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DEFENSE MODELING AND SIMULATION OFFICE: DEFINING THE INFRASTRUCTURE

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ABSTRACT

The continuing technology revolution has yielded dramatic new opportunities for the Department of Defense (DoD) in the area of modeling and simulation (M&S). Advances in the information sciences, including communication networks and high performance computer technology provides DoD the opportunity to effectively develop and mange this technology to prepare our forces for any military contingency. Recognizing this opportunity, the Deputy Secretary of Defense established the Defense Modeling and Simulation Office (DMSO) on June 21, 1991 to:

- Facilitate the application of M&S in education, training,and military operations; research and development; test and evaluation; analysis; and production and logistics disciplines.
- Assist in development of consistent DoD Component M&S plans.
- Establish a liaison process to coordinate and assist M&S efforts among DoD Components and the Defense industry.
- Foster cooperation among DoD Components to maximize M&S interoperability, eliminate duplicate development where possible, and promote high return on investment of advanced technologies.

In addition, DMSO coordinates the activities and implements the decisions of the Executive Council for Models and Simulations (EXCIMS), a senior level panel of DoD Component representatives.

In the process of creating a seamless, synthetic environment, an infrastructure is being designed and developed. The statements of need for ten infrastructure areas and the status of efforts to date in those areas are discussed.

1 PROBLEM STATEMENTS

1.1 Information Clearing House

There is a need within the M&S community, for improved communication and exchange of information. In accordance with the initial tasking, DMSO is to facilitate M&S information exchange among appropriate users. While there are many information systems already in existence, none are oriented to the support of the DoD M&S community with its specialized information requirements.

1.2 Standards

Although there are ongoing efforts in DoD to define a common base of information processing standards for use across DoD computing applications, there is a need for a core set of standards that are suitable across all applications. However, it is necessary to understand how the needs of the applications will influence the specification of the core set of standards and to determine if there are any unique standards required by the applications. M&S represent one major category of applications that must be addressed in this manner.

1.3 Architecture

Architecture provides a fundamental underpinning to support the ready interoperability, execution, and scaling of models and simulations. Several ongoing efforts address different aspects of the matter. Each of these efforts, however, define an architecture for its domain of applicability, not a common architecture. It is also necessary to develop and maintain an overview of M&S architecture as a whole. This overview is necessary to ensure that all relevant issues are being addressed, the appropriate interoperability between separate architectural efforts is being established, and unnecessary redundant activity is minimized.

1.4 Network

The current goal for the synthetic environment is the development of simulation network, the Defense Simulation Internet (DSI). Important for the near-term development of the DSI is the enhancement of the current facilities and the expansion of the existing facilities and capabilities to handle the increasing number of users and amount of traffic by the users on

the DSI.

1.5 Instrumentation

Live exercises for training and testing are simulations of actual combat. However, the program offices which are developing the instrumentation systems for supporting the live simulations do not typically have a requirement to develop interoperabilities with the instrumentation systems of other Services or with the other simulation classes, virtual and constructive. It is necessary to demonstrate the feasibility and utility of such interoperabilities and standards to prove and promote the concepts and vision of internetting training ranges. A major concern is that emerging instrumentation systems are likely to remain single Service oriented and the interoperability will have to be reverse engineered.

1.6 Command, Control, Communication, and Intelligence (C3I)

One of the primary needs of the simulation community is the ability to address the acquisition (Research, Development, Test and Evaluation), training, and analysis issues associated with C3I. The interest in this area is focused on bringing appropriate members of the Defense community, industry, and academia together to identify issues and develop plans to effectively and efficiently address the linkage of simulations to real world C3I systems and/or the representation of those C3I systems in simulations to include virtual, constructive, and live play.

1.7 Security

To ensure that key Defense agencies responsible for the development and management of security related systems and devices are aware of primary DoD M&S community programs, plans, and objectives, a baseline assessment of current efforts in the DoD is needed to provide appropriate systems and devices that will enable the M&S community to operate in a secure distributed environment. The assessment needs to (a) address information security policies, concepts of operations, and environments of use; (b) identify issues; and (c) provide recommendations with respect to policy requirements and technical solutions involving software, hardware, networks, data base management systems, data, personnel, and facilities in a highly distributed simulation environment; and emphasizing the interoperability among real exercises and systems, virtual simulations and constructive simulations.

