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Designing a common interchange format for unit data using the Command and Control information exchange data model (C2IEDM) and XSLT

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THESIS

DESIGNING A COMMON INTERCHANGE FORMAT FOR UNIT DATA USING THE COMMAND AND CONTROL INFORMATION EXCHANGE DATA MODEL (C2IEDM) AND XSLT

by

Glenn A. Hodges

September 2004

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13. ABSTRACT

A common problem between Military applications and operators is the consistent and meaningful exchange of data. Currently, several models and simulations exist for the purposes of training and analyzing military data. Due to the absence of an agreed-upon standard with which to represent unit data, much is lost during interchange and applications are not maximized. This thesis is a step towards a solution.

Extensible Markup Language (XML) technology has been widely accepted as a standard for representing information in such a way that it is self-documenting, self-validating and platform independent. By using the Command and Control Information Exchange Data Model (C2IEDM), formerly known as Generic Hub, and XML it is possible to develop a representation of unit data that is extensible and broadly useable by tactical systems and human operators alike. This thesis approaches the problem exploring the Model Driven Architecture (MDA) and the Extensible Modeling Simulation Framework (XMSF) as possible overarching architectural concepts for a global solution.

The C2IEDM is used as the core data interchange model for this research and applies XML technologies, schema and the Extensible Stylesheet Language for Transformations (XSLT) to derive a formatted data representation that is acceptable within the Flexible Asymmetric Simulation Technologies (FAST) Toolbox. The transformation example serves as template for other simulation programs to follow for interchange through the common base model.

This thesis shows that by using a common data representation like C2IEDM coupled with the power of XML and XSLT, unit information can be transformed and interchanged between applications. In order to accomplish this, an extensive analysis is done on recently performed and ongoing research as well as the development of exemplars to show how the proposed process is completed. The result of this work is a transformation of unit data extracted from an example C2IEDM instance file that is compliant with the schema for an actual unit order of battle tool used for modeling and simulation.

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DESIGNING A COMMON INTERCHANGE FORMAT FOR UNIT DATA USING THE COMMAND AND CONTROL INFORMATION EXCHANGE DATA MODEL (C2IEDM) AND XSLT

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LIST OF ACRONYMS & ABBREVIATIONS

ADS	Authoritative Data Source
APC	Armored Personnel Carrier
API	Application Programming Interface
ARM	ATCCIS Replication Mechanism
ATCCIS	Army Tactical Command and Control Information System
BIXS	Battlespace Information Exchange Schema
CAPES	Combined Arms Planning and Execution System
CBRN	Chemical, Biological, Radiological, Nuclear
C2	Command and Control
C2IEDM	Command and Control Information Exchange Data Model
CCS	Command and Control System
CFDB	Conventional Forces Database
CFE	Conventional Forces Europe
CFLD	Conventional Forces Land Database
CFV	Cavalry Fighting Vehicle
COA	Course of Action
COTS	Commercial-Off-The-Shelf
COI	Community of Interest
C&P	Characteristics and Performance
CP	Change Proposal
DAT	Data Access Tool
DIA	Defense Intelligence Agency

DIAMOND	Diplomatic and Military Operations in a Non-Warfighting Domain
DIF	Data Interchange Format
DMSO	Defense Modeling and Simulation Office
DTAC	Division Tactical Command Post
DTED	Digital Terrain Elevation Data
DoD	Department of Defense
EJB	Enterprise Java Beans
FAST	Flexible Asymmetric Simulation Technologies
GCCS	Global Command and Control System
GSORTS	Global Status of Resources and Training System
GUI	Graphical User Interface
GWOT	Global War On Terror
HLA	High Level Architecture
HTML	Hypertext Markup Language
IDA	Institute for Defense Analysis
IEM	Information Exchange Mechanism
IFV	Infantry Fighting Vehicle
IP	Internet Protocol
ISSM	Interim Static Stability Model
JAXB	Java Architecture for Data Binding
JCATS	Joint Conflict and Tactical Simulation
JEM	Joint Effects Model
JOEF	Joint Operational Effects Federation

JOPES	Joint Operations, Planning and Execution System
JWARN	Joint Warning and Reporting Network
NATO	North Atlantic Treaty Organization
NFDB	National Futures Database
NGIC	National Ground Intelligence Center
NGO	Non-Governmental Organization
MAPP	Modern Aids to Planning Program
NUWC	Naval Underwater Warfare Center
MIDB	Modernized Integrated Database
MIP	Multilateral Interoperability Programme
MOOTW	Military Operations Other Than War
M&S	Modeling and Simulation
MTOE	Military Table of Organization and Equipment
OIF	Operation Iraqi Freedom
OneSAF	One Semi-Automated Force
OMB	Object Management Group
OOTW	Operations Other Than War
OSD	Office of Secretary of Defense
OTB	OneSAF Testbed
PA&E	Program, Analysis, & Evaluation
PIM	Platform Independent Model
PSM	Platform Specific Model
PSO	Peace Support Operations

PVO	Private Volunteer Organization
RTI	Run Time Infrastructure
SASO	Stability and Support Operations
SHAPE	Supreme Headquarters Allied Powers Europe
SIPRNET	Secure Internet Protocol (IP) – Routed Network
SOAP	Simple Object Access Protocol
SVG	Scalable Vector Graphics
TUCHA	Type Unit Cargo Characteristics
TAEDP	Total Army Equipment Distribution Program
UDDI	Universal Description, Discovery and Integration
UOB	Unit Order of Battle
USAFMSA	U.S. Army Force Management System Agency
VIC	Vector In Commander
VRML	Virtual Reality Modeling Language
W3C	World Wide Web Consortium
WWW	World Wide Web
WSDL	Web Service Description Language
X3D	Extensible 3D Graphics Language
XMI	XML Metadata Interchange
XML	Extensible Markup Language
XMSF	Extensible Modeling and Simulation Framework
XSLT	Extensible Stylesheet Language for Transformation

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I. INTRODUCTION

A. CRITICAL PROBLEM STATEMENT

A recurring issue in simulation as well as command and control system (CCS) development and design is data interchange. Several constructive simulations exist which allow military commanders to train their staffs and subordinate commanders for war. However, there is not a fully operational simulation specifically designed to train commanders and staffs for stability and support operations (SASO). This is an important issue: as the United States moves forward in its global war on terror (GWOT), it finds itself ever increasingly in situations where forces must transition from combat to peace support operations (PSO). In order to adequately train for this, simulations and C2 systems must communicate in order to support unit training. The data interchange methods employed must be generic yet complete enough to facilitate and foster their training use and transition from one system to another. Additionally, due to the size and complexity of currently available simulations, a host of contractor support is generally required for their implementation and use. Generally speaking, most simulations have been independently developed by different contractors and have very different data input, output and structure requirements that foster data interchange difficulties. This prevents them from being used in conjunction with one another without extensive time, effort and specialized interfaces, such as the High Level Architecture (HLA).

B. OVERVIEW

The Extensible Markup Language (XML) has become the standard by which businesses, government and military organizations structure and exchange data. The Department of Defense (DoD) sees the potential for XML's use in both training and combat information exchange systems and is currently working toward converting many of its data driven applications into XML format so that data interchange is platform/application independent and complete. One initiative under development is the Flexible Asymmetric Simulation Technologies

(FAST) Toolbox. This project is creating a toolbox of simulations, databases, and computational models designed for future use at the unit level. The Diplomatic and Military Operations in a Non-Warfighting Domain (DIAMOND) model is one of the tools included in the FAST Toolbox. DIAMOND is a high-level modeling tool designed for use in PSO. Developers hope that once complete and validated, DIAMOND will fill the requirement for a SASO planning and training tool providing a simulation model suitable to draw on surrounding data, tools and techniques (DIAMOND, 2002).

Additional simulations, models and a Unit Order of Battle (UOB) tool are also contained within the FAST Toolbox providing commanders the tools required to train for and analyze combat scenarios both before and during conflict. Different military contractors have developed each of the simulation, database and computational tools in the Toolbox. As part of the testing and validation of these technologies, the Defense Modeling and Simulation Office (DMSO) has asked one of its participating partners, the Naval Postgraduate School (NPS), to investigate the design of data interchange methods between the applications within the FAST Toolbox. A focus area of concern is the interchange of data between command and control systems and these tools. This thesis is another step in ongoing research to discover a solution to this problem using XML technologies.

This thesis provides an example transformation of data from a data model used in command and control systems into another representation scheme that is used in a simulation/model suite. This exemplar shows that the semantic interchange of tactical data is possible without data loss or inaccuracy.

C. MOTIVATION

1. Messages from the Field

Such capabilities are mission critical and widely needed. The following observations are excerpts from email messages dealing with the use of simulations for both training and wartime operations. Since the author is an Army Simulation Officer, these discussions are directly relevant and have provided a strong motivation for this thesis work.

Army Simulation Officers enroute to and from Iraq are speaking out about the need for simulation and modeling tools to assist them in becoming more relevant and useful to their commanders in mission analysis, wargaming and course of action development and analysis phases of planning during wartime. This topic of discussion was not considered an issue until units entered war with simulations officers assigned to them. Throughout the shooting war and now during the SASO phase of operations in Iraq the question has become: What do we do now that we are not training?

> I would hope the FA 57 (Simulations Officer) is always looking for a way to use simulations to support the commander. Could a FA 57 incorporate some model or simulation into this process (our traditional combat operations information management process) to help speed up our decision making capability or provide better battle space visualization? The answer depends upon several variables: Are the tools available? Is the staff manned and equipped to handle such capabilities? Is the unit even receptive to such a concept? (personal correspondence from COL Wade B. Becnel, Chief, Strategic Experiential Education Group (SEEG), Center for Strategic Leadership (CSL), U.S. Army War College, 3 OCT 2003).

The answers to Colonel Becnel's questions are no, no and again (generally speaking) no. Why this unfortunate situation? First, the Simulation Operations functional area (FA57) for Army officers, which is a part of the Information Operations career field, is very new. Second, as computer technology rapidly increases, the Army and other services find themselves playing catch up when trying to train their members how to successfully implement these new technologies. To be fully understood many of these technologies require users to attend advanced civil schooling which is not always possible. Third, the simulation and modeling tools that are available are generally only acceptable for use at the very highest levels for planning and analysis. They require a great deal of time and support to operate and in many cases are not interoperable. The lower the level of command, the less time there is for database and scenario initialization that might enable computers to significantly assist what experienced commanders and staffs do routinely. Thus analog methods of course of action (COA) development, analysis and wargaming are executed the way they are taught in the school houses.

> The warfighter in an operation doesn't require a simulation that will tell him whether one COA is statistically better by .006 than another COA. What is needed, and where there is a capability gap, is a system that is fast enough to run through a COA, provide some dirty estimates on effects and deliver a credible outcome. The trick is that this outcome would be achieved through wargaming or rehearsals by the warfighter anyway if they do it analog. We need to leverage tools that speed up this process (personal correspondence from Major Mike Panko, Division Simulations Officer, 1ST Armored Division, 26 October 2003).

Additionally, the Armed Forces of the United States as well as Coalition forces are engaged in fast paced, unpredictable urban conflict unlike any seen since the street fighting of World War II. Then the enemy was uniformed and followed prescribed tactics, techniques and procedures that in some cases led to his defeat. This is not necessarily the case now. Current operations occur so fast that there is no time to fully utilize the simulation and modeling tools available. The FAST project is a step towards a solution, but due to the iterative nature of software development and the time required to test and evaluate useful tools (Crain, 2002), the tools are not available when and where they are needed most. The following quote emphasizes this point.

> As far as FA57s in the field and use of Sims during wartime goes I can only speak for 1st Armored Division. I have been integrated in as a Future Ops guy and one of the Battle Majors that deploys with the Assault Command Post / Division Tactical Assault Command Post (DTAC). My job as the Division Simulations Officer is nominal only right now and there is nothing in the immediate future that would indicate otherwise. Given that the Operation Iraqi Freedom (OIF) has become a SASO environment there has been no call for Sims, at all, to think through courses of action or to look at contingencies. There is no time to pull anything together and frankly there is no way for the Division to run any kind of an exercise when the day-to-day business is all consuming. Only Corps and higher have the resources to put anything together, from my perspective (personal correspondence from Major Mike Panko, Division Simulations Officer, 1st Armored Division, 20 SEP 2003).

Simulations Officers serve a dual purpose in their organizations. They are expected to be experts in simulation technologies as well as in tactical operations and training.

> One critical near-term 'deployed' role FA57s will also have to be prepared for and is only hinted upon in the thread is in-theater training (our typical garrison role). It's been a long time since the US Army has had to refit and/or reconstitute units and personnel in a combat zone, and our current field force mix of analog, digital, and hybrid analog-digital units will make this task even more complicated. With the units currently in place, casualties will create holes in organizations where people will have to be replaced. New arrivals must be quickly integrated into the units' ways and means of doing business. With the host of non-standard digital equipment we have in the inventory this role will become a critical function. When it comes to the digital equipment, no two divisions in the entire US Army have the same match of equipment unlike the more similar CL VII (major end items) (personal correspondence from Major Brandon Herl, Operations Officer, Warrior Training Center, Korea, 20 September 2003).

Lastly message traffic from LTC Rene Burgess addressing the issue of tools available, elicited the following:

> The kicker is that we have to have the tools -- low overhead, easy to integrate, easy to run tools that do a "good enough" job right now, not a perfect job some time in the future. There's a degree of risk in this...both from the agency that supports the right now requirement, and in the 57 in the field using a tool that is less than perfect (personal correspondence from LTC Rene Burgess, 24 October 2003).

2. DMSO FAST Project

The Defense Modeling and Simulation Office (DMSO) is the DoDs lead agency that oversees the development, management and acquisition of modeling and simulation (M&S) tools throughout all of the services. At the present time DMSO is working on a project that promises to provide better simulation and modeling support to lower levels of command. DMSO’s Military Operations Other Than War (MOOTW) Flexible Asymmetric Simulation Technologies (FAST) Toolbox project is designed to provide ready access to several modeling and simulation tools that will eventually assist commanders in decision support. An issue not yet resolved is the level of command this toolbox should support.

According to (Crain and others, 2004) the user level is primarily corps and below or "is intended to be used by tactical military staff members at the division and brigade echelons of command and below." This is a problem because of the different functionality requirements at these different levels of command. The Toolbox currently consists of the following pieces:

- Interim Static Stability Model (ISSM) – A civil stability and durable peace model that is applicable at the strategic and operational levels of war.

- Unit Order of Battle Data Access Tool (UOB DAT) – This tool allows users to tailor forces and equipment to specific missions across the levels of war.

- Diplomatic and Military Operations in a Non-warfighting Domain (DIAMOND) – This high-level stochastic simulation is focused towards MOOTW operations and advances planning/analysis at the operational and tactical levels.

- Joint Conflict and Tactical Simulation (JCATS) – An interactive simulation for conducting training and mission rehearsal at the tactical level.

- Canadian Forces Landmine Database (CFLD) – A repository of landmine data for analyst training and reference.

D. OBJECTIVES

The main objective of this thesis is to provide an exemplar to show that unit data represented using XML, exchanged using the C2IEDM and transformed using the XSLT, provides a recipe for successful data transfer. A subsequent objective is to compare two versions of the C2IEDM model, one which uses a database to hold its data and another that strictly uses XML to describe the data. Figure 1 illustrates the research intent. Using the C2IEDM document oriented schema developed by Capt. James Neushul (Neushul, 2003) and a C2IEDM source file generated from that schema by XMLSpy, a stylesheet written using XSLT extracts and formats necessary unit information from the source file that is required by applications within the FAST Toolbox. A result document is created and is validated against the UOB schema governing all data files used within the FAST Toolbox to ensure compliance. Future work suggests the development of additional transformations that can convert C2IEDM source files into and out of other formats to be used with other simulation and modeling packages within the DoD.

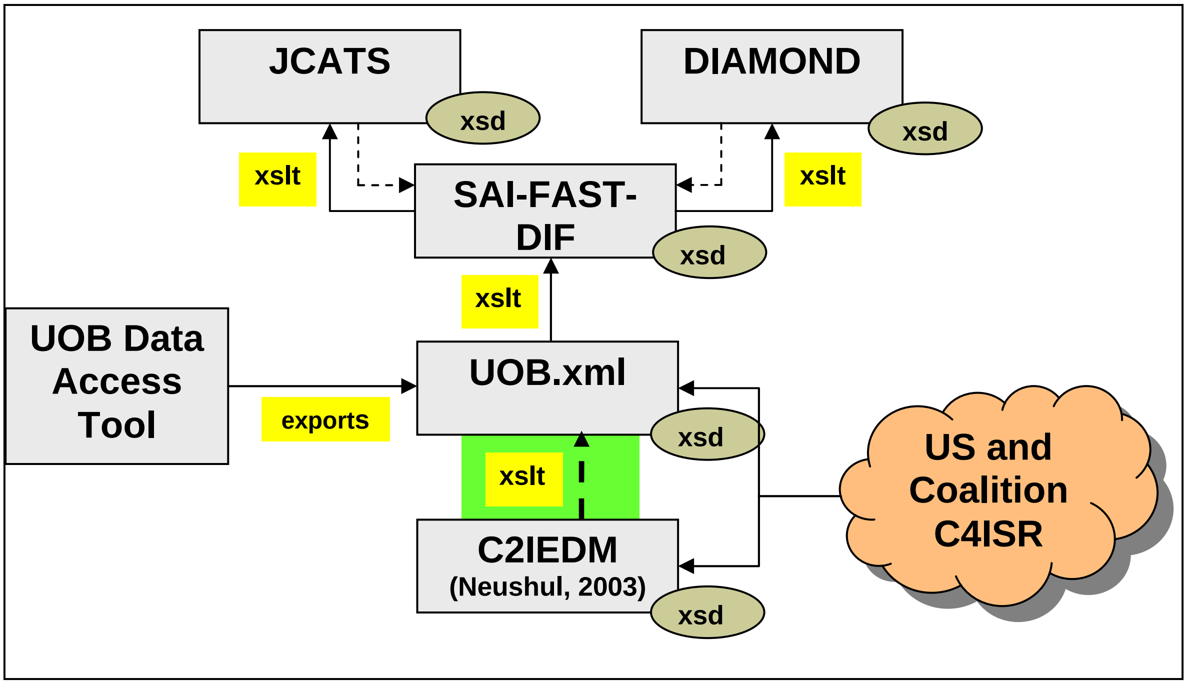

Figure 1. Green highlighted region depicts the interoperability to be achieved through this research.

E. ORGANIZATION OF THESIS

Chapter I provides an introduction that encompasses a working problem statement, an overview of the problems involved with data interchange, the motivation for this thesis work, the objectives of the thesis and finally the organization of the thesis document.

Chapter II discusses more background and related work that are referenced and expounded upon in other thesis chapters. Topics include a discussion of XML technologies including the Extensible Modeling and Simulation Framework (XMSF), an overview of the MOOTW FAST Toolbox, a discussion of data interoperability and interchange as well as scenario interchange, the Command and Control Information Exchange Data Model (C2IEDM), the Battle Management Language (BML), Extensible Battle Management Language (XBML) and lastly the TOPTIVA application.

Chapter III discusses the Model Driven Architecture (MDA) which is an enterprise-scale software development methodology. Produced by the Object Management Group (OMG), the MDA predicates itself on using models and modeling software to autogenerate computer code for processes that require complete documentation and that are easily updatable. The MDA is examined for its potential use in assisting to solve data interchange difficulties.

Chapter IV reviews the Unit Order of Battle (UOB) Toolset and its component parts: Databases, Data Access Tool (DAT) and Data Interchange Format (DIF). UOB is an authoritative source of unit order of battle information due to its completeness and relative ease of use.

Chapter V discusses the development of an exemplar transformation from a C2IEDM source document showing how data extracted from the C2IEDM model can be transformed using XSLT into a format used within the FAST technologies arena. This chapter introduces development of XML documents and schema and touches on the mental processes involved in the design and the development of the XSLT used for the exemplar transformation.

Chapter VI contains conclusions based on the work accomplished, successes achieved and short falls experienced. Recommendations for future extensions of this work are discussed.

II. BACKGROUND AND RELATED WORK

A. INTRODUCTION

This chapter provides needed background by synopsizing related work that is referenced and utilized in this thesis. Topics include a discussion of XML technologies including the Extensible Modeling and Simulation Framework (XMSF), an overview of the Flexible Asymmetric Simulation Technologies (FAST) Toolbox, a discussion of data interoperability and interchange as well as scenario interchange, a discussion of the Army Tactical Command and Control Information System (ATCCIS), an introduction to the Multilateral Interoperability Programme (MIP) and its relationship to the Command and Control Information Exchange Data Model (C2IEDM). The C2IEDM is introduced and both strengths and weaknesses are briefly discussed. The Battle Management Language (BML) and Extensible Battle Management Language (XBML) are reviewed and the TOPTIVA application is introduced.

B. EXTENSIBLE MODELING AND SIMULATION FRAMEWORK (XMSF)

The Extensible Modeling and Simulation Framework (XMSF), is defined as a composable set of standards, profiles and recommended practices for web-based modeling & simulation (M&S). Its basic precept is that XML-based markup languages, Internet technologies and Web Services will enable a new generation of distributed M&S applications to emerge, develop and interoperate. XMSF integrates several high-level requirements derived from years of experience with M&S frameworks and the challenges of their effective deployment across diverse networks and systems (Brutzman and others, 2002). XMSF is not an application or architecture, but a set of standards for technical solutions as well as processes for building distributed solutions establishing a technical framework and an engineering process for M&S applications utilizing web services and technologies (Tolk and Pullen, 2003).

The XMSF working group consists of several partners working on three action areas. Those areas are Web/XML, Internet/Networking, and Modeling and

Simulation (M&S). The motivation behind the XMSF project is the application of open standards and open source solutions to increase the efficiency and applicability of distributed simulation systems.

XMSF is a work in progress and as such several key factors have been identified. Foremost is that XMSF must not be constrained by proprietary technology that would stifle the open development of new technologies. It must be human and agent friendly and must support composable, reusable model components. It must be scalable enabling simulations to interact directly over distributed networks. In the context of the Model Driven Architecture, XMSF can be viewed as a web-based, “platform specific” solution, with the objective to identify the necessary base functionality for distributed M&S applications (Tolk and Pullen, 2003).

XMSF uses an extensible framework of XML-based languages that provide a bridge for legacy and future M&S requirements and systems. Three goals or challenges for XMSF which are of key importance to military simulation professionals are:

1. To provide open, affordable, extensible modeling and simulation capabilities for tactical scenarios of direct use to participants engaged in conflict and peace operations.
2. To improve the ease of use for developers and users, fueling rapid growth of interoperable simulations.
3. To provide support for all types and domains of M&S: constructive, analytical, live, virtual, playback-driven, agent-based, human-in-the-loop, heterogeneously distributed, logistical, and others (Brutzman and others, 2002).

An issue of interest when discussing XMSF is the topic of ontologies. An ontology is an “explicit formal specification of how to represent the objects, concepts and other entities that are assumed to exist in some area of interest and the relationships that hold among them” (Dictionary, 2004). Webster defines ontology as a basis of meaning of something. Ontologies require precise vocabularies that are acceptable to all parties. XML Schema and Namespaces are two methods used within XML to establish vocabularies which then can be used as the basis for ontologies. Much of the work done on the XMSF project has yielded the fact that the capabilities for such a framework exist and are robust enough for web-based simulation. The main issues now revolve around how to integrate the many technologies into the one coherent framework. Ontology research leading toward creation of a Semantic Web where software can access and reason about information on the Web is a key direction for military M&S work (Blais, 2004a).

One item of concern within the XMSF concept is the issue of the timing of technological evolution and availability. The M&S focus group of the XMSF project has directed its energies into the two areas of refining technical issues and defining use cases which test the reach of the XMSF concept. The timelines set forth for these two areas define near term as 1-2 years, mid term as 3-5 years and long term as greater than 5 years. Considering todays operational environment, solutions to XMSF problems/issues need to be geared towards "good enough" for near term implementation and fielding with continuing work towards perfecting solutions in the later time frames. Warfighters need workable solutions quickly rather than notionally perfect solutions 5 years from now.

In summary, XMSF can be described as an evolutionary strategy toward advanced distributed simulation using open standards – in particular standards related to the web – complementary to the high level architecture (HLA) to reach the next level of this domain of distributed computing (Tolk and Pullen, 2003).

C. FLEXIBLE ASYMMETRIC SIMULATION TECHNOLOGIES (FAST) TOOLBOX

The Flexible Asymmetric Simulation Technologies (FAST) Toolbox is sponsored by the Defense Modeling and Simulation Office (DMSO). The original concept of a FAST Toolbox came from the Military Operations Other Than War (MOOTW) Toolbox concept of operations (CONOPS) (Crain, 2002). The purpose of the CONOPS is to provide a long-range vision for the development of modeling and simulation (M&S) capabilities that support the needs of the Warfighter for the planning and conduct of MOOTW. Additionally, the development of the MOOTW "M&S in a Rucksack" is intended to complement, rather than compete with, current and planned U.S. Department of Defense (DoD) M&S MOOTW capabilities and developmental programs. Where possible and as appropriate, the MOOTW Toolbox is intended to incorporate and leverage other U.S governmental agencies, U.S non-governmental agencies, foreign governments, international non-governmental agencies and private organizational MOOTW M&S advances and efforts (Crain, 2002).

The current FAST Toolbox project incorporates the Joint Conflict And Tactical Simulation (JCATS), the Diplomatic and Military Operations in a Non-Warfighting Domain (DIAMOND), the Unit Order of Battle Data Access Tool (UOB DAT), the Interim Static Stability Model (ISSM) and the Canadian Forces Land Mine Database (CFLD). This toolbox is meant to be rapidly deployable on a single laptop computer and used at the warfighting level for military planning and aiding course of action development and analysis. Recent work published for the Spring Simulation Interoperability Workshop extends the possibilities of the FAST Toolbox viewing it as an exemplar of the XMSF project based on a profile approach taking into account the Interoperability Profile, Implementation Profile and Security Profile of the project (Blais, 2004b).

D. DATA INTEROPERABILITY AND DATA INTERCHANGE

Recent research conducted by Capt James Neushul USMC, focused on the abilities of open source, non-proprietary driven software to afford military leaders the flexibility to not only visualize the battlespace using 3D visual graphics but also to communicate across the boundaries of platform dependencies and control their data using XML technologies (Neushul, 2003). An excerpt from a report coming from Iraq emphasizes his point.

> A Lessons Learned report from Operation Iraqi Freedom (OIF) describes an inability to effectively communicate battlespace geometry for planning due to software incompatibilities, and cited a lack of adequate National Imagery support during preparation or combat phases. These observations describe problems with access to dynamic data as it is generated on the battlefield, and static data that has been collected and archived so that commanders can put battlespace information in a visual geographic

> context. There is a fundamental disconnect between the warfighter and the data that supports battlespace visualization (Neushul, 2003, 6).

A common theme running through this work is the use of open-source software, non-proprietary data standards and service-oriented contracts so that military leadership can gain and maintain control over their information processing needs. Capt. Neushul's research emphasizes multiple times that:

> Software must be required to be as adaptable and flexible as the individuals that use it. Demands must be made that force extensibility and Network-Centricity. Current practices of software licensing at the expense of data control must be rejected, and solutions that enable common visualization, and that incorporate information exchange data models must be adapted at all levels (Neushul, 2003, 17).

Captain Neushul also discusses an extensibility paradigm that sounds much like one of the driving concepts behind the MDA, which is platform independence. The ability to develop applications that may be used regardless of the operating system or hardware platform on which they will be applied is a key to many ideas dealing with extensible web-based technology usage. Data control via XML Schema is addressed here and detailed examples are presented providing evidence of the validity of the arguments made.

Battlefield visualization is also discussed and an example of how this can be accomplished using X3D (Web3D, 2004), GeoVRML (GeoVrml, 2004) and Scalable Vector Graphics (SVG) (W3C, 2004), is provided, demonstrating the power of XSLT and the X3D language to transform binary elevation data into a graphically viewable format in a web browser. Because of his work, 3D views of standard Digital Terrain Elevation Data (DTED) (DTED, 2004), data are now available to authorized users with access to web browsers, and warfighters in all theatres have the ability to use this tool to examine terrain that they may need to control.

E. SCENARIO INTERCHANGE

Many Navy efforts use the Naval Simulation System (NSS) (Naval Simulation System, 2004) as a force-on-force modeling and analysis tool. The original design intent of the NSS allowed NSS systems to communicate with one another while they were connected via a High Level Architecture (HLA) Run Time Infrastructure (RTI). This communication is done through the use of vendor-specific RTI application programming interfaces (API). Recent thesis work completed at the Naval Postgraduate School used the NSS to examine scenario interchange. The research demonstrated the ability to use XML to represent NSS scenario data so that NSS users could interchange scenario data amongst themselves and possibly other applications. The use of XSLT to transform scenario data into a textual format was also explored to enhance NSS capabilities (Hout, 2003). Central to this research is the desire to exchange data between NSS users and other applications using the host of XML technologies.

F. ARMY TACTICAL COMMAND AND CONTROL INFORMATION SYSTEM (ATCCIS)

"ATCCIS was founded in 1980 to see if interoperability could be obtained at reduced cost and developed according to technical standards agreed upon by multiple Nations and prescribed by NATO" (MIP, 2004). The objective of the Army Tactical Command and Control Information System (ATCCIS) (ATCCIS, 2004) was and continues to be to investigate whether interoperability through the development of a set of minimum standards for information interchange can be achieved at a reduced cost and developed according to technical standards prescribed by the North Atlantic Treaty Organization (NATO) and its participating nations. The program's goal was to identify a minimum set of specifications to be included within command and control (C2) systems, allowing interoperability between those systems. The ATCCIS program was not a formal NATO program, instead it was a voluntary and independent activity sponsored by the Supreme Headquarters Allied Powers Europe (SHAPE).

The ATCCIS specification is a managed interface between C2 information systems. It encompasses two parts: a data model and a replication mechanism called the ATCCIS Replication Mechanism (ARM). The ARMs function is to keep information up to date in cooperating systems whenever a C2 application changes the state of information it holds. The meaning and context of the information do not change and require no additional processing (NATO, 2002). When incorporated into a system, ATCCIS enables interoperability of information between other systems that also incorporate the same specification. The information exchange requirements, both horizontal and vertical, upon which ATCCIS is founded, encompass the spectrum of Joint and Combined Land Operations. ATCCIS has only one interface and is not concerned with the implementation or the display of any country C2 systems. As such, each country's command and control systems may be wholly different from each other and do not have to conform to any hardware or software standard. The ATCCIS program was merged with the Multilateral Interoperability Program (MIP) in the early part of 2002.

G. MULTILATERAL INTEROPERABILITY PROGRAM (MIP)

The Multilateral Interoperability Program (MIP) (MIP, 2004), was established in 1998 as a merger of two other programs: the Battlefield Interoperability Program (BIP) and the Quadrilateral Interoperability Program (QIP). "The aim of the Multilateral Interoperability Programme (MIP) is to achieve international interoperability of Command and Control Information Systems (C2IS) at all levels from corps to battalion, or lowest appropriate level, in order to support multinational (including NATO), combined and joint operations and the advancement of digitization in the international arena." (MIP, 2003, 5) In 2002 the Army Tactical Command and Control System merged with MIP. ATCCIS and MIP's parallel goals and development led to this natural merging. MIP is the custodian for the C2IEDM which is an extensible data model that provides a method for exchanging command and control data.

H. COMMAND AND CONTROL INFORMATION EXCHANGE DATA MODEL (C2IEDM)

The Command and Control Information Exchange Data Model (C2IEDM) is a product of the analysis of a wide spectrum of allied information exchange requirements by 16 nations. It is one of two parts that made up the ATCCIS. It models the information that allied land component commanders need to exchange (both vertically and horizontally). It serves as the common interface specification for the exchange of essential battlespace information (NATO, 2002). The model was designed to achieve two separate but related goals, one of which is focused on in this thesis. That goal is to describe objects in the battlespace (objects for the purposes of this work are units). This description includes the characteristics of the objects, their status, their locations, their interrelationships, capabilities, addresses, and other properties. The second goal that will not be investigated here is the goal of describing activities of those objects in the battlespace. The ATCCIS ARM mentioned above complements the C2IEDM.

The command and control information exchange data model's primary purpose is the generic representation of command and control information. It is a data model. "The C2IEDM is a container document that captures the information and data modeling artifacts. This document is also used as a standard to support national implementations of C2 applications and supports national data management activities outside of the MIP." (MIP, 2004c). Due to the extensive development of the model and complete documentation, many government organizations are currently moving towards using C2IEDM as their predominant data model. It comes as no surprise that the Department of Defense is one of those organizations. Figure 2 portrays the concept behind the MIP/C2IEDM project.

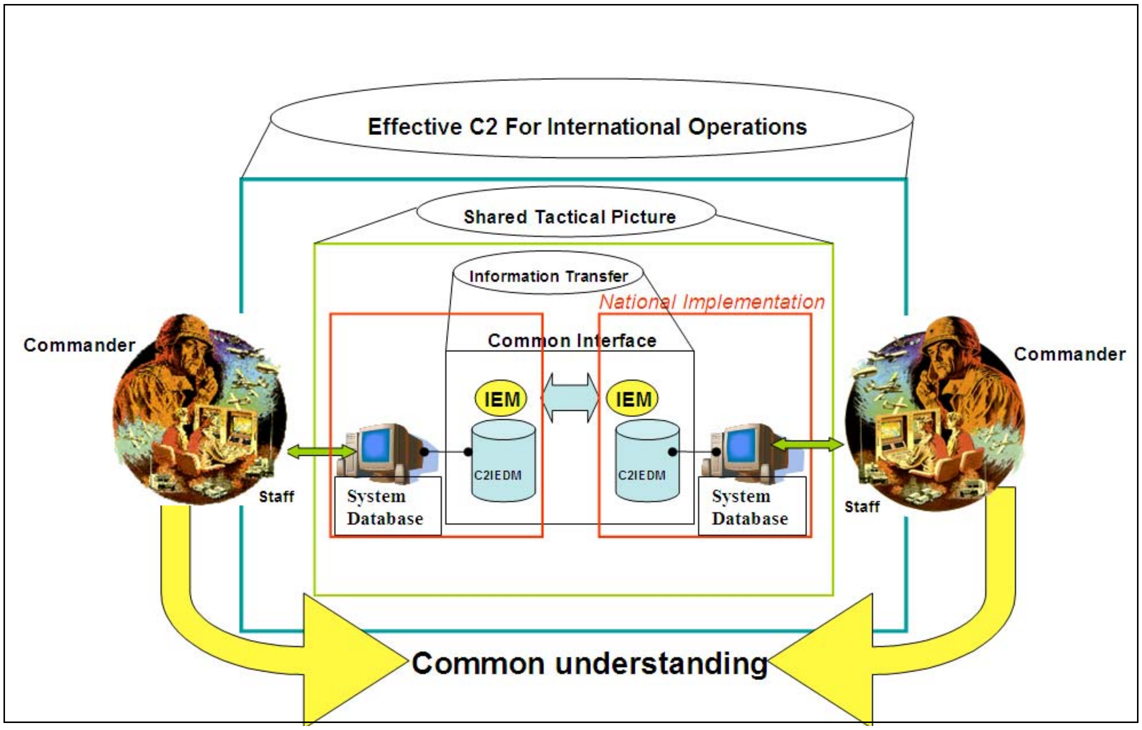

Figure 2. Concept of Information Transfer envisioned by the software developers at the Institute for Defense Analysis (IDA) (From Simaitis, 2004).

