximum fire to the flanks; (2) facilitates control; (3) facilitates rapid deployment into any other formation; (4) is used in road marches, night movements, and when passing through defiles or dense woods.

combat arm   Branch of the Army whose officers are directly involved in the conduct of actual fighting. They are Aviation, Infantry, Field Artillery, Air Defense Artillery, Armor, and Corps of Engineers.

combat orders   Orders pertaining to operations in the field. They include operation orders, administrative orders, and letters of instruction.

combat service support

A grouping of branches and officers primarily concerned with providing combat service support and/or administration to the Army as a whole. They are Adjutant General, Finance, Ordnance, Quartermaster, and Transportation. Engineer, Signal, and Military Police are both services and arms.

combat support arm

Branch of the Army whose officers provide operational assistance to the combat arms. They are Corps of Engineers, Signal Corps, Chemical Corps, Military Police Corps, and Military Intelligence. Certain branches are both an arm and a service.

combined arms More than one tactical branch of the Army used together in operations.

command   A specifically designated linetype organization with direct line authority from the next higher commander or the Chief of Staff, United States Army. It must have a clearly identifiable headquarters and an organization structure composed of a variety of units.

commander's estimate

The procedure whereby a commander decides how to best accomplish the assigned mission. It is a thorough consideration of the mission, enemy, terrain and weather, troops available, time (METT-T), and other relevant factors. The commander's estimate is based upon personal knowledge of the situation and upon staff estimates.

See also staff estimate

commander's intent

Commander's vision of the battle - how he expects to fight and what he expects to accomplish.

See concept of operations

command post   The principal facility employed by the commander to command and control combat operations. A CP consists of those coordinating and special staff activities and representatives from supporting Army elements and other services that may be needed to carry out operations. Corps and division HQ are particularly adaptable to organization by echelon into a tactical CP, a main CP, and a rear CP.

See also tactical command post, main command post, rear command post

commitment   Assignment of units and/or resources to given courses of actions or uses.

communications

Routes and transportation for moving troops and supplies, especially in a theater of operations.

company   Basic administrative and tactical unit in most branches of the Army. A company is on a command level below the battalion and above a platoon and is equivalent to a battery of artillery, etc.

compartment of terrain

Terrain area bounded on at least two sides by terrain features such as woods, ridges or villages, which limit observation and observed fire into the area from points outside the area.

concentration   Assembly of troops in a given locality for purposes of offense or defense.

concept of operation

A graphic, verbal, or written statement in broad outline that gives an overall picture of a commander's assumptions or intent in regard to an operation or series of operations; includes at a minimum the scheme of maneuver and fire support plan. The concept of operations is embodied in campaign plans and operations plans particularly when the plans cover a series of connected operations to be carried out simultaneously or in succession. It is described in sufficient detail for the staff and subordinate commanders to understand what they are to do and how to fight the battle without further instructions.

constraint   Something that restricts, limits, or regulates.

Source: American Heritage Dictionary

control   Authority or ability to direct or regulate.

Source: American Heritage Dictionary

control measures

Directives given graphically or orally by a commander to subordinate commands in order to assign responsibilities, coordinate fires and maneuver, and to control combat operations. Each control measure can be portrayed graphically. A minimum number of control measures should be used so that the operation progresses according to the concept of the operation. Less restrictive control measures are used, as much as possible, to permit subordinate commanders the freedom of action in executing assigned missions. In general, all control measures should be easily identified on the ground. Examples of control measures include boundaries, objectives, coordinating points, contact points, lines of departure, assembly areas, axis of advance, and direction of attack.

control point   A conspicuous terrain point which is given a name or number as a means of control of traffic movement.

convoy   A group of 10 or more vehicles organized for the purpose of control and orderly movement with or without escort protection.

corps   A tactical unit of ground forces between a field army and a division commanded by a lieutenant general and composed of two or more divisions and auxiliary service troops.

                      Source: American Heritage Dictionary

coordinating point
                      A control measure that indicates a specific location for the coordination of fires and maneuver between adjacent units. They usually are indicated whenever a boundary crosses the forward edge of the battle area (FEBA), and may be indicated when a boundary crosses report lines or phase lines used to control security forces. In NATO, physical contact between adjacent units is required.

corridor   Compartment of terrain, the longer axis of which is parallel to, or extends in, the direction of movement of a force.

course of action 1. Any sequence of acts that an individual or unit may follow.

                      2. A possible plan open to an individual or commander that would accomplish or is related to accomplishment of the mission.

                      3. A feasible way to accomplish a task or mission which follows the guidance given, will not result in undue damage/risk to the command, and is noticeably different from other actions being considered.

covered approach
                      1. Any route that offers protection against enemy observation or fire.

                      2. Approach made under protection of other forces or by natural cover.

covered movement
                      A movement of troops when adequate security is provided by other friendly forces.

covering barrier A barrier located beyond the forward edge of the battle area which is elected by field army, corps, or division to assist in delaying actions of covering and security forces.

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critical point   1. A roadway structure or feature which limits road width, overhead clearance, or vehicle load class as well as any feature which interferes with the meeting or crossing of two or more streams of traffic.

2. A selected point along a route used for reference in giving instructions. It includes start points, release points, and other points along a route where interference with movement may occur or timings are critical.

See also start point, release point, harbor area

Source: FM 55-10, FM 101-5, Page G-162

cross compartment
Compartment of terrain, the longer axis of which is perpendicular or oblique to the direction of movement of a force.

cross-country movement
The movement of military vehicles (usually tactical) across terrain without using roads and bridges.

crossing site   A crossing point or site used for vehicles and equipment to cross a restrictive terrain feature.

debarkation   The loading of troops with their supplies and equipment from ships and/or aircraft.

dedicated battery
A cannon battery whose total fire power is immediately available to suppress enemy direct fire weapons that threaten a designated company/team during a movement to contact.

deep battle   All actions that support the friendly scheme of maneuver and which deny the enemy commander the ability to employ his forces not yet engaged at the time, place, or in the strength of his choice.

defense area   Area assigned to a given unit to be protected from, and held against, enemy attack.

defense in place System of defense based upon firm resistance without retreat, as opposed to delaying action in successive positions.

deferred unit A unit whose required delivery date in support of a specific operation plan has been postponed.

defile A narrow passage that tends to restrict the movement of troops.

delaying position

Position taken to slow the advance of the enemy without being decisively engaged.

detached unit A unit that is serving away from the organization to which it is organic and to which it remains assigned. A detached unit may function as an independent organization, or it may be attached to or serve with or under another organization.

See also operational control

direct To give orders or commands.

Source: American Heritage Dictionary.

direct support 1. A mission requiring a force to support another specific force and authorizing it to answer directly the supported force's request for assistance.

2. In NATO, the support provided by a unit or formation not attached to, nor under command of, the supported unit or formation, but required to give priority to the support required by that unit or formation.