1.8 Behavioral Representation in Automated Forces

Efforts in the DoD community to develop Automated Forces (AFOR) capabilities have expanded significantly even though there is no explicit statement of functional specifications regarding what AFOR are or how they will be used. Similarly, there is limited understanding about how the flexible and realistic military behaviors envisioned for AFOR might build on and/or enhance existing capabilities in constructive combat models.

1.9 Automated Forces Testbed

Significant DoD resources are being spent to develop and field large simulations of computer controlled warfighting surrogates, or Automated Forces (AFOR), with flexible and realistic military behaviors. It is critical that a coordinated approach be taken by the community in designing, and implementing such capabilities to ensure that (a) economics of scale are quickly realized, (b) maximum application of available applicable technologies is achieved, (c) limited research resources are used optimally, and that (d) joint-service interoperability is achieved.

1.10 Verification, Validation, and Accreditation (VV&A)

While there is beginning to be some accepted agreements on the definitions, processes, and decisions associated with Verification and Validation & Accreditation (VV&A) of M&S, there are two major concerns that need to be addressed for distributed M&S systems: (a) identify which industry, Service, and academic group/agency should address particular VV&A problems and (b) what is the VV&A process (documentation and configuration control) to ensure effective interconnection of several models and simulations, geographically and physically separated that have been individually validated, verified, and accredited.

2 APPROACH

2.1 Information Clearing House

Based on the information and communications needs of the M&S community, an information analysis center is being established to provide scientific and technical information and support services, and an on-line information system is being developed to provide users with access to catalogs of models and simulations,

M&S related policy and standards documents, and access to remote sources of M&S information.

2.2 Standards

To determine how and what standards are necessary for the synthetic environment, it is necessary to: (a) develop an overview of M&S standards needs by reviewing M&S applications and architectural development efforts; (b) track the activities of the major standards activities to ensure that M&S needs are being considered and review the standards to ensure they do not impose any undue limitations on M&S applications; (c) identify those areas where M&S needs may be more advanced than those of other information processing applications and hence where community-wide standards efforts might not be addressing M&S needs; and (d) participate in standards bodies to assist in the design of existing, proposed, or new standards to meet M&S needs.

2.3 Architecture

To establish the architecture for the synthetic environment, it is necessary to: (a) develop a conceptual framework specifying the overall architecture in terms of its structure, interfaces, and the services it must provide within the general context in which models and simulations are developed and used; (b) monitor the activities of the major efforts developing architectural components; (c) conduct workshops to get broad community input on architectural concepts, drawing both on modeling and simulation developers and practitioners as well as the technical community; and (d) recruit academic/industrial organizations to conduct research on relevant architectural needs where further conceptual development is identified by the workshop.

2.4 Network

For the development of DSI, the existing protocol implementation of Internet Stream (ST) has to be enhanced. The original implementation does not support full dynamic routing and will need to be completed in order to provide robust capabilities across the DSI. In addition, since the current backbone is near the limit of its capacity, it is important to acquire Asynchronous Transfer Mode (ATM) interfaces. An interim approach would be to acquire ATM switches with multiple T1 interfaces and evolve to T3 interfaces as the additional capacity is needed. The second step for handling network growth is to fund the development of a nonproprietary protocol to provide ST type functionality over ATM on multiple commercial platforms. The protocol may be ST, but standardization of this functionality is still evolving. Intelligent gateways can also be used to manage growth by filtering messages to send them only to other simulated entities that require these messages.

2.5 Instrumentation

A three-pronged approach for instrumentation includes: (a) develop or modify models to become standards for joint, real-time, air-to-ground, air-to-air, and ground-to-air casualty assessments that have acceptance by all Services; (b) reduce significantly, data transmission rates so that the radio-frequency networks used by the instrumentation systems can handle the data requirements; and (c) demonstrate feasibility of coupling the National Training Center, Nellis Air Force Base and Fallon Air Force Base with the Joint Task Force Command, Control, and Communication system to develop interoperabilities between these ranges.