The C2IEDM models command and control information that combined arms and joint combined commanders want and need to exchange through the use of an entity-relationship type model (MIP, 2003c). "C2IEDM is intended to represent the core of the data identified for exchange across multiple functional areas and multiple views of the requirements. Toward that end, it lays down a common approach to describing the information to be exchanged in a command and control (C2) environment" (MIP, 2003c, 12). Objects in C2IEDM are classified as either types or items. Figure 3 shows the OBJECT-ITEM and OBJECT-TYPE structures. Object-types and items are the building blocks of the model and are related through the OBJECT-ITEM-TYPE structure. Each contains entities that provide further detail to information being transmitted. Figure 4 provides a high level view of the C2IEDM model that includes some of the associations and entity relationships seen in the model. Figures 5 and 6 show the expanded OBJECT-TYPE and OBJECT-ITEM constructs from the model.

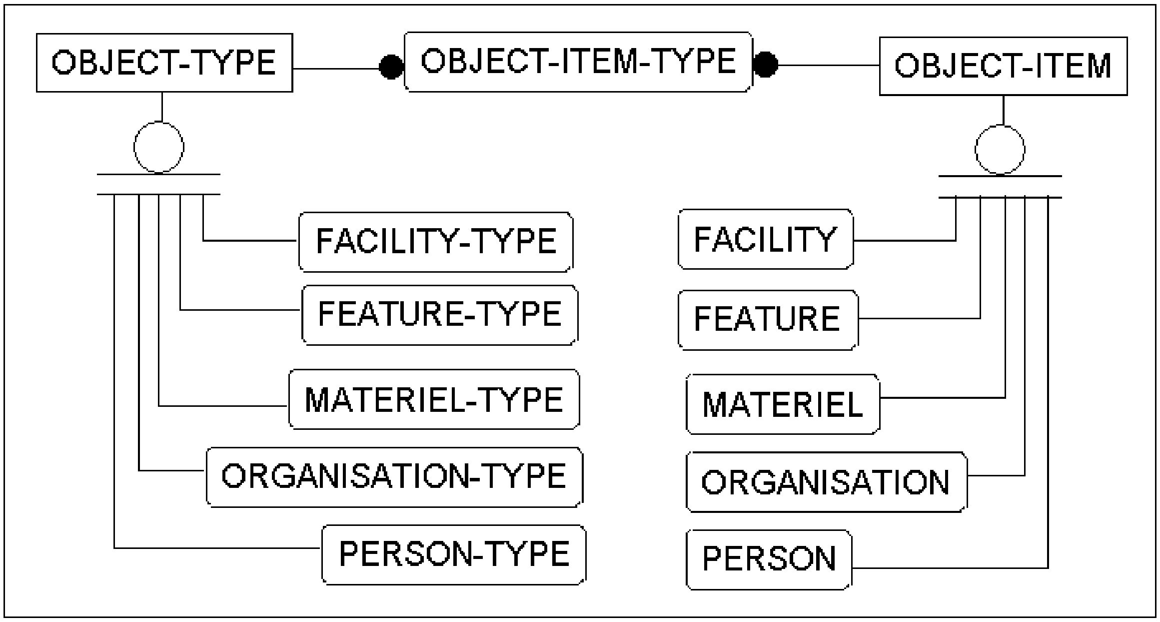

Figure 3. Core Kernel of C2IEDM containing OBJECT-TYPE, OBJECT-ITEM and OBJECT-ITEM-TYPE constructs. (From Johnson, 2004).

1. Strengths of the Model

The C2IEDM has a broad range of applicability which is further enhanced through the ability of adding national extensions. The models central concepts have been stable for 12 years. The documentation that speaks to these concepts is complete and detailed. The model has a multinational pedigree. Over 25 countries are currently represented within the MIP and are actively engaged in the development of the model for their country's military use. The semantic content of the model can be enriched to suit the needs of any community of interest (COI). Lastly the model is relatively easy to extend in response to operational data requirements. Each participating nation within the MIP at some point has or may need to create extensions to support their warfighting doctrine and operational procedures. An example of a U.S. led extension being proposed to NATO is found in the area of Chemical, Biological, Radiological, and Nuclear (CBRN) messaging and operations. The US CBRN community of interest (COI) evaluated the C2IEDM and found it deficient for representing NBC data required for requisite NBC C2 systems (Johnson, 2004).

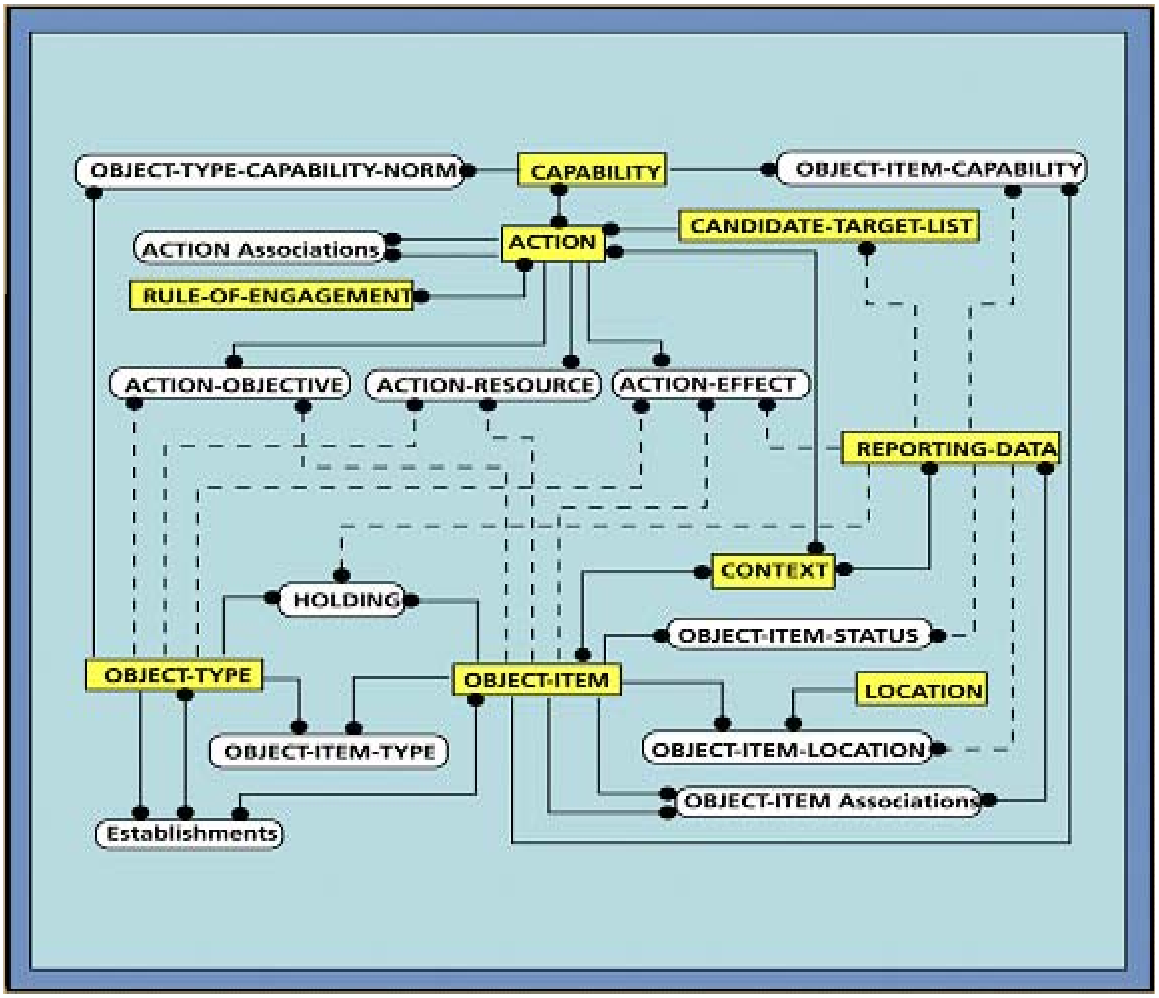

Figure 4. High level view of the C2IEDM model showing the many to many relationships between the different entities of the model (From Johnson, 2004).

To address the models shortcomings for their community, they developed the CBRN Data Model as part of a larger CBRN Data Initiative.

> The mission of the data initiative is to promote the interoperability and reuse of CBRN Data across the Joint Warning and Reporting Network (JWARN), the Joint Effects Model (JEM), the Joint Operational Effects Federation (JOEF) programs and other CBRN programs. The primary goal is to eliminate interoperability failures by mapping current and legacy CBRN data to a common reference schema. The use of a data schema promotes data reuse and standardization. To ensure commonality with joint and coalition C4ISR systems the data schema begins with a subset of the NATO Command and Control Information Exchange Data Model (C2IEDM), adds in those data elements needed to fully describe CBRN information, and relates that information to the existing C4

data elements resident in the current version of the C2IEDM. This work will result in a common data schema that can be used by all CBRN applications that need to interface with joint and coalition C4 systems including simulation systems (O'Keefe, 2003, 1-2).

The CBRN Data Model data exchange standard offers a technologically sound structure for Multi-Service interoperability development across NBC specific domains. The extended structure may also allow non-NATO Coalition Interoperability within the current NATO security posture.

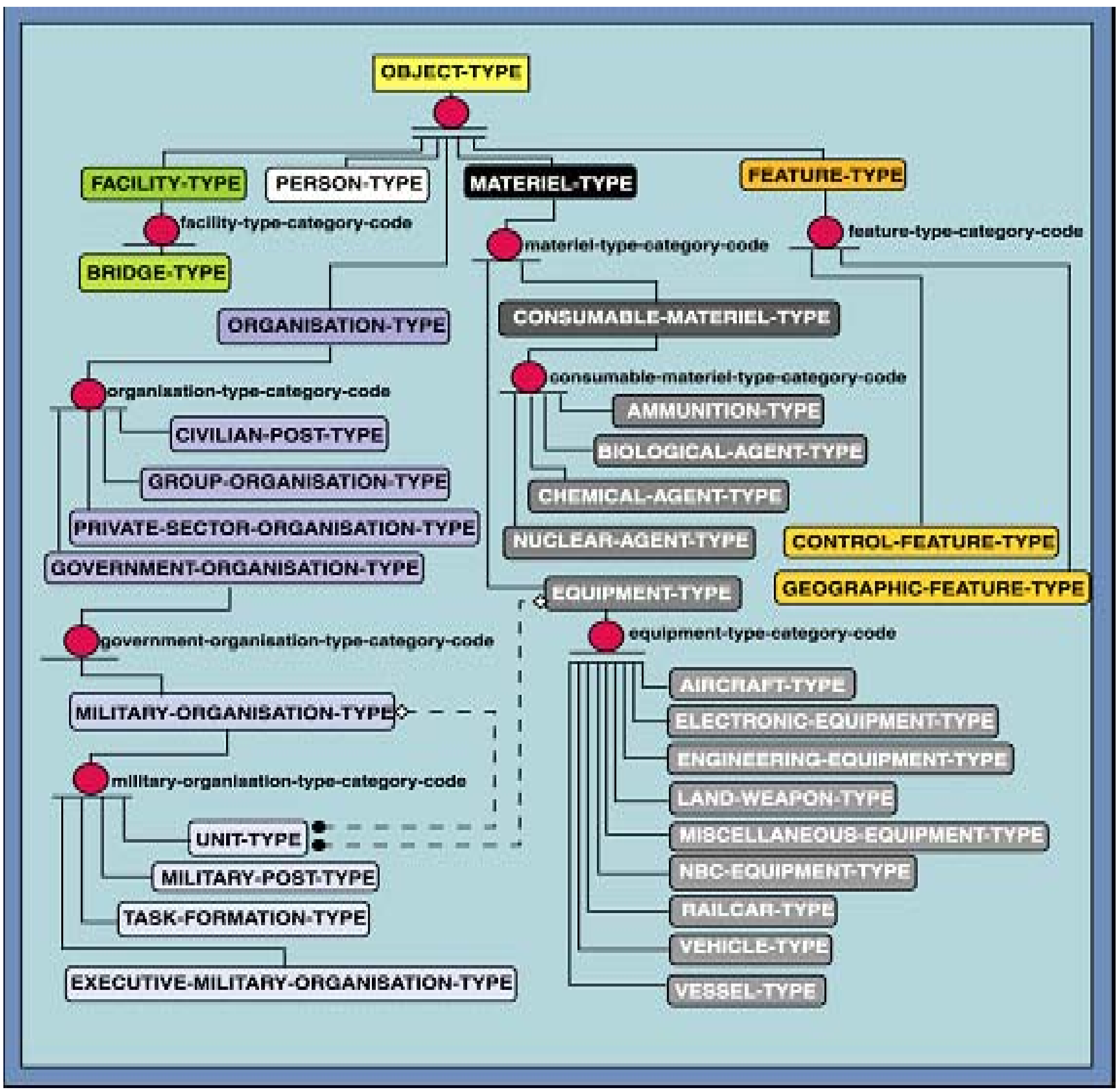

Figure 5. OBJECT-TYPE relational tree found in the C2IEDM (From Johnson, 2004).

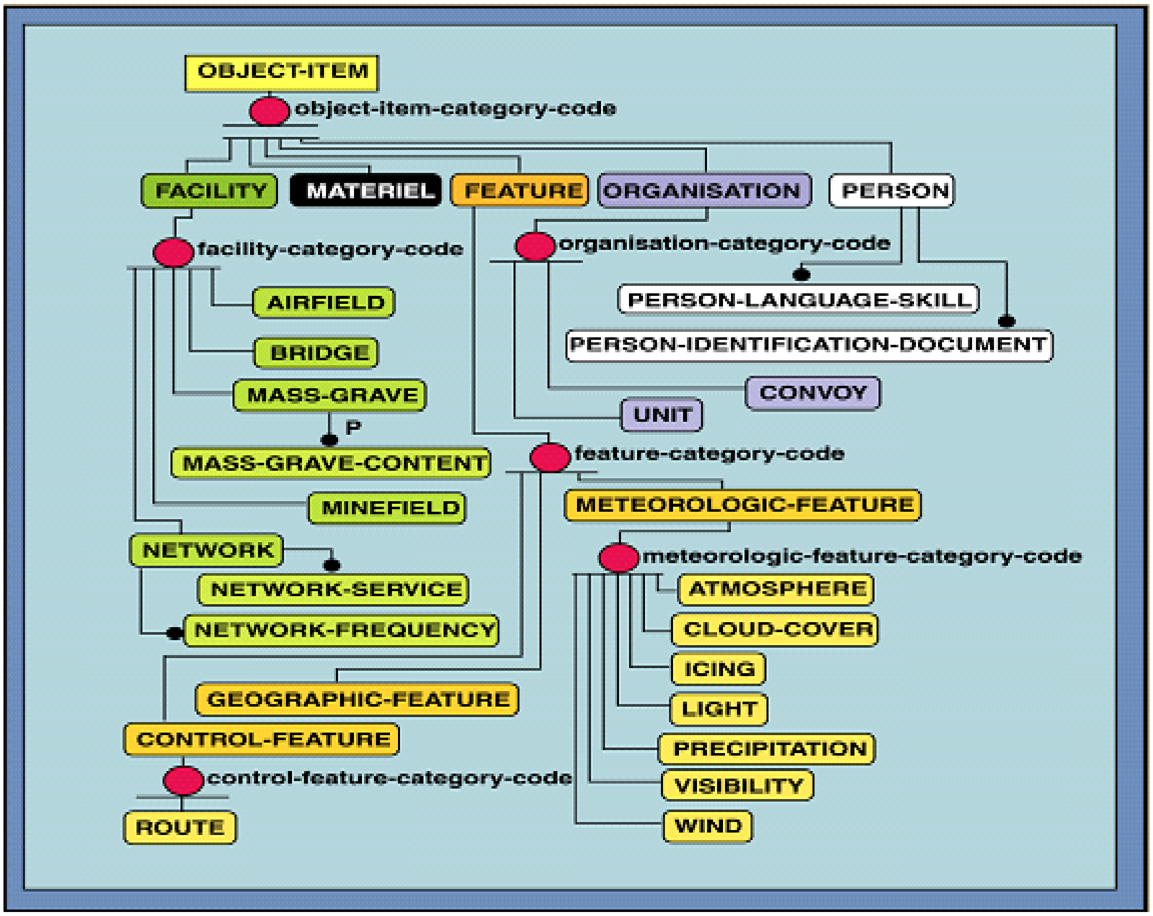

Figure 6. OBJECT-ITEM relational tree found in the C2IEDM (From Johnson, 2004).

Thus extensions to C2IEDM have been successfully demonstrated. Figure 7 shows a portion of the CBRN Data Model with showing two specific extended elements CBRN DETECTION and CBRN EVENT. Figure 8 shows the expanded CBRN EVENT namespace used within the CBRN Data Model. Additional elements of the CBRN Data Model can be seen in Figure 8. Figure 9 shows the level of detail that is possible in extensions to the C2IEDM. As with any model, extensions must follow the syntactic rules and conventions of that model. Figures 8 and 9 display several of the syntactic conventions used to describe CBRN data in the CBRN Data Model. Whether the CBRN Data Model will be eventually accepted as a formal extension of the C2IEDM remains the object of continued work.

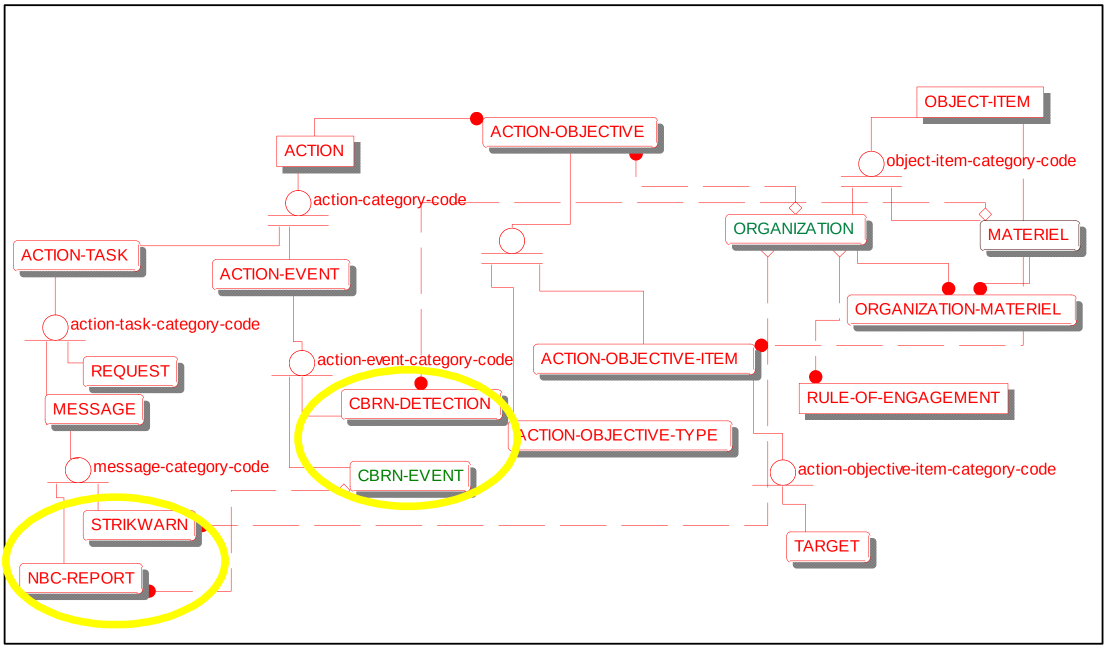

Figure 7. Extended C2IEDM showing the CRBN event (From Johnson, 2004).

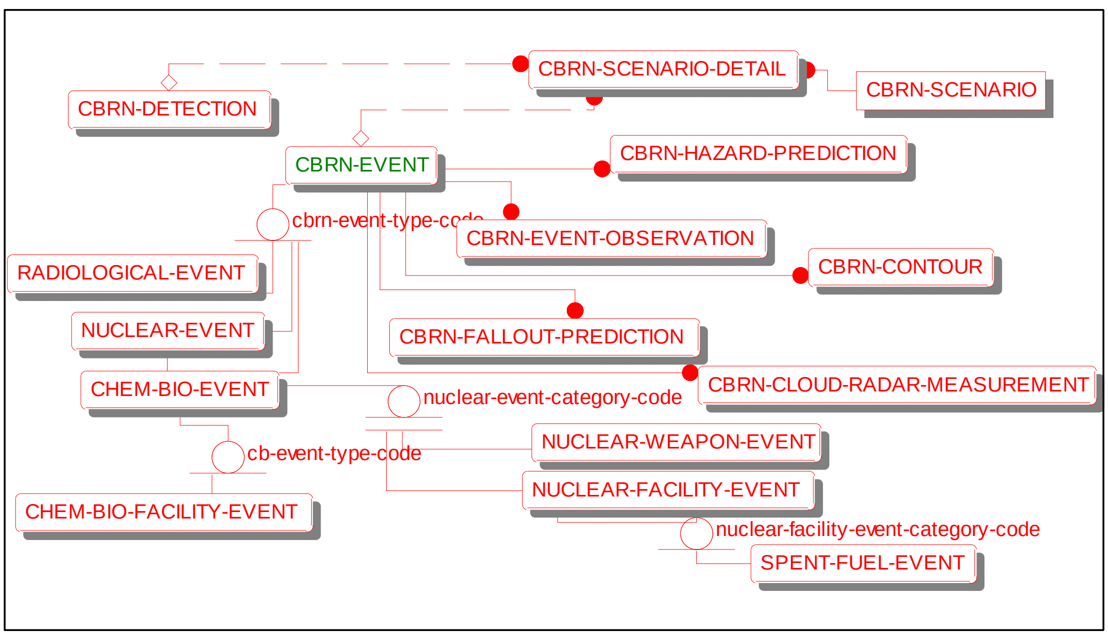

Figure 8. CRBN-EVENT construct of Extended C2IEDM showing additional detail (From Johnson, 2004).

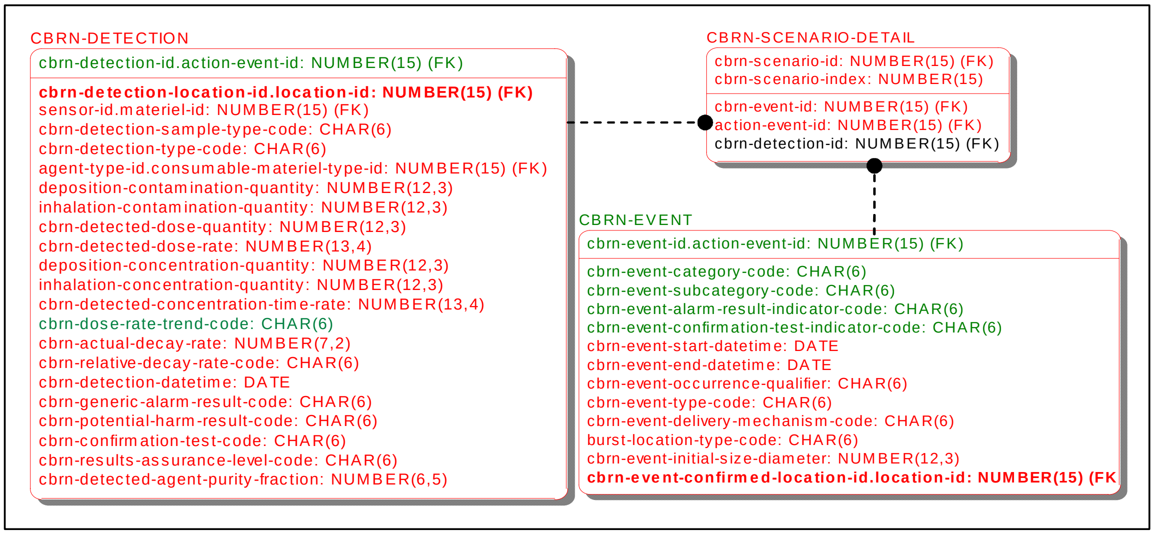

Figure 9. Expansion of several nodes of the CRBN C2IEDM extension (From Johnson, 2004).

Further information and Instructions for requesting extensions to the C2IEDM can be found in (MIP, 2003a).

2. Weaknesses of the Model

For all of its strengths, the C2IEDM also has limitations. According to the Institute for Defense Analysis (IDA) the model is relatively simple and understandable (Simaitis, 2003). Depending on the background of the reader and the representation used this may not be the case. The current C2IEDM Version 6.1 schema provided by IDA is much easier to understand than the Battlespace Information Exchange Schema (BIXS) created by Capt. James Neushul representing the same data exchange model. One of the reasons for this is IDAs use of a database to hold all of the data elements in the model. This technique makes the IDA version's structure much flatter and easier to traverse. This comes at a cost however. The use of a database creates problems for those developers who want the model absolutely exposed and extensible; i.e., in a human-readable, human-modifiable and document-centric structure. The document-centric version of the schema produced by Neushul uses only native XML to represent the data held within the model. Since the model contains many relationships, data in the BIXS must be replicated completely in many different locations throughout the model. While the BIXS version of the C2IEDM is human readable, it is not necessarily understandable. Multiple representations of the data throughout the schema potentially confuse users if they are not familiar and comfortable with the C2IEDM itself. Future work suggests methods to help reduce some of the BIXS complexity.

I. BATTLE MANAGEMENT LANGUAGE (BML) AND XBML

The Battle Management Language (BML) (MSIAC, 2004) is defined as an "unambiguous language used to command and control forces and equipment conducting military operations and to provide for situational awareness and a shared, common operational picture" (Tolk and Pullen, 2003, 10). BML is intended for use in exchanging command and control information between individuals using C2 systems, simulations and future robotic forces. Four principles have guided the development of BML. The first is that BML must not be ambiguous. Second, it must not constrain the military commander's intent within the limits of the military operational domain. Third, it must use and be compatible with existing C3I systems. Finally, it must allow all systems and participants to communicate information about themselves, their mission, and their environment in order to create situational awareness and a shared, common operational picture. BML also supports data consistency by checking the data used in simulation initialization, decision support and the recommended courses of action that are derived from iterative simulation runs using the actual operational context.

Currently the most widely used format for military communications is free text. The reason for this is that the underlying vocabularies are defined in the doctrinal manuals. However a difficulty with using free text is that to be understood the context in which the text is used must be clear. This is not always the case. Current messaging context, whether in the form of operations orders, fragmentary orders or warning orders, depends on the backgrounds of the sender and receiver, the operational context, and the branch of service of both the sender and receiver. In terms of information processing, machines do not do well with ambiguity. For this reason an XML Repository was added to the

BML development process to capture the harmonized results of mixing doctrinal manuals (semantic content) and C3I data models to check the consistency of messages, orders, courses of action, scenarios, and other context sensitive military information.

XBML is an XML version of BML that can be utilized as a web service via XML/SOAP and C2IEDM. The following is a list of supporting technologies for the project:

- XMSF
- C2IEDM
- Structured Representation of Doctrine
- Doctrinal Definitions and Task Lists: Joint Level Definitions and Task Lists; e.g. Joint Pub 1-02 Dictionary of Terms and Universal Joint Task List (UJTL)
- Service Definitions and Dictionaries; e.g., FM 101-5-1 Operational Terms and Graphics
- Service Task Lists; e.g. FM 7- 15, The Army Universal Task List (AUTL) (Hieb, 2003).

The XBML project is currently focusing on taking an existing Army BML testbed and using Simple Object Access Protocol (SOAP) /XML interfaces to develop a demonstration of XBML’s utility. The goal is to develop a testbed for “plugging in” C4I and simulation systems (see Figure 10) (Hieb, 2003). Ongoing work includes harmonizing BML semantic constructs with the C2IEDM data model.

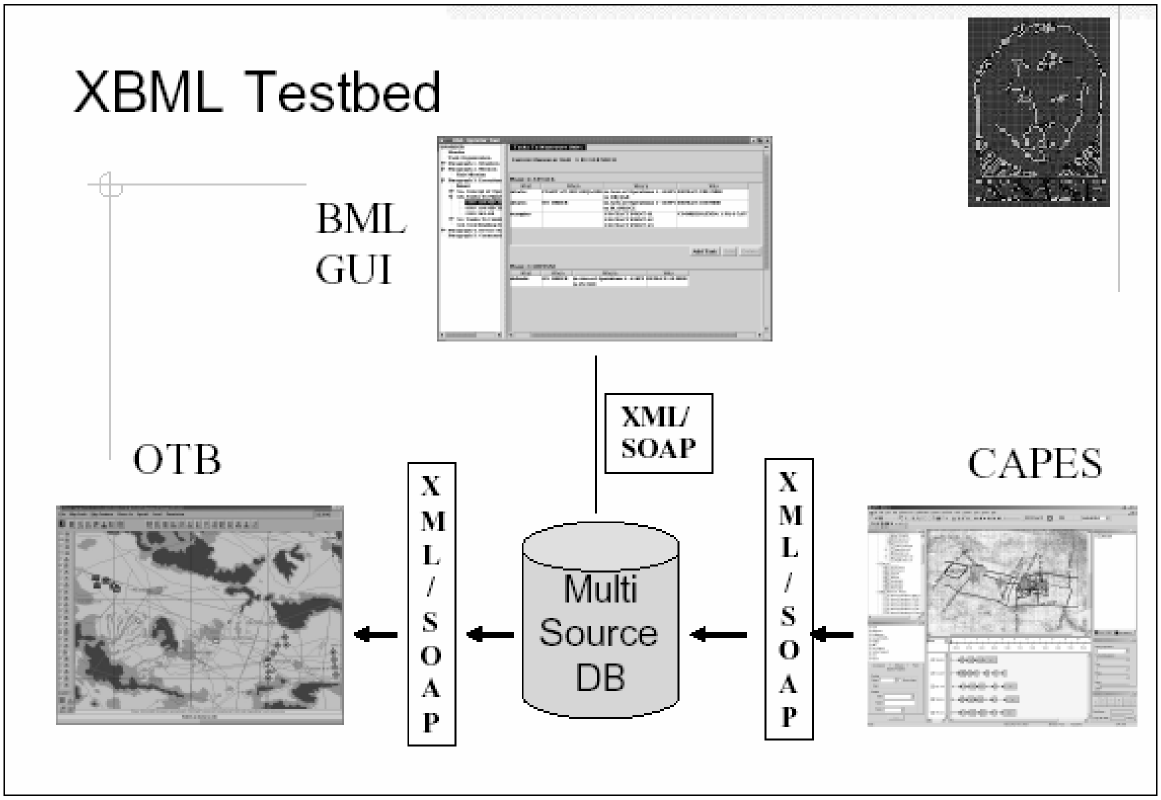

Figure 10. Pictorial representation of the XBML Testbed (From Heib, 2003).

LEGEND:

BML	Battle Management Language
GUI	Graphical User Interface
OTB	OneSAF Testbed
SOAP	Simple Object Access Protocol
CAPES	Combined Arms Planning and Execution System

J. TOPTIVA

The Theater Anti-Submarine Warfare Combat System (TASWCS) Operational Task (OPTASK) Interactive Viewing Application (TOPTIVA) is a command and control application that exposes the functional areas of the MIP C2IEDM project (Brutzman, 2004). The TOPTIVA application was developed at the Naval Undersea Warfare Center (NUWC) Newport RI and uses the C2IEDM as the data exchange format for tactical operational information via the

Operational Context eXchange Service (OCXS). This service is an XML messaging service that has also been developed by NUWC. TOPTIVA contains a graphical user interface (GUI) that allows users to visualize orders that have been transmitted via the OCXS messaging service. Figure 11 shows a snapshot of TOPTIVAs OpenMap™ presentation layer.