See also general support

division An administrative and tactical unit that is smaller than a corps but is self-contained and equipped for prolonged combat activity.

Source: American Heritage Dictionary.

double envelopment

A form of enveloping maneuver executed by three principal tactical groups; a secondary attack force which attacks the enemy frontally, and two enveloping attack forces which move around the flanks of the enemy position to attack the flanks or objectives in the rear of the enemy front line.

double staggered column

Two-lane column of vehicles moving in the same direction, so spaced that the vehicles in one lane are opposite the space between vehicles in the other lane.

earliest arrival time

The earliest date a unit should arrive "in theater" in support of a specific operation plan.

echelon

1. Subdivision of a headquarters (such as forward echelon, rear echelon).

2. Separate level of command. As compared to a brigade, a division is a higher echelon; a battalion is a lower echelon.

3. A fraction of a command in the direction of depth to which a principal combat mission is assigned (such as attack echelon, support echelon, reserve echelon).

4. A formation in which its subdivisions are placed one behind another, with a lateral and even spacing to the same side.

echelons above corps

Army headquarters and organizations that provide the interface between the theater commander (joint or combined) and the corps for operational matters, and between the continental United States (CONUS)/host nation and the deployed corps for combat service support (CSS). Operational EAC may be US only or allied headquarters while EAC for CSS will normally be US national organizations.

embarkation

The loading of troops with their supplies and equipment into ships and/or aircraft.

engineer

Member of the Corps of Engineers; soldier who performs engineer duties, including construction, demolition, surveying, road and bridge building, and camouflage.

execute

To perform or carry out what is required by orders.

Source: American Heritage Dictionary.

external control In highway transportation, the control exercised by a higher headquarters, such as a highway traffic regulation headquarters, and/or by military police, over a convoy, serial or march unit.

field artillery A basic branch of the Army. The branch name identifies personnel and units which employ cannons, rockets and missiles systems, with target acquisition means assisting in land combat operations.

final coordination line
A line close to the enemy position used to coordinate the lifting and shifting of supporting fires with the final deployment of maneuver elements. It should be recognizable on the ground.

final protective line
Line selected where an enemy is to be checked by interlocking fires from all available weapons. A final protective line may be parallel with, or oblique to, the front of the position.

fire direction Tactical employment of fire power; the exercise of tactical command of one or more units in the selection of targets, the concentration or distribution of fire, and allocation of ammunition for each mission.

fire support Assistance to those elements of the ground forces that close with the enemy (such as infantry and armor units), rendered by delivering field artillery fire, naval gun fire, and close air support.

flow cycle The complete sequence of phase movement through a traffic point.

flow phase Nonconflicting movement of traffic through a traffic point.

follow-up element
Elements following a march column whether for cleanup, prevention of straggling, maintenance and recovery of equipment, or other purposes.

forward command post
Station of a unit's headquarters where the commander and staff work. In combat, a unit's headquarters is often divided into a forward and rear echelon.

forward echelon That part of a headquarters which is principally concerned with the tactical control of battle.

See also rear echelon

free maneuver   Practice maneuver in which each force acts as it chooses, and is limited only by the field orders received, by restrictions of area and time, and by the actions of the opposing force.

general support   Support that is given to the supported force as a whole and not to any particular subdivision thereof.

See also direct support

going   The classification of terrain according to its ability to support the passage of vehicles.

grid coordinates   The easting and northing value (of a grid) that designate the location of a point with respect to the grid. Coordinates usually are expressed to the nearest 100, 10, or 1 meter, with the easting and northing values combined into a single expression.

Examples: 329378 (nearest 100 meters); 32943785 (nearest 10 meters), 3294837853 (nearest 1 meter).

guide on me   Order given by a battery commander for a unit to follow his movements. This unit then becomes the guide for the other units.

harbor area   An area designated for normal halts, for traffic control, and to avoid congestion in emergencies. Example applications are: to hold vehicles at both ends of a crossing or defile; to effect changes in density, especially at first or last light; to use as spillover areas in case of serious delay, which are likely to be caused by enemy air attack or its results; to use as areas where columns can rest and carry out maintenance and decontamination that may be necessary; to allow elements to change position in column if there is a change in priorities.

See also defile and critical point

Source: FM 101-5, Page G-20

headquarters company

Administrative and tactical element of battalion or larger unit, with personnel used for the purposes of administration, intelligence, communications, and other necessary activities.

headquarters detachment

        Administrative and tactical element of a battalion or larger unit. In this meaning, a headquarters detachment differs from a headquarters company in that it has fewer personnel.

heavy level of operations

        Operations involving more than 60 percent of all force maneuver echelons and all fire support means engaged in all-out combat demanding total strength application over a period of time to include possible employment of next higher echelon resources to assure accomplishment of the force mission.

highway capacity

        Maximum traffic flow obtainable on a given roadway using all available lanes.

highway regulation

        Planning, routing, and scheduling the actual use of highways by vehicles, personnel afoot (including troops, refugees, and civilians), and animals to utilize highway transportation facilities and equipment most effectively in order to meet operational requirements.

highway regulation plan

        A staff plan which combines pertinent information from standard operating procedures, directives, regulations, traffic circulation overlays, and staff estimates on the capabilities of the existing road network to handle the traffic that must go over it.

highway regulation point

        Point on the highway at which the highway transport service records and reports the arrival and departure of, and regulates elements of, highway movement by issuing instructions for the continuance of the march, detours, diversions, schedules, etc.

highway traffic regulations

        The coordination and the actual use of the road network by vehicles, personnel, and animals needed to meet military requirements. It consist of planning, routing, scheduling, and diverting movements on the available road networks in accordance with priorities.

holding force   Forces assigned to hold a place or position; force that carries out a holding attack.

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infantry   Infantry is a basic branch of the Army. The branch name identifies person-
                      nel and units who close with the enemy by means of fire and maneuver in
                      order to destroy or capture him, or to repel his assault by fire, close combat,
                      and counterattack. Personnel and units so identified fight dismounted or
                      mounted according to the mobility means provided.

intelligence   The product resulting from the collection, processing, integration, analysis,
                      evaluation, and interpretation of available information which concerns one
                      or more aspects of foreign nations or of areas of operations that is immedi-
                      ately or potentially significant to military planning and operations.

lane   1. A clear route through an obstacle. A single lane is normally 8 meters wide
                      and suitably marked; a double lane is 16 meters wide.

