Technical Evaluation Report –
RTO-MP-MSG-028 Conference on
Modelling and Simulation to Address NATO's
New and Existing Military Requirements

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OVERVIEW

The NATO Modelling and Simulation Group (NMSG) Conference (MSG-022) "Modelling and Simulation to Address NATO's New and Existing Military Requirements" was conducted in Koblenz, Germany from 7 to 8 October 2004. All sessions of the Conference were unclassified. The Conference audience of more than 100 persons included experts from NATO countries, Partners-for-Peace (PfP) nations, as well as invited nations.

Out of the 34 submitted abstracts, 15 Papers were selected for presentation. In addition to three invited papers, three keynote presentations and one capstone presentation were given. This technical evaluation report summarizes the core ideas and results presented in this wide variety of valuable contributions from NATO countries, PfP nations, and invited nations. In addition, for each category, the report provides an overview of the discussions conducted during the conference following each presentation.

INTRODUCTION

NATO is in the process of radical change through the NATO Transformation process and the development of new military requirements without neglected the existing ones. From a broad NATO perspective, the emphasis is on collaborative efforts to improve joint, combined capabilities. Two strategic commands, one operational (Allied Command Operations, ACO, located in Brussels, Belgium), and one functional (Allied Command Transformation, ACT, located in Norfolk, Virginia, United States) have been recently established. The second, functional strategic command ACT is responsible for the continuing transformation of military capabilities and for promoting interoperability of proposed implementations. Modelling and Simulation (M&S) has been recognised within NATO as a key element in addressing these new requirements and challenges of the NATO Transformation process. This year's conference was planned to focus on the ways in which Modelling and Simulation can address these new requirements and challenges and assist in the NATO Transformation process without neglecting the existing military requirements. To this end, the conference was designed to provide attendees a forum to advance M&S in the Alliance. The combination of M&S users and developers concentrated in this one forum educated attendees, and also provided fresh ideas for the furtherance of NATO M&S in addressing NATO's New and Existing Military Requirements.

The Call-for-Papers for this Conference asked for presentations focusing on how M&S can address:

- Support to the NATO Response Force,

- The use, development and employment of M&S in Military Exercising, Training and Decision Support, to include impact assessments and lessons-learned,

- Network Centric Warfare,

- Defence against Terrorism.

In addition, the conference addressed the more general themes of research, development, M&S-related standards activities and cost-effective application of M&S. The resulting paper submissions showed a slightly different spectrum of covered topics, emphasising the topics chosen as the final structure of the workshop, namely;

- Decision Support Tools to support NATO Operations using M&S Functionality

- Joint Training integrating Operational Systems and M&S Functionality

- Development of New Concepts utilizing M&S Functionality

- Integration of New Technology, in particular establishing common frameworks based on open standards, and

- Response to New Threats.

In all contributions, M&S functionality is seen as a key enabler to address NATO's new and existing military requirements. Commercial information technique (IT) can contribute tremendously for integration, but is only necessary, not sufficient. NATO's military expertise is essential in the M&S field as bridges between military requirements and technical solutions are needed, in particular, because the role of M&S in future analysis, operations, training and experimentation is likely to increase. In principle, the Keynote speakers supported this perspective:

- Mr. Harald Stein, Vice President of the German Procurement Agency, pointed out that M&S is already supporting all levels of training and will do the same for support to operations, in particular course of action analysis, and experimentation. The evaluation of necessary NATO transformation, in particular the analysis of highly complex military operations, will require new and existing M&S applications from all nations.

- Rear Admiral Xavier Païtard, Head of the French Military Mission to the Supreme Allied Commander Transformation and Deputy Assistant Chief of Staff, Future Capabilities, Research & Technology (DACOS FCRT), set the frame in which NATO Transformation has to be seen. Although NATO's ACT and the United States Joint Forces Command (JFCOM) are working hand in hand on transformation, the interpretation of this term within NATO and the United States is slightly different. NATO's transformation goals are to achieve decision superiority within the alliance, to be able to reach coherent effects on all levels of NATO operations and to enable and facilitate joint deployment and sustainment. To this end, NATO categorises its efforts into five transformation objective areas, namely Information Superiority & Net Enabled Capabilities, Effective Engagement & Joint Manoeuvres, Effective Civil-Military Cooperation (CIMIC), Expeditionary Operations and Integrated Logistics. Future M&S must support the analyses and evaluation of all processes, in particular the decision making process, the information flow and specific effects, including but not limited to traditional military effects.

  Admiral Païtard stressed that the NATO staff proposes solutions for the nations and that these recommendations are not necessarily mandatory. However, M&S can be used to communicate the desired effects of a proposed solution to the various procuring nations in order to align the national efforts effectively. The NATO Response Force will be the testbed to validate new

concepts. M&S support builds the core of many efforts in this direction by embedding reliable answers and realistic representations into future models and applicable M&S functionality.