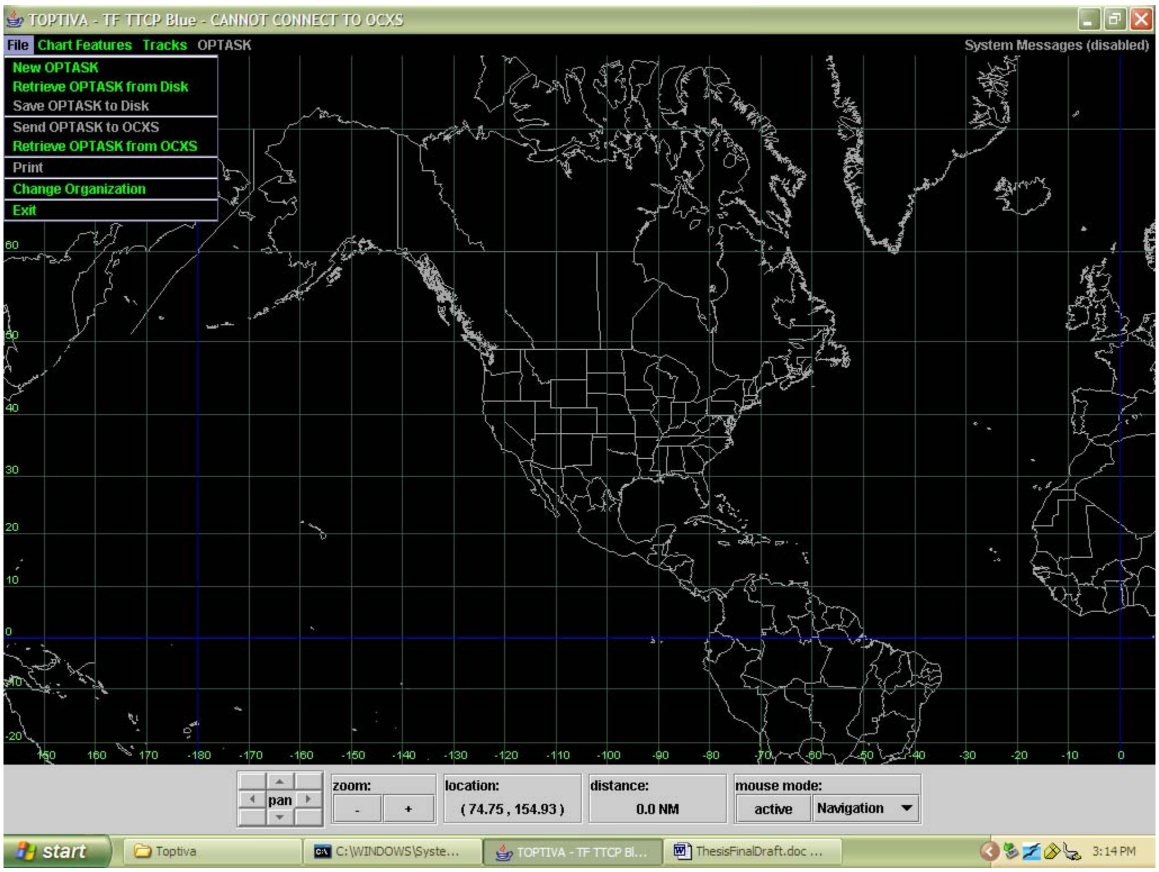

Figure 11. OpenMap™ screen shot from TOPTIVA which uses the C2IEDM data model.

In its current state TOPTIVA only incorporates a small fraction of the total C2IEDM. Work continues to fully develop this technology so that it may be incorporated into more submarine combat control system (CCS) simulation exercises as well as other virtual battle experiments for the U.S. Navy.

K. SUMMARY

This chapter has reviewed several pieces of research geared towards increasing the military's ability to exchange data within the C2 and simulation communities of interest. It has reviewed the current issues dealing with the lack of integration and extensibility of current systems and solutions to these problems using XML technologies and extensible frameworks. XML is the prevailing technology in most applications and areas where the qualities of extensibility, openness and integration are necessary. Most of the examples discussed in this chapter focus heavily on the necessary ability to interchange information between applications and amongst new and existing systems. This focus is prevalent throughout the DoD as it has become readily apparent that the current stovepiped methodology of system development with a later desire for integration and interoperability is no longer acceptable. All of the efforts discussed in this chapter are attempting to harness existing technologies for the enhancement of the nation’s warfighting and defense capabilities.

III. MODEL DRIVEN ARCHITECTURE (MDA)

A. INTRODUCTION

This chapter discusses the Model Driven Architecture (MDA). MDA is a software development methodology that predicates itself on using models and modeling software to autogenerate computer code for processes that require complete documentation and that are easily updatable. The MDA is examined for its potential use in assisting to solve data interchange difficulties.

B. MDA DEFINITION

The Object Management Group's (OMG) Model Driven Architecture (MDA) provides an approach for designing and building component based systems that remain decoupled from the languages, platforms and middleware environments that are eventually used in the implementation of those systems. A key characteristic of the MDA process is the ability of an organization to be able to model their systems once and then transition them over time as standards and infrastructure technologies become more mature (Parr and Keith-Magee, 2003).

> The essence of MDA is that the criterion of executable software architecture should be driven by the formulation of models rather than by manually writing source code. Source code is generated from the models by a compilation step much as machine code is generated from source code. The MDA initiative aims to move software development to a higher level of abstraction (Arlow and Neustadt, 2003, 50)

The MDA concept has evolved from the need to build solutions for widespread software-development computing problems in business. It is a simple concept to explain yet much more difficult to employ, since the technologies necessary to realize MDA concept have not been fully developed and implemented. Prior to code implementation, a development cycle is followed to make the concept of an application a reality. This development cycle sometimes follows a waterfall model, sometimes not, but generally is an iterative process that includes feedback from the client for whom the application is being developed. Traditionally, during the design phase, high-level models are created on paper, white boards etc. to describe the concepts and functionalities required and necessary for the application.

A common complaint in software design and development is the lack of detailed documentation accompanying developed software. Many programmers believe that their only job is to write the code implementing a solution to a particular problem they have been given. They believe that it is someone else's responsibility to compile the documentation necessary for the purposes of understanding the development process, the potential problems and the requirements for upgrading or maintaining the application software. A second complaint during this design phase is that a lot of work has been done to develop a model of the application but no progress is made on writing the code to implement the solution. Often developers want to skip this part of the process because they feel that they are wasting their time. They know that the models and documentation developed in this stage are useful but that they will be out of date and relatively useless once the project is complete.

MDA is an attempt to correct this trend. Its goals are to use and develop if necessary the graphical modeling tools needed in the design process and to make them more robust so that they actually do more than just graphically represent the application under development. During the implementation of the MDA process different models come into existence. In keeping with current trends of extensibility, MDA is driven to use concepts and tools that will allow extensibility. To do this, the MDA is designed to first develop a platform-independent model (PIM) that abstractly reflects the application. The modeling tool used to create this model includes functionality to create the computer software to fully implement this model. An important point is that the Object Management Group (OMG) considers source code to be a valid model since it is a formal specification that has a distinct semantic meaning and models executable machine code that is developed through the use of an interpreter and compiler (Arlow and Neustadt, 2003). Once PIM development is complete, a transformation process is used on this model which generates subsequent platform-specific models (PSMs). These PSMs are tailored to the platform on which they will operate. Again during a transformation process, the modeling tool generates the computer software necessary for the model to run on that particular platform. This platform-specific model then undergoes a transformation that generates application software.

In addition to the models and software to run the application, software that adds functionality between like and unlike systems is created during the transformational processes. This software acts as and is called a bridge. Since the information is present for each of the models to know what is required of them, it is possible to generate specific bridges to connect the different platforms.

C. MDA STRUCTURE

1. Platform-Independent Model (PIM)

This is the high level model created during the design process which takes into account all of the functionality of the application under development. This model is based on a high level of abstraction and is focused towards the best solution to the problem at hand. This model has no ties to operating systems or other proprietary software or system. PIMs are the most abstract of the architecture models and are the most valuable.

2. Platform-Specific Models (PSM)

These models directly result from the platform independent model. "A PSM is tailored to specify your system in terms of the implementation constructs that are available in one specific implementation technology" (Kleppe, 2003). They contain both business and platform information, are created by mapping the PIM to a particular platform stack, are detailed models using Unified Modeling Language (UML), and are the basis of source code and associated artifacts (Arlow and Neustadt, 2003). PSMs are less abstract than PIMs and are used to generate source code, which in turn is the least abstract feature of the MDA.

3. Source Code

Source code is generated in one of two ways. It is manually generated by the application programmer or it is generated through the modeling tool, an example of which is eXecutable UML. Source code is the least abstract model in the MDA process but it is considered by the OMG to be a model since it represents machine language.

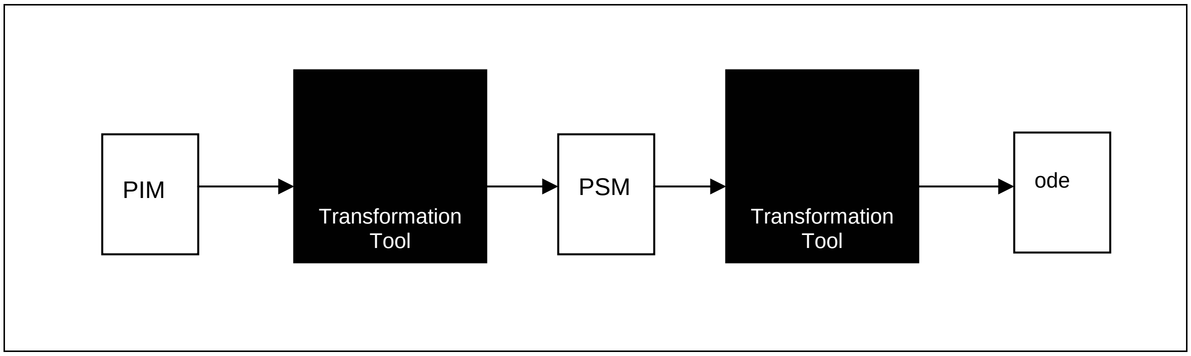

Figure 12. Steps in MDA development Process (From Kleppe and others, 2003).

D. USING MDA FOR DATA MODELING

The original thesis intent is depicted in Figure 13. The goal there was to use the UOB version 7.7 schema as the target structure, populated with data extracted from the Battlefield Information Exchange schema (BIXS). The BIXS acts as the PIM and the UOB acts as the first in a series of PSMs. Once the unit information was formatted correctly using the UOB structure it could be further transformed, using XSLT, into other PSMs usable within the FAST Toolbox such as JCATS and DIAMOND. This concept was originally supported by such statements as

> Models suitable for use in the MDA have to be written in a well-defined language (Kleppe, 2003) which XML is and that in reality it is difficult to draw the line between platform independent and platform specific. Is a model written in UML specific for the Java platform because one of the class diagrams defines one or more interfaces? Is a model that describes the interactions of components specific for a certain platform only because some of the components are 'legacy' components, which may be written in, let's say, COBOL? It is hard to tell (Kleppe, 2003, 22).

Using XML and XSLT to conduct the required modeling appears to work in the abstract, but there are concerns that this idea may not necessarily conform to the intent of the MDA.

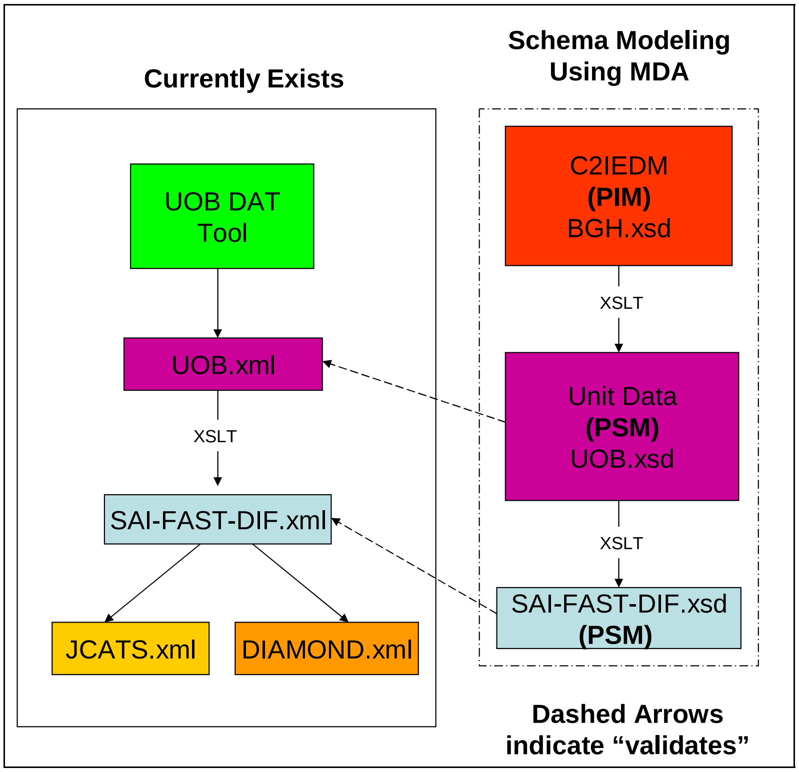

Figure 13. Original thesis model utilizing MDA concepts.

Since the OMG stated that code is itself a model, all of the data modeling necessary for this work could be represented using XML. XML is a meta markup language which can be applied to design other languages used to provide structure to text documents which makes them well defined. However, XML is also considered a type of implementation, so its use as part of the PIM may violate the MDA intent, although the modeling language is not the real issue, expressing the abstract model is. It can be argued that C2IEDM is a specific implementation as well. A PSM represents a specific application instead of a specific language used to develop an application. From this perspective, JCATS and DIAMOND are PSMs.

The use of XSLT for transforming data models parallels the MDA transformation process. However as discussed previously, the differentiation of what constitutes a PSM or PIM depends on the developer's point of view. For data modeling, there is a one-to-one mapping of the concepts from MDA to XML based technologies. However, UML is the prevailing modeling language specifically eXtensible UML, mentioned in the MDA literature that is necessary to make MDA fully functional. Other technologies were introduced such as the Extensible Metadata Interchange (XMI) and Enterprise Java Beans (EJB) but it was apparent that since the OMG is the developer and custodian to the UML, it is the tool recommended for successful implementation of the MDA.

E. NEXT STEPS

While using MDA may be the method some businesses will attempt to use for the development of their software applications in the future it appears that MDA is not yet the best method in the context of this thesis. Several limitations of the MDA of note follow. First MDA is software centric even though the OMG desires it not to be and it is focused on an application's architecture. Secondly, the tools to fully implement the MDA are promising but are still emerging and generally speaking are too advanced for the average user. Third, reworking legacy systems so that they fall into the architecture is not only difficult but prohibitively expensive.

Generally, the intent of the MDA is sound but the necessity to be an expert using only certain tools to implement the architecture is not. It is not clear how technologies like XML and XSLT fit within the MDA. Further maturity in MDA software tools and greater availability of well-adopted examples may eventually change this situation. Rearchitecting large numbers of diverse legacy software systems is not a practical approach. Instead, this thesis looks at correlating tactical data models, so that XML-based documents and message interchange might achieve broad interoperability in daily practice.

IV. UNIT ORDER OF BATTLE (UOB) TOOLSET

A. INTRODUCTION

This chapter introduces the Unit Order of Battle (UOB) Toolset and its component parts, the data sources found within UOB, the Data Access Tool (DAT)used to extract information from the databases and the Data Interchange Format (DIF) used. The UOB is an authoritative source for unit order of battle information due to its completeness and relative ease of use. Additional information about the UOB and instructions for downloading the tool may be found are discussed in (UOB, 2004).

Before proceeding, two questions need to be answered. First, what comprises a complete unit description? This question must take into consideration both DoD and NATO/coalition forces if it is to be complete. Normally, Order of Battle (OOB) consists of identification, strength, command structure, and disposition of the personnel, units, and equipment of any military force (Hout, 2003). Secondly, where might the information be located? Several data sources currently exist that contain unit information. The answers to both of these questions appear to be located within the UOB Toolset located within the FAST Toolbox.

DMSO’s Data Engineering program sponsors the UOB Toolset. The project was put together to address the problem of too many unit order of battle sources with overlapping and sometimes inconsistent data. The UOB Toolset is the most acceptable source of unit order of battle comprised to date.

B. UOB TOOLSET

The Unit Order of Battle (UOB) Toolset consists of three main components: a library of UOB data sources, a data access tool (DAT), and a data interchange format (DIF). Figure 14 depicts the UOB DATs major components and pictorially represents their interactions.

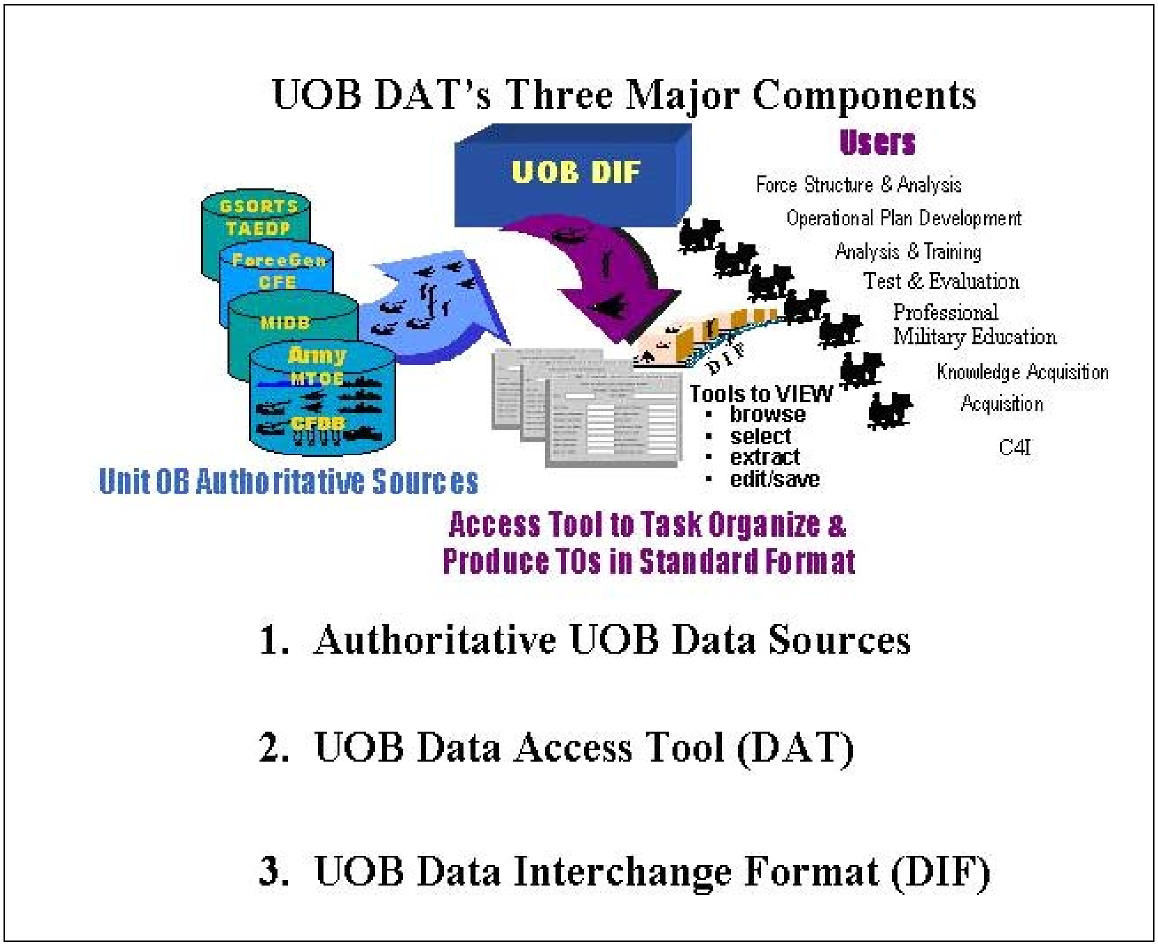

Figure 14. The UOB Toolset Components (From Cipparone and Hopkins, 2003)

1. UOB Data Sources

As was mentioned earlier, UOB data is available from a variety of sources. These include both U.S. and non-U.S. forces at UNCLASSIFIED and SECRET classification levels. DMSO's Authoritative Data Sources project has identified several sources of UOB data (Hopkins, 1999). Currently, the UOB Toolset provides access to a significant number of these data sources. Organizations owning units maintain the UOB source data and provide them in their native formats to the maximum extent possible. To address the need for authoritative classified UOB data, the Toolset provides access to the following classified resources.

- Conventional Forces Database (CFDB) – The CFDB was created by US Central Command (CENTCOM) under the sponsorship of the Joint Staff (JS) J8's Modern Aids to Planning Program (MAPP) and contains current data about US Army, Navy, Air Force, and Marine units, personnel, and equipment from many sources. The CFDB is updated twice a year and is distributed by the Office of Defense (OD) Program, Analysis, & Evaluation (PA&E). The database is classified as SECRET.
- Global Status of Resources and Training System (GSORTS) and the Global Command and Control System (GCCS) – two authoritative operational data sources for US Army, Navy, Air Force, and Marine units, personnel, and equipment. These two sources are classified SECRET.
- Modernized Integrated Database (MIDB) – MIDB, created by the Defense Intelligence Agency (DIA), contains general military intelligence data on many foreign facilities, units, personnel, equipment and targets. The MIDB database is classified SECRET.
- ForceGen – created by the National Ground Intelligence Center (NGIC). ForceGen is an Authoritative Data Source (ADS) of information and contains eighteen countries UOB data with projections ahead for twenty years. This database is classified SECRET.
- Conventional Forces Europe (CFE) – The CFE contains U.S. Units located in Europe and forces of other countries in Europe that are members of the arms control agreements. This database is unclassified but only available on the SIPRnet and DMSO's MOOTW tool kit.

To address the need for unclassified data, the Toolset also provides access to:

- Unclassified ForceGEN – Contains non-U.S. forces, maintained by the NGIC. The database contains both a heavy and light force structure.

- Army MTOE –This database contains all Army Units with their authorized and required personnel and equipment data. There are two versions of this source: one that provides unit information down to the Company level and one that provides unit information down to the lowest Army organizational level, usually the team level. This database is maintained by U.S. Army Force Management System Agency (USAFMSA).
- Generic U.S. units – This is an extract from the Type Unit Cargo Characteristics (TUCHA) Joint Operations, Planning and Execution System (JOPES) reference file.
- Non-Governmental Organizations (NGOs) – This consists of selective approximations of Non-Governmental Organizations (NGO), Private Volunteer Organizations (PVO), and International Organizations (IO) that have been constructed and added to the database for use with applications concerned with MOOTW.
- Characteristics and Performance (C&P) data – A link has also been created between significant unit equipment and the SPIRIT and JANES C&P databases.

In the future, DMSO plans to expand the UOB data available via the Toolset by including future year projected data for U.S. Army units from Total Army Equipment Distribution Program (TAEDP) and the DIA National Futures Database (NFDB) (Cipparone and Hopkins, 2003).

2. UOB Data Access Tool (DAT)

The UOB DAT provides access to the UOB data sources identified above and the ability to manipulate UOB data to serve specific application requirements. The DAT is a tool using both server and client relationships in a virtual data warehouse architecture. Only the client Data Access Tool and any UOB data the user chooses to save locally are resident at the user's site. The authoritative UOB data server is resident at the data producer's location and is accessible by the client DAT across the public Internet (for unclassified data) or the SIPRNET (for classified data). This architecture ensures that UOB DAT users are accessing the most currently available data from the authoritative sources. It also alleviates the need to replicate and maintain UOB data storage at each user's site. The producers of the authoritative data are responsible for storing and maintaining the data. The data access tool features a graphical user interface depicted in Figure 15, which allows users to retrieve and browse unit order of battle data and associated information and select individual units easily and quickly across distributed networks.

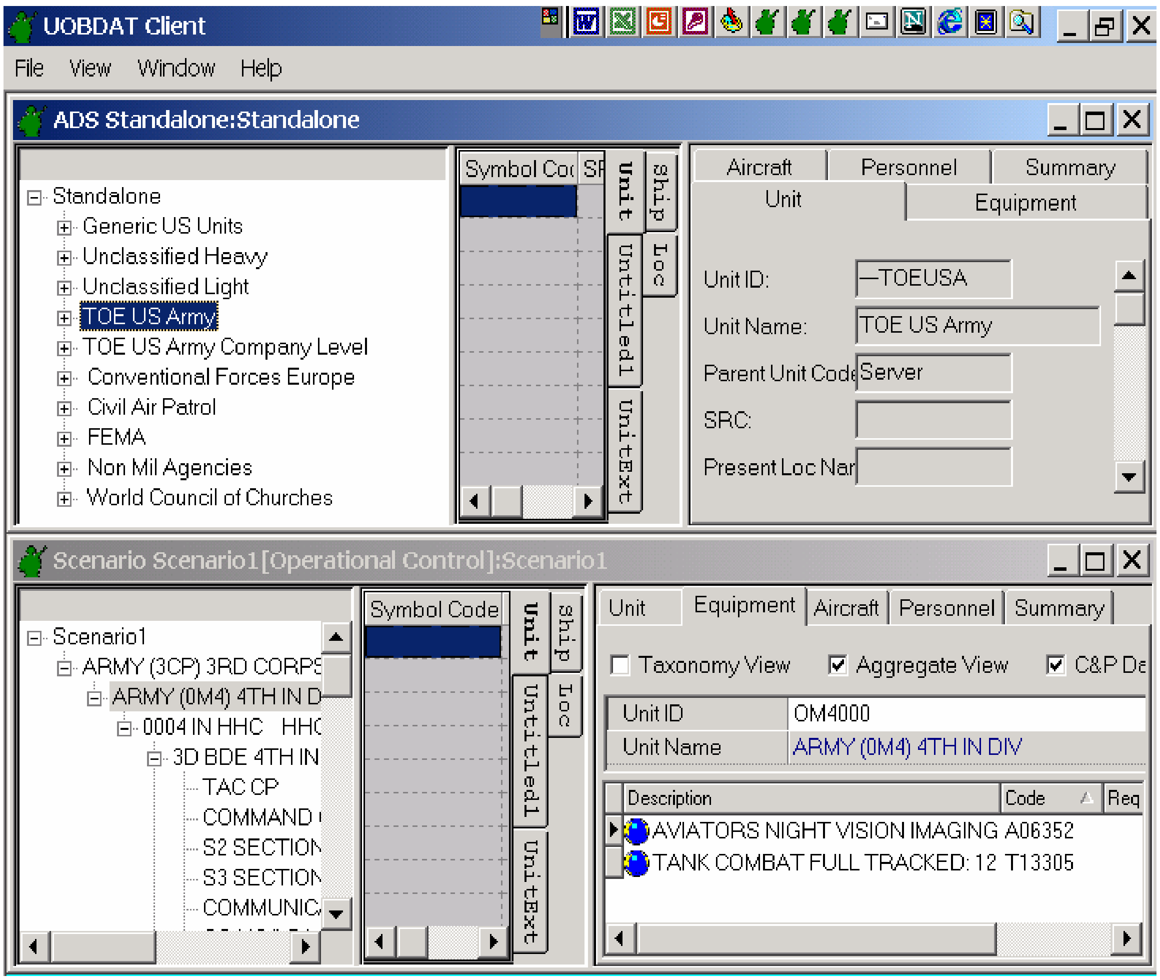

Figure 15. The UOB DAT Main Browser/Editor Screen.

3. UOB Data Interchange Format (DIF)

The UOB DIF is the last, critical component of the UOB Toolset established by DMSO. By utilizing this single format, M&S developers have access to data from a variety of UOB data sources. This interchange format eliminates the need to develop an understanding of each UOB data source's format and the need to write interfaces unique to each data source. The UOB DIF is based on data element standards submitted to the DoD Data Standardization Program and encompasses the key information elements common to the authoritative data sources enumerated above. Logically, the UOB DIF is comprised of five interrelated sets of information:

1. Identification of units and their organizational hierarchy.
2. Aircraft associated with units.
3. Personnel associated with units.
4. Equipment associated with units.
5. Aircraft / equipment characteristics and performance data.

The UOB DIF has implemented four of the above items as either ASCII comma delimited or fixed width files. A portion of the UOB DIF data model is shown in Figure 16.

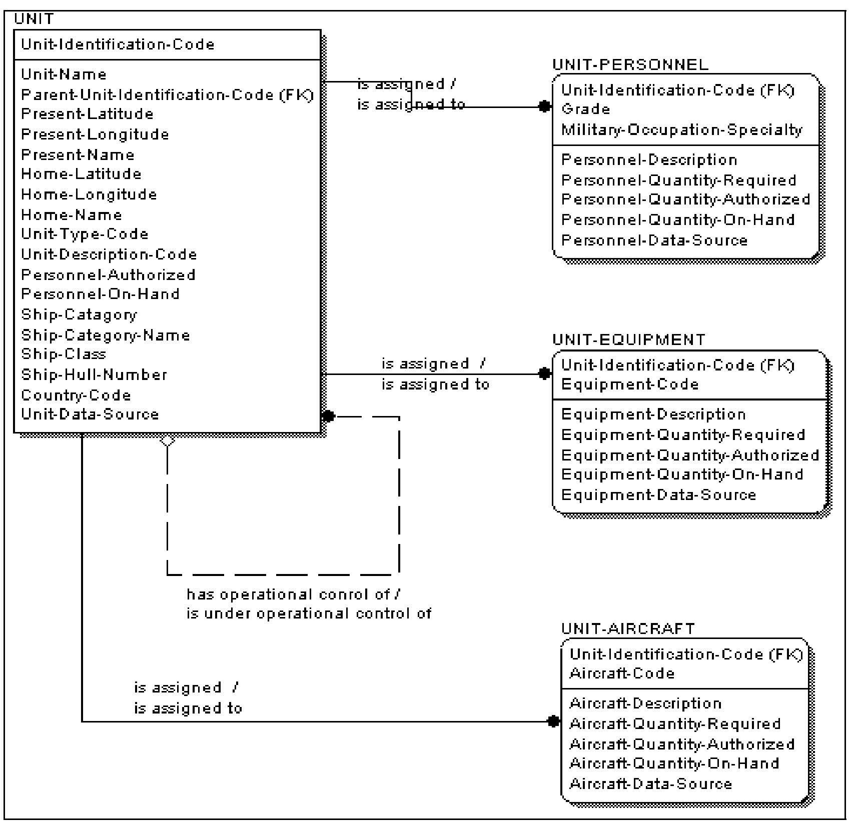

Figure 16. Pictorial representation of part of the UOB Data Model (From Cipparone and Hopkins, 2003).

The logical and well-structured format of the UOB Toolset allows users of military unit data to tailor the data to fit the needs of their models and simulations. The UOB schema that describes the structure of an extracted UOB file is the guiding structure target used during the document development in this work.

C. SUMMARY

The UOB consists of three main parts: a Data Access Tool (DAT), a Data Interchange Format (DIF), and several databases. The databases comprise a complete and thorough compilation of classified, unclassified, U.S. and Foreign military unit information that is accessible using the DAT. The DAT allows users to manipulate unit information though the use of an intuitive graphical user interface. The DIF, based on standards developed for the DoD Standardization Program, holds the key information elements common to the authoritative data sources held within the UOB.

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V. UNIT DATA TRANSFORMATION

A. INTRODUCTION

Chapter V addresses the transformation of unit data extracted from the BIXS C2IEDM using XSLT. This chapter provides an exemplar showing the power of XSLT to transform the data extracted from the BIXS C2IEDM into the format governed by the UOB version 7.7 schema. Appendix A contains the UOB schema. Appendix B contains the extracted UOB unit file which provides an example of what the result document may look like after the transformational process. Based on the conventions used in a schema, Appendix C is the XSLT stylesheet written to conduct the transformation. Appendix D is the result document from the XSLT transformation. Appendix E is the schema developed by the author prior to his ability to extract files from the UOB and Appendix F is the result document developed by the Author that validates against Appendix D. It should be noted here that several documents may be compliant with the same schema but may not look exactly alike. The reader will notice subtle differences between the extracted UOB file and the XSLT result document. Both documents are UOB schema compliant.

B. XML SCHEMA DEFINED, DISCUSSED AND COMPARED

What is an XML schema? “An XML schema is any type of model document that defines the structure of something” (Hunter and others, 2003, 217). Perhaps a better way to look at it in the context of this effort is that a schema defines an XML tagset according to the W3C XML Schema recommendation. This work focuses on an XML document describing a military unit. XML Schemas are themselves XML documents, so they use the XML syntax and support XML Namespaces. Namespaces allow the combining of elements from different XML Schemas. They provide a method for development of ontologies by allowing several elements with the same name but from different XML languages to be used in a single document. Elements are differentiated from one another based upon their assigned namespace.

XML Schemas contain data types that can be either simple or complex. These allow developers to control the content of conforming documents more rigidly. When describing an element in a schema as a complex type that element may contain other elements, attributes, or both. Sometimes when designing XML Schema, we need to design our own data types. To do this, we may use either complex or simple type definitions. Simple type definitions use an existing data type in the XML language as their base or another user-defined data type. Simple type definitions are sometimes called derived types (Hunter and others, 2003).

All XML documents must start with a root element, and since XML Schema are a specific type of XML document they have a specific root element. For most XML Schema the word schema is the root element and to ensure uniqueness the namespace prefix xsd is commonly used. Generally, after the root element of the schema, the root element of the document is identified. To develop a schema, it is important to first know what the result document needs to look like. Appendix B shows what the result document may look like here. As was mentioned in the introduction, schema allow for flexibility in what the result document looks like that validates against them. This design decision allows for information, albeit sometimes incomplete, to still be of some use to the application.

Appendix A provides the governing structure for the result document. The ability to extract information from the UOB databases in XML format eliminates the need to develop a result document by hand. Initial failed attempts at extracting information from the UOB database resulted in the author's development of a schema and result document which closely resembles the ones extracted from the UOB version 7.7. While the schema and result documents are similar, several important differences exist. These differences are discussed now.

1. Schema Compared

Any document to be validated against the author's schema found in Appendix E must have a root element called `UnitData.` From there the schema defines the structure of the result document beginning with the administrative data of the unit. Both complex and simple types of definitions are necessary to describe the information using the XML language. The author's schema provides an outer structure for the document by using one all-encompassing complex type definition. This definition includes multiple elements that make up the rest of the structure. Figure 17 shows a portion of this structure. Two of the elements inside the complex type definition require the use of additional simple type definitions. In Figure 17 only the simple type definition for the `UnitLevelCode` element is shown.

These simple type definitions are required because enumerated lists are necessary to describe all of the valid data values that may occupy the element in this XML document. They restrict the element data in the document to be of base string and then use the `xs:enumeration` element in the schema to elaborate on the exact items allowed inside this element in the result document. This accomplishes two things. First it prevents incorrect information from being accepted in the result document (no undefined enumeration strings are allowed). Second, it assists the document's author to see exactly what data is considered acceptable in these elements. The remaining elements inside the complex type definition allow plain strings and are not as restrictive to the nature of what these strings must say. Compared to the UOB version 7.7 schema in Appendix A, the author's schema is much more restrictive. This is an example of where a developer under time constraints has the flexibility to be lenient as to what he allows to be accepted as valid XML content. Time permitting either enumerations or simple type definitions using patterns and other built-in XML data types might replace these simple strings to provide even more stringent control of the information in the XML document.