                      2. Strip of roadway intended to accommodate the forward movement of a
                      single line of vehicles, usually 8 feet to 13 feet in width.

length of column

                      The length of roadway occupied by a column in movement including the
                      gaps inside the column for the front of the leading vehicle to the rear of the
                      last vehicle.

letter of instructions

                      Form of order by which superior commanders give information as to broad
                      aims, policies, and strategic plans for operations in large areas over a con-
                      siderable period of time. It is issued to large units of a command and has
                      the same authority as an operations order. A letter of instruction is intended
                      for the guidance and control of the operations of a large command.

line of departure In ground operations, a line, ordinarily located on or behind the last avail-
                      able terrain mask which can be reached without exposure to hostile obser-
                      vation and small arms fire; suitable, clearly defined terrain features such as
                      roads, edges of woods, and friendly front lines may be used.

logistics   The planning and carrying out of the movement and maintenance of forces.
                      In its most comprehensive sense, those aspects of military operations
                      which deal with (1) design and development, acquisition, storage, move-
                      ment, distribution, maintenance, evacuation, and disposition of material; (2)
                      movement, evacuation, and hospitalization of personnel; (3) acquisition or
                      construction, maintenance, operation, and disposition of facilities; and (4)
                      acquisition or furnishing of services.

logistic support Provision of adequate material and services to a military force to assure successful accomplishment of assigned missions.

main command post

The main command post consists of those staff activities involved in controlling and sustaining current operations and in planning future operations. The main CP normally operates under the control of the chief of staff. In addition to the chief of staff, the main CP consists of G1, G2, G3, and G4 elements; fire support and chemical elements, tactical air control party (TACP) element, and an Army airspace command and control (A2C2) element consisting of air defense artillery (ADA) and Army aviation staff elements. The main CP exercises command and control of the current operations in case where a tactical CP is not employed.

See also rear command post, tactical command post

main defense area

The area in which the main defensive battle is fought. For any particular command, this area extends from the forward edge of the battle area to the rear boundaries of those units comprising its main defensive forces.

maneuver The movement of forces supported by fire to achieve a position of advantage from which to destroy or threaten destruction of the enemy. A principle of war (from FM 100-5).

maneuver control

Employing forces on the battlefield through movement in combination with fire or fire potential to achieve an advantage over the enemy in order to accomplish the mission. The tactical commander is responsible for this function.

Source: FM 55-10

maneuvering force

Element of a combat unit that seeks to seize an attack objective through movement to a more advantageous position with respect to the enemy.

march column Consists of all elements using the same route for a single movement of troops. March columns, regardless of size, are composed of three elements: a head, a main body, and a trail party, which perform various functions.

See also functional unit

march unit Unit which moves and halts at the order of a single commander. The march unit normally corresponds to one of the smaller troop units such as a squad, section, platoon, company, or battery.

metalled road Road constructed of gravel, crushed stone, slag, or similar material with a binder of fine aggregate tar or cement.

mission 1. The primary task assigned to an individual, unit, or force. It usually contains the elements of who, what, where, and the reason therefor, but seldom specifies how.

2. The dispatching of one or more aircraft to accomplish one particular task.

mobile unit A unit equipped with sufficient organic vehicles for the purposes of transporting all assigned personnel and equipment from one location to another at one time.

moderate level of operations
Operations involving 30-60 percent of all force maneuver echelons and over 50 percent of all fire support means engaged in continuous combat over a period of time, during which the employment of next higher echelon resources to assure accomplishment of the force mission is not anticipated.

motor march Controlled movement of troops in which all elements move by motor.

movement A change in the location of military troops.

Source: American Heritage Dictionary.

movement capacity
The sum total of the capabilities of the shipping and receiving agencies and the transport services.

movement control
The planning, routing, scheduling, control, and in-transit visibility of personnel, units, equipment, and supplies moving over lines of communication in accordance with the directives of command planning. It is a continuum involving the synchronization and integration of movement information and

programs spanning the strategic, operational and tactical levels of war. Movement control is guided by a system of balancing requirements against capabilities and allocating resources based on the combat commander's priorities.

Source: FM 55-10

movement instructions

Detailed instructions for the execution of a movement. They are issued by a transportation officer as an implementation of the movement programs, and represent accepted procedure to be followed by the shipper or receiver and transport services.

movement plan 1. Up-to-date logistics data reflecting a summary of transportation requirements, priorities, and limiting factors incident to the movement of one or more units or other special grouping of personnel by highway, marine, rail, or air transportation.

2. A command directive that the TAMCA plans and plans division prepares with input from all movement control levels. The plan allots available transportation to support requirements based on tactical priorities that the operational commander sets the supply and movement priorities for unit commanders. The plan provides transportation priorities to resolve competition, traffic, and mode management decisions so that available transportation assets are best used and comply with any Host Nation-imposed restrictions.

movement program

A plan prepared by a transportation movements section and issued in the name of the commander for the accomplishment of required movement by available transportation facilities projected over a stated period of time.

movement requirement

The request to transport personnel or material that has been approved by the appropriate commander.

movement to contact

Ground movement which is conducted in a theater of operations preliminary to combat to place troops in position to close with the enemy. Movement to contact is usually conducted in three phases: a. Contact remote; b. Contact improbable; c. Contact imminent.

objective area 1. A defined geographical area where an objective is to be captured or reached by the military forces.

2. In airborne, air assault, and amphibious operations, it is the proposed area of operations and includes the airhead or beachhead.

oblique compartment
Compartment of terrain, whose long axis is diagonal to the direction of march or to the front.

obstacle 1. Any obstruction that stops, delays, or diverts movement. Obstacles may be natural: deserts, rivers, swamps, or mountains; or they may be artificial: barbed wire entanglements, pits, concrete or metal antimechanized traps, and they may be issued ready-made or they may be constructed in the field.

2. A definable terrain feature that inhibits intervisibility or movement.

offensive 1. Condition of a force when it is attacking.

2. Attacking; ready to attack.

3. Suitable for attack; used for attack. Gun and tanks are often offensive weapons.

open column A motor column in which distance between vehicles is increased to accomplish greater dispersion.

open route Roadway over which a minimum of supervision is exercised.

operation order for road movement
Instructions issued for movement of personnel and prescribed equipment for one location to another within a stated period of time. These orders are issued by the authority having jurisdiction over the personnel involved in the order.

operational control
The authority delegated to a commander to direct forces assigned so that the commander may accomplish specific missions or tasks that are usually limited by function, time, or location; to deploy units concerned; and to retain or assign tactical control of those units. It does not of itself include administrative or logistic control. In NATO, it does not include authority to assign separate employment of components of the units concerned.

operational plan

A plan for a single or series of operations to be carried out simultaneously or in succession. It is usually based upon stated assumptions and is the form of directive employed by higher authority to permit subordinate commander to prepare supporting plans and orders.

option
Something chosen or available as a choice.

Source: American Heritage Dictionary.

order
A communication, whether written, oral, or by signal, that conveys instructions from a superior to a subordinate. In a broad sense, the terms "order" and "command" are synonymous. However, an order implies discretion as to the details of execution whereas a command does not.

organic
Assigned to and forming an essential part of a military organization; an element normally shown in the unit's table of organization and equipment (TOE).

plan
1. Formulate a scheme or program for the accomplishment of tactical objectives.