2.6 Command, Control, Communication, and Intelligence (C3I)

The major approach for C3I will involve the sponsoring of a C3I Infrastructure Working Group to bring key government agencies (e.g., Joint Staff, CECOM, ASD for C3I, etc.) together on a regular basis to discuss plans, share information, identify issues and provide input to the Defense M&S master plan and develop recommendations specific to the linkage and representation of C3I in simulation environments of the future.

2.7 Security

For security, a task force comprised of representatives of the Functional Working Groups, Technology Working Groups, will work to bring key agencies from the DoD together to discuss the various issues associated with the operation of secure networks. The task force will identify key personnel from the M&S community and security community together and provide an appropriate forum to address this problem.

2.8 Behavioral Representation in Automated Forces

For AFOR there are interoperability concerns arising from the use of computer-controlled warfighter surrogates in simulations. The term Automated Forces is intended to include simulations of platform and crew-level entities as well as models of command posts and higher level aggregate entities. Therefore, the

approach will be to survey technical approaches used in the development of Automated Forces programs. This survey will produce a list of attributes and characteristics of each approach and identify appropriate techniques for the behavioral representation of AFOR. Specific issues to be addressed include: development and documentation of functional specifications; tools to support software design and development; configuration management; verification, validation and accreditation; supporting data; and scalability.

2.9 Automated Forces Testbed

In support of the AFOR behavioral representation infrastructure, the need to establish an AFOR testbed will be addressed. Such a testbed should: (a) facilitate in-depth technical exchange across organizational and service boundaries; (b) promote the collection and dissemination of relevant information and expertise to the AFOR community; and (c) conduct hands-on assessment and analysis of those methods and technologies.

2.10 Verification, Validation, and Accreditation (VV&A)

The proposed approach will: (a) review the VV&A and/or equivalent activities that have been implemented within (i) DoD (current VV&A procedures being used for some M&S), (ii) industry (e.g., banking, telecommunications, financial auditing), (iii) software (e.g., Software Engineering Institute's maturity process, validation and verification procedures in selected industries), and (iv) equivalent mathematical and related theories; (b) define a set of process options to address the needs of VV&A and determine a means to order those options; (c) develop a consensus among the various communities of the most likely processes which should satisfy the defined needs (These needs may include better support tools, e.g., CASE, manuals, and case histories of M&S interconnections); and (d) define the various aspects of necessary DoD policy that need to be changed or developed.

3. CURRENT STATUS

While efforts have been initiated to establish task forces in each of the ten areas, work has progressed in six of the ten infrastructure areas.

3.1 Information Clearing House

The University of Central Florida's Institute for Simulation and Training (IST) is now affiliated with the Tactical Warfare Simulation and Technology Information Analysis Center (TWSTIAC) program. In TWSTIAC, IST has the technical initiative and leadership for simulation technology. The purpose of TWSTIAC is to provide access to databases containing documents, pictures, and other material dealing with the technologies and research related to M&S. The TWSTIAC will apply scientific, engineering, M&S, and acquisition disciplines to support the operational needs of the DoD, civilian agencies, and other users in distributed interactive simulation.

The Defense Modeling and Simulation Information System became operational in June 1993. The Defense Modeling and Simulation Information System provides: (a) access to the available service catalogs on models and simulations; (b) information on recent modeling and simulation activities, e.g., conferences and working group meetings; (c) a modeling and simulation glossary; (d) electronic mail; (e) access to news groups; and (f) access to the internet.

3.2 Standards

The infrastructure task force on standards will facilitate the identification, establishment, acceptance, and implementation of standards, protocols, and other appropriate mechanism to promote efficient and effective interoperability, open systems, and the reusability of hardware, software, and data for M&S applications. These standards, protocols, and other mechanisms will be consistent with and build upon current national, federal, DoD, and, where practical, international standards.

The overall goals of the task force are: (a) define, evaluate, and recommend appropriate DMSO investment and policy strategies for M&S standards and standardization efforts; (b) identify and document unaddressed, broad-based standards and standardization needs and requirements of current and future M&S customers; (c) provide the initial focal point, as well as consensus building and proactive advice and leadership, for M&S standards and standard related matters to other DMSO infrastructure task force teams, thrust leaders, and program managers; (d) provide and support the broadest dissemination of information to M&S customers on standards and standard related matters; and (e) serve as monitors and catalysts for DoD interests in national and international standards bodies.