After the administrative data, information about the unit's personnel is expected. For this another complex type element named `Personnel` is used and required in the XML document. It contains the definition for the elements containing information about job descriptions, military ranks, military occupational specialties, numbers authorized, numbers on hand, etc. Again, enumerated lists and simple type definitions are used to best describe this data. The simple type definition used here is different however. This time the built-in data type called `pattern` is used. This data type allows the document author to specify the exact string pattern in terms of letters, numbers etc. allowed inside the element. Figure 18 shows the portion of the author's schema that uses the `pattern` data type for defining the content of the `MilitaryOccupationSpecialityCode` element.

```
<xs:element name="AdministrativeUnitInformation">
    <xs:complexType>
        <xs:sequence>
            <xs:element name="ParentUIC" type="xs:string"/>
            <xs:element name="ParentUTC" type="xs:string"/>
            <xs:element name="ParentULC" type="xs:string"/>
            <xs:element name="SRC" type="xs:string"/>
            <xs:element name="UnitUIC" type="xs:string"/>
            <xs:element name="UnitName" type="xs:string"/>
            <xs:element name="UnitTypeCode" type="xs:string"/>
                    <xs:element name="UnitLevelCode">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="SEC"/>
                        <xs:enumeration value="SQD"/>
                        <xs:enumeration value="PLT"/>
                        <xs:enumeration value="HFT"/>
                        <xs:enumeration value="TRP"/>
                        <xs:enumeration value="CO"/>
                        <xs:enumeration value="SQ"/>
                        <xs:enumeration value="BN"/>
                        <xs:enumeration value="REG"/>
                        <xs:enumeration value="BDE"/>
                        <xs:enumeration value="DIV"/>
                        <xs:enumeration value="CPS"/>
                        <xs:enumeration value="A"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
</xs:element>
```

Example simpleType

Example enumeration

Figure 17. Example `enumeration` used to specifically define what is allowed within the `UnitLevelCode` element of the `AdministrativeUnitInformation` element.

```
<xs:element name="MilitaryOccupationSpecialityCode">
    <xs:simpleType>
        <xs:restriction base="xs:string">
            <xs:pattern value="[0-9]{2}[A-Z]{1}([0-9]{2}|[0-9]{1}[A-Z]{1})"/>
        </xs:restriction>
    </xs:simpleType>
</xs:element>
```

Figure 18. An example of the XML `pattern` data type in use.

The pattern structure seen above allows for the first two digits of the pattern to be numbers between zero and nine. The next digit has to be one letter from A-Z. The third and fourth digits are two more numbers from zero through nine or can be just one number between zero and nine and one letter between A and Z. This is much different from the conventions used in the UOB schema. The UOB schema is not this restrictive and simply allows any string to be used inside this element. The loose structure of the UOB version 7.7 schema invites difficulties when it uses the less restrictive data types.

In order to restrict anyone from filling in “none” as a valid value for the three elements of number authorized, on hand, and required, the element content is restricted to a type of non-negative integer (see Figure 19). In XML, this indicates that the numbers 0 through 9 are completely acceptable but no negative numbers are allowed and because the data must be a number, the input of strings will cause an error during XML validation, such as: “This file is not valid: Invalid value for database type nonNegativeInteger in element ‘numberRequired’” (generated by XMLSPY Enterprise Edition).

```
<xs:element name="NumberRequired"    type="xs:nonNegativeInteger"/>
<xs:element name="NumberAuthorized"  type="xs:nonNegativeInteger"/>
<xs:element name="NumberOnHand"      type="xs:nonNegativeInteger"/>
```

Figure 19. Example Non-negative Integer type use in Appendix E.

The last piece of XML Schema developed by the author (Appendix E) involves the unit equipment. The unit equipment element is a complex type element and includes those fields listed in the equipment file from UOB DAT. The use of the `pattern` data type again assists in ensuring that the equipment codes are in the correct format. Non-negative integers in the other elements of the complex type ensure no improper string usage. Once this step is complete, the schema is complete and it is then checked to ensure that it is well-formed, xml valid and XML Schema valid using the XML authoring tool XMLSPY by Altova.

2. Document Development

Given a complete schema an author has numerous software-tool options for generating a new XML document. Outside of trivial examples, authors will generally use software to generate data files. Some XML authoring tools can auto generate example documents if valid schemas exist. Generated documents can be useful to developers for revealing flaws in a schema. Autogeneration also saves time. When used, the document author simply is required to fill in the content of his document. This research effort used both approaches. XMLSPY generated one document, which was used to check the author's design idea for Appendix E. This uncovered several problems namely in the authors use of patterns and enumerated lists.

Although the structure of the schema in Appendix E was inspired by the UOB DAT, it is a more rigidly structured document than the UOB version 7.7 schema provided in Appendix A. The reader should notice that although the Unit.xsd file does not fully encompass all NATO country-specific information it does enforce more rigid standards for things such as equipment and MOS codes. The more rigid structure ensures that the data being passed is in the correct format which creates a more stable environment. The permissive use of invalid strings for information may allow incorrect or false information to be accepted into an application, subsequently causing false outcomes or (even worse) fatal errors during execution. Such mission-critical errors are avoidable through careful schema design.

C. XSLT DOCUMENT DEVELOPMENT

1. General Information

Using XSLT to transform XML documents is a powerful and difficult endeavor. The reason for this is clear. We are attempting to take a source document with specific information governed by one schema, and precisely transform it into a generic form of the same data governed by a much different schema, in such a way as to allow different applications to use the corresponding data with consistent semantics. Many transformations may be necessary for legacy models and simulations but if a standard method and model of representation (i.e. ontology) are established then future models and simulations are likely to have less difficulty interchanging data.

XSLT stands for Extensible Stylesheet Language for Transformations (Kay, 2003). It is another language in the growing family of XML languages used in this case to transform one type of XML document into another. XSLT is not just for producing other XML documents. It also can be used to generate HTML and databases of different sorts from an XML document. It has the ability to transform XML documents into other XML documents and to transform XML into plain text. It cannot, however, transform plain text into XML. XSLT uses a two stage approach to transform XML documents.

> The first stage is a structural transformation, in which the data is converted from the structure of the incoming XML document to a structure that reflects the desired output. The second stage is formatting, in which the new structure is output in the required format such as HTML or PDF (Kay, 2003, 14).

XML and XSLT use an abstract data structure called a tree to represent document content. Source trees are formed from the initial XML document through parsing and result trees are formed by the XSLT parser through serialization. As a result of the use of trees, there is no single API or data representation of the contents of the tree, only a conceptual model that defines the objects in the tree, their properties and their relationships to one another (Kay, 2003). When referring to the result tree, reference is being made to the structure and content rather than format. Reference to the result document indicates that the result tree is in the form of an XML document or other readable document form specified. Two methods of structuring data in the result tree are through the use of built-in templates or through the use of user developed templates. In the XSLT language, the `xsl:template` element defines a template rule. This rule is triggered when a matching portion of the source XML document is processed by the XML parser. The "`match`" attribute of the `xsl:template` element identifies a pattern to be used from the source document node tree.

To begin any transformation process a template must typically be applied to the root node of the source document. The root element is identified by setting the `match` attribute equal to the forward slash character (/). If the XSLT parser does not find this explicit statement, it will use a built-in template to handle this situation. Templates consist of elements and text nodes. Elements in the template may either be classified as instructions or data depending on their namespace. When a template is instantiated the instructions within that template are applied to the source document and the data nodes are copied to the result tree. For the purposes of this work, the result tree is then formatted into an XML document.

After the root template match, additional templates are necessary to transform each part of the source document into the desired result document. This XSLT uses a C2IEDM file as the source file and transforms all usable data extracted into a UOB compliant document to be used as initialization information for simulations in the FAST Toolbox. The following excerpt generally describes the basic structure for a document that is compliant with the C2IEDM.

> C2IEDM structure labels class objects as `OBJECT-TYPE` and individually identified instances as `OBJECT-ITEM`. Implicit in the distinction between type and item is the assumption that data relating to `OBJECT-TYPE`s will tend to be static (i.e., the values of the attributes are not likely to change very often over time), whereas the values of attributes of `OBJECT-ITEM`s are likely to be more dynamic. For example, if a characteristic is about a type (e.g., M1A1 Abrams Tank), it is an attribute of `OBJECT-TYPE`.

> Thus, calibre of main gun, track width, and load class are characteristics of `OBJECT-TYPE`. However, the call sign, actual fuel level, munitions holdings, and current operational status of a specific tank are characteristics of an `OBJECT-ITEM` (NATO, 2002, 9).

The result document generated here does not use this structure nor does it use these names for its elements. Instead it follows its own schema which is uniquely different. A UOB version 7.7 schema-compliant document for unit data is partially shown in Figure 20. Upon review it can be seen that the structure is significantly different from the C2IEDM structure description given above.

```xml
?xml version="1.0" encoding="UTF-8"?>
<UOB xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="UOB Schema
7.7.xsd">
    <ForceStructureInformation>
        <Name/>
        <FileName/>
        <Description/>
        <Purpose/>
        <CreatedBy/>
        <CreationDate>2004-04-15</CreationDate>
        <LastModifiedBy/>
        <LastModifiedDate>2004-04-15</LastModifiedDate>
    </ForceStructureInformation>
    <Relationships>
        <Relationship type="Operational Control">
            <Assigned>
                <UnitNode UIC="WG2LA0"/>
            </Assigned>
        </Relationship>
    </Relationships>
    <Units>
        <Unit UIC="WG2LA0" dataSource="ARMYTOE">
            <Name>1ST SQDN 3D ARMORED CAVALRY, A CAV TRP, CAV SQDN</Name>
            <TypeCode> </TypeCode>
            <LevelCode> </LevelCode>
            <TotalPersonnel>
                <Authorized>132</Authorized>
                <OnHand>132</OnHand>
            </TotalPersonnel>
            <SRC>
                <Code>17487L000</Code>
                <Name>CAV TRP, CAV SQDN</Name>
            </SRC>
            <OpfacRule>
                <Code>AB200</Code>
                <Title>AR CO/CAV TRP CDR (TRACK)</Title>
            </OpfacRule>
            <SymbolCode>S*G*UCRVA-*****</SymbolCode>
            <Resource>
                <Personnel code="92Y3O">
                    <Description>SUPPLY SGT</Description>
                    <Grade>E6</Grade>
                    <Required>1</Required>
                    <Authorized>1</Authorized>
                </Personnel>
                <Personnel code="19K1O">
                    <Description>TANK CREWMAN</Description>
                    <Grade>E4</Grade>
                    <Required>9</Required>
                    <Authorized>9</Authorized>
                </Personnel>
                <Equipment code="T13305">
                    <Description>TANK COMBAT FULL TRACKED: 120MM GUN M1A2</Description>
                    <Required>9</Required>
                </Equipment>
                <Equipment code="F60530">
                    <Description>FIGHTING VEHICLE: FULL TRACKED CAVALRY HI SURVIVABILITY
                   (CFV)</Description>
                    <Required>13</Required>
                </Equipment>
            </Resource>
        </Unit>
    </Units>
</UOB>
```


Figure 20. Example of a partial unit document extracted from UOB version 7.7.

The following table depicts for the reader the association between the elements of the UOB schema and the locations where the data was found in the C2IEDM. The paths to the data locations are shown using the XPath language.

A careful review of and frequent consultation with this table while reading the remainder of this chapter will greatly assist the reader in understanding the development described. This table provides the beginning for a complete round-trip mapping of the UOB and the C2IEDM in what is believed to be a lossless manner. The following is provided to enhance the understanding of the table below. Attributes directly follow the element they are assigned to. Some elements have more than one attribute. The word “None” indicates that no correspondence was found between the C2IEDM and the UOB for that element or attribute. The word “Unknown” indicates that there may be a correspondence but that the author was unable to locate it.

Table 1.   Table of correspondences between the elements in the UOB schema and the XPath expressions pointing to the location of the data in the C2IEDM.

Table of Correspondences between UOB and C2IEDM	
Elements and Attributes from the Unit Order of Battle (UOB) schema Attributes in **BOLD** font	Command and Control Information Exchange Data Model (C2IEDM) XPath expressions to data for UOB elements shown in `Courier New font`
UOB	None
ForceStructureInformation	None
Units	None
Name	None
FileName	None
Description	None
Purpose	None
CreatedBy	None
CreationDate	None
LastModifiedBy	None

Table of Correspondences between UOB and C2IEDM	
LastModifiedDate	None
Unit* * depends on whether looking at item or type	/BattlespaceData/OBJECT-ITEM/ORGANISATION/UNIT /BattlespaceData/OBJECT-TYPE/ORGANISATION-TYPE/UNIT-TYPE
UIC	Unknown
dataSource	None
Name	/BattlespaceData/OBJECT-ITEM/ORGANIZATION/UNIT/unit-formal-abreviated-name
Present	/BattlespaceData/LOCATION/POINT/
Name	Unknown
Latitude	/BattlespaceData/LOCATION/POINT/ABSOLUTE-POINT/absolute-point/absolute-point-latitude-coordinate
Longitude	/BattlespaceData/LOCATION/POINT/ABSOLUTE-POINT/absolute-point/absolute-point-longitude-coordinate
DescriptionCode	/BattlespaceData/OBJECT-TYPE/ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-category-code
LevelCode	/BattlespaceData/OBJECT-TYPE/ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code
Resource* * depends on whether looking at item or type	/BattlespaceData/OBJECT-ITEM/HOLDING /BattlespaceData/OBJECT-TYPE/HOLDING
Personnel* * depends on whether looking at item or type	/BattlespaceData/OBJECT-ITEM/HOLDING /BattlespaceData/OBJECT-TYPE/HOLDING
code	/BattlespaceData/OBJECT-TYPE/object-type-name
Description	Unknown

Table of Correspondences between UOB and C2IEDM	
Grade	/BattlespaceData/OBJECT-TYPE/PERSON-TYPE/person-type-rank-code
Required* * depends on whether looking at item or type	/BattlespaceData/OBJECT-ITEM/HOLDING/holding-operational-quantity /BattlespaceData/OBJECT-TYPE/HOLDING/holding-operational-quantity
Authorized* * depends on whether looking at item or type	/BattlespaceData/OBJECT-ITEM/HOLDING/holding-total-quantity /BattlespaceData/OBJECT-TYPE/HOLDING/holding-total-quantity
Equipment	/BattlespaceData/OBJECT-TYPE/MATERIEL-TYPE/EQUIPMENT-TYPE
code	/BattlespaceData/OBJECT-TYPE/object-type-name
Required* * depends on whether looking at item or type	/BattlespaceData/OBJECT-ITEM/HOLDING/holding-operational-quantity /BattlespaceData/OBJECT-TYPE/HOLDING/holding-operational-quantity
Authorized* * depends on whether looking at item or type	/BattlespaceData/OBJECT-ITEM/HOLDING/holding-total-quantity /BattlespaceData/OBJECT-TYPE/HOLDING/holding-total-quantity

2. Force Structure Information

After reviewing the schema governing the result document, the XSLT transformation process begins using a template that simply outputs the administrative information for the unit which is called `ForceStructureInformation` in the result document. This section includes information about the document like the unit name and when the document was created or modified. Figure 21 shows this template and the XSLT rule that calls it. Several templates are needed to fully extract all information about the unit in question from the C2IEDM model. Those templates deal with unit data, personnel data and equipment data.

```
<xsl:call-template name="FileHeader"/>

<xsl:template name="FileHeader">
    <xsl:element name="Name"/>
    <xsl:element name="FileName"/>
    <xsl:element name="Description">Document generated using XSLT on XML C2IEDM Ver 6.1 model</xsl:element>
    <xsl:element name="Purpose"/>
    <xsl:element name="CreatedBy">C2IEDM From Command and Control System</xsl:element>
    <xsl:element name="CreationDate"/>
    <xsl:element name="LastModifiedBy"/>
    <xsl:element name="LastModifiedDate"/>
</xsl:template>
```

Figure 21. XSLT template used to extract ForceStructureInformation from C2IEDM.

Figure 22 shows the results of the XSLT used above. This portion of the stylesheet is very easy to understand and requires little processing on the part of the XSLT processor because no computations are being conducted. The instructions given to the parser are to simply create the elements listed above and output them as seen below.

```
<ForceStructureInformation>
    <Name/>
    <FileName/>
    <Description>Document generated using XSLT on XML C2IEDM Ver 6.1 model</Description>
    <Purpose/>
    <CreatedBy>C2IEDM From Command and Control System</CreatedBy>
    <CreationDate/>
    <LastModifiedBy/>
    <LastModifiedDate/>
</ForceStructureInformation>
```

Figure 22. ForceStructureInformation output of XSLT of C2IEDM.

3. Unit Identification

To begin the transformation of unit identification data a handle is required for each unit contained in the C2IEDM model. Once the handle is obtained, using it to assist in the traversal of the model provides a relative amount of certainty that the information extracted belongs to the unit assigned the handle. The handles used for traversing the C2IEDM are the `object-item-id` and `object-type-id`. These are extracted from the C2IEDM when the template shown in Figure 23 is called to obtain the unit's name. This is done for two reasons. First it ensures that the ids are attached to that particular unit and no other. Second obtaining the id's at this level and saving them into variables allows them to be passed into other templates.

```
<xsl:template match="unit-formal-abbreviated-name">
  <xsl:element name="Unit">
    <xsl:attribute name="UIC" />
    <xsl:attribute name="dataSource" />
    <xsl:element name="Name">
      <xsl:value-of select="." />
    </xsl:element>
    <xsl:variable name="ObjectItemID" select="../../../object-item-id" />
    <xsl:variable name="ObjectTypeID" select="../../../OBJECT-ITEM-TYPE/object-type-id" />
    <xsl:call-template name="RelativeUnitLocation">
      <xsl:with-param name="UnitObjectItemID" select="$ObjectItemID" />
      <xsl:with-param name="UnitObjectItemLocationID" select="../../../OBJECT-ITEM-
LOCATION/location-id" />
    </xsl:call-template>
    <xsl:call-template name="UnitTypeCategoryCode">
      <xsl:with-param name="OTypeID" select="$ObjectTypeID" />
    </xsl:call-template>
    <xsl:call-template name="UnitTypeSizeCode">
      <xsl:with-param name="ObjTypID" select="$ObjectTypeID" />
    </xsl:call-template>
    <xsl:element name="Resource">
      <xsl:call-template name="PersonnelHoldings" />
      <xsl:call-template name="EquipmentHoldings" />
    </xsl:element>
  </xsl:element>
</xsl:template>
```

Figure 23. Main template used within the XSLT to extract unit information from the C2IEDM.

In order to extract the unit's name, the parser is directed to follow the path in the apply-templates call. The `select` attribute of the `xsl:value-of` element extracts the name of the unit and acts as the starting point for the rest of the transformation. From there the parser is instructed to back up three levels to extract the `object-item-id` from the `OBJECT-ITEM` element and the `object-type-id` from the `OBJECT-ITEM-TYPE` element. Once this is complete the handles for the object-item and object-type are set. Figure 24 shows an XMLSpy grid view of part of the BIXS containing the `OBJECT-ITEM`, `OBJECT-TYPE` and `UNIT` elements of the model.

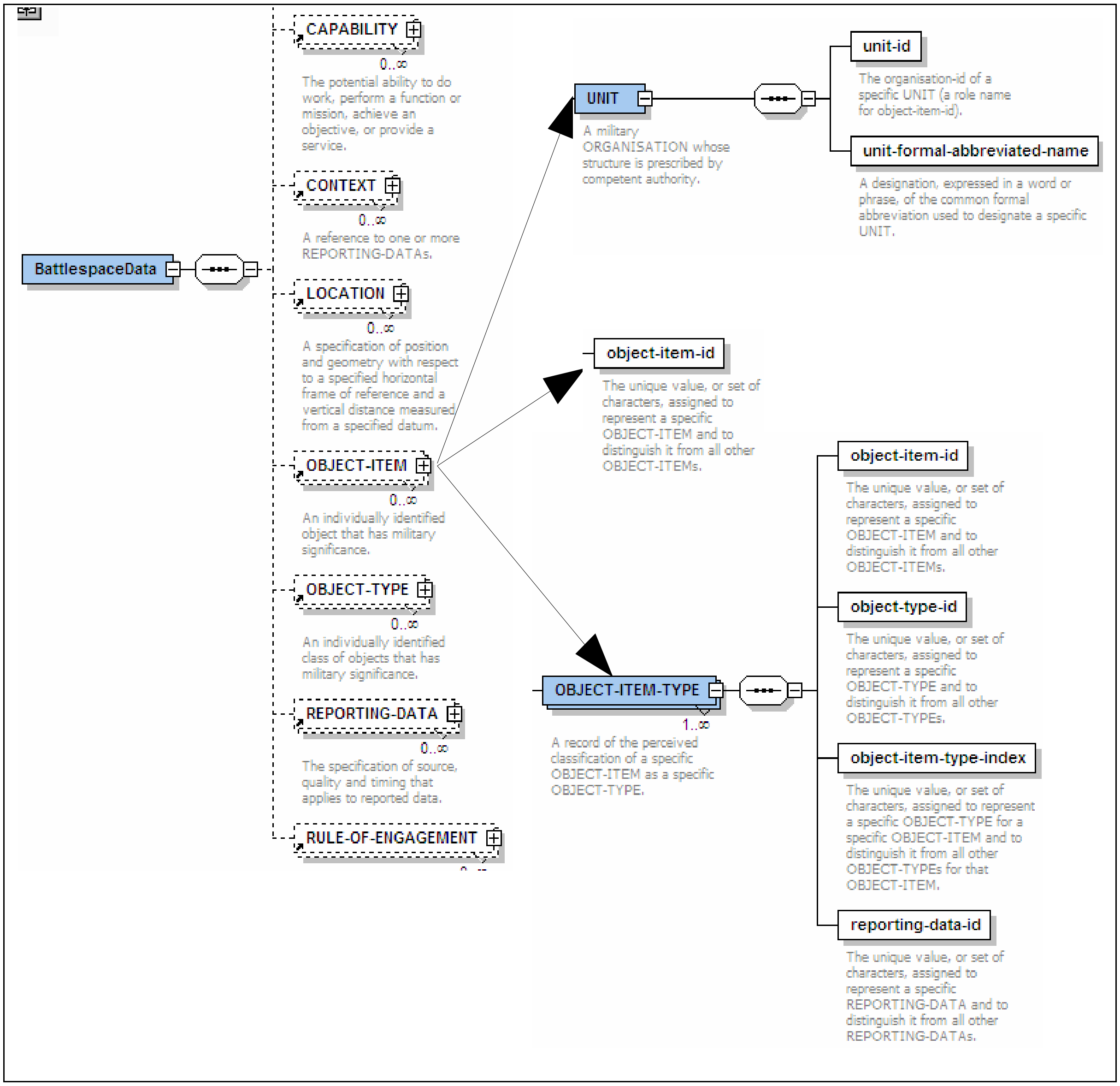

Figure 24. Grid view of BIXS containing `object-item-id`, `OBJECT-ITEM-TYPE` and `UNIT` constructs.

4. Personnel Identification and Extraction

Figure 23 includes two template calls, one for Personnel holdings and one for Equipment holdings. The extraction and formatting of the personnel holdings is discussed in this section. The UOB version 7.7 schema dictates that personnel, equipment and aircraft are used as resources as can be seen in

Figure 25. This thesis is focused on Personnel and Equipment holdings of a specific U.S. Army unit that contains no aircraft. Recommended future work includes increasing the robustness of this XSLT to include all equipment specific to the U.S Navy, Air Force, Marines and Coast Guard.

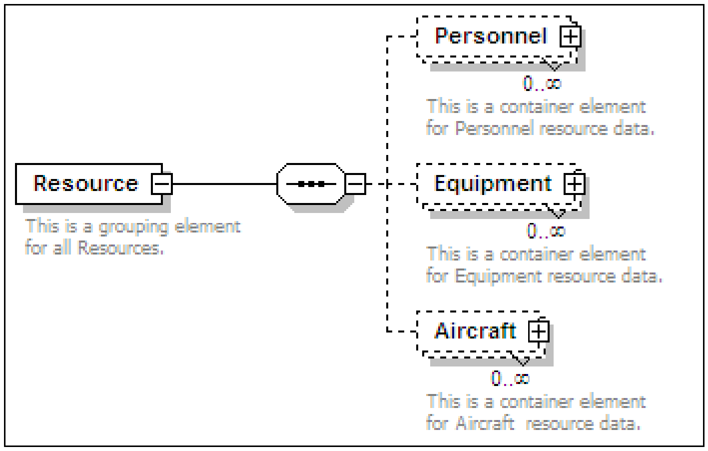

Figure 25. Resource construct found in UOB schema.

The expanded personnel information included in the target UOB schema is shown in Figure 26. Not all of this information is required to initialize a simulation or can be found within a command and control system. The items focused on here are the `Description`, `Grade`, (Quantity) `Required` and (Quantity) `Authorized` elements. These are items that are extractable from the C2IEDM. Recommendations for national modifications to the C2IEDM to include more specifics about personnel are being made to the MIP through works such as this thesis.

Resources in the UOB are classified as `HOLDING`s in the C2IEDM as shown in Figure 27. In order to extract information from the C2IEDM pertaining to personnel three templates are called. First is the PersonnelHoldings template seen in Figure 28, the second is the PersonnelTemplate seen in Figure 29 and the third is the PersonnelHoldingNumbers in Figure 30. The PersonnelHoldings template instructs the XSLT processor to backup from its current location where the formal unit name was obtained, to the `HOLDING` element of the C2IEDM model. There it extracts the `HOLDING` `object-type-id` for each `HOLDING` and places them into a temporary variable called `holdingObjectTypeID`. This variable is then compared to the `object-type-ids` from each of the `OBJECT-TYPE` elements. Two tests are then conducted to ensure that the holdings are for the same specified `OBJECT-ITEM` and are coded as personnel objects. Once those two tests are passed the XSLT processor outputs the structure for the result document and the contents found in the C2IEDM model. The `xsl:value-of` element with `select` attribute located inside the attribute named `code` selects the MOS name of the `OBJECT-TYPE` from the C2IEDM structure.

The PersonnelTemplate is responsible for extracting the Grade information necessary for the result document. When this template is called it maintains the scope of the PersonnelHoldings template. This means that the scope of the `object-item-id` and `object-type-id` are not lost which again helps ensure that the information being tested for and extracted is connected to the personnel holdings of the unit being examined. Currently, the C2IEDM merges officer ranks of O1's and O2's together in one grade called OF1. Additionally, enlisted ranks above E7 Sergeant First Class and Warrant Officer 2 do not exist. While this is adequate for many other countries it is not acceptable for the US military and additional ranks are necessary. Upon U.S. implementation of the C2IEDM as the standard data interchange model, a national extension would be required to encompass these additional rank requirements. Instructions pertaining to the election of model extensions can be found on the MIP website in the documentation section under the Guide to Change Proposals (CP) (MIP, 2004a).

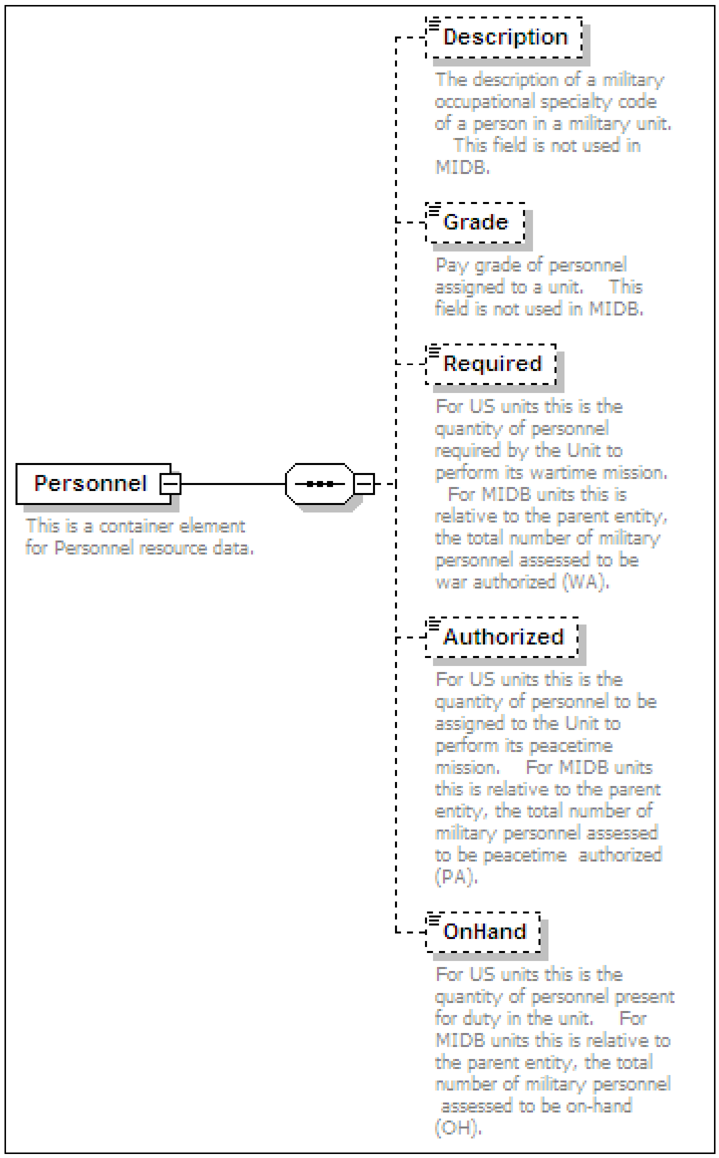

Figure 26. Expanded Personnel element found in UOB schema.

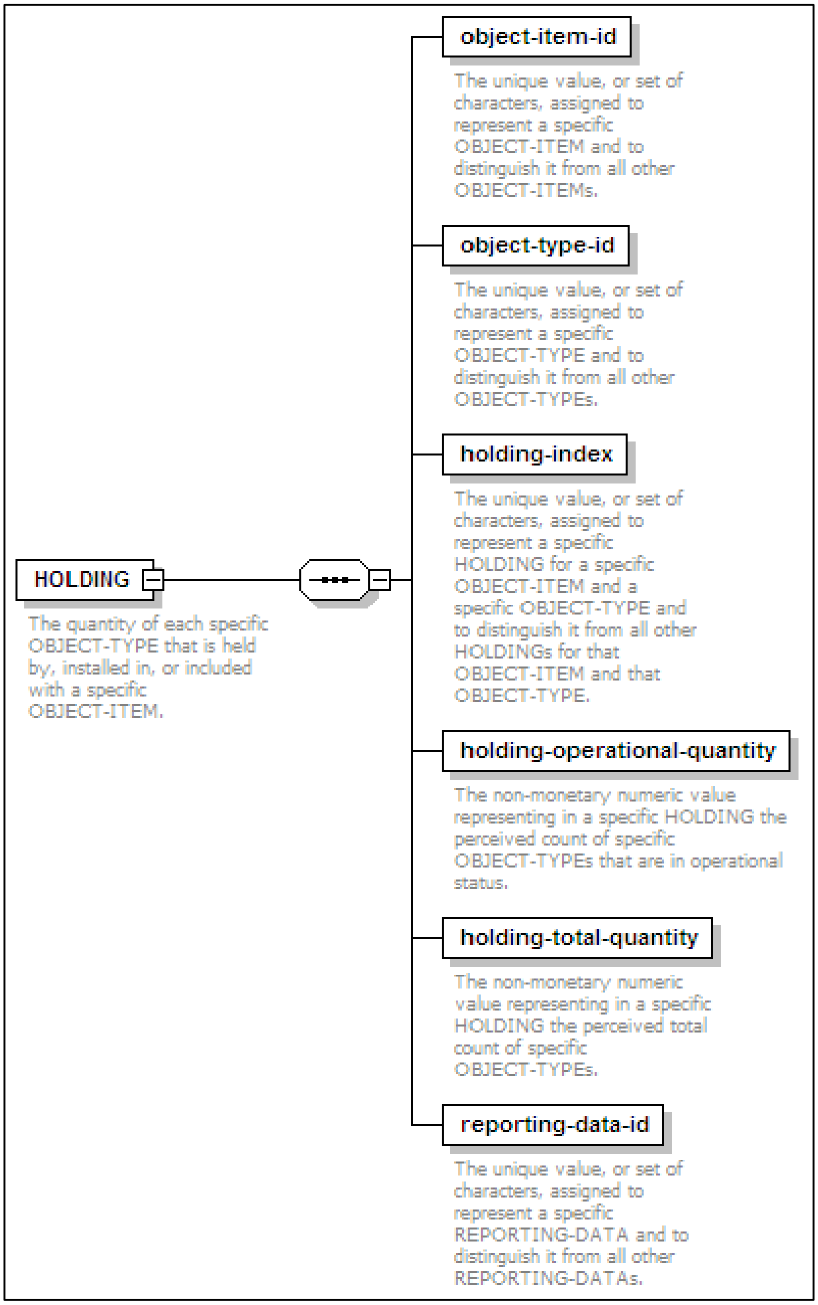

Figure 27. HOLDING construct found within the C2IEDM.

```
<xsl:template name="PersonnelHoldings">
    <xsl:for-each select="../../../HOLDING">
        <xsl:variable name="holdingObjectTypeID" select="object-type-id" />
            <xsl:variable name="holdingObjectItemID" select="object-item-id" />
            <xsl:for-each select="../../OBJECT-TYPE">
                <xsl:variable name="objectTypeID" select="object-type-id" />
            <xsl:if test="$objectTypeID = $holdingObjectTypeID">
                <xsl:if test="object-type-category-code /* [local-name() = 'PE']">
                    <xsl:element name="Personnel">
                        <xsl:attribute name="code">
                            <xsl:value-of select="object-type-name" />
                      </xsl:attribute>
                        <xsl:call-template name="PersonnelTemplate" />
                        <xsl:call-template name="PersonnelHoldingsTemplate" />
                  </xsl:element>
              </xsl:if>
          </xsl:if>
      </xsl:for-each>
   </xsl:for-each>
</xsl:template>
```

Figure 28. PersonnelHoldings template from C2IEDM to UOB XSLT.

```
    <xsl:template name="PersonnelTemplate">
        <xsl:element name="Description"/>
        <xsl:element name="Grade">
            <xsl:choose>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OF1']">01/02</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OF2']">03</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OF3']">04</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OF4']">05</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OF5']">06</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OF6']">07</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OF7']">08</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OF8']">09</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OF9']">10</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OR1']">E1</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OR2']">E2</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OR3']">E3</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OR4']">E4</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OR5']">E5</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OR6']">E6</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OR7']">E7</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OR8']">W1</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() = 'OR9']">W2</xsl:when>
                <xsl:otherwise>Unknown</xsl:otherwise>
            </xsl:choose>
        </xsl:element>
    </xsl:template>
```

Figure 29. PersonnelTemplate template called within the PersonnelHoldings template from C2IEDM to UOB XSLT.