2. The results of the formulation in 1.

Source: American Heritage Dictionary.

prescribed load
The quantity of combat essential supplies and repair parts (other than ammunition) authorized by major commanders to be on hand in units and which is carried by individuals or on unit vehicles. It is normally a 15-day level. The prescribed load is continuously reconstituted as used.

primary road
A linear surface feature making an open way for vehicles on an artificially made surface of bitumen or concrete, of a width greater than 6 meters.

probable line of departure

A line previously selected on the ground where attacking units deploy prior to beginning an assault under conditions of limited visibility.

rear area
For any particular command, that area extending rearward from the rear boundary of its main defense area to that command's rear boundaries. The area primarily provided for the performance of administrative and logistic functions.

rear command post

The rear CP consists of those staff activities concerned primarily with combat service support (CSS) of the force, administrative support of the HQ, and other activities not immediately concerned with current operations. Typical representatives within the rear echelon are elements of the G1 and G4 sections, G5, Adjutant General (AG), Staff Judge Advocate (SJA), Inspector General (IG), Provost Marshal (PM), supporting Military Intelligence (MI) elements concerned with counterintelligence and prisoner of war interrogation (IPW) activities, and the tactical airlift representative of the tactical air control party (TACP). Normally, rear CPs are near or collocated with CSS units (for example, COSCOM).

See also main command post, Gx, COSCOM

rear echelon That part of a headquarters which is principally concerned with administrative and logistical matters.

reconnaissance in force

A limited objective operation by a considerable force to discover and test the enemy's dispositions and strengths, or to develop other intelligence.

regiment Administrative and tactical unit, on a command level below a division or brigade and above a battalion, the entire organization of which is prescribed by table of organization. The commanding officer of a regiment is usually a colonel.

regulating officer

Officer in command of a regulating station responsible for the smooth, orderly movement of troops and material within the area controlled.

regulating unit Unit within the marching column that sets the pace for the rest of the column.

release point A clearly-defined control point (or critical point) on a route at which specific elements of a column of ground vehicles or flight of aircraft revert to their respective commanders, each one of these elements continuing its movement towards its appropriate destination.

2. In dismounted attacks, that point at which a commander releases control of subordinate units to their commanders/leaders.

See also critical point, start point

request　　　Ask an entity to do something.

　　　　　　　Source: American Heritage Dictionary.

restricted traffic　Limited traffic, traffic over a route controlled by regulations limiting speeds, types of vehicles permitted maximum weight allowed, and hours at which the route may be open to different types of traffic.

retirement　　A retrograde operation in which a force out of contact moves away from the enemy.

retrograde　　An organized movement to the rear or away from the enemy. It may be forced by the enemy or may be made voluntarily. Such movements may be classified as withdrawal, retirement, or delaying operations.

road clearance distance
　　　　　　　The total distance the head of a motor column must travel for the entire column to clear a given section of road.

road movement graph
　　　　　　　Time space diagram used in planning and controlling marches, both road and foot, and in preparing or checking road movement tables.

road movement table
　　　　　　　A composite list showing the general organization and time and space schedule for march movement. It is generally published as an annex to an operation order for road movement.

road reconnaissance report
　　　　　　　A report which contains detailed information necessary for classification of a road.

road screen　　Anything that is used to conceal movement along a road from enemy observation, especially artificial concealment or camouflage.

route　　　The prescribed course to be traveled from a specific point of origin to a specific destination.

route classification
　　　　　　　Classification assigned to a route indicating the heaviest vehicle that can be accepted. It is based on the weakest bridge or portion of the route.

route column   1. Close order formation of troops, suitable for marching.

2. A flexible formation adopted for contact remote phase of movement to contact. During this phase, troops need not be tactically grouped, and may move by various means of transportation and by different routes.

routes of communication

Network of roads, etc., over which supplies are carried and combat movements are made. Routes of communication include navigable waters, aircraft landing, and rail facilities.

schedule control system

System of traffic control in which truck column and troops are dispatched over fixed routes at given rate of speed according to a time schedule.

secondary road   A linear surface feature making an open way for vehicles on an artificially made surface of gravel, bitumen, or concrete, and of a width between 4 and 6 meters.

signal axis   Line or route on which lie the starting and probable future locations of the command post of a unit during a troop movement; main route along which messages are relayed or sent to and from combat unit in the field.

single envelopment

Maneuver made against one flank, around one flank against the rear, of the initial disposition of the enemy.

staff   Officers who are specially ordered or detailed to assist the commander in his exercise of command. The staff provides information for the commander, makes a continuing study of the situation for anticipatory planning, submits recommendations as to plans and orders on its own initiative or in response to directives, translates decisions of the commander into orders, provides for dissemination thereof, and supervises, as directed, the execution of orders to insure adherence to and successful execution of the intentions and policies of the commander.

staff estimate   The staff officer's evaluation of how factors in his particular field of interest will influence the courses of action under consideration by the commander.

See also commander's estimate, Gx

start point   A clearly defined initial control point (or critical point) on a route at which specified elements of a column of ground vehicles or flight of aircraft come under the control of the commander having responsibility for the movement.

See also critical point, release point

strategic   Pertaining to the overall planning and conduct of large-scale combat operations.

Source: American Heritage Dictionary.

supplementary position

That location which provides the best means to accomplish a task that cannot be accomplished from the primary or alternative positions.

support echelon 1. Those elements that furnish logistical assistance to combat units.

2. Those units that support, by fire, the commander's plan of maneuver.

support unit   Unit that acts with, and assists or protects, another unit, but does not act under the orders of the commander of the protected unit of which it is not an organic part.

tactical   Pertaining to the employment of units in combat.

tactical column Contact improbable phase of movement to contact during which troops are tactically grouped to facilitate prompt adaptation of combat formations.

tactical command post

The tactical CP is the forward echelon of a headquarters. The tactical CP may consist of G2, G3, fire support, tactical air control party (TACP), air defense artillery (ADA), and combat service support (CSS) liaison (G1, G4) elements. It is located well forward on the battlefield so that the commander is in proximity to subordinate commanders and can directly influence operations. At division, the tactical CP is located within FM radio range of the committed brigades.

See also command post, main command post, Gx

tactical communications

Communications provided by, or under the operational control of, commanders of combat forces, combat troops, combat support troops, or forces assigned a combat service support mission.

tactical high mobility

The highest level of mobility designating the requirements for extensive cross-country maneuverability characteristic of operations in the ground-gaining and fire support environment.

tactical logistics The provision of logistics support to combat forces deployed within a theater of operations.

tactical movement

Movement of troops and equipment with a tactical mission under combat conditions when not in direct ground contact with the enemy.

tactical plan Plan for a particular combat operation, exclusive of arrangements for supply, evacuation, maintenance, or administration.

tactical standard mobility

The second highest level of mobility designating the requirement for occasional cross-country movement.

tactical support mobility

A level of mobility designating the requirement for infrequent off-road operations over selected terrain with the preponderance of movement on primary and secondary roads.

task force 1. Based upon mission, a temporary grouping of units under one commander formed to carry out a specific operation or mission, or a semipermanent organization of units under one commander to carry out a continuing single task. Units may be designated as a TF, regardless of attachments, whenever they are on a semi-independent mission. Brigades and higher units normally are not designated as TFs unless the mission requires joint airborne, amphibious, or other special, semi-independent operations.

