Title

A Case Study for the Naval Training Meta-FOM (NTMF):
Analyzing the Requirements from MAGTF FOM

Track

Modeling and Simulation

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Abstract

An analysis of a representative cross section of Naval simulation/stimulation & training systems highlighted that the battle-spaces represented in these systems differ in both content and resolution. These differences currently preclude Naval training systems from operating together in a meaningful way. In response, the Navy Modeling and Simulation Office (NAVMSMO) together with NAVSEA PMS430 has sponsored the development of a Naval Training Meta-Federation Object Model (FOM) (NTMF). The NTMF is being developed by inputs from the Navy M&S trainer experts in response to the DoD M&S vision of interoperability and consistency.

The NTMF is focused on providing the mechanism to deliver a synthetic battlespace representation that is interoperable and consistent for use by Navy and Marine Corps trainers. The NTMF will contribute to the DoD vision through interaction and communication between participating simulations/stimulations, and it will be the basis for the creation of a common synthetic battle-space representation.

This paper will begin with an overview of the NTMF. Next we will discuss recent developments within the Marine Air Ground Task Force (MAGTF) FOM. Lastly, we will analyze the MAGTF FOM requirements and their impact to the development of the NTMF, as well as additional topics for inclusion within the NTMF.

1 Overview of the NTMF

Recognizing the need for training devices, models and simulators to operate together at various levels of detail, fidelity, and resolution (and that the differences and similarities between simulations had to be understood before meaningful interoperability could be achieved) a diverse group of Government and Industry personnel met in December 1998 to explore the value of the interoperation of training devices. This diverse team consisted of representatives from a wide range of Navy air, surface and subsurface trainers as well as Marine Corps training systems. The objective of this group, the NTMF Working Group, was, and is to explore the utility and viability of creating a Naval Training Meta-FOM. The NTMF will capture the nature and characteristics of a common, shared simulation battlespace needed as the first step to enable meaningful interoperability of Naval Forces Category A trainers and simulators. This series of ad hoc meetings and working sessions, chaired by PMS430, focused and continues to focus on the development of the shared battlespace through the development of specific Use Cases using the Federation Development and Execution Process (FEDEP) and High Level Architecture (HLA) products as the underlying infrastructure.

An analysis of a representative cross section of Naval simulation/stimulation & training systems highlighted that the battlespaces represented in these systems differ in both content and resolution. These differences currently preclude Naval training systems from operating together in a meaningful way. As a result of this analysis, the most recent working group sessions have focused on the development of Use Cases consisting of a variety of trainers to address specific warfare scenarios, how to apply HLA concepts, tools, and processes to develop a means to enable the interoperability of Naval simulation/stimulation & training systems in a consistent manner. The NTMF process will provide a common battle space representation, and documentation allowing for interoperability and consistency between Naval simulation/stimulation & training systems.

In the January 1999 to July 2000 timeframe, a "questionnaire" developed by the NTMF Planning Group, was sent to 14 participating programs, spanning training Categories A, B, and C (Tiers 1-3). Questions were designed to gather information concerning the capabilities, structure, and status of the targeted trainers. The responses were used to help focus the initial Federation Object Model (FOM) development and to examine the potential to expand distributed training capabilities, by identifying the HLA requirements, programmatic requirements, and a battlespace representation. The NTMF Planning group (drawn from the Working Group) is in the process of restructuring and revising the questionnaire, and to refocus the questions to support the NTMF's current needs.

The objective of the NTMF Working Group has been to explore the utility and viability of creating a Naval Training Meta-FOM to capture the nature of the common, shared battle space as the first step to enabling meaningful interoperability. The NTMF Working/Planning Group's products to date include the Terms of Reference document, an NTMF Concept Paper, an analysis of the responses received from the fourteen programs that returned the completed questionnaire, a Project Plan, a 0.2 version of the FOM and a Use Case document. Currently the NTMF team is composed of a part time core team to implement the NTMF goals. The Core team, together with a Working Group (composed of DoD, Navy, Marine Corps and industrial representatives) meets on a quarterly basis to develop the NTMF products. The working group subject matter experts (SME) are assisting in the writing and reviewing of Use Cases as well as identifying data needed for the FOM development.