The last template call to the PersonnelHoldingNumbers template, instructs the XSLT processor to extract the data held in the `holding-operational-`

quantity and holding-total-quantity elements for the OBJECT-TYPE specified. Figure 30 provides the template used for this operation. An assumption is made here that the holding-operational-quantity and the holding-total-quantity correspond to the Required and Authorized portions of the personnel construct for the UOB seen previously in Figure 26. Once the processor is finished with the template the personnel portion of the result document is complete.

```
<xsl:template name="PersonnelHoldingNumbers">
  <xsl:element name="Required">
    <xsl:value-of select="HOLDING/holding-operational-quantity" />
  </xsl:element>
  <xsl:element name="Authorized">
    <xsl:value-of select="HOLDING/holding-total-quantity" />
  </xsl:element>
</xsl:template>
```

Figure 30. PersonnelHoldingNumbers template used to extract the quantities of required and authorized personnel from the C2IEDM.

5. Equipment Identification and Extraction

The extraction of equipment holdings from the C2IEDM is more difficult due to the many different types or categories of equipment that the C2IEDM allows. The unit being examined in this work is an Armored Cavalry unit that contains all of the types of equipment that are classified by the C2IEDM except for vessels and railcars. Figure 31 depicts the equipment structure required in the UOB schema. For each piece of equipment in a unit a description of the piece of equipment, the required number of pieces for the unit, the authorized number of pieces and the number of pieces actually on hand is recorded. While this is straightforward enough, the C2IEDM does not group equipment in such a compact manner. To begin the traversal of the C2IEDM for equipment, it is necessary to again iterate through the unit's holdings found in the HOLDING element of the model. This time, a test is conducted to see if the unit holdings are of type MATERIEL-TYPE. Equipment is initially grouped under the

OBJECT-TYPE/MATERIEL-TYPE construct in C2IEDM. Further subdivisions occur after this point which categorizes equipment as Land-Weapon-Type, Aircraft-Type, etc.

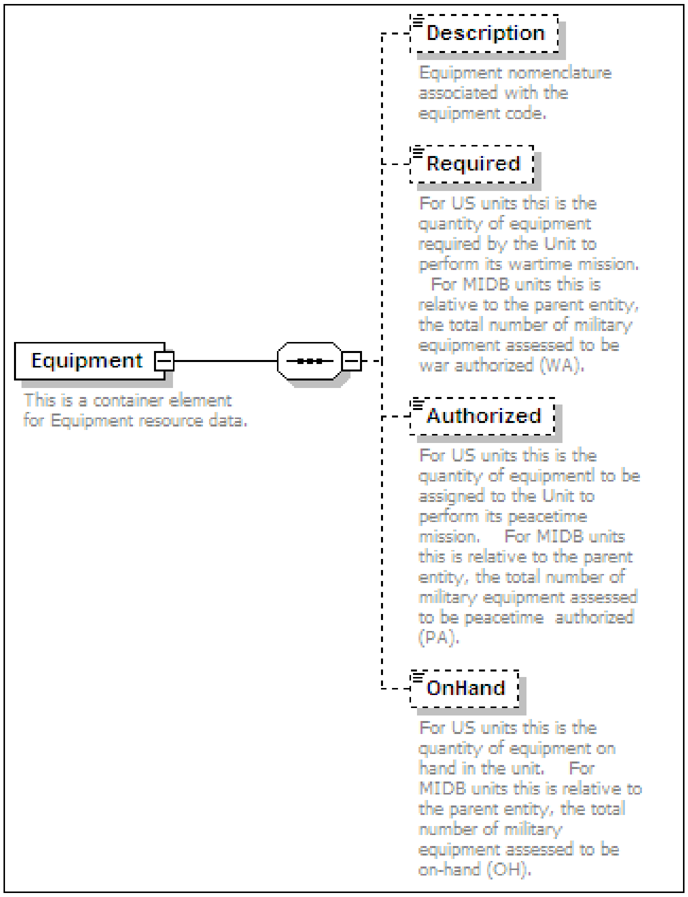

Figure 31. Equipment construct found in UOB schema version 7.7.

Figure 32 shows the MATERIEL-TYPE structure found in the C2IEDM. Figure 33 shows the first of three templates used to extract equipment resources from the C2IEDM. The first template sets the conditions for identifying the type of holding for the unit as that of MATERIEL-TYPE. This is important because holdings in the C2IEDM may be of several different types. Implementation of this template begins by instructing the XSLT parser to again back up to the HOLDING element in the C2IEDM maintaining scope and extracting the object-type-id associated with the HOLDING. Then the parser moves to the OBJECT-TYPE element and compares the object-type-id found there with the one found in the `HOLDING` element. If the two match the parser then checks to see if the category code found within that `OBJECT-TYPE` is of type `MA` which indicates `MATERIEL-TYPE`. When that test executes successfully the template found in Figure 34 is called and executed.

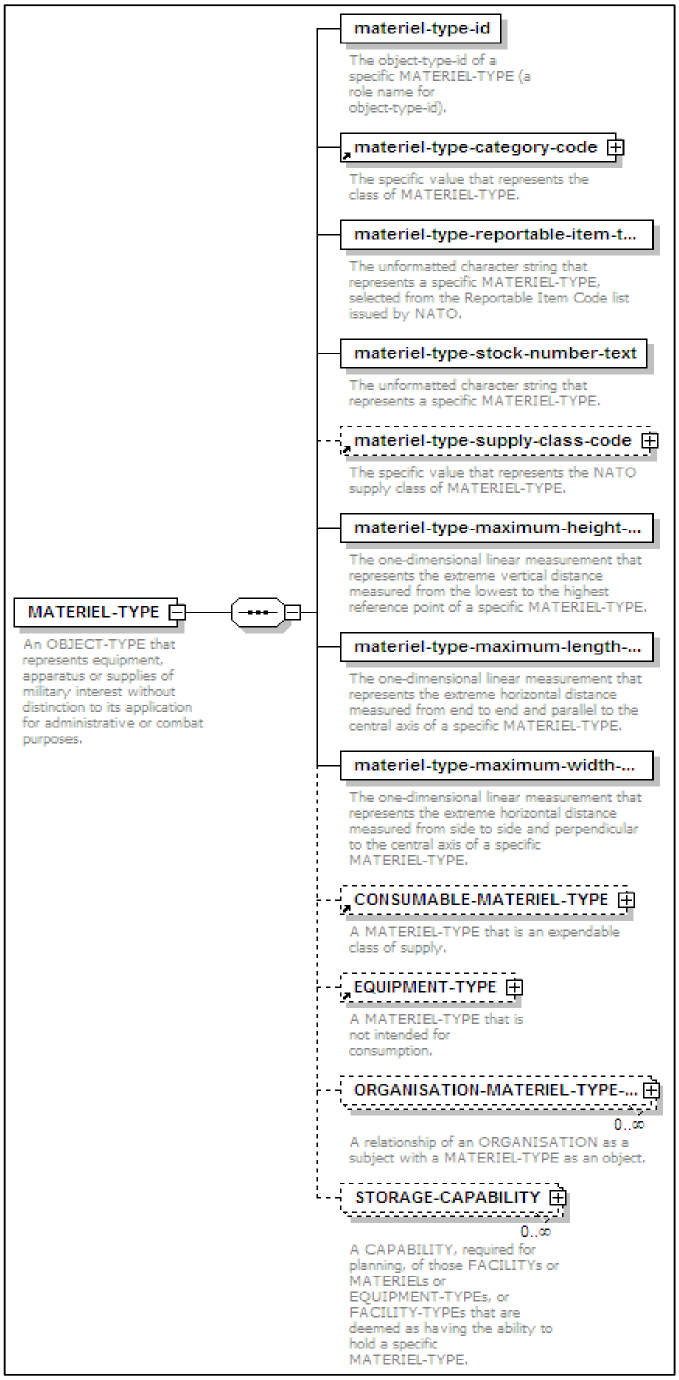

Figure 32. `MATERIEL-TYPE` construct found in the C2IEDM.

```
<xsl:template name="EquipmentHoldings">
    <xsl:for-each select="../../../HOLDING">
        <xsl:variable name="holdingObjectTypeID" select="object-type-id"/>
        <xsl:for-each select="../../OBJECT-TYPE">
        <xsl:variable name="objectTypeID" select="object-type-id"/>
            <xsl:if test="$objectTypeID = $holdingObjectTypeID">
                <xsl:if test="object-type-category-code /* [local-name() = 'MA']">
                    <xsl:apply-templates select="MATERIEL-TYPE"/>
                </xsl:if>
            </xsl:if>
        </xsl:for-each>
    </xsl:for-each>
</xsl:template>
```

Figure 33. EquipmentHoldings template used to determine `OBJECT-TYPE` in the equipment extraction portion of the C2IEDM to UOB XSLT.

```
<xsl:template match="MATERIEL-TYPE">
    <xsl:if test="materiel-type-category-code /* [local-name() = 'EQ']">
        <xsl:element name="Equipment">
            <xsl:attribute name="code"> <xsl:value-of select="../object-type-name"/> <xsl:attribute/>
            <xsl:apply-templates select ="./EQUIPMENT-TYPE"/>
            <xsl:element name="Required">
                <xsl:value-of select="../HOLDING/holding-operational-quantity"/>
            </xsl:element>
            <xsl:element name="Authorized">
                <xsl:value-of select="../HOLDING/holding-total-quantity"/>
            </xsl:element>
        </xsl:element>
    </xsl:if>
</xsl:template>
```

Figure 34. `MATERIEL-TYPE` template used to test the classification of equipment in the C2IEDM to UOB XSLT.

The template in Figure 34 begins by conducting a test to see if the type of materiel identified in the model is of equipment type. It does this by checking to see if the `materiel-type-category-code` is `EQ.` Then it begins to output part of the result structure necessary for the output document. It then calls the template that will identify and extract the type of unit equipment it has found. Figure 35 shows the `EQUIPMENT-TYPE` construct located in the C2IEDM and Figure 36 shows a portion of the XSLT template created to determine the equipment's equipment type. This template uses a `choose` construct with a series of `when` tests to determine the type of equipment it has identified. The result of this template is that the type of equipment is identified and the parser extracts the description of the piece of equipment from its category code. The parser then returns to the template seen in Figure 34 and extracts the quantities on hand and authorized for the item of equipment.

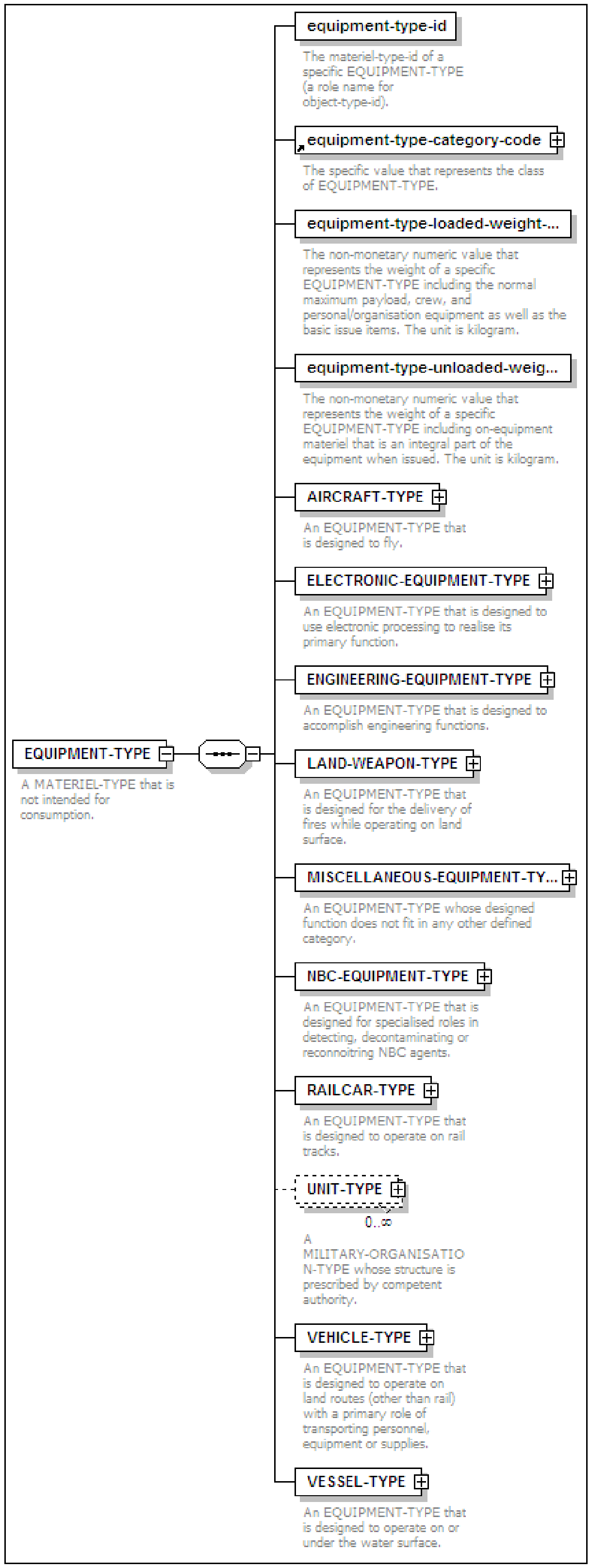

Figure 35. `EQUIPMENT-TYPE` construct found in C2IEDM.

```
<xsl:template match="EQUIPMENT-TYPE">
  <xsl:element name="Description">
    <xsl:choose>
      <xsl:when test="equipment-type-category-code /* [local-name() = 'AIRCFT']">
        <xsl:value-of select="AIRCRAFT-TYPE/aircraft-type-subcategory-code/*/@value" />
      </xsl:when>
      <xsl:when test="equipment-type-category-code /* [local-name() = 'ELCTRN']">
        <xsl:value-of select="ELECTRONIC-EQUIPMENT-TYPE/electronic-equipment-type-
subcategory-code/*/@value" />
      </xsl:when>
      <xsl:when test="equipment-type-category-code /* [local-name() = 'ENGEQ']">
        <xsl:value-of select="ENGINEERING-EQUIPMENT-TYPE/engineering-equipment-type-
category-code/*/@value" />
      </xsl:when>
      <xsl:when test="equipment-type-category-code /* [local-name() = 'LNDWEP']">
        <xsl:value-of select="LAND-WEAPON-TYPE/land-weapon-type-category-
code/*/@value"/>
      </xsl:when>
      <xsl:when test="equipment-type-category-code /* [local-name() = 'MISCEQ']">
        <xsl:value-of select="MISCELLANEOUS-EQUIPMENT-TYPE/miscellaneous-equipment-
type-category-code/*/@value" />
      </xsl:when>
      <xsl:when test="equipment-type-category-code /* [local-name() = 'NBCEQ']">
        <xsl:value-of select="NBC-EQUIPMENT-TYPE/nbc-equipment-type-category-
code/*/@value"/>
      </xsl:when>
      <xsl:otherwise />
    </xsl:choose>
  </xsl:element>
</xsl:template>
```

Figure 36. Partial EquipmentType template used to extract equipment descriptions from the `EQUIPMENT-TYPE` construct found in C2IEDM.

Figures 37 and 38 show the `equipment-type-category-code` and `land-weapon-type-category-code` constructs from the C2IEDM. Once the parser has gotten down to the command `xsl:value-of` seen in Figure 36, it extracts the content of the attribute `value` which contains a brief description of the piece of equipment. This data is necessary input for the `description` element found in the UOB schema compliant result document.

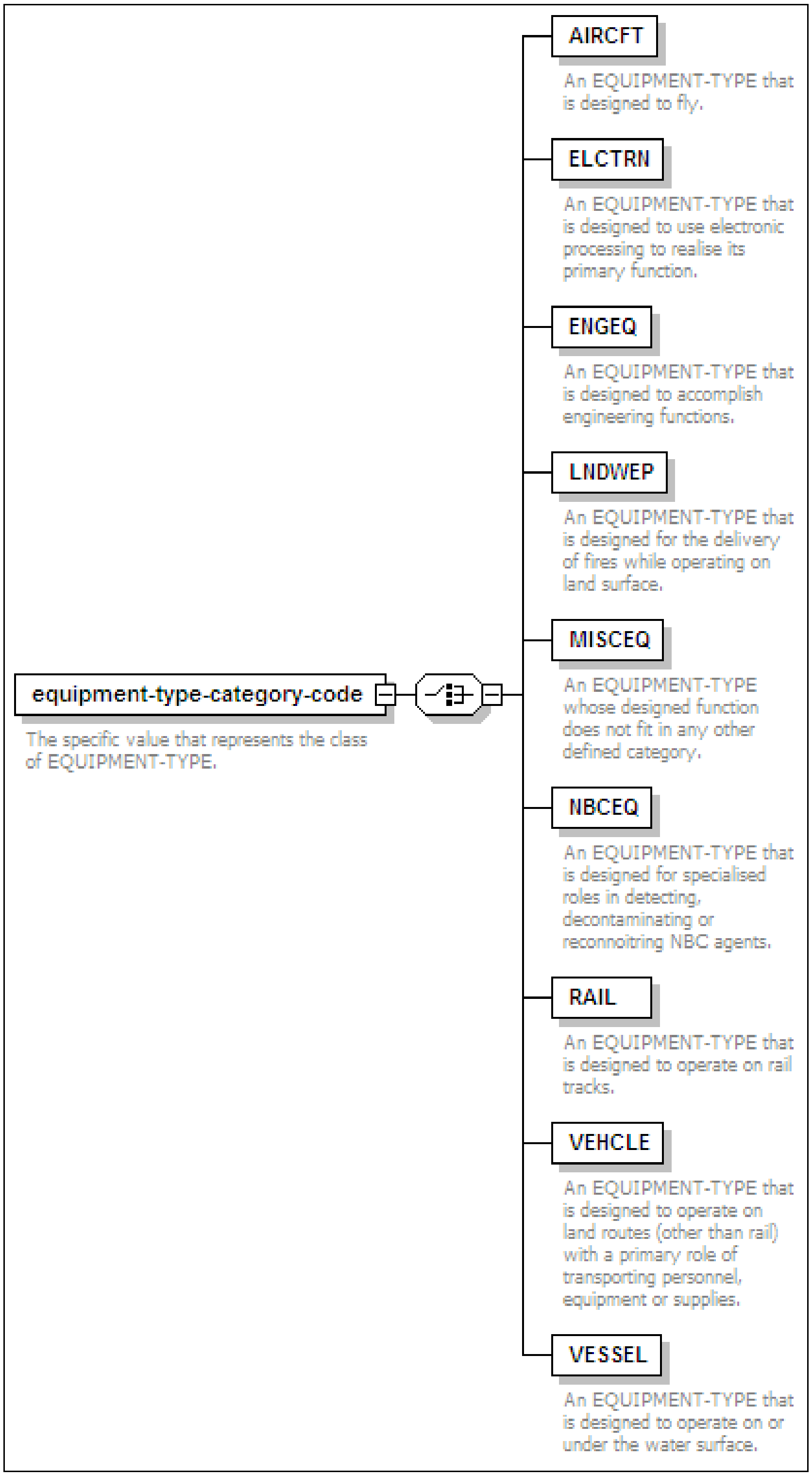

Figure 37. `Equipment-type-category-code` construct found in the C2IEDM.

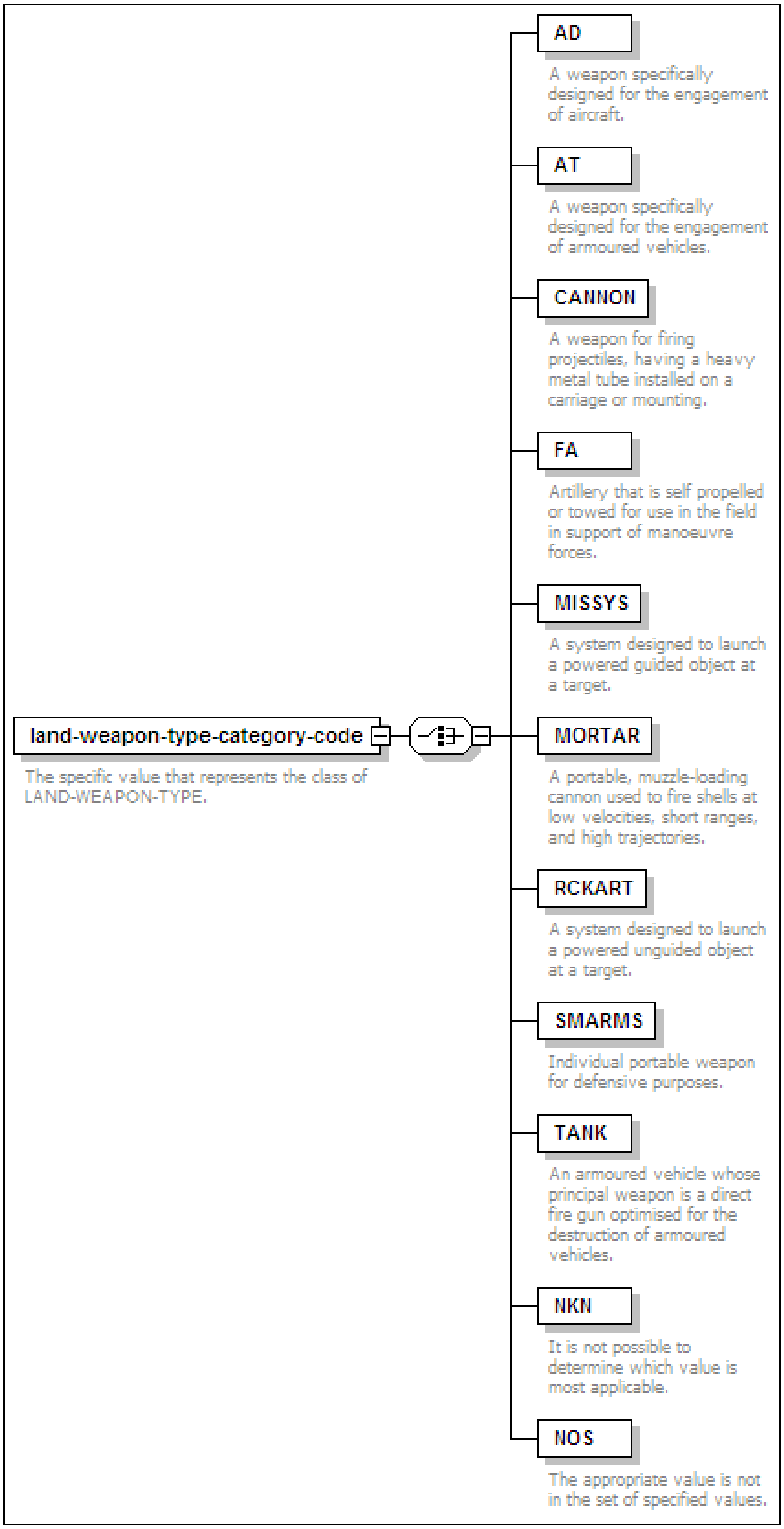

Figure 38. `Land-weapon-type-category-code` construct found in the C2IEDM.

6. Unit Present Location

To obtain the unit's present location from the C2IEDM more than the `object-item-id` and `object-type-id` are required. The structure within the C2IEDM that contains the longitude and latitude for the unit object is not concerned with the `object-item` or `object-type-id`. It is concerned with a `location-id`. Figure 39 shows the template that is executed to extract the present location for the unit.

```
<xsl:template name="RelativeUnitLocation">
    <xsl:param name="UnitObjectItemID"/>
    <xsl:param name="UnitObjectItemLocationID"/>
    <xsl:element name="Present">
        <xsl:element name="Name">This is the Name of the Current Geographical Location of this unit</xsl:element>
        <xsl:for-each select="../../../OBJECT-ITEM-LOCATION">
            <xsl:variable name="ObjectItemLocationObjectItemID" select="object-item-id"/>
            <xsl:variable name="ObjectItemLocationLocationID" select="location-id"/>
            <xsl:for-each select="../../LOCATION">
                <xsl:variable name="LocationID" select="location-id"/>
                <xsl:if test="$UnitObjectItemID = $ObjectItemLocationObjectItemID">
                    <xsl:if test="$UnitObjectItemLocationID = $LocationID">
                        <xsl:element name="Latitude">
                            <xsl:value-of select="POINT/ABSOLUTE-POINT/absolute-point-latitude-coordinate"/>
                        </xsl:element>
                        <xsl:element name="Longitude">
                            <xsl:value-of select="POINT/ABSOLUTE-POINT/absolute-point-longitude-coordinate"/>
                        </xsl:element>
                    </xsl:if>
                </xsl:if>
            </xsl:for-each>
        </xsl:for-each>
    </xsl:element>
</xsl:template>
```

Figure 39. Relative Unit Location template to extract latitude and longitude for the unit current location.

When the template is called two parameters are passed to it. The first is the `UnitObjectItemID` which contains the original `object-item-id` extracted for the unit in the first template call. The second parameter, UnitObjectItemLocationID is the location-id obtained from the OBJECT-ITEM-LOCATION element of the BIXS. This parameter is carefully selected by backing out from the context of the unit-formal-abbreviated-name to the OBJECT-ITEM-LOCATION structure and then down the tree to the location-id. The first iteration inside the template searches through all of the object-item-ids and location-ids found within the OBJECT-ITEM-LOCATION structure in the model and assigns them to local variables. A second iteration is then used to search through all of the location-ids in the model found in the LOCATION structure and places them in a local variable as well. From there the object-item-ids and location-ids are checked against the ones passed into the template. The first test conducted in the template checks to see if the object-item-id that was passed to the template matches the one extracted from the OBJECT-ITEM-LOCATION structure.

The second test conducted in the template checks to see if the location-id extracted from the LOCATION element of the model matches the one extracted from the OBJECT-ITEM-LOCATION element. This test ensures that the location-ids match and allows the extraction of the latitude and longitude from the model to commence. The values of latitude and longitude are located within the POINT structure of the BIXS. Before the extraction of the latitude and longitude, the parser's context is in the LOCATION structure. The POINT element is a child of LOCATION so all that is required to extract the latitude and longitude is to direct the parser to the location of the values using the XPath expression seen within the template.

7. Unit Type Category Code

One piece of information that is important to have is the military unit's type. The focus here is on a U.S. Army Cavalry Troop whose primary mission is reconnaissance and combat operations. Units in the U.S Army are grouped into one of three class types, combat, combat service support and combat support. Armored Cavalry troops, like A Troop 1/3 ACR are categorized as combat units. Examples of combat service support and combat support unit types are

Transportation and Military Intelligence units respectively. Figure 40 shows the UnitTypeCategoryCode template from the XSLT stylesheet used to extract what the UOB denotes as the `DescriptionCode` for the unit. Only three codes are necessary for the classification of the unit type here: AAC for combat, AAS for combat support and AAV for combat service support. Additional codes are available within the UOB which satisfy the other services and countries' requirements to classify their units.

```
<xsl:template name ="UnitTypeCategoryCode">
<xsl:param name="OTypeID"/>
    <xsl:element name="DescriptionCode">
        <xsl:for-each select="../../../../OBJECT-TYPE">
        <xsl:variable name="LocalObjectTypeID" select="object-type-id"/>
            <xsl:if test="$OTypeID = $LocalObjectTypeID">
                <xsl:if test="object-type-category-code/* [local-name() = 'OR']">
                    <xsl:if test="ORGANISATION-TYPE/organisation-type-category-code/* [local-name() = 'GVTORG']">
                        <xsl:if test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-TYPE/government-
organisation-type-category-code/* [local-name() = 'MILORG']">
                            <xsl:if test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-TYPE/MILITARY-
ORGANISATION-TYPE/military-organisation-type-category-code/* [local-name() = 'UNIT']">
                                <xsl:choose>
                                    <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-
TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-category-code/* [local-name() =
'COMBAT']">AAC</xsl:when>
                                    <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-
TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-category-code/* [local-name() =
'COMSER']">AAV</xsl:when>
                                    <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-
TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-category-code/* [local-name() =
'COMSPT']">AAS</xsl:when>
                                    <xsl:otherwise>U</xsl:otherwise>
                                </xsl:choose>
                            </xsl:if>
                        </xsl:if>
                    </xsl:if>
                </xsl:if>
            </xsl:if>
        </xsl:for-each>
    </xsl:element>
</xsl:template>
```

Figure 40. UnitTypeCategoryCode template used to extract data from the `unit-type-category-code` of the BIXS.

For this implementation to succeed, one of many tree structures within the C2IEDM must be traversed in order. The method to do this within the XSLT is through a series of `if` tests. The tests conducted at each level of the tree check node contents and codes to ensure that they meet the specified requirements. Step one in the process is to direct the parser to again iterate through all of the `OBJECT-TYPEs` in the model and select their `object-type-ids`. This is done so that the extracted `object-type-id` may be compared against the `object-type-id` passed in during the template call. Matching these `ids` indicates that we are dealing with the correct unit.

Next the `object-type-category-code` for the `OBJECT-TYPE` selected is checked to see if it is of type `ORGANIZATION-TYPE`. This test is required because `OBJECT-TYPES` may have several different values within the model and only the `'OR'` value is needed here indicating that the object is an organization. Next the parser checks to see if the `organisation-type-category-code` of that `ORGANISATION-TYPE` is `GVTORG`. The `GVTORG` code indicates a `GOVERNMENT-ORGANISATION-TYPE` and is the one we are concerned with. Figure 41 shows the `ORGANISATION-TYPE` structure of the C2IEDM. Figure 42 depicts the `organisation-type-category-code`.

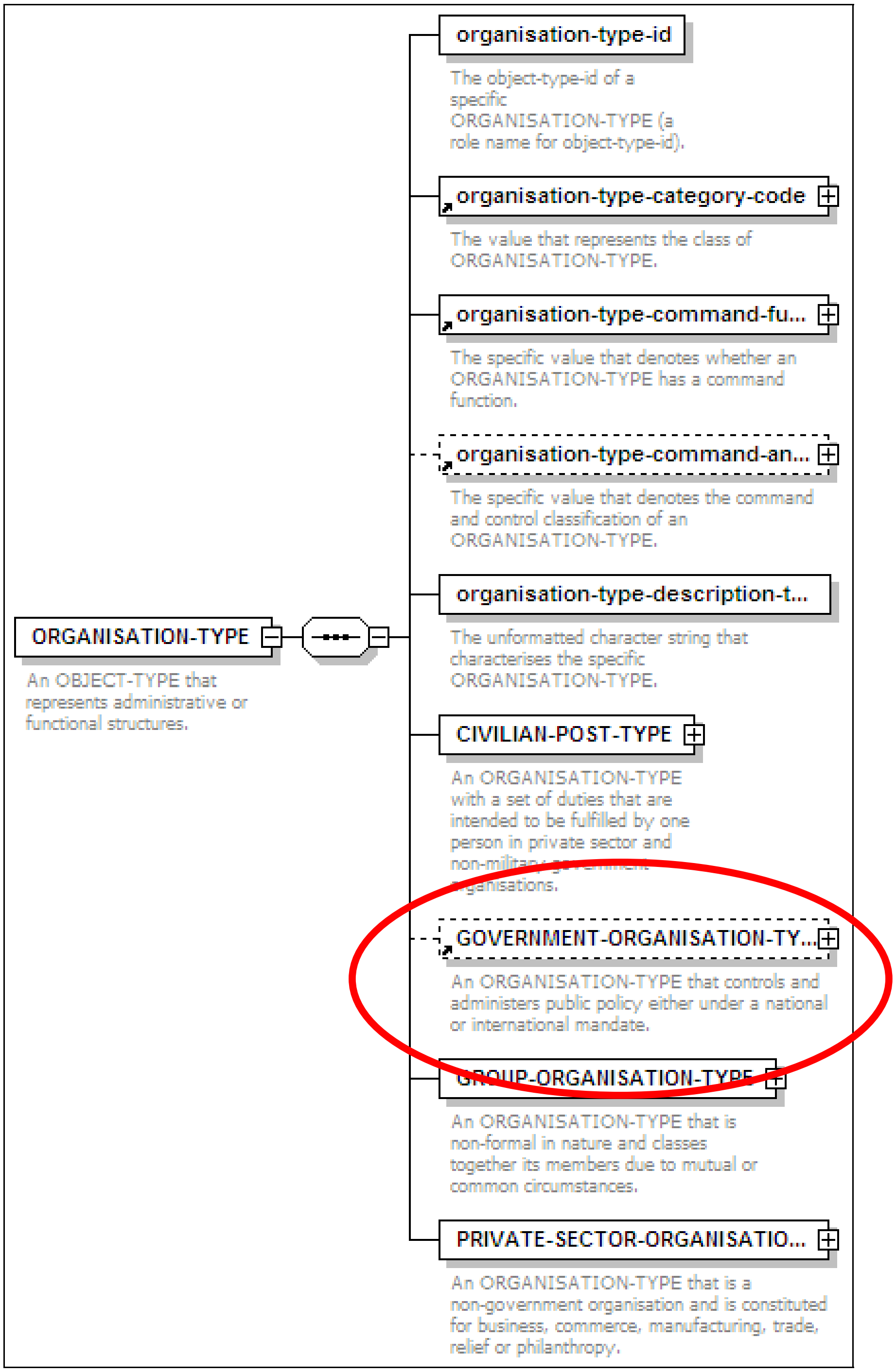

Figure 41. `ORGANISATION-TYPE` structure found in the BIXS.