2. Based upon organization, a battalion-sized unit of the combat arms consisting of a battalion control headquarters, with at least one of its major subordinate elements (a company), and the attachment of at least one company-sized element of another combat or combat support arm. An example is an infantry battalion headquarters; one or more of its organic companies; and the attachment of one or more of the following: a tank company, an armored cavalry troop, or an engineer company.

See also task organization

task organization

A temporary grouping of forces designed to accomplish a particular mission. Task organization involves the distribution of available assets to subordinate control headquarters by attachment or by placing assets in direct support (DS) or under the operational control of the subordinate.

technical intelligence

Intelligence concerning foreign technological developments, and the performance and operational capabilities of foreign material, which have or may have a practical application for military purposes.

terrain   The total of all natural or man-induced non-meteorological phenomena that influence the performance of vehicles, personnel, or other systems.

terrain analysis The process of interpreting a geographic area to determine the effect of the natural and man-made features on military operations.

terrain evaluation

The evaluation and interpretation of an area of probable military operations to determine the effect of the terrain on the lines of action open to opposing forces in the area.

terrain factor   Any attribute of the terrain that can be adequately described at any point (or any instant of time) by a single measurable value; for example, slope or obstacle height.

tertiary road   A linear surface feature making an open way for vehicles or persons on a natural treated surface to improve its trafficability or gravel surface (including footpaths) less than 4 meters wide.

throughput distribution
>The shipment of supplies from point of origin as far forward into the combat zone as possible, bypassing intermediate supply activities.

thrust line
>Line forming the base of all coordinates in the thrust line system locating the position of objects on a map. It is a line designated by the commander, and located on the map by two reference points, or by a reference point and a direction. Somewhere along the thrust line is a base point, designated by the commander, from which all coordinates are measured. Points are located by giving their distance along the thrust line, forward or back of the base point, and their distance perpendicular to the thrust line.

time distance
>Time required for any one vehicle to travel between two given points at a given rate of speed.

time gap
>The sum of the intervals between columns and elements of the columns. It is expressed in minutes.

time interval
>The time that elapses between successive elements of a column as they move past a given point.

traffic control
>Includes enforcing traffic laws and regulations, investigating traffic accidents and directing traffic. It is a function of the Military Police.

traffic control point
>A place at which traffic is controlled either by military police or by mechanical means.

traffic headquarters
>Headquarters exercising highway traffic regulation, which is planning, routing, scheduling, and directing the actual use of the highway by vehicles, personnel afoot (including troops, refugees, and other civilians), and animals to utilize highway transportation facilities and equipment most effectively in accordance with assigned tasks.

traffic management
>The direction, control, and supervision of all functions incident to the procurement and use of freight and passenger transportation services.

traffic map
>Map used in planning and regulating the flow of traffic. It includes routes, road data, the direction of movement, and the amount of traffic moving.

transportation engineering

> The science of evaluating the requirements for and planning the layout and functional aspects of transportation facilities; and of developing the most efficient relationships with respect to transportation equipment, transportation facilities, and traffic movement patterns so as to ensure adequate, safe, and efficient movement by all means of transportation.

transportation intelligence

> A facet of technical intelligence, it is the end product resulting from the collection, evaluation, interpretation, analysis, and integration of all available information about the air, land, and water transportation systems of foreign areas of operations that are of immediate or potential military significance. This intelligence includes data on the characteristics, condition, development, organization, material operation, maintenance, and construction of transportation systems facilities.

transportation management

> The performance of command and/or staff functions related to planning, coordinating, evaluating, and analyzing all aspects of water, rail, highway, and air transportation systems; development of transportation policies and doctrine; assessment of capabilities in terms of current and projected transport requirements; allocation and monitoring the use of transportation resources in accordance with established priorities; and preparation of contingency transportation plans.

transportation movements

> The management of the movement capability to ensure maximum accomplishment of movement requirements.

troop
A subordinate unit of the cavalry squadron. The troop has both administrative and tactical functions. It is equivalent to a company or battery.

uncover
Expose or leaved unprotected by movement or maneuver.

uncovered movement

> A movement made when security normally provided by other friendly forces is lacking.

withdrawal
A retrograde operation in which a force in contact with the enemy frees itself for a new mission.

Appendix H   Movement Control Domain Acronyms

The acronyms in this appendix are drawn from those used in various documents. If the acronym's meaning is not given elsewhere in this report, a definition is given as well as the full name of the acronym.

A2C2   *Army Airspace Command and Control*

ACCS   *Army Command and Control Systems*

                 The acronym for refering to the grouping of command and control systems used at all levels of command, including AWIS and others for strategic purposes and ATCCS for tactical usage.

ACP   *Air Control Point*

ACR   *Armored Cavalry Regiment*

ADA   *Air Defense Artillery*

AFATDS   *Advanced Field Artillery Tactical Data System*

                 The node of the ATCCS system for the Fire Support BFA.

AO   *Area of Operations*

ASAS   *All Source Analysis System*

                 The node of the ATCCS system for the Intelligence and Electronic Warfare BFA.

ASL   *Authorized Stockage List*

                 A list of items from all classes of supplies to be stocked at a specific echelon of supply.

ATCCS   *Army Tactical Command and Control System*

                 An integrated system consisting of five functional nodes, one supporting each BFA, that constitutes a FLCS for use at the ECB level.

ATMCT   *Air Terminal Movement Control Team*

AWIS   *Army WWMCCS Information System*

A system used by the Army which is part of the WWMCCS system used by all three military services.

See WWMCCS

BFA   *Battlefield Functional Area*

One of the areas of interest for controlling tactical assets in a combat situation. The BFAs for the ATCCS domain are 1) Maneuver, 2) Air Defense, 3) Fire Support, 4) Intelligence and Electronic Warfare, and 5) Combat Service Support.

BMCT   *Branch Movement Control Team*

BMNT   *Beginning Morning Nautical Twilight*

Begins when the sun is 12 degrees below the horizon. It is the start of that period where, in good conditions and in the absence of other illumination, enough light is available to identify the general outlines of ground objects, conduct limited military operations, and engage in most types of ground movement without difficulty.

CAS   *Close Air Support*

CMCC   *Combined Movement Control Center*

COMMZ   *COMMunications Zone*

COSCOM   *COrps Support COMmand*

CS   *Combat Support*

CSS   *Combat Service Support*

CSSCS   *Combat Service Support Control System*

The node of the ATCCS system for the Combat Service Support BFA.