1.1 The Requirements for the NTMF

The NTMF initiative, in addition to developing a synthetic battle-space representation, addresses the need for compliance with the DoD High Level Architecture (HLA) to facilitate interoperability across Naval Training simulations/stimulations. The NTMF will provide a common battle space representation allowing for interoperability and consistency between Naval simulation/stimulation & training systems as well as their interface with *Command and Control systems* (Figure 1)

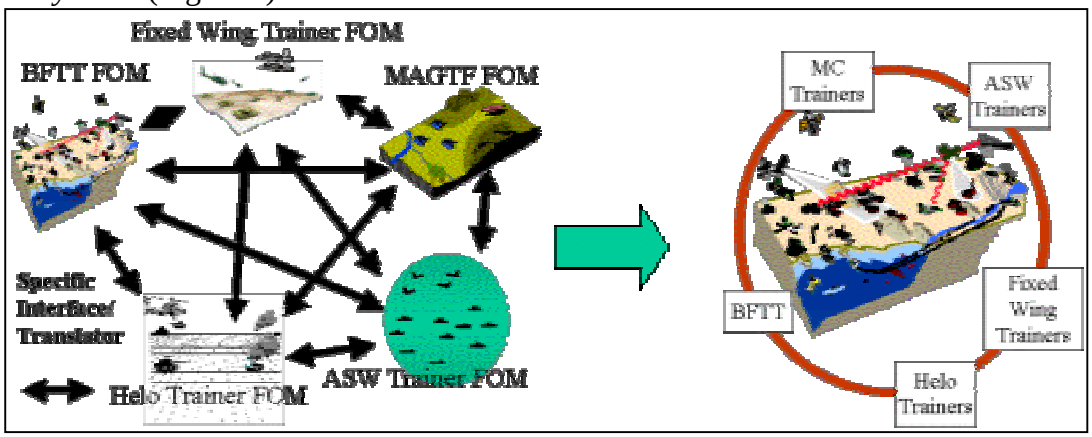

Figure 1: NTMF common battle space representation (on the right)

Three key overall requirements for Naval simulation/stimulation and training systems have been identified. These are:

- *The need for the Force to be able to train, as it will fight.* The NTMF, in following this philosophy, will increase training efficiency, and therefore, Naval warfare mission readiness and performance.
- *The need for a common synthetic battle space to ensure training systems and operators can interact in a meaningful way.* The NTMF will provide a venue for standardizing the representation of the mission space. This will also help to eliminate duplication of effort in recreating mission space elements (synthetic natural environment and battle space entities).
- *The need for simulation/stimulation & training (S&T) systems to evolve and change to match the evolution of Naval Forces, weapons systems, and threat.* S&T systems need to be able to evolve and adapt to warfare-related advancements quickly and without requiring changes to numerous trainers. The NTMF, by eliminating multiple interfaces to federations and federates, will facilitate this progress through the creation of and subscription to a standard lexicon, semantics, data dictionary, and taxonomy. Together these products will lead to a higher degree of interoperability among Naval Forces trainers.

Although the concept of an NTMF is extremely useful, there are challenging problems and hurdles to overcome. Constraints facing the NTMF initiative include the large numbers of existing legacy simulations/stimulations which have yet to achieve HLA compliance, the lack of fully specified and documented training requirements in the simulation domain, the lack of a central organization to facilitate ground rules development to achieve HLA-based training standardization, and the existing funding environment. As an example there are many legacy sonar trainers using different models and algorithms to simulate the same phenomenon. If these trainers are HLA compliant, and linked together, in a training federation, it is highly likely that the output from each trainer will differ due to different implementation of the environment and threat characteristics. If one trainer uses the Parabolic Equation while another uses the ASTRAL model and yet another uses the RAYMODE model to calculate transmission (propagation) loss, the detection range based on the "same" target characteristics will be quite different. While the trainers may be data interoperable, because they are HLA compliant, there is still a gap in understanding the differences between the predictions from the three trainers. The NTMF process will address these and other types of issues and bring the training and simulation community a step closer to meaningful interoperability.

1.2 NTMF Goals

The primary goal of the NTMF is to provide a means to facilitate meaningful interoperability of Naval simulation/stimulation & training systems in a consistent manner that supports stated training requirements and objectives. The NTMF will achieve this goal by meeting the following objectives:

- Provide a venue for standardizing the representation (a framework of understanding) of the Naval battlespace in the simulation domain. This includes the development of common understanding of the models, model inputs and outputs, required communications/interface among Naval training systems, and the development of a specification and format for the data that will be exchanged among training systems.

- Document this Naval battlespace.
- Provide a recommended process to be used for connecting Naval training simulations/stimulations together and for assessing the commonality and sufficiency of the battlespace representation.

Secondary goals and objectives of the NTMF include:

- Provide a path for facilitating inter-service interoperability through the evolution of the NTMF.
- Eliminate the duplication of effort in recreating the simulation battlespace by providing a standard battlespace representation that can be used, as a starting point, for new simulation/stimulations & training systems, pre-planned product improvements (P3Is), and updates to legacy systems.