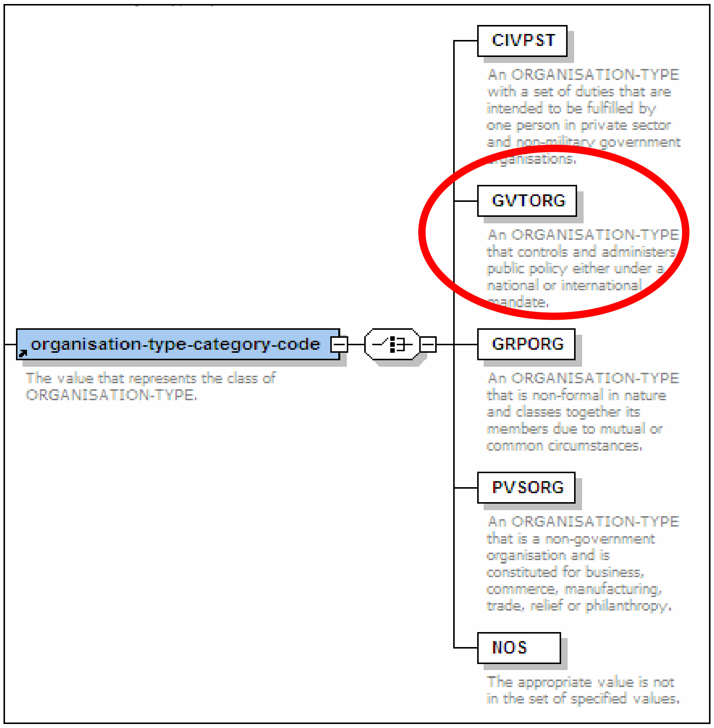

Figure 42. The expanded `organization-type-category-code` found within the `ORGANISATION-TYPE` structure from the BIXS.

Next the parser proceeds one level deeper into the source tree structure to determine if the `GOVERNMENT-ORGANISATION-TYPE's government-organisation-type-category-code` is `MILORG`. `MILORG` is the category code indicating an organization is a military organization. Figure 43 depicts part of the tree structure containing the `government-organisation-type-category-code` structure found within the BIXS schema that is traversed to obtain this information. Now the parser checks the structure seen in Figure 44 to see if the `MILITARY-ORGANISATION-TYPE` has a `military-organization-type-category-code` of `UNIT`. This indicates that the node being examined is a unit and that the only further processing required is to extract the information referencing what type of unit we are examining. The extraction of the code labeling the unit is completed using a choice statement that is similar to a switch statement in other coding languages. The choice statement may be reviewed in Figure 40. Figure 45 shows the partial tree structure leading to the `UNIT-TYPE` node of the BIXS schema.

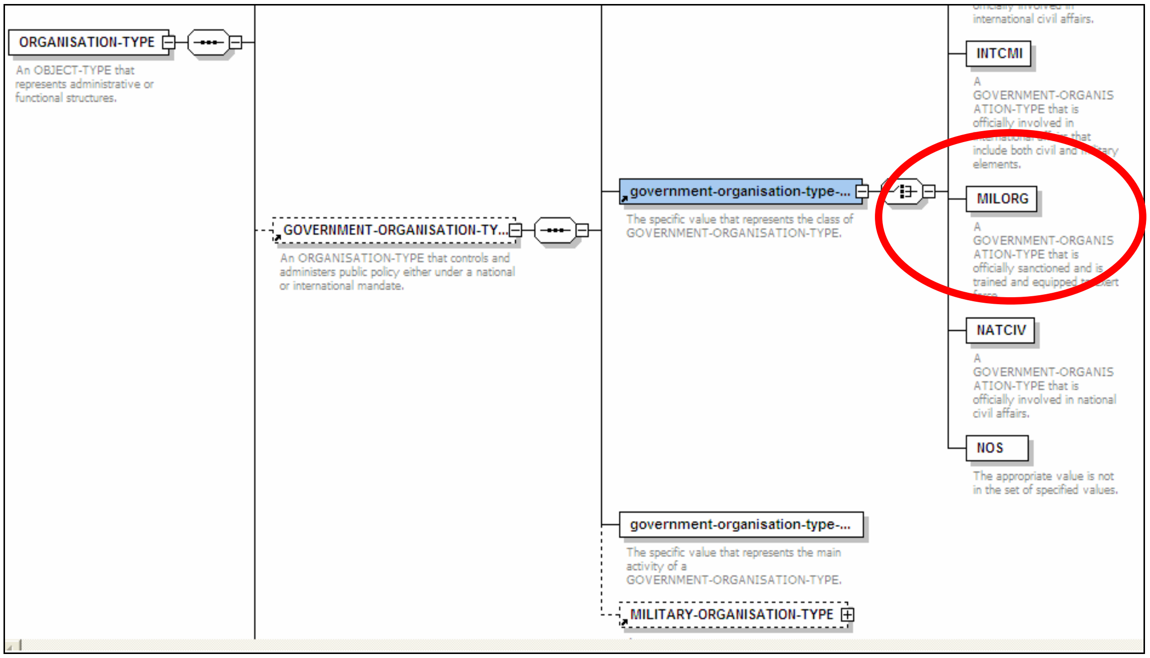

Figure 43. Partial tree structure of ORGANISATION-TYPE showing MILORG government-organisation-type-category-code from BIXS.

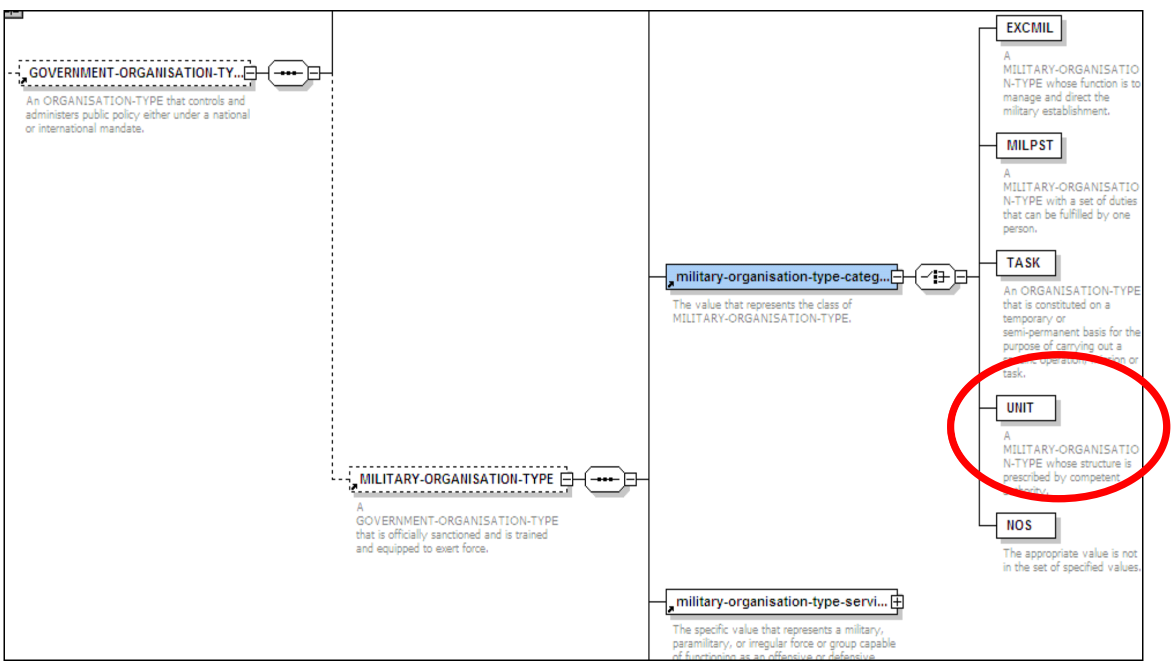

Figure 44. Partial tree structure showing UNIT military-organisation-type-category-code inside of the MILITARY-ORGAINISATION-TYPE element of the C2IEDM.

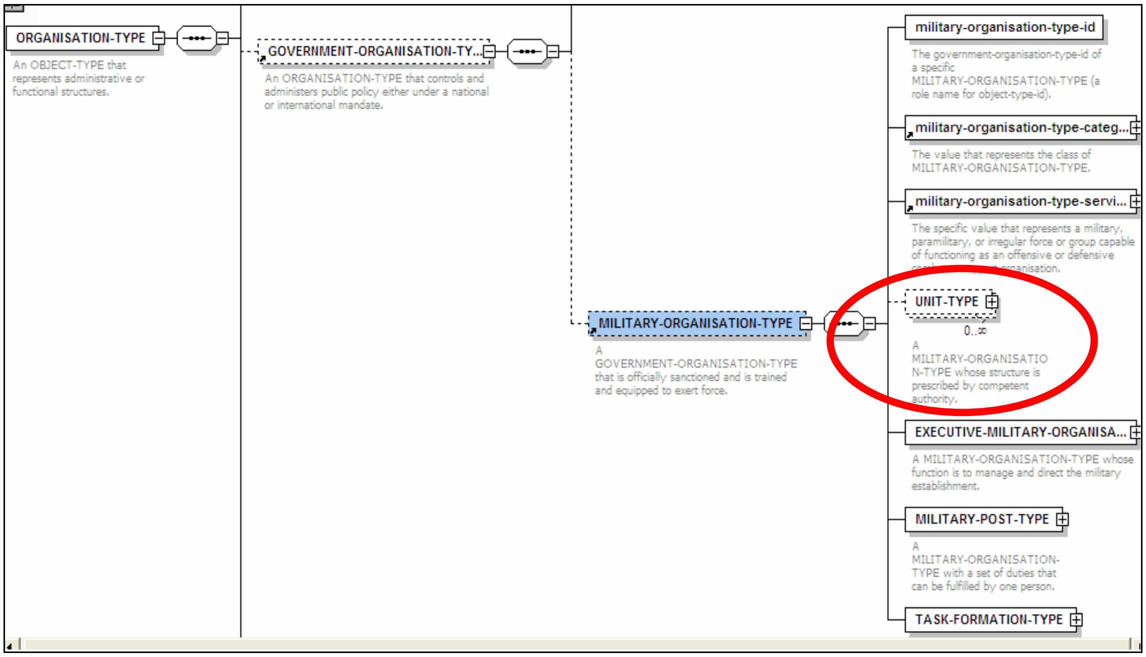

Figure 45. Partial tree structure showing `UNIT-TYPE` element of the `MILITARY-ORGAINISATION-TYPE` structure within the C2IEDM.

Figure 46 shows the expanded `UNIT-TYPE` structure found within the C2IEDM. This construct in the source document is the final focal point for both template extractions of the `DescriptionCode` being attempted here and the `LevelCode` discussed in the next section. These two pieces of information are the last two pieces extracted to build our UOB compliant unit source document. Figure 47 shows the expanded view of the `unit-type-category-code` with the three unit types found within the `UNIT-TYPE` node. A great deal of information is contained within the `UNIT-TYPE` structure that is not examined within the current work. Extensions of this research include increasing the robustness of the unit document to include other service requirements, some of which may be satisfied through data extraction from the `UNIT-TYPE` element.

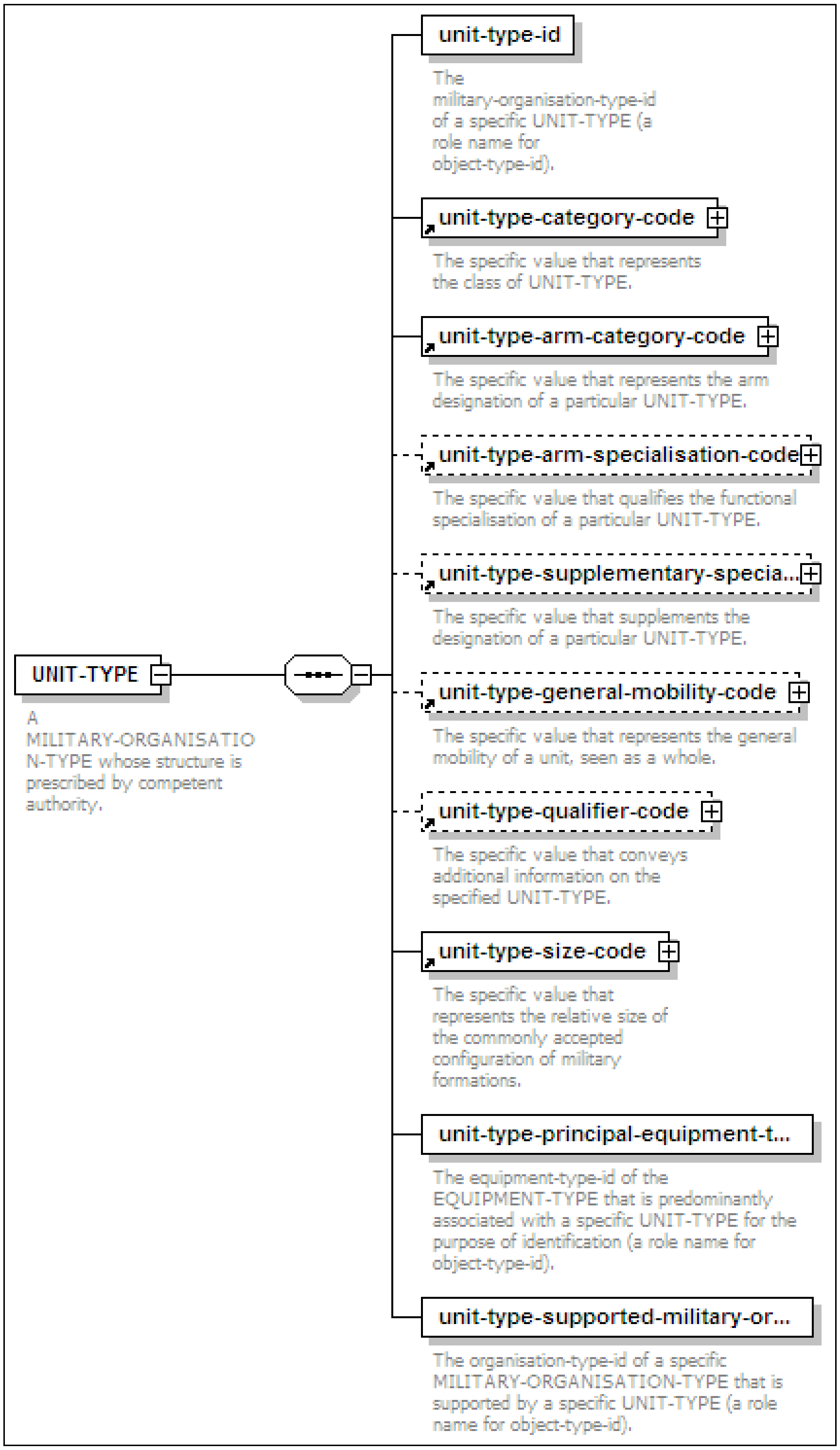

Figure 46. `UNIT-TYPE` structure found in the BIXS containing both the `unit-type-category-code` and the `unit-type-size-code`.

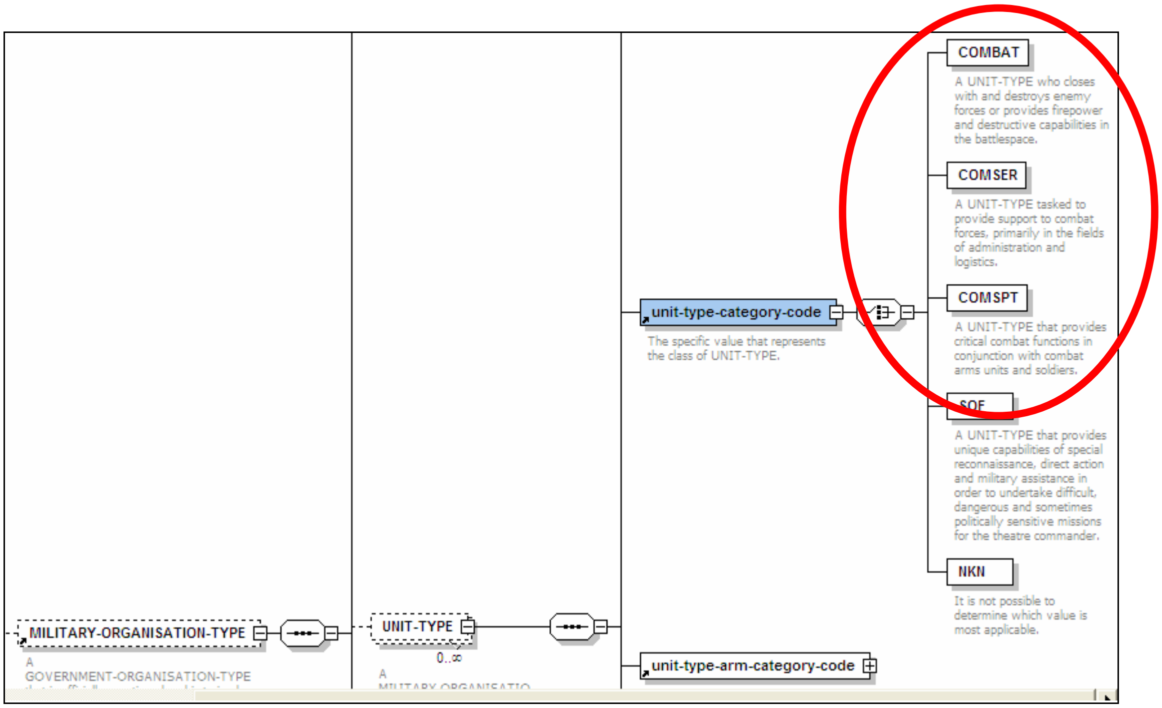

Figure 47. The `unit-type-category-code` structure found in the BIXS containing the unit description information.

8. Unit Type Size Code

The last piece of the unit document deals with the echelon of the unit. The term echelon is synonymous in this instance with size. Army units range in size from sections to armies. The size of the unit in this work is a Troop. Troops in the U.S. Army are special organizations found only in Cavalry units. Outside of Cavalry units, this size of unit is called a Company. Companies and Troops contain the same level of commander although their organizations differ greatly. Generally, the standard size term used when discussing a unit of this level or echelon, is Company. This is noticeable within the C2IEDM as there is not a Troop echelon within the model. UOB on the other hand does include Troop as one of its standard unit echelons. The two closest matches to be found within C2IEDM are company and company-team. For some, the company-team may be a more accurate description of a Cavalry Troop. This is due to the makeup of a Troop. A Cavalry Troop within a heavy Cavalry Regiment will have a mix of vehicles including tanks, armored personnel carriers (APC), cavalry fighting vehicles (CFV), armored maintenance recovery assets and wheeled vehicles ranging in size and hauling capability from ½ to 5 tons. While a company-team does not have the expanse of assets that a Troop has, it does contain a mix of tanks, infantry fighting vehicles (IFV), APCs, wheeled vehicles and may have attached to it additional assets that it would not normally have. This is generally done if the unit is being assigned a mission that it was not originally designed for like a screening mission. Screen, Guard and Cover missions are standard for the Cavalry but not necessarily for Armored or Mechanized Brigades. Figure 48 shows the partial template that extracts the `unit-type-size-code` from the C2IEDM. The full template may be viewed in Appendix D.

```
<xsl:template name="UnitTypeSizeCode">
    <xsl:param name="ObjTypID"/>
    <xsl:element name="LevelCode">
        <xsl:for-each select="../../../../OBJECT-TYPE">
            <xsl:variable name="LocalObjTypID" select="object-type-id"/>
            <xsl:if test="$ObjTypID = $LocalObjTypID">
                <xsl:if test="object-type-category-code/* [local-name() = 'OR']">
                    <xsl:if test="ORGANISATION-TYPE/organisation-type-category-code/* [local-name() = 'GVTORG']">
                        <xsl:if test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-TYPE/government-
organisation-type-category-code/* [local-name() = 'MILORG']">
                            <xsl:if test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-TYPE/MILITARY-
ORGANISATION-TYPE/military-organisation-type-category-code/* [local-name() = 'UNIT']">
                                <xsl:choose>
                                    <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-
TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/* [local-name() = 'BDE']">BDE</xsl:when>
                                    <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-
TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/* [local-name() = 'CBTTM']">CO</xsl:when>
                                    <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-
TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/* [local-name() = 'COY']">CO</xsl:when>
                                    <xsl:otherwise>U</xsl:otherwise>
                                </xsl:choose>
                            </xsl:if>
                        </xsl:if>
                    </xsl:if>
                </xsl:if>
            </xsl:if>
        </xsl:for-each>
    </xsl:element>
</xsl:template>
```

Figure 48. Partial template used to extract the unit `LevelCode` necessary for the UOB result document.

It so happens that this template is identical to the one used to extract the unit `DescriptionCode` information in the previous section. The only difference in this template is in the `choose` construct. For this implementation the necessary information is located in the `unit-type-size-code`. Figure 49 shows the partial tree structure encompassing the `unit-type-size-code` structure. Once the proper match is made inside the `choose` statement the information is extracted and the result document is complete.

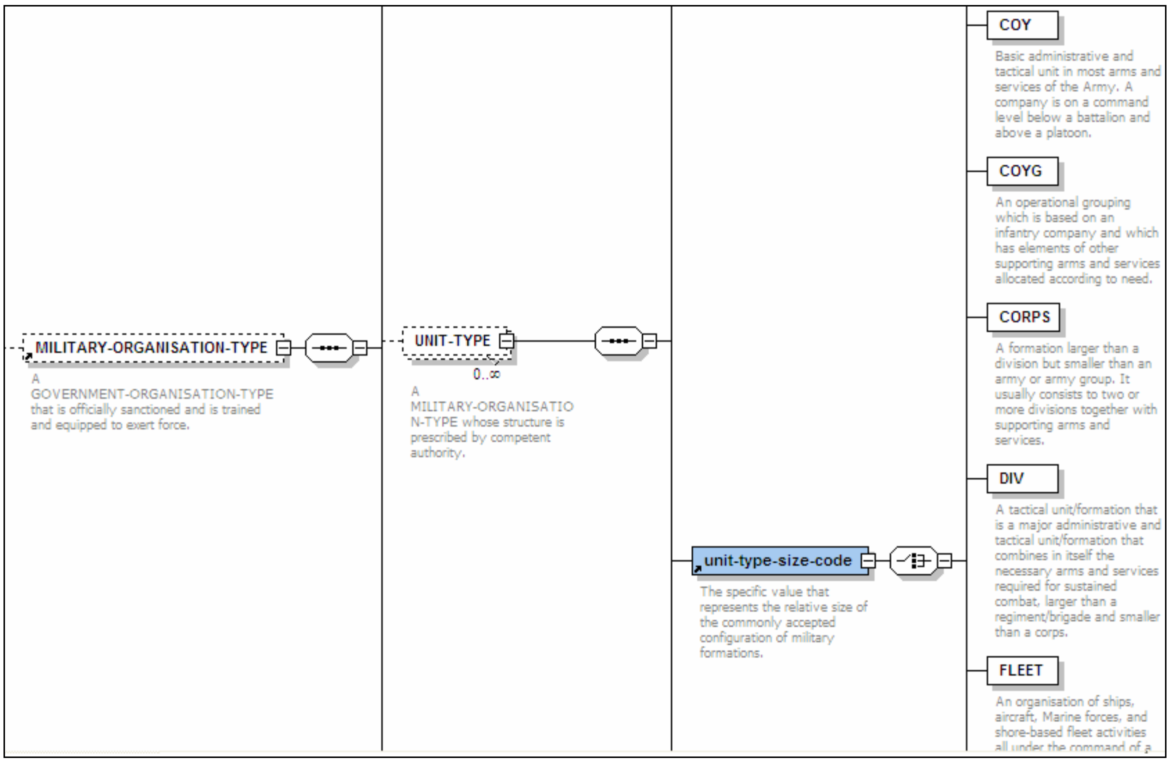

Figure 49. Partial `unit-type-size-code` structure found within the C2IEDM used to obtain the unit `LevelCode` for the UOB compliant result document.

D. SUMMARY

This chapter has discussed the importance of XML and has provided an exemplar using XML and XSLT to transform data about a military unit from a form understood by a command and control system into a form usable by a simulation. The exemplar shows the enabling power of XML and XSLT as methods of data representation that facilitate interoperability. The work completed here provides a reason why a solid understanding of XSLT by simulation developers and its incorporation into the process of data interchange is vital to the extensibility of models and simulations. This is a key point.

Since XML is extensible and platform independent its use has fostered interoperability without the post development requirement for special wrapper or interface. While it is arguable that if all simulations and C2 systems were written in the same computer language this would also be possible, it is not true that the extensibility and ease of use would be comparable. The focus here is on the data and its representation not the code used to run either application. The C2IEDM representation used in this example was vital to the success of the transformation due to its representation using XML. Without this representation of the C2IEDM a more complex procedure would have been necessary for the extraction of the data contained within a database. The bottom line is “the role of XML Transformation for interoperability cannot be understated, since it allows integration of existing databases and systems, and promotes application independent information management at the data level” (Neushul, 2003).

On the other hand, human judgment was applied throughout in order to make the data associations summarized in Table 1. The full power of automated interoperability across systems will only be realized when software is able to understand the common concepts used by different data models and XML representations. This is the hope of emerging Semantic Web research and applications (Blais, 2004a).

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VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

New uses are being created on a daily basis for our legacy models and simulations in the fight on terrorism. New systems are needed. We no longer have a well defined threat. Some say that today's threat is pan-national and asymmetric. Few disagree.

The importance of knowledgability incorporating XML in the analysis, design and development phases of current and future systems cannot be overstated. The current lack of interoperability between our command and control systems, models and simulations is unacceptable. Precious resources, (both money and manpower) are being spent to develop useful tools for both military analysts and training professionals, but very little money or time is being spent developing the interfaces or interoperability between these systems until too late in the development process. It is no longer enough to have great software tools. They must also interface with one another and be modular enough to support common data models and exchange documents.

The C2IEDM model incorporates the ontology of the military community, is extensible, and has been shown to be interoperable and transformable for use with a simulation package. Joint Forces Command (JFCOM) is incorporating the C2IEDM in their new command and control structure. The simulation community of interest (COI) has recognized that they need to begin focusing on interoperability between themselves and the Command and Control COI. Figure 50 (Chaum and others, 2004) depicts DMSO's vision for future interoperability incorporating many of the concepts addressed in this thesis. The use of XML based technologies and architectures such as XMSF enhance the possibilities for interoperability, interchange and visualization.

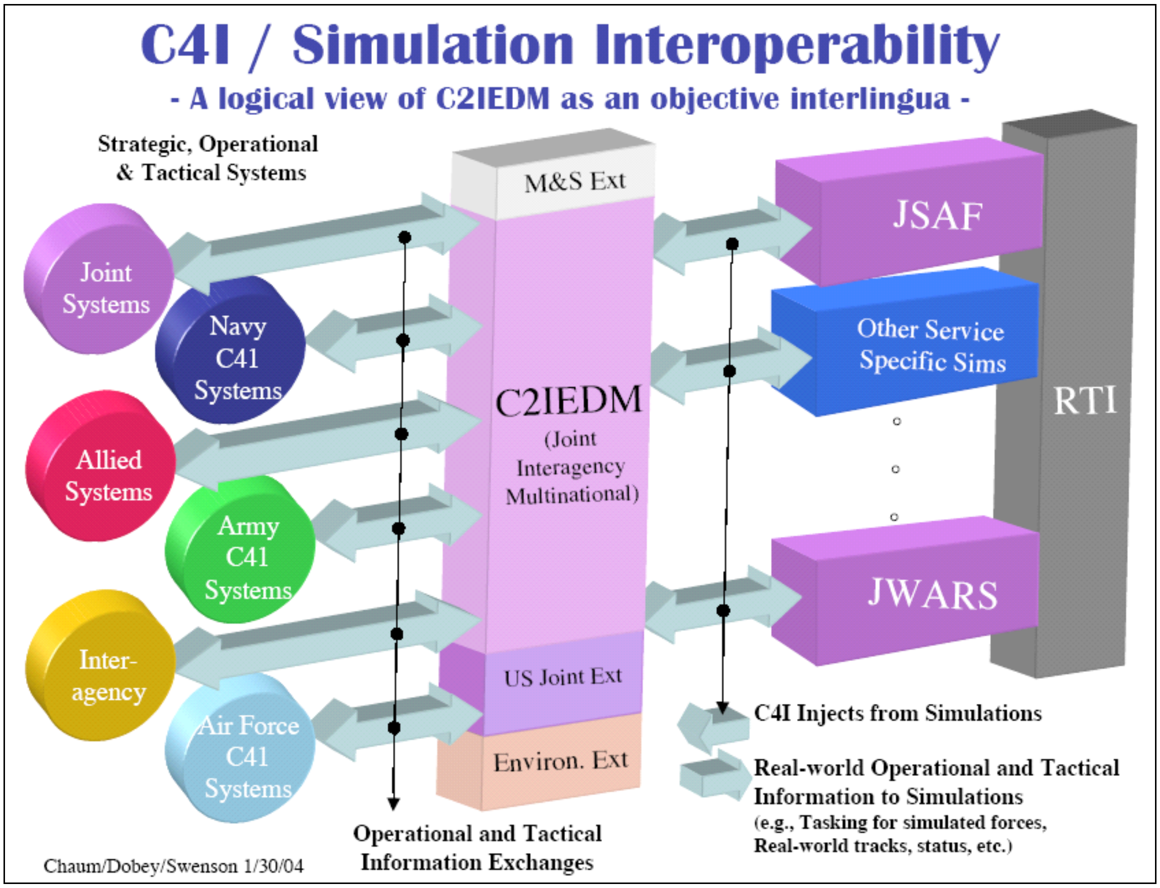

Figure 50. DMSO's vision of future interoperability using C2IEDM (From Chaum and others, 2004)

This research has provided the reader with several examples of how the DoD and academia are working towards interoperable solutions that fit within today's military concept of operations. To say that this work has uncovered the "Holy Grail" to fix all of the interoperability difficulties within the DoD would be a bit naïve. This examination of using the C2IEDM as the data interchange method to interface with the FAST Toolbox is only the tip of the iceberg in terms of C2/simulation interoperability. The FAST Toolbox is a relatively new set of tools that have been built under the purview of interoperability. Other modeling and simulation tools such as Vector in Commander (VIC) and Janus are not so new and were designed and built during a period when interoperability with C2 systems was not an issue. Now we are looking for ways to re-engineer these tools to enhance them for today's warfighting missions and leverage their power within other applications.

The C2IEDM is a complex and powerful data exchange model. Its ability to bend to the needs of the user is critical in today's unpredictable environment. It has been tested on several occasions to show that through its use interoperability amongst national C2 systems can be achieved and that a common operating picture can be shared. This work has shown that using the C2IEDM within the Simulation COI, interoperability between a simulation package and C2 system using the C2IEDM as the data interchange mechanism may also be achieved. This is a critical point. While further enhancements and development are necessary for the C2IEDM to completely satisfy the needs of many simulation and C2 applications, it can be used now for data interchange within some applications. Coupling XML with XSLT provides a sound method for describing and transforming data between applications as an after thought but careful design including the use of these technologies wrapped in an architecture like XMSF will provide extensible, open and interchangeable solution to an old and continuing problem within the C2 and simulation COIs.

Unfortunately there is never enough time to accomplish everything. The following lists several projects that can extend the work done in this research to make it more robust.

B. RECOMMENDATIONS FOR FUTURE WORK

Several items are listed in this section as future work. The first recommendation is to complete the work started here by fleshing out this XSLT so that any military unit described in the C2IEDM can be extracted and used within the FAST Toolbox. The focus here was on a single U.S. Army ground Cavalry unit and its main equipment. There were no aircraft, watercraft or railroad equipment associated with the unit selected so the XSLT is not designed to handle units that have those types of equipment. This is the next logical step in extending and completing the current research.

In order to accomplish this however, a complete source file(instance document) is necessary. One of the difficulties encountered during this work was the lack of a complete source file based on the BIXS. In order to test the current XSLT process, a source file was auto generated from the BIXS by XMLSpy. Values were changed in that source file where the author believed they belonged. This resulted in a partial file that has been subsequently built upon throughout the development of the XSLT. In order to properly test and evaluate this XSLT file, software should be written to extract the data values from the IDA C2IEDM database and create a source file based on the BIXS. With this, full and rigorous testing of the work created here may be completed.

The next proposal is the revision of the BIXS created by Capt. James Neushul (Neushul, 2003). Neushul's BIXS is a very complex and lengthy document. It is an XML document with a very large hierarchical structure. The C2IEDM itself causes this problem with its many to many relationships. When exposed using XML, data that is normally contained within a database in tables is now replicated many times in many different places within the structure of the model. Aside from this, the BIXS is a powerful piece of work. Because the BIXS version of the C2IEDM's data is completely exposed, XSLT may be brought to bear on it and there is no reason, other than time, that it cannot be fully manipulated to suit the needs of users. A similar rendition of the model using a database to hold data values would require additional software to traverse and manipulate tables in the databases, something humans alone cannot do. An effort to increase the usefulness of the BIXS has been to apply Java Architecture for Data Binding (JAXB) to it. This effort has had limited success. This is mainly due to the enormous size of the document. One recommended step to revising the BIXS is to name the complex types that are found within the model. This will help to reduce the size of many of the methods generated by applying JAXB.

One logical follow-on project of this work is the creation of additional XSLT to transform unit data from the UOB version 7.7 schema structure to the BIXS (C2IEDM) structure. This may be the next exemplar showing the extensibility of the C2IEDM and its value in the C2/simulation communication process. Table 1 of this work provides the beginnings for a round trip showing information transfer from C2IEDM to UOB and back. Along with this, the implementation of both XSLTs in the FAST Toolbox would be the final exemplar to prove that the C2IEDM is the logical choice for connecting simulations and C2 systems.

Another avenue for research is the incorporation of the BIXS into work involving tactical chat and tactical messaging. Research and development is ongoing involving the use of C2IEDM in the area of mission planning and visualization.

Further research is needed into the MDA concept summarized here. Many questions raised during the research into this architecture need to be answered before the MDA can be fully understood and utilized outside of the OMG. Time will tell if MDA will falter or flourish as a proven architecture for software development.

A chapter of this work that was not realized was the prospect of developing a web service to fully expose the UOB toolset. From a user's perspective, the UOB is one stop shopping for data related to military units. As it stands, using UOB requires special permissions and a server and client. A more robust UOB toolset could use the power of the web to make unit data available for any level commander who could use the data along with other applications such as X3D, to create realistic training scenarios at the small unit level. These types of applications would provide a powerful training environment for units with small footprints and smaller budgets.