CTMC   *Combined Transportation Movement Center*

CTO   *Corps Transportation Officer*

DAMMS-R   *Department of the Army Movement Management System - Redesign*

DISCOM   *DIvision Support COMmand*

DODAAC   *Department Of Defense Activity Address Code*

DS   *Direct Support*

DTG   *Date Time Group*

DTO   *Division Transportation Office(r)*

EAC   *Echelons Above Corps*

ECB   *Echelons Corps and Below*

Those command entities at the Corps level or below. For example, Division, Brigade, Regiment, Battalion, etc.

EENT   *End Evening Nautical Twilight*

Occurs when the sun has dropped 12 degrees below the horizon, and is the instant of last available daylight for the visual control of limited ground operations. At the EENT, there is no further sunlight available.

FAADC3I   *Forward Area Air Defense Command, Control, Communications, and Intelligence*

The node of the ATCCS system for the Air Defense BFA.

FEBA   *Forward Edge of Battle Area*

The front line of the combat area where enemy units are in close proximity.

FLCS   *Force Level Control System*

A system for coordinating the usage of Army units and their assets at various levels of command. For example, ATCCS is a FLCS for Corps, Division, and Brigade level units with planned extensions to include the maneuver Battalion level units. WWMCCS is a FLCS at the EAC level.

FLOT   *Forward Line of Own Troops*

The line showing the position of all friendly forces who are closest to the enemy.

FRAGO   *FRAGmentary Order*

GS   *General Support*

Gx   *General's staff, area x*

Members of a command staff organization headed by an general officer whose responsibilities are designated by the numeral following the G. They include:

G1: Administration and Personnel

G2: Intelligence

G3: Operations and Plans

G4: Logistics

G5: Civil Affairs

HET   *Heavy Equipment Transporter*

HHC   *Headquarters and Headquarters Company*

HHD   *Headquarters and Headquarters Detachment*

HMCT   *Highway Movement Control Team*

HNS   *Host Nation Support*

HQ   *HeadQuarters*

HRP   *Highway Regulating Point*

HRPT   *Highway Regulating Point Team*

HTD   *Highway Traffic Division*

IEW   *Intelligence/Electronic Warfare*

IPB   *Intelligence Preparation of the Battlefield*

A systematic approach to analyzing the enemy, weather, and terrain in a specific geographic area. It integrates enemy doctrine with the weather and terrain as they relate to the mission and the specific battlefield environment. This is done to determine and evaluate enemy capabilities, vulnerabilities, and probable courses of action.

Jx   *Joint force staff, area x*

Staff officer to a joint force commander (multination and/or multiservice), with the responsibilities designated by the numeral x. See Gx

JOPES   *Joint Operational Planning and Execution System*

LIC   *Low-Intensity Conflict*

Political-miltary confrontation between contending states or groups below conventional war and above the routine, peaceful competition among states. It frequently involves protracted struggles of competing principles and ideologies. Low-intensity conflict ranges from subversion to the use of armed force. It is waged by a combination of means employing political, economic, informational, and military instruments. Low-intensity conflicts are often localized, generally in the Third World, but contain regional and global security implications.

LOC   *Lines Of Communication*

MBA   *Main Battle Area*

MCA   *Movement Control Agency*

MCC   *Movement Control Center*

MCO   *Movement Control Officer*

MCS   *Maneuver Control System*

The node of the ATCCS system for the Maneuver BFA.

MCT   *Movement Control Team*

METT-T   *Mission, Enemy, Terrain, Troops, and Time available*

MHE   *Material Handling Equipment*

MI   *Military Intelligence*

MP   *Military Police*

MSR   *Main Supply Route*

MTMC   *Military Traffic Management Center*

OPCON   *OPerational CONtrol*

OPORD   *OPerational ORDer*

OPLAN   *Operational PLAN*

PDN   *Physical Distribution Network*

POD   *Port Of Debarkation*

POE   *Port Of Embarkation*

POL   *Petroleum, Oil, and Lubricants*

RAOC   *Rear Area Operations Center*

RCAS   *Reserve Component Automation System*

RMCT   *Regional Movement Control Team*

RMMT   *Rail Movement Management Team*

RP   *Release Point*

Sx   *Staff, area x*

Staff officer to a commander not of general rank, with the responsibilities designated by the numeral x. See Gx

S&S	*Supply and Service, or Service and Support*
	Also abbreviated as S/S.
SOP	*Standard Operating Procedure*
SP	*Start Point*
TAACOM	*Theater Army Area COMmand*
TACCS	*Tactical Army Combat Service Support Computer System*
TAMCA	*Theater Army Movement Control Agency*
TCMD	*Transportation Control and Movement Document*
TCN	*Transportation Control Number*
TCP	*Traffic Control Post or Plan*
TMR	*Transportation Movement Release*
TMT	*Transportation Movement Transport*
TOA	*Transportation Operating Agency*
TOE	*Table of Organization and Equipment*
TP	*Transportation Priority*
TPFDL	*Time-Phased Force Deployment List*
TR	*Transportation Request*
TRANSCOM	*TRANSportation COMmand*
UIC	*Unit Identification Code*

WWMCCS   *World Wide Military Command and Control System*

The agency that provides the national command authorities with the information on world situations needed for accurate and timely decisions, to include the communications required for reliable transmission of those decisions with a minimum of delay under all conditions of peace and war for the national direction of US military forces. It consists of the facilities, equipment, communications, procedures, and personnel that provide technical and operational support involved in the function of command and control of U.S. military forces.