1.3 NTMF Status

The NTMF is currently at version 0.2, and is based on the Real Time Platform Reference (RPR) FOM 2.0. The preliminary versions of the NTMF are designed to focus on five functional areas [1]:

- Scenario definition including the synthetic natural environment, platform initialization and order of battle planning. It is also using the Tactical Environmental Data Server (TEDS) as the basis for the environmental data in the FOM.
- Ground truth platform behaviors including maneuvers, expendables, weapons.
- Tactical and Intelligence information including platform tracks, areas of uncertainty, and queuing information.
- Tactical command and control of the virtual battle (has not been prototyped as yet).
- Exercise coordination including equipment status and recovery (also has not been prototyped yet).

The NTMF version 0.2 is available on the PMS430 web site www.pms430.com along with other NTMF material, including the NTMF draft Software Design Document [1]. In the rest of this paper we will discuss the issues associated with the potential integration of the MAGTF FOM with the NTMF, as well as additional areas that are being considered for inclusion in the NTMF.

2 Relationship Between NTMF And MAGTF FOM

Before proceeding with our discussion of the relationship between NTMF and MAGTF FOM, it is important to consider recent events occurring in the development of the MAGTF FOM [2]. The MAGTF FOM is currently supporting the Deployable Virtual Training Environment (DVTE) [3] program, and is derived from the RPR FOM 1.0. Specific changes are being planned to the RPR FOM 1.0 in order to realize the MAGTF FOM. The purpose is to make the RPR FOM more amenable to the types of training systems the Marine Corps will use.

From the NTMF perspective, these changes can be categorized as follows: operational and scenario specific changes, design changes, and special purpose changes. An example will best describe these three categories. It should be noted that the proposed MAGTF modifications are currently experimental up to this point, and may be subject to change.

Operational and scenario specific changes deal with how Marines deploy, organize, and how they conduct their operation. The former include the types of documents the Marines use

to exchange information and their command organizations, for example. The types of items included in the latter are more basic. For example, a weapon that's fired needs to have its trajectory, etc known to other simulations and/or simulators. The type of weapon may need to be known in order to simulate the blast characteristics. It's anticipated that the operational changes to the MAGTF FOM will be easily integrated into the NTMF. With regard to the scenario specific items, most of the elements from the RPR FOM are already defined for these kinds of events, and it appears that very little change needs to be made to the RPR FOM for this purpose, and no significant changes appear necessary to NTMF.

With regard to the design changes, several areas are being examined. Some of these areas include the enumeration scheme, aggregation and disaggregating, and simulation management, while others deal with reorganization of the RPR FOM class structure. These are a few examples, and additional changes can be found in [4]. These types of changes, which change the fundamental structure of the RPR FOM, may have a significant impact to the NTMF. For example, these changes being considered to RPR FOM in order to realize the MAGTF FOM are geared specifically to help Marine Corps training system, and may have consequences for Navy training systems.

With regard to special purpose changes, these include areas such as learning hooks (the ability to capture things such as blue-on-blue kills). Although it's not clear at this point the impact this will have to the MAGTF FOM. This area is important in that it has the potential to aid in the student-instructor learning process. This is currently being investigated within MAGTF FOM and a decision on this topic is pending.

One of the goals of NTMF is to incorporate the necessary changes from MAGTF FOM, since the NTMF is concerned not only with Navy systems, but also Marine Corps systems. However, since the scope of NTMF is much larger than MAGTF FOM, any design changes and/or special purposes changes made to NTMF must also take the requirement of these other systems into consideration. Addressing this issue is one of the primary objectives within the NTMF working group.

An important distinction between MAGTF FOM and NTMF lies in the version of RPR FOM that each is based on. The MAGTF FOM is based on RPR FOM version 1.0, whereas the NTMF will be based on version 2.0. This fact alone may void the decision to incorporate some of the designs from MAGTF FOM into NTMF, by the mere fact that RPR FOM version 2.0 already has those mechanisms in place.

Regular discussions continue between the developers of the MAGTF FOM and NTMF, in order to ensure that the necessary changes are made to the NTMF to support Marine Corps training.

3 Proposed Developments within NTMF

In addition to tracking the development of the MAGTF FOM, there are several other areas that have recently been the subject of inclusion within the NTMF. As a case in point, consider the DVTE program. One of the goals of the DVTE is to eventually provide Marine Corps training onboard an Amphibious Task Force (ATF) ship during embarkation. This training will encompass the spectrum of operations including amphibious landing. In order for the NTMF to provide the interoperability mechanism for these and related operations, specific additions are planned to the NTMF. These additions include the definition of the parameters that encompass ship-to-shore movement events, particularly OPTASK messages and communications oriented information.