Lastly, a full comparison of the two versions of C2IEDM mentioned and used here is necessary. Many developers and users alike are unclear as to which representation of the C2IEDM will work best for them. While the several representations developed may subscribe to the intent of the C2IEDM model their presentation methods are in some cases much different. The BIXS and the IDA C2IEDM schemas provide two good examples to compare and contrast to address what aspects of each are good and bad. One is database centric while the other is very much document centric. These constructive reviews should be made available to the developers of the respective versions of the model schemas so that they may mature their versions making them stronger and more understandable to the many communities of interest that will be implementing them in the near future.

This work began with a focus on improving the data interchange abilities of current command and control systems and simulations so that critical training might be accomplished during this time of war. Originally the training envisioned was the type necessary to prepare soldiers to operate in the stability and support operations that we find ourselves in today. Messages from soldiers involved in OIF and OEF underscored the need for tools to train and operate in that difficult environment. Six months later, many of the challenges remain the same and new ones have surfaced especially the need to maintain a training environment during ongoing operations. Correspondence monitored since the beginning of this work indicates that steps towards the interoperability of C2 systems and simulations have taken over the driver’s seat and solutions are starting to appear. These solutions are only temporary fixes while the enduring problem remains.

The technologies focused on in this research were the Extensible Markup Language (XML), the Extensible Stylesheet Language for Transformation (XSLT) and the Flexible Asymmetric Simulation Technologies (FAST) Toolbox, the Command and Control Information Exchange Data Model (C2IEDM) and the Model Driven Architecture (MDA). Early in the work it was determined that while the MDA provided a promising architecture for certain software development it was not suitable for the work to be undertaken here. The C2IEDM was examined and utilized with great success and is the leading data model to be used within the DoD. The deliverable was an exemplar to show that by using XML, XSLT and C2IEDM data could be represented, transformed and interchanged between C2 systems and simulation technologies. This was done successfully and it has been shown that both XML and XSLT are powerful and relatively easy to use and that they provide solid solutions to part of the problem of interoperability, data representation and transformation. C2IEDM is the lynch pin that is going to connect C4ISR systems and simulations correctly and completely in the future.

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LIST OF REFERENCES

Arlow, Jim, and Ila Neustadt. *Enterprise Patterns and MDA Building Better Software with Archetype Patterns and UML.* Indianapolis IN: Wiley Publishing Inc., 2003.

Army Tactical Command and Control Information System Web Site. http://www.mip-site.org/ATCCIS/ATCCIS_Home.htm accessed 23 July 2004.

Blais, Curtis. "Semantic Web: Implications for Modeling and Simulation System Interoperability." *04F-SIW-030, Proceedings of the Fall Simulation Interoperability Workshop, Arlington, VA: 2004.*

Blais, Curtis. "Extensible Modeling and Simulation Framework (XMSF) Exemplars in Analytic Combat Modeling." *045-SIW-142, Proceedings of the Spring Simulation Interoperability Workshop, Arlington VA: 2004.*

Booher, Harold, ed. *Handbook of Human Systems Integration*. Hoboken, NJ: John Wiley & Sons, Inc., 2003.

Brutzman, Don, Michael Zyda, Mark Pullen, and Katherine Morse. "Extensible Modeling and Simulation Framework (XMSF) Challenges for Web-Based Modeling and Simulation." *Proceedings of the Technical Challenges Workshop, Strategic Opportunities Symposium*. *Held in Monterey, CA: 2002*.

Brutzman, Donald. "Establishing XML Tactical Chat (XTC) 1.0 Codebase using Jabber Extensible Messaging and Presence Protocol (XMPP)." Monterey CA: 2004.

Carey, Scott E., Martin S. Kleiner, Michael R. Hieb, and Richard Brown. "Standardizing Battle Management Language – A Vital Move Towards the Army Transformation." *01F-SIW-067, Fall Simulation Interoperability Workshop, Orlando, FL, September 2001.* https://simci.army.mil/ds/dscgi/ds.py/View/Collection-404 accessed 2 August 2004.

Carey, Scott E., Martin S. Kleiner, Michael R. Hieb, and Richard Brown. "Standardizing Battle Management Language – Facilitating Coalition Interoperability." *02E-SIW-005, European Simulation Interoperability Workshop, London, UK, June 2002.* https://simci.army.mil/ds/dscgi/ds.py/View/Collection-404 accessed 23 July 2004.

Cauldwell, Patrick, Rajesh Chawla, Vivek Chopra, Gary Damschen, Chris Dix, Tony Hong, Francis Norton, Uche Ogbuji, Glenn Olander, Mark Richman, Kristy Saunders, Zoran Zaev. *Professional XML Web Services.* Birmingham, UK: Wrox Press Ltd., 2001.

Cerami, Ethan. *Web Services Essentials*. Sebastopol CA: O'Reilly & Associates, 2002.

Chaum, Eric., Virginia Dobey, Steve Swenson. "C4I / Simulation Interoperability." Personal Correspondence with Eric Chaum, 17 September 2004.

Cipparone, John and Mike Hopkins. "Unit Order of Battle Data Access Tool." http://www.msiac.dmso.mil/UOB accessed 23 December 2003.

Crain, Forrest W. "Operations Other Than War, Modeling and Simulation in a Rucksack for the Warfighter: Concept of Operations for Developing a Prototype." *Aberdeen Proving Ground, MD: Dynamics Research Corporation for Army Research Laboratory, 2002.*

Crain, Forrest W., John S. Cipparone, Dean S. Hartley III, Dave Holdsworth. "Military Operations Other Than War (MOOTW) Flexible Asymmetric Simulation Technologies (FAST) Prototype Toolbox: Concept of Operations (Revision 1)." *Aberdeen Proving Ground, MD: Dynamics Research Corporation for Army Research Laboratory, 2004.*

Diamond Model of Peace Support Operations. Crown Copyright (2001) material.

Dictionary Webpage. http://dictionary.reference.com accessed 14 September 2004

Digital Terrain Elevation Data (DTED) Level 0. http://geoengine.nima.mil/geoEngine/help/dted_pub.htm accessed 24 July 2004.

Frankel, David. *Model Driven Architecture Applying MDA to Enterprise Computing.* Indianapolis, IN: Wiley Publishing Inc., 2003.

GeoVRML. (www.GeoVRML.org) accessed 23 July 2004.

Hieb, Michael. "Extensible Battle Management Language." October 2003. http://www.netlab.gmu.edu/xmsf/pubs accessed 23 July 2004.

Hopkins, Mike. "Information Paper: Unit Order of Battle (UOB) Data Access Tool (DAT)." Alexandria, VA: Defense Modeling and Simulation Office, 1999.

Hout, Gary. "Toward XML Representation of NSS Simulation Scenario for Mission Scenario Exchange Capability." Master's Thesis, Naval Postgraduate School, 2003.

Hunter, David, Kurt Cagle, Chris Dix, Roger Kovack, Jonathan Pinnock, and Jeff Rafter., *Beginning XML 2nd Edition.* Indianapolis, IN: Wiley Publishing Inc., 2003.

Johnson, Thomas. "Extended C2IEDM Data Model to Include ATP-45 Message Sets and Data Elements: NATO NBC Communications Information System (CIS) Interoperability." *Briefing presented at the NBC, CIS and W&R SC6 Meeting, Skive Denmark, June 2004.*

Kay, Michael. *XSLT 2nd Edition Programmers Reference.* Indianapolis, IN: Wiley Publishing Inc., 2003.

Kleppe, Anneke, Jos Warmer, and Wim Bast. *MDA Explained The Model Driven Architecture: Practice and Promise.* Boston, MA: Addison-Wesley 2003.

Naval Simulation System. "NSS Design, Development and User Support" http://www.metsci.com/ssd/nss.html accessed 24 July 2004.

Multilateral Interoperability Programme (MIP) Web Site. http://www.mip-site.org accessed 24 July 2004.

MIP, "C2IEDM Guide to Change Proposals for MIP Data Specifications (C2IEDM GuideToCP)". Greding, Germany: 20 November 2003. http://www.mip-site.org accessed 13 September 2004.

MIP, "C2IEDM-Management Process For Data Specification Against Requirements (Including Comparison of C2IEDM with LC2IEDM V5)

(C2IEDM ManagementProcessForDataSpec).” Greding, Germany: 20 November 2003. http://www.mip-site.org accessed 23 July 2004.

MIP, C2IEDM OVERVIEW – US – DMWG Edition 6.1. Greding, Germany: 20 November 2003. http://www.mip-site.org accessed 23 July 2004.

Modeling and Simulation Information and Analysis Center (MSIAC) Homepage. (http://www.msiac.dmso.mil) accessed 23 July 2004

NATO, Army Tactical Command and Control Information System (ATCCIS) Working Group, The Land C2 Information Exchange Data Model, Working Paper 5-5, Edition 5.0, ATCCIS Baseline 2.0, 18 March 2002.

Neushul, James. “Interoperability, Data Control and Battlespace Visualization Using XML, XSLT, and X3D.” Master’s Thesis, Naval Postgraduate School, 2003.

Parr, Shawn, Russell Keith-Magee. “The Next Step – Applying the Model Driven Architecture to HLA.” Bently WA, Australia: Calytrix Technologies Pty Ltd, 2003.

Unit Order of Battle (UOB) Data Access Tool (DAT) Project Homepage. http://www.msiac.dmso.mil/UOB accessed 23 July 2004.

W3C, “Scalable Vector Graphics (SVG): XMLGraphics for the Web.” http://www.w3.org/Graphics/SVG accessed 24 July 2004.

Simaitis, Gene. “Anatomy of the C2 Information Exchange Data Model (C2IEDM).” *Briefing presented at the Modeling and Simulation Workshop, Held in Alexandria Virginia: February 2004.*

Schraagen, J. M., Chipman, S and Shalin, V. eds. *Cognitive Task Analysis*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc., 2000.

Tolk, Andreas and J. Mark Pullen. “Ideas for a Common Framework for Military M&S and C3I Systems.” *Proceedings of the 2003 Euro Simulation Interoperability Workshop, Held in Stockholm Sweden: June 2003*.

Web3D Consortium. “Open Standards for Real-Time 3D Communication.” http://www.web3d.org/x3d accessed 23 July 2004.

APPENDIX A. UOB SCHEMA VERSION 7.7

The following document is the schema used to validate information entering and exiting the UOB DAT. It was provided by the DMSO personnel responsible for maintaining the UOB toolset. Further information about the UOB toolset can be found at http://www.msiac.dmso.mil/UOB.


```
<?xml version="1.0" encoding="UTF-8"?>
<!-- edited with XMLSPY v2004 rel. 3 U (http://www.xmlspy.com) by JZanakos (Dynamics
Research Corp) -->
<!-- edited with XML Spy v4.4 U (http://www.xmlspy.com) by Joseph E. Eck (Computing
Technologies, Inc.) -->
<!--Changed Unit Name to optional from required.  Changed Relatinship from required to
optional.  Changed DataSource from required to optional -->
<!-- Added the optional field ParentOrg -->
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">
    <xs:element name="UOB">
        <xs:annotation>
            <xs:documentation>This element contains all UOB data.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="ForceStructureInformation" minOccurs="0"/>
                <xs:element ref="Relationships" minOccurs="0"/>
                <xs:element ref="Units"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="Unit">
        <xs:annotation>
            <xs:documentation>DataSource also applies to Equipment, Aircraft and Personnel
Resources, but is not defined for each.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Name" minOccurs="0">
                    <xs:annotation>
                        <xs:documentation>For US units this is the name of the unit.    For MIDB
units:  Translated unit name or identification given the unit by appropriate authority or orders as
used in official orders or communications within the national military or civilian establishment of
the country of allegiance.  A unit name must be established for every unit in the data base.  For
each Unit logical record, unit naming conventions established in production programs should be
employed.  If official sources are not available, the unit name believed most correct is used.  a
unit's primary designation usually includes service specialty and command
echelon.</xs:documentation>
                    </xs:annotation>
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="60"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
```

```
        <xs:element name="Present" minOccurs="0">
            <xs:annotation>
                <xs:documentation>This is a continer element for Present location
data.</xs:documentation>
            </xs:annotation>
            <xs:complexType>
                <xs:sequence>
                    <xs:element name="Name" minOccurs="0">
                        <xs:annotation>
                            <xs:documentation>For US units this is the present Name of the
geographic location where the Unit is presently located.    For MIDB units this is the location
name for the present coordinates.</xs:documentation>
                        </xs:annotation>
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="24"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:element>
                    <xs:element name="Latitude" minOccurs="0">
                        <xs:annotation>
                            <xs:documentation>Present Unit latitude of the geographic
location.</xs:documentation>
                        </xs:annotation>
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="7"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:element>
                    <xs:element name="Longitude" minOccurs="0">
                        <xs:annotation>
                            <xs:documentation>Present Unit longitude of the geographic
location.</xs:documentation>
                        </xs:annotation>
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="8"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:element>
                </xs:sequence>
            </xs:complexType>
        </xs:element>
        <xs:element name="Home" minOccurs="0">
            <xs:annotation>
                <xs:documentation>This is a container element for Home location
data.</xs:documentation>
            </xs:annotation>
            <xs:complexType>
                <xs:sequence>
                    <xs:element name="Name" minOccurs="0">
                        <xs:annotation>
                            <xs:documentation>For US units this is the name of the
geographic location where the Unit is garrisoned.    For MIDB units this is the location name of
the coordinates.</xs:documentation>
```

```
                </xs:annotation>
                <xs:simpleType>
                  <xs:restriction base="xs:string">
                    <xs:maxLength value="24"/>
                  </xs:restriction>
                </xs:simpleType>
              </xs:element>
              <xs:element name="Latitude" minOccurs="0">
                <xs:annotation>
                  <xs:documentation>The latitude of the geographic location where
the Unit is garrisoned.</xs:documentation>
                </xs:annotation>
                <xs:simpleType>
                  <xs:restriction base="xs:string">
                    <xs:maxLength value="7"/>
                  </xs:restriction>
                </xs:simpleType>
              </xs:element>
              <xs:element name="Longitude" minOccurs="0">
                <xs:annotation>
                  <xs:documentation>The longitude of the geographic location
where the Unit is garrisoned.</xs:documentation>
                </xs:annotation>
                <xs:simpleType>
                  <xs:restriction base="xs:string">
                    <xs:maxLength value="8"/>
                  </xs:restriction>
                </xs:simpleType>
              </xs:element>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name="TypeCode" minOccurs="0">
          <xs:annotation>
            <xs:documentation>A five-character alphanumeric code that uniquely
identifies each type unit of the U.S. Armed Forces.   The first position of Unit Type Code (UTC)
applies to all the US Services.  The UTC is a 5-character A/N code that is associated with and
allows each type organization to be categorized into a class having common characteristics.  The
first character of the UTC, as described below, identifies the functional category of the unit.  Each
Service may define the function differently or may not have a valid use for the code.  Therefore,
each Service functional definition  is provided for the first position of the UTC as appropriate.  The
remaining four characters are Service assigned codes.</xs:documentation>
          </xs:annotation>
          <xs:simpleType>
            <xs:restriction base="xs:string">
              <xs:maxLength value="5"/>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="DescriptionCode" minOccurs="0">
          <xs:annotation>
            <xs:documentation>For US Units this is a 3 Character Unit Description Code
(UDC) associated with the unit showing unit status (Combat, Combat Support, Combat Service
Support, Active Duty, National Guard, or Reserve).</xs:documentation>
          </xs:annotation>
          <xs:simpleType>
```

```
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="3"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="LevelCode" minOccurs="0">
                <xs:annotation>
                    <xs:documentation>A three-letter alphanumeric code used to specify the
organizational level (echelon) of the Unit.</xs:documentation>
                </xs:annotation>
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="3"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="TotalPersonnel" minOccurs="0">
                <xs:annotation>
                    <xs:documentation>This is a container element for unit personnel
data.</xs:documentation>
                </xs:annotation>
                <xs:complexType>
                    <xs:sequence>
                        <xs:element name="Authorized" type="xs:short" minOccurs="0">
                            <xs:annotation>
                                <xs:documentation>For US units this is the quantity of authorized
personnel of the unit.   For MIDB units this is relative to the parent entity, the total number of
military personnel assessed to be war authorized (WA).</xs:documentation>
                            </xs:annotation>
                        </xs:element>
                        <xs:element name="OnHand" type="xs:short" minOccurs="0">
                            <xs:annotation>
                                <xs:documentation>For US units this is the quantity of personnel
present for duty in the unit.   For MIDB units this is relative to the parent entity, the total number
of military personnel  assessed to be on-hand (OH).</xs:documentation>
                            </xs:annotation>
                        </xs:element>
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
            <xs:element name="CountryCode" minOccurs="0">
                <xs:annotation>
                    <xs:documentation>State/Country code associated with  the geographic
location of the Unit.</xs:documentation>
                </xs:annotation>
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="2"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="Ship" minOccurs="0">
                <xs:annotation>
                    <xs:documentation>This is a container element for Ship
data.</xs:documentation>
                </xs:annotation>
```

```
                <xs:complexType>
                    <xs:sequence>
                        <xs:element name="Category" minOccurs="0">
                            <xs:annotation>
                                <xs:documentation>For the US Navy this is the Navy category
type of ship.</xs:documentation>
                            </xs:annotation>
                            <xs:simpleType>
                                <xs:restriction base="xs:string">
                                    <xs:maxLength value="6"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:element>
                        <xs:element name="CategoryName" minOccurs="0">
                            <xs:annotation>
                                <xs:documentation>The Navy category name of
ship.</xs:documentation>
                            </xs:annotation>
                            <xs:simpleType>
                                <xs:restriction base="xs:string">
                                    <xs:maxLength value="56"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:element>
                        <xs:element name="HullNumber" minOccurs="0">
                            <xs:annotation>
                                <xs:documentation>A unique ship type and  number located on the
Hull of a ship.  It is composed of the type of ship ie SSBN and a number ie 726 or the CV
63.</xs:documentation>
                            </xs:annotation>
                            <xs:simpleType>
                                <xs:restriction base="xs:string">
                                    <xs:maxLength value="4"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:element>
                        <xs:element name="Class" minOccurs="0">
                            <xs:annotation>
                                <xs:documentation>A Navy class of ships which other like ships
are associated ie the Ohio Class.</xs:documentation>
                            </xs:annotation>
                            <xs:simpleType>
                                <xs:restriction base="xs:string">
                                    <xs:maxLength value="25"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:element>
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
            <xs:element name="SRC" minOccurs="0">
                <xs:annotation>
                    <xs:documentation>This is a container element for SRC
data.</xs:documentation>
                </xs:annotation>
                <xs:complexType>
```

```xml
        &lt;xs:sequence&gt;
            &lt;xs:element name="Code" minOccurs="0"&gt;
                &lt;xs:simpleType&gt;
                    &lt;xs:restriction base="xs:string"&gt;
                        &lt;xs:maxLength value="9"/&gt;
                    &lt;/xs:restriction&gt;
                &lt;/xs:simpleType&gt;
            &lt;/xs:element&gt;
            &lt;xs:element name="Name" minOccurs="0"&gt;
                &lt;xs:simpleType&gt;
                    &lt;xs:restriction base="xs:string"&gt;
                        &lt;xs:maxLength value="32"/&gt;
                    &lt;/xs:restriction&gt;
                &lt;/xs:simpleType&gt;
            &lt;/xs:element&gt;
        &lt;/xs:sequence&gt;
    &lt;/xs:complexType&gt;
&lt;/xs:element&gt;
&lt;xs:element name="OpfacRule" minOccurs="0"&gt;
    &lt;xs:complexType&gt;
        &lt;xs:sequence&gt;
            &lt;xs:element name="Code" minOccurs="0"&gt;
                &lt;xs:simpleType&gt;
                    &lt;xs:restriction base="xs:string"&gt;
                        &lt;xs:maxLength value="5"/&gt;
                    &lt;/xs:restriction&gt;
                &lt;/xs:simpleType&gt;
            &lt;/xs:element&gt;
            &lt;xs:element name="Title" minOccurs="0"&gt;
                &lt;xs:simpleType&gt;
                    &lt;xs:restriction base="xs:string"&gt;
                        &lt;xs:maxLength value="46"/&gt;
                    &lt;/xs:restriction&gt;
                &lt;/xs:simpleType&gt;
            &lt;/xs:element&gt;
        &lt;/xs:sequence&gt;
    &lt;/xs:complexType&gt;
&lt;/xs:element&gt;
&lt;xs:element name="SymbolCode" minOccurs="0"&gt;
    &lt;xs:annotation&gt;
        &lt;xs:documentation&gt;Mil-Std 2525-B Symbolic Codes&lt;/xs:documentation&gt;
    &lt;/xs:annotation&gt;
    &lt;xs:simpleType&gt;
        &lt;xs:restriction base="xs:string"&gt;
            &lt;xs:maxLength value="15"/&gt;
        &lt;/xs:restriction&gt;
    &lt;/xs:simpleType&gt;
&lt;/xs:element&gt;
&lt;xs:element name="Rolledup" minOccurs="0"&gt;
    &lt;xs:simpleType&gt;
        &lt;xs:restriction base="xs:string"&gt;
            &lt;xs:maxLength value="1"/&gt;
        &lt;/xs:restriction&gt;
    &lt;/xs:simpleType&gt;
&lt;/xs:element&gt;
&lt;xs:element name="Subtracted" minOccurs="0"&gt;
```

```
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:maxLength value="1"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="ParentOrg" type="xs:string" minOccurs="0"/>
                <xs:element name="ORG_EID_S" type="xs:double" minOccurs="0"/>
                <xs:element ref="Resource" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
            <xs:attributeGroup ref="UnitIdentificationCode"/>
            <xs:attribute name="dataSource" use="optional">
                <xs:annotation>
                    <xs:documentation>The source of the unit data ie Conventional Forces Data
Base (CFDB), Defense Intelligence Agency's (DIA), Moderized Intergrated Data Base (MIDB),
Conventional Forces Europe (CFE), Generic, or the National Ground Intelligence Center's (NGIC)
ForceTracking Information System (FORTRIS) and others.</xs:documentation>
                </xs:annotation>
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:maxLength value="10"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
    <xs:element name="Units">
        <xs:annotation>
            <xs:documentation>This is a grouping element for Units.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Unit" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="Relationships">
        <xs:annotation>
            <xs:documentation>This is a grouping element for Relationships.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Relationship" maxOccurs="unbounded">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="Description" type="xs:string" minOccurs="0">
                                <xs:annotation>
                                    <xs:documentation>A description of the
relationship.</xs:documentation>
                                </xs:annotation>
                            </xs:element>
                            <xs:element name="Assigned" minOccurs="0">
                                <xs:complexType>
                                    <xs:sequence>
                                        <xs:element ref="UnitNode" maxOccurs="unbounded"/>
                                    </xs:sequence>
```

```
                                    <xs:attribute name="type" type="xs:string" use="optional"/>
                                </xs:complexType>
                            </xs:element>
                            <xs:element name="Unassigned" minOccurs="0">
                                <xs:complexType>
                                    <xs:sequence>
                                        <xs:element ref="UnitNode" minOccurs="0"
maxOccurs="unbounded"/>
                                    </xs:sequence>
                                </xs:complexType>
                            </xs:element>
                        </xs:sequence>
                        <xs:attribute name="type" type="xs:string" use="required"/>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:attributeGroup name="UnitIdentificationCode">
        <xs:attribute name="UIC" use="optional">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:maxLength value="15"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:attribute>
    </xs:attributeGroup>
    <xs:element name="UnitNode">
        <xs:annotation>
            <xs:documentation>Represents the position of a Unit in a relationship hierarchy. The
root UnitNode is  implicitly defined and multiple roots are allowed.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="UnitNode" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
            <xs:attribute name="UIC" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
    <xs:element name="ForceStructureInformation" nillable="true">
        <xs:annotation>
            <xs:documentation>Information about the Force Structure.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:sequence minOccurs="0">
                <xs:element name="Name" type="xs:string" minOccurs="0">
                    <xs:annotation>
                        <xs:documentation>The name of the Force Structure.</xs:documentation>
                    </xs:annotation>
                </xs:element>
                <xs:element name="FileName" type="xs:string" minOccurs="0">
                    <xs:annotation>
                        <xs:documentation>The file name of the Force
Structure.</xs:documentation>
                    </xs:annotation>
                </xs:element>
```

```
                <xs:element name="Description" type="xs:string" minOccurs="0">
                    <xs:annotation>
                        <xs:documentation>A brief description of wha the Force Structure 
is.</xs:documentation>
                    </xs:annotation>
                </xs:element>
                <xs:element name="Purpose" type="xs:string" minOccurs="0">
                    <xs:annotation>
                        <xs:documentation>A brief description for why the Force Structure was 
created.</xs:documentation>
                    </xs:annotation>
                </xs:element>
                <xs:element name="CreatedBy" type="xs:string" minOccurs="0">
                    <xs:annotation>
                        <xs:documentation>The name of the person or group who created the Force 
Structure.</xs:documentation>
                    </xs:annotation>
                </xs:element>
                <xs:element name="CreationDate" type="xs:date" minOccurs="0">
                    <xs:annotation>
                        <xs:documentation>The date the Force Structure was 
created.</xs:documentation>
                    </xs:annotation>
                </xs:element>
                <xs:element name="LastModifiedBy" type="xs:string" minOccurs="0">
                    <xs:annotation>
                        <xs:documentation>The name of the person or group who last modified the 
Force Structure.</xs:documentation>
                    </xs:annotation>
                </xs:element>
                <xs:element name="LastModifiedDate" type="xs:date" minOccurs="0">
                    <xs:annotation>
                        <xs:documentation>The date of the last modification to the Force 
Structure.</xs:documentation>
                    </xs:annotation>
                </xs:element>
            </xs:sequence>
            <xs:attribute name="extracted" type="xs:boolean" use="optional" default="false">
                <xs:annotation>
                    <xs:documentation>A flag to indicate whether or not the Force Structure was 
extracted.  Extracted Force Structures can have only one relationship type.</xs:documentation>
                </xs:annotation>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
    <xs:element name="Resource">
        <xs:annotation>
            <xs:documentation>This is a grouping element for all Resources.</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Personnel" minOccurs="0" maxOccurs="unbounded">
                    <xs:annotation>
                        <xs:documentation>This is a container element for Personnel resource 
data.</xs:documentation>
                    </xs:annotation>
```

```xml
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="Description" minOccurs="0">
                                <xs:annotation>
                                    <xs:documentation>The description of a military occupational
specialty code of a person in a military unit.    This field is not used in MIDB.</xs:documentation>
                                </xs:annotation>
                                <xs:simpleType>
                                    <xs:restriction base="xs:string">
                                        <xs:maxLength value="110"/>
                                    </xs:restriction>
                                </xs:simpleType>
                            </xs:element>
                            <xs:element name="Grade" minOccurs="0">
                                <xs:annotation>
                                    <xs:documentation>Pay grade of personnel assigned to a unit.
This field is not used in MIDB.</xs:documentation>
                                </xs:annotation>
                                <xs:simpleType>
                                    <xs:restriction base="xs:string">
                                        <xs:maxLength value="3"/>
                                    </xs:restriction>
                                </xs:simpleType>
                            </xs:element>
                            <xs:element name="Required" type="xs:short" minOccurs="0">
                                <xs:annotation>
                                    <xs:documentation>For US units this is the quantity of personnel
required by the Unit to perform its wartime mission.    For MIDB units this is relative to the parent
entity, the total number of military personnel assessed to be war authorized
(WA).</xs:documentation>
                                </xs:annotation>
                            </xs:element>
                            <xs:element name="Authorized" type="xs:short" minOccurs="0">
                                <xs:annotation>
                                    <xs:documentation>For US units this is the quantity of personnel
to be assigned to the Unit to perform its peacetime mission.    For MIDB units this is relative to the
parent entity, the total number of military personnel assessed to be peacetime  authorized
(PA).</xs:documentation>
                                </xs:annotation>
                            </xs:element>
                            <xs:element name="OnHand" type="xs:short" minOccurs="0">
                                <xs:annotation>
                                    <xs:documentation>For US units this is the quantity of personnel
present for duty in the unit.    For MIDB units this is relative to the parent entity, the total number
of military personnel  assessed to be on-hand (OH).</xs:documentation>
                                </xs:annotation>
                            </xs:element>
                        </xs:sequence>
                        <xs:attribute name="code" use="required">
                            <xs:annotation>
                                <xs:documentation>Military Occupation Specialty (MOS) code or job
code of personnel assigned to a military unit.    This Field is not used in
MIDB.</xs:documentation>
                            </xs:annotation>
                            <xs:simpleType>
                                <xs:restriction base="xs:string">
```

```
                  <xs:maxLength value="7"/>
                </xs:restriction>
              </xs:simpleType>
            </xs:attribute>
          </xs:complexType>
        </xs:element>
        <xs:element name="Equipment" minOccurs="0" maxOccurs="unbounded">
          <xs:annotation>
            <xs:documentation>This is a container element for Equipment resource
data.</xs:documentation>
          </xs:annotation>
          <xs:complexType>
            <xs:sequence>
              <xs:element name="Description" minOccurs="0">
                <xs:annotation>
                  <xs:documentation>Equipment nomenclature associated with the
equipment code.</xs:documentation>
                </xs:annotation>
                <xs:simpleType>
                  <xs:restriction base="xs:string">
                    <xs:maxLength value="65"/>
                  </xs:restriction>
                </xs:simpleType>
              </xs:element>
              <xs:element name="Required" type="xs:short" minOccurs="0">
                <xs:annotation>
                  <xs:documentation>For US units thsi is the quantity of equipment
required by the Unit to perform its wartime mission.    For MIDB units this is relative to the parent
entity, the total number of military equipment assessed to be war authorized
(WA).</xs:documentation>
                </xs:annotation>
              </xs:element>
              <xs:element name="Authorized" type="xs:short" minOccurs="0">
                <xs:annotation>
                  <xs:documentation>For US units this is the quantity of equipmentl
to be assigned to the Unit to perform its peacetime mission.    For MIDB units this is relative to the
parent entity, the total number of military equipment assessed to be peacetime  authorized
(PA).</xs:documentation>
                </xs:annotation>
              </xs:element>
              <xs:element name="OnHand" type="xs:short" minOccurs="0">
                <xs:annotation>
                  <xs:documentation>For US units this is the quantity of equipment
on hand in the unit.    For MIDB units this is relative to the parent entity, the total number of
military equipment assessed to be on-hand (OH).</xs:documentation>
                </xs:annotation>
              </xs:element>
            </xs:sequence>
            <xs:attribute name="code" use="required">
              <xs:annotation>
                <xs:documentation>Unique code assigned to each piece of
equipment.</xs:documentation>
              </xs:annotation>
              <xs:simpleType>
                <xs:restriction base="xs:string">
                  <xs:maxLength value="15"/>
```

```
                        </xs:restriction>
                    </xs:simpleType>
                </xs:attribute>
            </xs:complexType>
        </xs:element>
        <xs:element name="Aircraft" minOccurs="0" maxOccurs="unbounded">
            <xs:annotation>
                <xs:documentation>This is a container element for Aircraft  resource
data.</xs:documentation>
            </xs:annotation>
            <xs:complexType>
                <xs:sequence>
                    <xs:element name="Description" minOccurs="0">
                        <xs:annotation>
                            <xs:documentation>Aircraft nomenclature associated with each
aircraft code.</xs:documentation>
                        </xs:annotation>
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:maxLength value="48"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:element>
                    <xs:element name="Required" type="xs:short" minOccurs="0">
                        <xs:annotation>
                            <xs:documentation>For US units this is the quantity of aircraft
required by the Unit to perform its wartime mission.    For MIDB units this is relative to the parent
entity, the total number of military aircraft assessed to be war authorized
(WA).</xs:documentation>
                        </xs:annotation>
                    </xs:element>
                    <xs:element name="Authorized" type="xs:short" minOccurs="0">
                        <xs:annotation>
                            <xs:documentation>For US units this is the quantity of aircraftl to
be assigned to the Unit to perform its mission.    For MIDB units this is relative to the parent
entity, the total number of military aircraft assessed to be peacetime authorized
(PA).</xs:documentation>
                        </xs:annotation>
                    </xs:element>
                    <xs:element name="OnHand" type="xs:short" minOccurs="0">
                        <xs:annotation>
                            <xs:documentation>For US units this is the quantity of aircraft on
hand in the unit.    For MIDB units this is relative to the parent entity, the total number of military
aircraft assessed to be on-hand (OH).</xs:documentation>
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APPENDIX B. EXTRACTED UOB UNIT FILE VERSION 7.7

This unit file was extracted from the UOB version 7.7. It serves as a representation compliant with the UOB version 7.7 schema used during the C2IEDM to UOB transformation. This is what the result file may look like when the transformation is completely finished.


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</Equipment>
<Equipment code="L92352">
<Description>MACHINE GUN 7.62 MILLIMETER: FIXED</Description>
<Required>18</Required>
</Equipment>
<Equipment code="P70517">
<Description>PURGING KIT FIRE CONTROL: ORG MAINT</Description>
<Required>1</Required>
</Equipment>
<Equipment code="V35477">
<Description>TELESCOPE STRAIGHT: MILITARY</Description>
<Required>12</Required>
</Equipment>
<Equipment code="L44680">
<Description>LAUNCHER GRENADE SMOKE: SCREENING RP M250</Description>
<Required>9</Required>
</Equipment>

```
<Equipment code="Y03104">
    <Description>VIEWER INFRARED: AN/PAS-7</Description>
    <Required>12</Required>
</Equipment>
<Equipment code="T58051">
    <Description>TOOL KIT MECHANICS:</Description>
    <Required>2</Required>
</Equipment>
<Equipment code="M68405">
    <Description>MORTAR 120 MILLIMETERS:</Description>
    <Required>2</Required>
</Equipment>
<Equipment code="N05050">
    <Description>NIGHT VISION SIGHT SET: AN/UAS-11</Description>
    <Required>6</Required>
</Equipment>
<Equipment code="B90494">
    <Description>BORESIGHTING EQUIPMENT WEAPON: MUZZLE
ALIGNMENT</Description>
    <Required>9</Required>
</Equipment>
<Equipment code="T13305">
    <Description>TANK COMBAT FULL TRACKED: 120MM GUN
M1A2</Description>
    <Required>9</Required>
</Equipment>
<Equipment code="K27594">
    <Description>KIT GROUND HOP: M1 TANK</Description>
    <Required>1</Required>
</Equipment>
<Equipment code="W32182">
    <Description>TOOL KIT ARTILLERY MECHANICS: ORD</Description>
    <Required>4</Required>
</Equipment>
<Equipment code="A10837">
    <Description>ADAPTER HARDWARE: M1 PECULIAR (STE-
M1/FVS)</Description>
    <Required>1</Required>
</Equipment>
<Equipment code="L92386">
    <Description>MACHINE GUN 7.62 MILLIMETER: LIGHT
FLEXIBLE</Description>
    <Required>12</Required>
</Equipment>
<Equipment code="M68258">
    <Description>MORTAR: SUBCALIBER INSERT 120 MILLIMETER
M303</Description>
    <Required>2</Required>
</Equipment>
<Equipment code="C60294">
    <Description>COMPUTER SET BALLISTICS: MORTAR M23</Description>
    <Required>2</Required>
</Equipment>
<Equipment code="M51419">
    <Description>MISSILE SIMULATION ROUND: (TOW)</Description>
    <Required>12</Required>
```

</Equipment>
<Equipment code="C10990">
<Description>CARRIER 120 MILLIMETER MORTAR: SELF PROPELLED ARMORED</Description>
<Required>2</Required>
</Equipment>
<Equipment code="E98103">
<Description>ELEC TRANSFER KEYING DEVICE ETKD: KYK-13/TSEC</Description>
<Required>1</Required>
</Equipment>
<Equipment code="F91627">
<Description>DEMOLITION SET EXPLOSIVE: INITIATING NON ELECTRIC</Description>
<Required>2</Required>
</Equipment>
<Equipment code="L40063">
<Description>LASER INFRARED OBSERVATION SET: AN/GVS-5</Description>
<Required>6</Required>
</Equipment>
<Equipment code="A22496">
<Description>AIMING CIRCLE:</Description>
<Required>2</Required>
</Equipment>
<Equipment code="A70522">
<Description>ADAPTER TEST ELECTRICAL SYSTEM BREAKOUT: M1 TANK</Description>
<Required>1</Required>
</Equipment>
<Equipment code="P49587">
<Description>PJH SURFACE VECHILE RADIO SET: AN/VSQ-2(V)1 (PJHI)</Description>
<Required>8</Required>
</Equipment>
<Equipment code="T62405">
<Description>TOOL SET BATTALION MAINTENANCE TEAM: ARMOR/MECH INF/FLD ARTY</Description>
<Required>1</Required>
</Equipment>
<Equipment code="Q03468">
<Description>QUADRANT FIRE CONTROL: GUNNERS</Description>
<Required>11</Required>
</Equipment>
<Equipment code="K41392">
<Description>KIT GROUND HOP: IFV/CFV</Description>
<Required>1</Required>
</Equipment>
</Resource>
</Unit>
</Units>
</UOB>

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APPENDIX C. C2IEDM TO UOB XSLT

This is the XSLT created by the author to extract unit data from a C2IEDM instance document and transform it into a UOB schema compliant result document that can be used within the FAST project as an initialization file for a simulation.