Appendix I   MoveCon Vehicle and Sample Road Data

Id	Type	Length	Width	Height	Load	Description
101a	M151	6.5	5.5	4.5	3	Utility vehicle, $\frac{1}{4}$ ton, 4x4 "Jeep"
102a	M151	6.5	5.5	4.5	3	Utility vehicle, $\frac{1}{4}$ ton, 4x4 "Jeep"
103a	M151	6.5	5.5	4.5	3	Utility vehicle, $\frac{1}{4}$ ton, 4x4 "Jeep"
110c	M151	6.5	5.5	4.5	3	Utility vehicle, $\frac{1}{4}$ ton, 4x4 "Jeep"
206a	M880	9.5	6.5	6.0	4	Cargo truck, $1\frac{1}{4}$ ton, 4x4
208a	M880	9.5	6.5	6.0	4	Cargo truck, $1\frac{1}{4}$ ton, 4x4
209b	M880	9.5	6.5	6.0	4	Cargo truck, $1\frac{1}{4}$ ton, 4x4
222b	M35	11.5	7.5	7.5	10	Cargo truck, $2\frac{1}{2}$ ton, 6x6
226b	M35	11.5	7.5	7.5	10	Cargo truck, $2\frac{1}{2}$ ton, 6x6
227b	M35	11.5	7.5	7.5	10	Cargo truck, $2\frac{1}{2}$ ton, 6x6
231b	M35	11.5	7.5	7.5	10	Cargo truck, $2\frac{1}{2}$ ton, 6x6
310c	M814	14.0	7.0	8.25	21	Cargo truck, 5 ton, 6x6, w/winch
314c	M814	14.0	7.0	8.25	21	Cargo truck, 5 ton, 6x6, w/winch
317c	M814	14.0	7.0	8.25	21	Cargo truck, 5 ton, 6x6, w/winch
322d	M814	14.0	7.0	8.25	21	Cargo truck, 5 ton, 6x6, dropside
323d	M814	14.0	7.0	8.25	21	Cargo truck, 5 ton, 6x6, dropside
324d	M814	14.0	7.0	8.25	21	Cargo truck, 5 ton, 6x6, dropside
404b	M127	40.5	8.4	10.4	25	Trailer, platform, $12\frac{1}{2}$ ton w/M818 tractor
405b	M127	40.5	8.4	10.4	25	Trailer, platform, $12\frac{1}{2}$ ton w/M818 tractor
408b	M127	40.5	8.4	10.4	25	Trailer, platform, $12\frac{1}{2}$ ton w/M818 tractor
414b	M127	40.5	8.4	10.4	25	Trailer, platform, $12\frac{1}{2}$ ton wM818 tractor
452f	M871	43.0	8.8	11.5	35	Trailer, container, $22\frac{1}{2}$ ton w/M818 tractor
457f	M871	43.0	8.8	11.5	35	Trailer, container, $22\frac{1}{2}$ ton w/M818 tractor
462f	M871	43.0	8.8	11.5	35	Trailer, container, $22\frac{1}{2}$ ton w/M818 tractor
465g	M871	43.0	8.8	11.5	35	Trailer, container, $22\frac{1}{2}$ ton w/M818 tractor
513a	M872	53.2	9.1	12.2	46	Trailer, container, 34 ton w/M915 tractor
517a	M872	53.2	9.1	12.2	46	Trailer, container, 34 ton w/M915 tractor
519b	M872	53.2	9.1	12.2	46	Trailer, container, 34 ton w/M915 tractor

Table 3 List of Logistical Vehicles

Id	Type	Length	Width	Height	Load	Description
711a	M151	6.5	5.5	4.5	3	Utility vehicle, $\frac{1}{4}$ ton, 4x4 "Jeep",
712a	M151	6.5	5.5	4.5	3	Utility vehicle, $\frac{1}{4}$ ton, 4x4 "Jeep"
713a	M151	6.5	5.5	4.5	3	Utility vehicle, $\frac{1}{4}$ ton, 4x4 "Jeep",
714a	M151	6.5	5.5	4.5	3	Utility vehicle, $\frac{1}{4}$ ton, 4x4 "Jeep"
722b	M35	28.0	7.5	8.2	11	Truck, $2\frac{1}{2}$ ton towing 105 mm howitzer
724b	M35	28.0	7.5	8.2	11	Truck, $2\frac{1}{2}$ ton towing 105 mm howitzer
725b	M35	28.0	7.5	8.2	11	Truck, $2\frac{1}{2}$ ton towing 105 mm howitzer
726b	M35	28.0	7.5	8.2	11	Truck, $2\frac{1}{2}$ ton towing 105 mm howitzer
727b	M35	28.0	7.5	8.2	11	Truck, $2\frac{1}{2}$ ton towing 105 mm howitzer
728b	M35	28.0	7.5	8.2	11	Truck, $2\frac{1}{2}$ ton towing 105 mm howitzer
729b	M814	31.5	8.2	8.6	22	Truck, 5 ton towing 155 mm howitzer
731c	M814	31.5	8.2	8.6	22	Truck, 5 ton towing 155 mm howitzer
732c	M814	31.5	8.2	8.6	11	Truck, 5 ton towing 155 mm howitzer
791c	M35	22.0	7.5	9.5	12	Truck, $2\frac{1}{2}$ ton towing water tank
794b	M35	28.0	7.5	8.2	12	Truck, $2\frac{1}{2}$ ton towing MKT75 kitchen
742c	M35	22.5	7.5	11.5	12	Truck, $2\frac{1}{2}$ ton towing antenna/shelter
743c	M35	22.5	7.5	11.5	12	Truck, $2\frac{1}{2}$ ton towing antenna/shelter
746c	M35	22.5	7.5	8.2	12	Truck, $2\frac{1}{2}$ ton towing diesel generator
747c	M35	22.5	7.5	8.2	12	Truck, $2\frac{1}{2}$ ton towing diesel generator
751b	M814	28.5	9.2	10.2	15	Truck, 5 ton towing FC TCA trailer
752b	M814	28.5	9.2	10.2	15	Truck, 5 ton towing FC TCA trailer
755c	M127	38.5	8.8	10.3	25	Truck/trailer w/FIST team vehicle
756c	M127	38.5	8.8	10.3	25	Truck/trailer w/FIST team vehicle
757c	M127	38.5	8.8	10.3	25	Truck/trailer w/FIST team vehicle
795a	M814	26.5	8.2	9.8	22	Truck, 5 ton towing 4000 gal. gasoline tank

Table 4 List of Vehicles for Sample Field Artillery Unit Move

Seg. Id.	Endpoints	Length	Speed	Width	Weather	Load	Height	Obst.
A	0217, 0631	14.5	55	9.5	X	90	100.0	N
B	0217, 1225	12.8	40	9.2	Y	30	12.5	N
C	0217, 1113	9.8	35	8.8	Y	55	13.3	N
D	0217, 0604	13.6	55	9.3	X	90	100.0	N
E	0631, 2031	14.0	55	9.5	X	90	100.0	N
F	0631, 1225	8.7	45	8.4	Y	40	11.9	N
G	0604, 1402	8.2	55	9.5	X	90	15.2	N
H	1225, 1924	7.1	40	9.2	Y	25	13.8	N
I	1113, 1924	13.6	45	9.8	Y	40	12.9	N
J	1113, 2813	17.0	55	9.3	X	90	100.0	N
K	1113, 1905	11.3	55	9.7	X	90	100.0	N
L	1402, 1905	5.8	55	9.8	X	90	12.9	N
M	1402, 2802	14.0	55	9.5	X	90	100	N
N	1924, 3122	12.1	55	9.3	X	90	100.0	N
O	2031, 3731	17.0	55	9.5	X	90	100.0	N
P	2031, 3824	19.3	45	8.8	X	40	12.2	N
Q	1905, 3208	13.3	55	9.2	X	90	13.4	N
R	2813, 3122	15.8	55	9.0	X	90	14.8	N
S	2813, 3208	6.4	45	8.8	Y	45	13.5	N
T	2802, 3208	6.4	45	8.8	Y	35	13.0	N
U	2802, 3603	8.1	55	9.2	X	90	100.0	N
V	3122, 3824	7.3	45	8.8	X	90	100.0	N
W	3122, 3717	7.1	45	9.0	X	90	12.5	N
X	3208, 3717	10.3	55	9.2	X	90	100.0	N
Y	3603, 4505	9.2	55	9.2	X	35	12.8	N
Z	3731, 3824	7.1	55	9.0	X	90	100.0	N
AA	3731, 4429	7.3	55	9.2	X	90	100.0	N
AB	3824, 4516	10.6	45	8.5	Y	45	12.5	N
AC	3717, 4516	8.1	55	9.0	X	90	100.0	N
AD	3717, 4505	14.4	55	9.5	X	50	13.2	N
AE	4429, 4516	13.1	55	9.5	X	90	100.0	N
AF	4506, 4516	10.0	55	9.5	X	90	100.0	N