3.1 Ship-to-Shore Movement

Ship to Shore movement [5] of an assault phase of an amphibious operation is the deployment of landing forces from assault shipping, to specific areas ashore. It's objective is to land troops, equipment and supplies at prescribed times and places. It is generally conducted through waterborne or helicopter borne means, or both. In order for the NTMF to support this kind of simulated operation, the NTMF working group is examining OPTASK messages and communications and their relevance to the NTMF.

3.1.1 Operational Tasking (OPTASK) Messages

Naval Operational Tasking (OPTASK) messages provide detailed procedural guidance for the conduct of operations within the specific warfare area. Worldwide and Navy OPTASKS give basic guidelines for battle groups in the development of specific warfare procedures. OPTASKS are issued before a battle group gets underway, and provided whenever a ship joins the battle group. OPTASK messages exist for the many warfare areas, but the one the NTMF group is initially interested in with regard to ship-to-shore movement is the OPTASK AMPHIB message. This message provides the amphibious task force commander (CATF) with the means to promulgate essential instructions and information for the amphibious operation. It contains such information as the naval gunfire schedule of fire, helicopter flight corridors, naval gunfire support zones, fire support area, helicopter landing zones, etc. The information contained in these messages generally emanate from the planning process.

The positive impact to training systems such as DVTE may be the ability to pass along control measures from various planning systems (e.g., important boundaries, areas, zones) to an AAR system, as well as also helicopter related information to aviation simulators. The inclusion of these types of parameters to the NTMF may impact a C4I gateway, as it is there that the parsing occurs before the information is interfaced to various simulations/simulators.

3.1.2 Communications

In simulators specifically designed for training, especially those that train in team warfighting, communications is very important. Most training systems ignore this aspect, and assume perfect communications, either through IP-based audio tools when the trainers must communicate, or assume perfect communications within the models that are used in the simulations. The ability to capture communications has been recognized within the NTMF working group as a critical need.

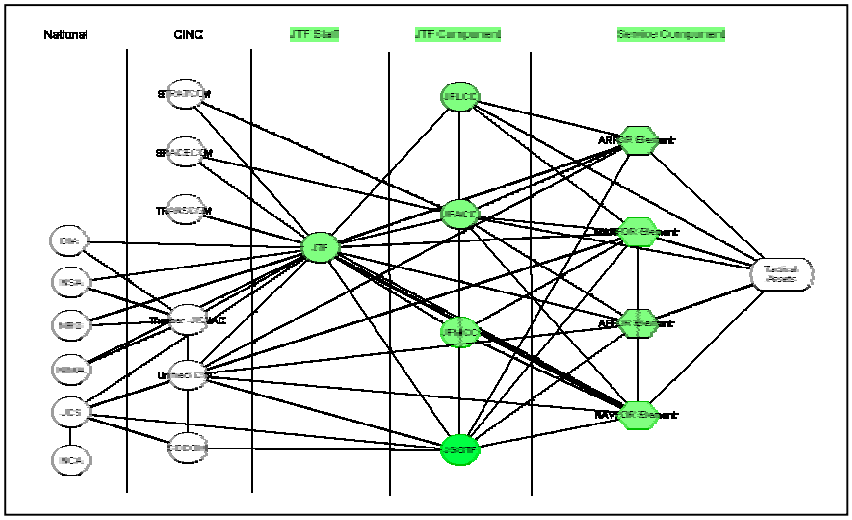

Figure 2: The Scope of NETWARS models and simulation (shaded)

Recently, the NTMF working group has begun outlining an approach for building communication threads into the NTMF. The developments within the Network Warfare Simulation (NETWARS) program [6] have set the foundation for this work. The NETWARS program has developed a joint communications modeling and analysis system, appropriately called NETWARS. The NETWARS toolkit is composed of a graphical front end, primarily used for scenario development, and a back-end simulation engine comprised of the OPNET simulation package [7]. The scope of NETWARS communication modeling & simulation is shown in Figure 2.

NETWARS has developed the concept of an Information Exchange Requirement (IER). An IER is defined as the communications exchange between two nodes. Contained in an IER are such attributes as size of exchange, type of exchange (voice, video, data), frequency of exchange, classification, perishability, producer equipment, sender equipment, producer task, consumer task, and network/link utilized. The IER is coupled with the equipment models and network models within NETWARS to simulate the communications traffic in the scenario. Figure 3 shows a small example of the many naval entities and their IER pathways

The Navy has recently developed a methodology for IER data collection, and has started to collect this data in support of the NETWARS communication studies [8]. This IER data is being housed in a relational database, from which NETWARS access the data as needed for the simulation.