```
<?xml version="1.0" encoding="UTF-8"?>
<xsl:stylesheet version="1.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
    <xsl:output method="xml" version="1.0"/>
    <xsl:template match="/">
        <xsl:element name="UOB">
            <xsl:element name="ForceStructureInformation">
                <xsl:call-template name="FileHeader"/>
            </xsl:element>
            <xsl:element name="Units">
                <xsl:apply-templates select="BattlespaceData/OBJECT-
ITEM/ORGANISATION/UNIT/unit-formal-abbreviated-name"/>
            </xsl:element>
        </xsl:element>
    </xsl:template>
    <xsl:template name="FileHeader">
        <xsl:element name="Name"/>
        <xsl:element name="FileName"/>
        <xsl:element name="Description">Unit document generated using XSLT on XML C2IEDM
Ver 6.1 model</xsl:element>
        <xsl:element name="Purpose"/>
        <xsl:element name="CreatedBy">Transformation of C2IEDM Source File to the UOB
Format</xsl:element>
        <xsl:element name="CreationDate">2004-04-15</xsl:element>
        <xsl:element name="LastModifiedBy"/>
        <xsl:element name="LastModifiedDate">2004-08-10</xsl:element>
    </xsl:template>
    <xsl:template match="unit-formal-abbreviated-name">
        <xsl:element name="Unit">
            <xsl:attribute name="UIC"/>
            <xsl:attribute name="dataSource"/>
            <xsl:element name="Name">
                <xsl:value-of select="."/>
            </xsl:element>
            <xsl:variable name="ObjectItemID" select="../../../object-item-id"/>
            <xsl:variable name="ObjectTypeID" select="../../../OBJECT-ITEM-TYPE/object-type-
id"/>
                <xsl:call-template name="RelativeUnitLocation">
                <xsl:with-param name="UnitObjectItemID" select="$ObjectItemID"/>
                <xsl:with-param name="UnitObjectItemLocationID" select="../../../OBJECT-ITEM-
LOCATION/location-id"/>
            </xsl:call-template>
            <xsl:call-template name="UnitTypeCategoryCode">
                <xsl:with-param name="OTypeID" select="$ObjectTypeID"/>
            </xsl:call-template>
            <xsl:call-template name="UnitTypeSizeCode">
```

```
                <xsl:with-param name="ObjTypID" select="$ObjectTypeID"/>
            </xsl:call-template>
            <xsl:element name="Resource">
                <xsl:call-template name="PersonnelHoldings"/>
                <xsl:call-template name="EquipmentHoldings"/>
            </xsl:element>
        </xsl:element>
    </xsl:template>
    <xsl:template name="PersonnelHoldings">
        <xsl:for-each select="../../../HOLDING">
            <xsl:variable name="holdingObjectTypeID" select="object-type-id"/>
            <xsl:variable name="holdingObjectItemID" select="object-item-id"/>
            <xsl:for-each select="../../OBJECT-TYPE">
                <xsl:variable name="objectTypeID" select="object-type-id"/>
                <xsl:if test="$objectTypeID = $holdingObjectTypeID">
                    <xsl:if test="object-type-category-code /* [local-name() = 'PE']">
                        <xsl:element name="Personnel">
                            <xsl:attribute name="code"><xsl:value-of select="object-type-
name"/></xsl:attribute>
                            <xsl:call-template name="PersonnelTemplate"/>
                            <xsl:call-template name="PersonnelHoldingNumbersTemplate"/>
                        </xsl:element>
                    </xsl:if>
                </xsl:if>
            </xsl:for-each>
        </xsl:for-each>
    </xsl:template>
    <xsl:template name="PersonnelTemplate">
        <xsl:element name="Description"/>
        <xsl:element name="Grade">
            <xsl:choose>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OF1']">01/02</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OF2']">03</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OF3']">04</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OF4']">05</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OF5']">06</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OF6']">07</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OF7']">08</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OF8']">09</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OF9']">10</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OR1']">E1</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OR2']">E2</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OR3']">E3</xsl:when>
```

```
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OR4']">E4</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OR5']">E5</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OR6']">E6</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OR7']">E7</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OR8']">W1</xsl:when>
                <xsl:when test="PERSON-TYPE/person-type-rank-code/* [local-name() =
'OR9']">W2</xsl:when>
                <xsl:otherwise>Unknown</xsl:otherwise>
            </xsl:choose>
        </xsl:element>
    </xsl:template>
    <xsl:template name="EquipmentHoldings">
        <xsl:for-each select="../../../HOLDING">
            <xsl:variable name="holdingObjectTypeID" select="object-type-id"/>
                <xsl:for-each select="../../OBJECT-TYPE">
                <xsl:variable name="objectTypeID" select="object-type-id"/>
                <xsl:if test="$objectTypeID = $holdingObjectTypeID">
                    <xsl:if test="object-type-category-code /* [local-name() = 'MA']">
                        <xsl:apply-templates select="MATERIEL-TYPE"/>
                    </xsl:if>
                </xsl:if>
            </xsl:for-each>
        </xsl:for-each>
    </xsl:template>
    <xsl:template match="MATERIEL-TYPE">
        <xsl:if test="materiel-type-category-code /* [local-name() = 'EQ']">
                <xsl:element name="Equipment">
                    <xsl:attribute name="code"><xsl:value-of select="../../object-type-
name"/></xsl:attribute>
                    <xsl:apply-templates select="./EQUIPMENT-TYPE"/>
                    <xsl:element name="Required">
                        <xsl:value-of select=”../HOLDING/holding-operational-quantity"/>
                    </xsl:element>
                    <xsl:element name="Authorized">
                        <xsl:value-of select=”../HOLDING/holding-total-quantity"/>
                    </xsl:element>
                </xsl:element>
            </xsl:for-each>
        </xsl:if>
    </xsl:template>
    <xsl:template name="EquipmentType">
        <xsl:element name="Description">
            <xsl:choose>
                <xsl:when test="equipment-type-category-code /* [local-name() = 'AIRCFT']">
                    <xsl:value-of select="AIRCRAFT-TYPE/aircraft-type-subcategory-
code/*/@value">
                </xsl:when>
                <xsl:when test="equipment-type-category-code /* [local-name() = 'ELCTRN']">
                    <xsl:value-of select="ELECTRONIC-EQUIPMENT-TYPE/electronic-equipment-
type-subcategory-code/*/@value">
```

```
                </xsl:when>
                <xsl:when test="equipment-type-category-code /* [local-name() = 'ENGEQ']">
                    <xsl:value-of select="ENGINEERING-EQUIPMENT-TYPE/engineering-
equipment-type-category-code/*/@value">
                </xsl:when>
                <xsl:when test="equipment-type-category-code /* [local-name() = 'LNDWEP']">
                    <xsl:value-of select="LAND-WEAPON-TYPE/land-weapon-type-category-
code/*/@value">
                </xsl:when>
                <xsl:when test="equipment-type-category-code /* [local-name() = 'MISCEQ']">
                    <xsl:value-of select="MISCELLANEOUS-EQUIPMENT-TYPE/miscellaneous-
equipment-type-category-code/*/@value">
                </xsl:when>
                <xsl:when test="equipment-type-category-code /* [local-name() = 'NBCEQ']">
                    <xsl:value-of select="NBC-EQUIPMENT-TYPE/nbc-equipment-type-category-
code/*/@value">
                </xsl:when>
                <xsl:when test="equipment-type-category-code /* [local-name() = 'RAIL']">
                    <xsl:value-of select="RAILCAR-TYPE/railcar-type-category-code/*/@value">
                </xsl:when>
                <xsl:when test="equipment-type-category-code /* [local-name() = 'VEHCLE']">
                    <xsl:value-of select="VEHICLE-TYPE/vehicle-type-category-code/*/@value">
                </xsl:when>
                <xsl:when test="equipment-type-category-code /* [local-name() = 'VESSEL']">
                    <xsl:value-of select="VESSEL-TYPE/vessel-type-subcategory-code/*/@value">
                </xsl:when>
                <xsl:otherwise/>
            </xsl:choose>
        </xsl:element>
    </xsl:template>
    <xsl:template name="PersonnelHoldingNumbersTemplate">
        <xsl:element name="Required">
            <xsl:value-of select="HOLDING/holding-operational-quantity"/>
        </xsl:element>
        <xsl:element name="Authorized">
            <xsl:value-of select="HOLDING/holding-total-quantity"/>
        </xsl:element>
    </xsl:template>
    <xsl:template name="UnitTypeCategoryCode">
        <xsl:param name="OTypeID"/>
        <xsl:element name="DescriptionCode">
            <xsl:for-each select="../../../../OBJECT-TYPE">
                <xsl:variable name="LocalObjectTypeID" select="object-type-id"/>
                <xsl:if test="$OTypeID = $LocalObjectTypeID">
                    <xsl:if test="object-type-category-code/* [local-name() = 'OR']">
                        <xsl:if test="ORGANISATION-TYPE/organisation-type-category-code/*
[local-name() = 'GVTORG']">
                            <xsl:if test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-
TYPE/government-organisation-type-category-code/* [local-name() = 'MILORG']">
                                <xsl:if test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/military-organisation-type-category-
code/* [local-name() = 'UNIT']">
                                    <xsl:choose>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-category-
code/* [local-name() = 'COMBAT']">AAC</xsl:when>
```

```
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-category-
code/* [local-name() = 'COMSER']">AAV</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-category-
code/* [local-name() = 'COMSPT']">AAS</xsl:when>
                                        <xsl:otherwise>U</xsl:otherwise>
                                    </xsl:choose>
                                </xsl:if>
                            </xsl:if>
                        </xsl:if>
                    </xsl:if>
                </xsl:if>
            </xsl:for-each>
        </xsl:element>
    </xsl:template>
    <xsl:template name="UnitTypeSizeCode">
        <xsl:param name="ObjTypID"/>
        <xsl:element name="LevelCode">
            <xsl:for-each select="../../../../OBJECT-TYPE">
                <xsl:variable name="LocalObjTypID" select="object-type-id"/>
                <xsl:if test="$ObjTypID = $LocalObjTypID">
                    <xsl:if test="object-type-category-code/* [local-name() = 'OR']">
                        <xsl:if test="ORGANISATION-TYPE/organisation-type-category-code/*
[local-name() = 'GVTORG']">
                            <xsl:if test="ORGANISATION-TYPE/GOVERNMENT-ORGANISATION-
TYPE/government-organisation-type-category-code/* [local-name() = 'MILORG']">
                                <xsl:if test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/military-organisation-type-category-
code/* [local-name() = 'UNIT']">
                                    <xsl:choose>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'ARMY']">A</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'AGP']">AG</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'BN']">BN</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'BDE']">BDE</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'CBTTM']">CO</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'COY']">CO</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'CORPS']">CPS</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'DIV']">DIV</xsl:when>
```

```
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'FLEET']">FLT</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'FLIGHT']">FT</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'PLT']">PLT</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'RGT']">RGT</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'REGION']">REG</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'SECT']">SEC</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'SQUAD']">SQD</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'SQDRNA']">SQ</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'SQDRNL']">SQ</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'TEAM']">TM</xsl:when>
                                        <xsl:when test="ORGANISATION-TYPE/GOVERNMENT-
ORGANISATION-TYPE/MILITARY-ORGANISATION-TYPE/UNIT-TYPE/unit-type-size-code/*
[local-name() = 'WING']">WG</xsl:when>
                                        <xsl:otherwise>U</xsl:otherwise>
                                    </xsl:choose>
                                </xsl:if>
                            </xsl:if>
                        </xsl:if>
                    </xsl:if>
                </xsl:if>
            </xsl:for-each>
        </xsl:element>
    </xsl:template>
    <xsl:template name="RelativeUnitLocation">
        <xsl:param name="UnitObjectItemID"/>
        <xsl:param name="UnitObjectItemLocationID"/>
        <xsl:element name="Present">
            <xsl:element name="Name">Current Loc</xsl:element>
            <xsl:for-each select="../../../OBJECT-ITEM-LOCATION">
                <xsl:variable name="ObjectItemLocationObjectItemID" select="object-item-id"/>
                <xsl:variable name="ObjectItemLocationLocationID" select="location-id"/>
                <xsl:for-each select="../../LOCATION">
                    <xsl:variable name="LocationID" select="location-id"/>
                    <xsl:if test="$UnitObjectItemID = $ObjectItemLocationObjectItemID">
                        <xsl:if test="$UnitObjectItemLocationID = $LocationID">
                            <xsl:element name="Latitude">
```

```
                                <xsl:value-of select="POINT/ABSOLUTE-POINT/absolute-point-
latitude-coordinate"/>
                            </xsl:element>
                            <xsl:element name="Longitude">
                                <xsl:value-of select="POINT/ABSOLUTE-POINT/absolute-point-
longitude-coordinate"/>
                            </xsl:element>
                        </xsl:if>
                    </xsl:if>
                </xsl:for-each>
            </xsl:for-each>
        </xsl:element>
    </xsl:template>
</xsl:stylesheet>
```

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APPENDIX D. C2IEDM TO UOB RESULT DOCUMENT

This is the result document generated when the XSLT in Appendix C was used on a sample C2IEDM source file (instance document). Due to the size of the source file it is not included here but is available upon request.


```
<?xml version="1.0" encoding="UTF-8"?>
<UOB>
    <ForceStructureInformation>
        <Name/>
        <FileName/>
        <Description>Unit document generated using XSLT on XML C2IEDM Ver 6.1
model</Description>
        <Purpose/>
        <CreatedBy>Transformation of C2IEDM Source File to the UOB Format</CreatedBy>
        <CreationDate>2004-04-15</CreationDate>
        <LastModifiedBy/>
        <LastModifiedDate>2004-08-10</LastModifiedDate>
    </ForceStructureInformation>
    <Units>
        <Unit UIC="" dataSource="">
            <Name>A 1/3 ACR</Name>
            <Present>
                <Name>Current Loc</Name>
                <Latitude>lat</Latitude>
                <Longitude>long</Longitude>
            </Present>
            <DescriptionCode>AAC</DescriptionCode>
            <LevelCode>CO</LevelCode>
            <Resource>
                <Personnel code="12C">
                    <Description/>
                    <Grade>03</Grade>
                    <Required>1</Required>
                    <Authorized>2</Authorized>
                </Personnel>
                <Personnel code="11B30">
                    <Description/>
                    <Grade>E6</Grade>
                    <Required>2</Required>
                    <Authorized>6</Authorized>
                </Personnel>
                <Equipment code="Linebacker">
                    <Description>Air-defence</Description>
                    <Required>6</Required>
                    <Authorized>9</Authorized>
                </Equipment>
                <Equipment code="M8 Alarm">
                    <Description>Automated biological detector</Description>
                    <Required>2</Required>
                    <Authorized>2</Authorized>
```

```xml
                </Equipment>
            </Resource>
        </Unit>
        <Unit UIC="" dataSource="">
            <Name>3rd Armored Cavalry Regiment</Name>
            <Present>
                <Name>Current Loc</Name>
                <Latitude>latit2</Latitude>
                <Longitude>long2</Longitude>
            </Present>
            <DescriptionCode>AAC</DescriptionCode>
            <LevelCode>RGT</LevelCode>
            <Resource>
                <Personnel code="92Y40">
                    <Description/>
                    <Grade>E7</Grade>
                    <Required>3</Required>
                    <Authorized>5</Authorized>
                </Personnel>
                <Personnel code="92Y10">
                    <Description/>
                    <Grade>E3</Grade>
                    <Required>1</Required>
                    <Authorized>3</Authorized>
                </Personnel>
                <Equipment code="M1098 HMMWV">
                    <Description>Ambulance</Description>
                    <Required>10</Required>
                    <Authorized>15</Authorized>
                </Equipment>
                <Equipment code="Avenger2">
                    <Description>Air-defence</Description>
                    <Required>3</Required>
                    <Authorized>2</Authorized>
                </Equipment>
            </Resource>
        </Unit>
    </Units>
</UOB>
```

APPENDIX E. AUTHOR-GENERATED XML SCHEMA FOR UOB

This document was created by the author using the XMLSPY IDE for XML authoring. The content for the schema is derived from the information in the UOB DAT and **is not** the UOB governing schema. The UOB governing schema is found in Appendix B. This schema was developed during the early stages of this research when the author was unable to extract the files necessary from the UOB version 7.4 Toolset. Version 7.7 corrected the extraction problems. This schema and the UOB DAT schema differ in the manner in which they restrict what data is allowed in many locations of the result document. The UOB version 7.7 schema is not as restrictive or directive as this schema.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:element name="UnitData">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="AdministrativeUnitInformation">
                    <xs:annotation>
                        <xs:documentation>
                        This is the information including the units size by the echelon it occupies, the
type of unit and its name or how it is refered to in formal military communications.
                        </xs:documentation>
                    </xs:annotation>
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="ParentUIC" type="xs:string"/>
                            <xs:element name="ParentUTC" type="xs:string"/>
                            <xs:element name="ParentULC" type="xs:string"/>
                            <xs:element name="SRC" type="xs:string"/>
                            <xs:element name="UnitUIC" type="xs:string"/>
                            <xs:element name="UnitName" type="xs:string"/>
                            <xs:element name="UnitTypeCode" type="xs:string"/>
                            <xs:element name="UnitLevelCode">
                                <xs:simpleType>
                                    <xs:restriction base="xs:string">
                                        <xs:enumeration value="SEC"/>
                                        <xs:enumeration value="SQD"/>
                                        <xs:enumeration value="PLT"/>
                                        <xs:enumeration value="HFT"/>
                                        <xs:enumeration value="TRP"/>
                                        <xs:enumeration value="CO"/>
                                        <xs:enumeration value="SQ"/>
                                        <xs:enumeration value="BN"/>
```

```xml
                    <xs:enumeration value="REG"/>
                    <xs:enumeration value="BDE"/>
                    <xs:enumeration value="DIV"/>
                    <xs:enumeration value="CPS"/>
                    <xs:enumeration value="A"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:element>
        <xs:element name="UnitDescriptionCode">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:enumeration value="AAC"/>
                    <xs:enumeration value="AAS"/>
                    <xs:enumeration value="AAV"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:element>
        <xs:element name="PresentLongitude" type="xs:string"/>
        <xs:element name="PresentLatitude" type="xs:string"/>
        <xs:element name="PresentLocationName" type="xs:string"/>
        <xs:element name="HomeLongitude" type="xs:string"/>
        <xs:element name="HomeLatitude" type="xs:string"/>
        <xs:element name="HomeLocationName" type="xs:string"/>
        <xs:element name="CountryCode" type="xs:string"/>
        <xs:element name="ShipCategory" type="xs:string" minOccurs="0"/>
        <xs:element name="ShipCategoryName" type="xs:string"
minOccurs="0"/>
        <xs:element name="ShipClass" type="xs:string" minOccurs="0"/>
        <xs:element name="ShipHullNumber" type="xs:integer" minOccurs="0"/>
        <xs:element name="Source" type="xs:string"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="Personnel" minOccurs="1" maxOccurs="unbounded">
    <xs:annotation>
      <xs:documentation>
      This is the information encoded from UOB.  It is broken down as it is
displayed in UOB and is currently configured for US Army units only.  Additional rules need to be
added to encompass all US and NATO units.</xs:documentation>
    </xs:annotation>
    <xs:complexType>
      <xs:sequence>
        <xs:element name="JobDescription" type="xs:string"/>
        <xs:element name="MilitaryOccupationSpecialityCode">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:pattern value="[0-9]{2}[A-Z]{1}([0-9]{2}|[0-9]{1}[A-Z]{1})"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:element>
        <xs:element name="MilitaryRank">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:enumeration value="PVT"/>
                    <xs:enumeration value="PV2"/>
                    <xs:enumeration value="PFC"/>
```

```
                        <xs:enumeration value="SPC"/>
                        <xs:enumeration value="SGT"/>
                        <xs:enumeration value="SSG"/>
                        <xs:enumeration value="SFC"/>
                        <xs:enumeration value="MSG"/>
                        <xs:enumeration value="1SG"/>
                        <xs:enumeration value="SGM"/>
                        <xs:enumeration value="CSM"/>
                        <xs:enumeration value="2LT"/>
                        <xs:enumeration value="1LT"/>
                        <xs:enumeration value="CPT"/>
                        <xs:enumeration value="MAJ"/>
                        <xs:enumeration value="LTC"/>
                        <xs:enumeration value="COL"/>
                        <xs:enumeration value="BG"/>
                        <xs:enumeration value="MG"/>
                        <xs:enumeration value="LTG"/>
                        <xs:enumeration value="GEN"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="MilitaryGrade">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="E1"/>
                        <xs:enumeration value="E2"/>
                        <xs:enumeration value="E3"/>
                        <xs:enumeration value="E4"/>
                        <xs:enumeration value="E5"/>
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                        <xs:enumeration value="E7"/>
                        <xs:enumeration value="E8"/>
                        <xs:enumeration value="E9"/>
                        <xs:enumeration value="O1"/>
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                        <xs:enumeration value="O5"/>
                        <xs:enumeration value="O6"/>
                        <xs:enumeration value="O7"/>
                        <xs:enumeration value="O8"/>
                        <xs:enumeration value="O9"/>
                        <xs:enumeration value="O10"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="NumberRequired" type="xs:nonNegativeInteger"/>
            <xs:element name="NumberAuthorized" type="xs:nonNegativeInteger"/>
            <xs:element name="NumberOnHand" type="xs:nonNegativeInteger"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="UnitEquipment" minOccurs="1" maxOccurs="unbounded">
    <xs:complexType>
        <xs:sequence>
            <xs:element name="EquipmentDescription" type="xs:string"/>
```

```xml
                            <xs:element name="EquipmentCode">
                                <xs:simpleType>
                                    <xs:restriction base="xs:string">
                                        <xs:pattern value="[A-Z]{1}[0-9]{5}"/>
                                    </xs:restriction>
                                </xs:simpleType>
                            </xs:element>
                            <xs:element name="NumberRequired" type="xs:nonNegativeInteger"/>
                            <xs:element name="NumberAuthorized" type="xs:nonNegativeInteger"/>
                            <xs:element name="EquipmentPiecesOnHand"
type="xs:nonNegativeInteger"/>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

APPENDIX F. AUTHOR-GENERATED EXAMPLE UNIT DOCUMENT

The following is a manually generated XML document describing A Troop 1st Squadron 3rd Armored Cavalry Regiment using Altova's XMLSPY Enterprise Edition 2004. All of the data in this document was taken from the UOB Client Version 7.4 data base. Element tags are based on the descriptions used in the UOB toolset. This document validates with the XML Schema in Appendix E but **is not an extracted file** from the UOB database. The file extracted and used to conduct the transformations described in Chapter V is located in Appendix B.


```xml
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="C:\Graduate Courses\Fall 04 Quarter\MV 3250
XML\GenericTransform.xsl"?>
<UnitData xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="UnitData.xsd">
    <AdministrativeUnitInformation>
        <ParentUIC>WG2LAA</ParentUIC>
        <ParentUTC>2YUTT</ParentUTC>
        <ParentULC>SQ</ParentULC>
        <SRC>17487L000</SRC>
        <UnitUIC>WG2LA0</UnitUIC>
        <UnitName>Squadron 3rd Armored Cavalry, A CAV TRP, CAV SQDN</UnitName>
        <UnitTypeCode>2</UnitTypeCode>
        <UnitLevelCode>TRP</UnitLevelCode>
        <UnitDescriptionCode>AAC</UnitDescriptionCode>
        <PresentLongitude/>
        <PresentLatitude/>
        <PresentLocationName>Iraq</PresentLocationName>
        <HomeLongitude/>
        <HomeLatitude/>
        <HomeLocationName>Colorado</HomeLocationName>
        <CountryCode>US</CountryCode>
        <Source>UOB</Source>
    </AdministrativeUnitInformation>
    <Personnel>
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        <MilitaryRank>PFC</MilitaryRank>
        <MilitaryGrade>E3</MilitaryGrade>
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        <NumberAuthorized>2</NumberAuthorized>
        <NumberOnHand>0</NumberOnHand>
    </Personnel>
    <Personnel>
        <JobDescription>Gunner</JobDescription>
        <MilitaryOccupationSpecialityCode>11C10</MilitaryOccupationSpecialityCode>
        <MilitaryRank>PFC</MilitaryRank>
```

```
    <MilitaryGrade>E4</MilitaryGrade>
    <NumberRequired>2</NumberRequired>
    <NumberAuthorized>2</NumberAuthorized>
    <NumberOnHand>0</NumberOnHand>
</Personnel>
<Personnel>
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    <MilitaryOccupationSpecialityCode>11C10</MilitaryOccupationSpecialityCode>
    <MilitaryRank>PFC</MilitaryRank>
    <MilitaryGrade>E4</MilitaryGrade>
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    <NumberAuthorized>2</NumberAuthorized>
    <NumberOnHand>0</NumberOnHand>
</Personnel>
<Personnel>
    <JobDescription>Squad Leader</JobDescription>
    <MilitaryOccupationSpecialityCode>11C30</MilitaryOccupationSpecialityCode>
    <MilitaryRank>SSG</MilitaryRank>
    <MilitaryGrade>E6</MilitaryGrade>
    <NumberRequired>2</NumberRequired>
    <NumberAuthorized>2</NumberAuthorized>
    <NumberOnHand>0</NumberOnHand>
</Personnel>
<Personnel>
    <JobDescription>Section Leader</JobDescription>
    <MilitaryOccupationSpecialityCode>11C40</MilitaryOccupationSpecialityCode>
    <MilitaryRank>SFC</MilitaryRank>
    <MilitaryGrade>E7</MilitaryGrade>
    <NumberRequired>1</NumberRequired>
    <NumberAuthorized>1</NumberAuthorized>
    <NumberOnHand>0</NumberOnHand>
</Personnel>
<Personnel>
    <JobDescription>Platoon Leader</JobDescription>
    <MilitaryOccupationSpecialityCode>12B00</MilitaryOccupationSpecialityCode>
    <MilitaryRank>2LT</MilitaryRank>
    <MilitaryGrade>O1</MilitaryGrade>
    <NumberRequired>2</NumberRequired>
    <NumberAuthorized>2</NumberAuthorized>
    <NumberOnHand>0</NumberOnHand>
</Personnel>
<Personnel>
    <JobDescription>Commander</JobDescription>
    <MilitaryOccupationSpecialityCode>12C00</MilitaryOccupationSpecialityCode>
    <MilitaryRank>CPT</MilitaryRank>
    <MilitaryGrade>O3</MilitaryGrade>
    <NumberRequired>1</NumberRequired>
    <NumberAuthorized>1</NumberAuthorized>
    <NumberOnHand>0</NumberOnHand>
</Personnel>
<Personnel>
    <JobDescription>Executive Officer</JobDescription>
    <MilitaryOccupationSpecialityCode>12B00</MilitaryOccupationSpecialityCode>
    <MilitaryRank>1LT</MilitaryRank>
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```

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<MilitaryGrade>E4</MilitaryGrade>
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<MilitaryRank>PFC</MilitaryRank>
<MilitaryGrade>E3</MilitaryGrade>
<NumberRequired>12</NumberRequired>
<NumberAuthorized>12</NumberAuthorized>
<NumberOnHand>0</NumberOnHand>
</Personnel>
<Personnel>
<JobDescription>CFV Driver</JobDescription>
<MilitaryOccupationSpecialityCode>19D10</MilitaryOccupationSpecialityCode>
<MilitaryRank>SPC</MilitaryRank>
<MilitaryGrade>E4</MilitaryGrade>
<NumberRequired>13</NumberRequired>
<NumberAuthorized>13</NumberAuthorized>
<NumberOnHand>0</NumberOnHand>
</Personnel>
<Personnel>
<JobDescription>Vehicle Driver</JobDescription>
<MilitaryOccupationSpecialityCode>19D10</MilitaryOccupationSpecialityCode>
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```xml
</Personnel>
<Personnel>
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    <MilitaryRank>SGT</MilitaryRank>
    <MilitaryGrade>E5</MilitaryGrade>
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    <NumberAuthorized>13</NumberAuthorized>
    <NumberOnHand>0</NumberOnHand>
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<Personnel>
    <JobDescription>Squad Leader</JobDescription>
    <MilitaryOccupationSpecialityCode>19D30</MilitaryOccupationSpecialityCode>
    <MilitaryRank>SSG</MilitaryRank>
    <MilitaryGrade>E6</MilitaryGrade>
    <NumberRequired>4</NumberRequired>
    <NumberAuthorized>4</NumberAuthorized>
    <NumberOnHand>0</NumberOnHand>
</Personnel>
<Personnel>
    <JobDescription>Section Leader</JobDescription>
    <MilitaryOccupationSpecialityCode>19D30</MilitaryOccupationSpecialityCode>
    <MilitaryRank>SSG</MilitaryRank>
    <MilitaryGrade>E6</MilitaryGrade>
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    <NumberAuthorized>4</NumberAuthorized>
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    <MilitaryOccupationSpecialityCode>19D40</MilitaryOccupationSpecialityCode>
    <MilitaryRank>SFC</MilitaryRank>
    <MilitaryGrade>E7</MilitaryGrade>
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    <NumberAuthorized>2</NumberAuthorized>
    <NumberOnHand>0</NumberOnHand>
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<Personnel>
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    <MilitaryRank>PFC</MilitaryRank>
    <MilitaryGrade>E3</MilitaryGrade>
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    <NumberAuthorized>9</NumberAuthorized>
    <NumberOnHand>0</NumberOnHand>
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<Personnel>
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    <MilitaryRank>SPC</MilitaryRank>
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```

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<NumberOnHand>0</NumberOnHand>
</Personnel>
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<JobDescription>Tank Commander/Master Gunner</JobDescription>
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<MilitaryGrade>E6</MilitaryGrade>
<NumberRequired>1</NumberRequired>
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<MilitaryGrade>E7</MilitaryGrade>
<NumberRequired>2</NumberRequired>
<NumberAuthorized>2</NumberAuthorized>
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</Personnel>
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<MilitaryRank>1SG</MilitaryRank>
<MilitaryGrade>E8</MilitaryGrade>
<NumberRequired>1</NumberRequired>
<NumberAuthorized>1</NumberAuthorized>
<NumberOnHand>0</NumberOnHand>
</Personnel>
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<JobDescription>M1 Tank Turret Mechanic</JobDescription>
<MilitaryOccupationSpecialityCode>45E10</MilitaryOccupationSpecialityCode>
<MilitaryRank>SPC</MilitaryRank>
<MilitaryGrade>E4</MilitaryGrade>
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<NumberAuthorized>1</NumberAuthorized>
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<MilitaryGrade>E5</MilitaryGrade>
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<NumberAuthorized>1</NumberAuthorized>
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<JobDescription>Equipment Rec/Parts Specialist (PLL Clerk)</JobDescription>
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<MilitaryRank>SPC</MilitaryRank>
<MilitaryGrade>E4</MilitaryGrade>
<NumberRequired>1</NumberRequired>
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<NumberOnHand>0</NumberOnHand>
</Personnel>
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<NumberOnHand>0</NumberOnHand>
</Personnel>
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<EquipmentCode>A10769</EquipmentCode>
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<NumberAuthorized>1</NumberAuthorized>
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</UnitEquipment>
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<EquipmentPiecesOnHand>0</EquipmentPiecesOnHand>
</UnitEquipment>
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