Table 5 List of Route Segment Characteristic Data
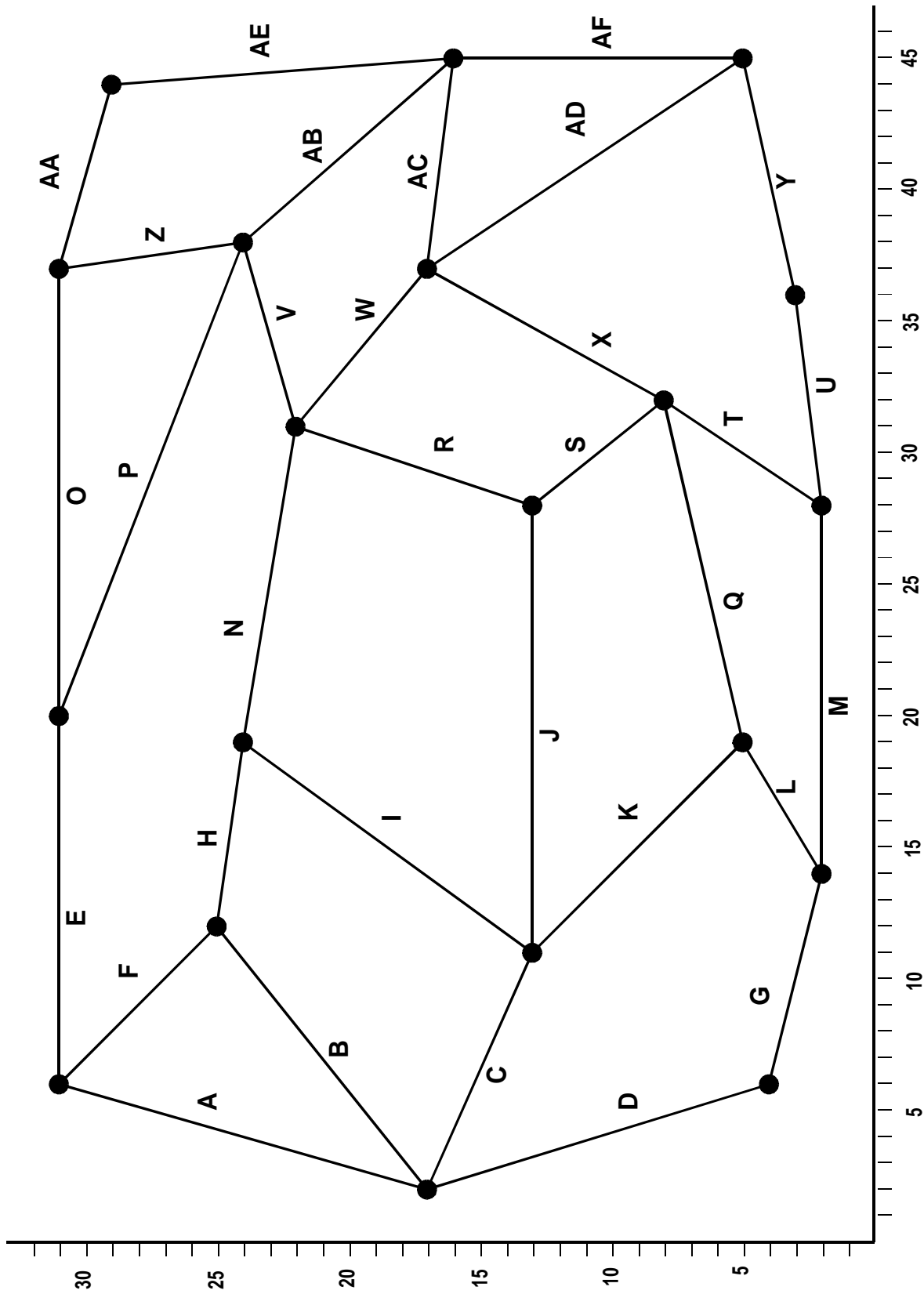
Figure I-1 Road Segment Map

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Index of Feature and Entity Names

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
Unclassified	None

2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT
N/A	Approved for Public Release
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	Distribution Unlimited
N/A	

4. PERFORMING ORGANIZATION REPORT NUMBER(S	5. MONITORING ORGANIZATION REPORT NUMBER(S)
CMU/SEI-91-TR-28	ESD-TR-91-28

6a. NAME OF PERFORMING ORGANIZATION	6b. OFFICE SYMBOL (if applicable)	7a. NAME OF MONITORING ORGANIZATION
Software Engineering Institute	SEI	SEI Joint Program Office

6c. ADDRESS (City, State and ZIP Code)	7b. ADDRESS (City, State and ZIP Code)
Carnegie Mellon University Pittsburgh PA 15213	ESD/AVS Hanscom Air Force Base, MA 01731

8a. NAME OFFUNDING/SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (if applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
SEI Joint Program Office	ESD/AVS	F1962890C0003

8c. ADDRESS (City, State and ZIP Code)	10. SOURCE OF FUNDING NOS.			
Carnegie Mellon University Pittsburgh PA 15213	PROGRAM ELEMENT NO 63756E	PROJECT NO. N/A	TASK NO N/A	WORK UNIT NO. N/A

11. TITLE (Include Security Classification)
Application of Feature-Oriented Domain Analysis to the Army Movement Control Domain, APPENDICES A - I

12. PERSONAL AUTHOR(S)
Sholom G. Cohen, Jay L. Stanley, Jr., A. Spencer Peterson, and Robert W. Krut, Jr.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Yr., Mo., Day)	15. PAGE COUNT
Final	FROM TO	June 1992	154 pp.

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse of necessary and identify by block number)
FIELD	GROUP	SUB. GR.	common Army terminology and requirements
			domain analysis tool support
			movement control

19. ABSTRACT (Continue on reverse if necessary and identify by block number)
This report documents an analysis of the army movement control domain performed by the Software Engineering Institute (SEI) and a team of movement control experts from the Army. This report includes common terminology and requirements extracted from Army doctrine, experts in the field, and movement control systems. The report also describes the potential for prototyping of systems using domain analysis products and the tool support needed.

(please turn over)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
UNCLASSIFIED/UNLIMITED SAME AS RPTDTIC USERS ■	Unclassified, Unlimited Distribution

22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE NUMBER (Include Area Code)	22c. OFFICE SYMBOL
John S. Herman, Capt, USAF	(412) 268-7631	ESD/AVS (SEI)