3.3 Network

The network task force will: (a) examine network infrastructure needs for M&S and recommend

to DMSO products, processes, and projects to address network shortfalls; (b) focus on wide area network services and capacity growth requirements and impact of transition to fee-for-service; (c) identify transition and integration model/roadmap for the distributed networking environment; (d) identify the community served by the network; and (e) facilitate policy, standards, and consensus building relating to networks, and synergy with the distributed interactive simulation protocol development.

3.4 Instrumentation

The instrumentation task force has found that existing instrumentation systems do not interoperate with each other (lack of standards, high update rates, limited bandwidth, and small number of players) and existing IEEE 1278 defined protocol units use too many bits per entity state and are difficult to use over radio-frequency links. The issues that the task force intends to focus on include: radio-frequency bandwidth, latency, lack of all entity data with field instrumentation, data minimization techniques, joint casualty assessments, and gateways for existing and emerging instrumentation systems.

3.5 Behavioral Representation in Automated Forces

The behavioral representation task force has focused on the need for the development of a taxonomy of human behavioral variables in M&S applications. The process for developing AFORs that adequately represent human behavior, whether considered individually or as teams, requires: (a) understanding the purpose (is it for training, analysis, and/or evaluation), mission (what type is it, e.g., combat, relief, etc.), environment (what effect will external factors have, e.g., weather, type of threat, etc.), level of resolution (what will the focus be, e.g., an individual or a larger entity, e.g., crew, brigade, etc.), and level of fidelity (how much human representaion is necessary, e.g., effects of individual mannerisms may be important when representing an individual or squad that may be unnecessary in larger size units) of the particular M&S application, (b) selecting the independent variables that define changes in the application scenario, (c) applying appropriate behavioral representation criteria (criticality, availability of data, technical feasibility, development time, and cost) to the selected application, (d) introducing the behaviors (sensory and perceptual; physical and motor; cognitive and attention; social and communication; psychological and emotional) into the AFOR, and (e) evaluating the performance of the AFOR in accordance with measures derived from the purpose of the simulation and the mission to be accomplished.

3.6 Automated Forces Testbed

The AFOR testbed concept is intended to be the hands-on component of the AFOR behavioral representation effort. The AFOR testbed task force will provide a forum for users and developers to consider AFOR issues from a broad DoD perspective. The task force will help coordinate a community-wide effort to identify common functionality across AFOR implementations, develop a set of requirements for building AFOR models, produce a capstone AFOR architecture, achieve increased AFOR functionality, and facilitate more effective use of AFOR technology in applications.

One of the most crucial infrastructure needs for the AFOR community, as identified in the SAFOR survey, is the need for a structured mechanism to involve potential end-users in the AFOR development process. Two AFOR testbeds are proposed as the initial mechanism. The Systems Engineering Testbed will facilitate the coordinated development of advanced AFOR systems, methods, and algorithms to meet the near-term and long-term needs of the DoD community. Specific areas to be addressed include: architecture development, technology coordination, methodological development, and information sharing. The User Testbed will (a) provide a means for describing AFOR capabilities and address AFOR requirements throughout the DoD, (b) permit assessments of AFOR systems that compare user requirements with capabilities, and (c) document and disseminate findings on deficiencies and user developed methods, solutions, and recommendations.

AUTHOR BIOGRAPHY

ROBERT J. SMILLIE is currently on long-term assignment to the Defense Modeling and Simulation Office. In that role, he is responsible for determining how virtual reality research will effect modeling and simulation applications in DoD. He is also concerned with what aspects of behavior in models and simulations are related to human performance. When not at DMSO, he is a scientist with the Human Factors Engineering Branch of the RDT&E Division of the Naval Command, Control, and Ocean Surveillance Center in San Diego, California. He received his Ph.D. in human factors/psychology from North Carolina State University in 1977. His research interests include information design and automated delivery of technical information.