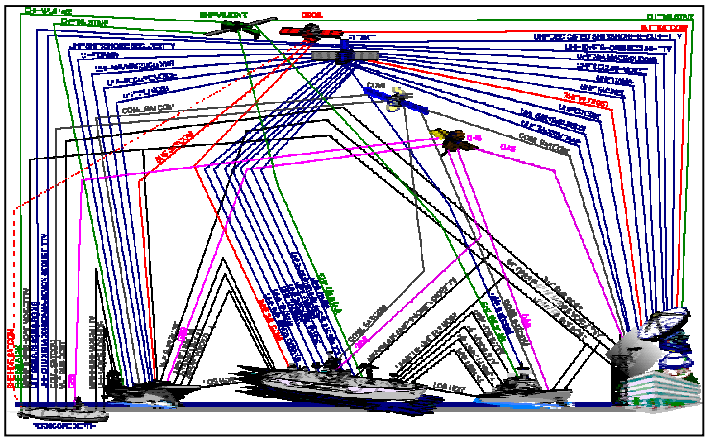

Figure 3: Naval Entity IER "Pathways"

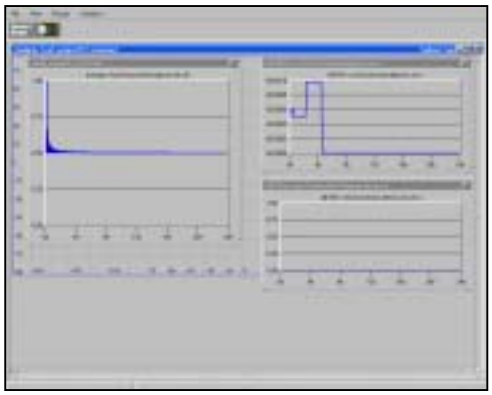

Figure 4: Results from NETWARS Simulation

The output of a NETWARS simulation provides measure of performance results such as IER attempts, Time to Live, failures, speed of service, link throughput, grade of service, message completion rate, message error rate, etc. Some statistics are shown in Figure 4 from an actual simulation run.

The idea is to build an IER structure, or its attributes, within the NTMF, so that in the future simulations such as NETWARS may interact with training simulators/simulations in order to provide realistic communications effects. This can also impact training systems that use IP-based audio to allow trainees to communicate. For example, integrating this IP-based audio traffic with NETWARS would impact whether the audio exchange occurs, is delayed, etc (as simulated by NETWARS). . One issue that might arise is the time delay within NETWARS to simulate the communication effect. Latency may impact the effectiveness of the overall simulation/simulator or training system.

Recent NETWARS developments include the ability to run over the HLA RTI, and whereas in the past only gathered aggregate statistics about IER's, is now able to take into

consideration individual IER statistics. This appears to have significantly impacted NETWARS capability; by allowing it to federate with other simulations and provide individual IER related effects to those simulations based on its underlying communications models.

At this point, it is unclear whether this would be useful for programs such as DVTE. In other words, does the inclusion of communications provide a benefit to the DVTE training system? However, the importance of communications modeling can be of value. For example, suppose Joint Semi Automated Forces (JSAF) is being used to model the behavior of certain entities in a simulation (pre-defined behaviors are built in). For the sake of discussion, we will not assume that training is involved. The behavior of the JSAF entities in reality should also depend on what the other entities are communicating with the entities in question and not just the inherent behavior built into the models. Rather than assuming perfect communication, the ability to add communications modeling may alter the behavior of the entities, thereby possibly changing the outcome of the simulation or alters the training experience. Whether NETWARS is chosen as the simulation to include in a federation requiring communications effects or not, the idea is that the IER structure is the de-facto standard for defining a communications exchange, and should be taken into consideration for future interoperability with these types of simulations.

It should be noted that the planned IER developments within the NTMF might impact the other warfare areas as well, and not just ship to shore movement.

4 Summary

We have discussed the motivation for the development of the NTMF, and are taking into consideration the developments within the MAGTF FOM. Since the goal of NTMF is to build the interoperability mechanism for Navy and Marine Corps training and simulation systems, the NTMF working group is examining the MAGTF FOM requirements for possible inclusion within NTMF. We have categorized these changes into those related to the operational environment; those related to design, and special purpose. Any changes adopted from the MAGTF FOM must also take into consideration how these changes will affect the systems that will use, or plan to use, the NTMF. Furthermore, the characteristics identified with OPTASK messages and communications are being investigated for possible inclusion within the NTMF.

5 References

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