• Dr. Jürgen Geisler, leading scientist at the German Frauenhofer Institut (FHI), showed M&S as a key technology and major methodology in the context of NATO transformation. His main topic was the necessity to use a holistic approach of M&S supporting the lifecycle of a product on all scale, i.e., from the atomic scale up to the product environment. Commercial solutions, such as web services or the Model Driven Architecture (MDA) of the Object Model Group (OMG) may not be 100% solutions for M&S challenges, but they prove to be 80% core solutions with potential to be extended to fulfil the special needs of the M&S community. His recommendation was to focus on the necessary 20% add-ons instead of trying to come up with a 100% self-made solution. In particular, in the NATO context the use of commercially viable and open frameworks, such as proposed by the Extensible M&S Framework (XMSF) initiative mentioned in several papers was seen to be an interesting option.

Papers in these proceedings accompany the keynote and invited presentations. All presentations proved to be valuable and will support the decision process within NATO on how to support M&S. Within the following sections, the core ideas and discussion results are grouped by the topics used to structure the conference. The paper numbers in these proceedings will be used as references to the papers, i.e., paper 4 is the paper on "M&S in Decision Support for Course of Action Analysis, APLET", etc.

This technical evaluation report does not intended to recite paper abstracts or give pure summaries, but to show the general developments and common ideas allowing the analyses of trends within NATO/PfP nations and other invited nations. To this end, discussion points, recommendations made during or after the presentation, and everything else of interest to the NATO M&S community is contained within the section.

INVITED PAPERS

The first invited paper was given by Mr. C. Wright of NATO/ACT and set the stage for many recommendations concerning the use of M&S for transformation. The focus of NATO M&S currently shifts towards operations in urban areas, which requires new areas of competence to accomplish such missions. One of the main challenges still is the necessary paradigm shift from attrition centric to manoeuvre centric models. Another main challenge is to deal with the various and not necessarily hierarchically organised multiple relations between Net Enabled Capabilities. M&S must facilitate the alignment and orchestration of operational elements. One of the most urgent tasks is the derivation of detailed solutions on the component level to facilitate the effective communication of capability descriptions for procuring agencies, i.e., force proposals and recommended solutions of the NATO staff to the nations. Generally, the procurement analysis is shifting from gap-analysis driven procurement to operational concepts analysis driving the development of necessary capabilities. The same or related models are currently used to support ongoing operations. Questions such as "How many systems are on the road, how many will be available in the operations area within the next eight hours?" are currently answered using M&S functionality in NATO operations in Bosnia-Herzegovina and Afghanistan. In parallel, NATO exercises such as the upcoming M&S event "First Wave" (Fall 2004) set new standard for distributed training of NATO forces. Within "First Wave", a number of sites from the seven nations participating will support real-time networked Air Operations Training. This event is co-sponsored by NMSG and the Studies, Analysis and Simulation (SAS) panel, which in itself is an example of future cooperation.

An example of a possible new generation of M&S tools is presented in paper 2. M&S must support the operational planning process of NATO in a way, that current operations and counter operations in new ongoing operations can be evaluated, such as counter moral operations, access operations, precision

strikes, counter protection operations, information operations, etc. It is furthermore of particular interest to include such operations in the operational training. NATO is currently using the "Zoran Sea" scenario, a fictitious scenario described in more detail in paper 2 and also referred to in paper 6.

Practical experiences showed that the search for a universal tool applicable to all sorts of analysis and training needs is likely to be unsuccessful. The NATO M&S Master Plan[1] consequently asked for federations of aligned and orchestrated tools supporting the warfighter. The NATO Code of Best Practise for Command and Control Assessment (NCOBP)[2] gives the same recommendation. Although the solution proposed in paper 2 does not fulfil all recommendations, the model GAMMA presented in paper 2 is without doubt a future application example. GAMMA makes extensive use of software agent technology and is relatively open to extensions; however, solutions must be migrated into the GAMMA framework and cannot be federated with the system. On the requirement side, the following incidents can be evaluated: kidnapping of high valued foreigners, murder, riots and similar events often observable in real operations. The trainee can react in the form of intensified patrols, more discussions within CIMIC operations, etc. The consequent application of object-oriented technology in conjunction with the object-agent-structure supported by the underlying development system Delphi permits new modules to be integrated easily. Although GAMMA is an open system, it may not qualify as a framework for the integration for national solutions and real world IT systems – in particular Command and Control information systems – is not handled through a common infrastructure, but via the interface and/or re-implementation concept. The concepts developed by GAMMA will contribute to the definition of a system-of-systems framework necessary for the next generation of NATO M&S systems.

The mandate to connect M&S and operational needs to support the "train as you fight, fight as you train" philosophy provided the core of the message delivered by paper 3, presenting the Joint National Training Capability (JNTC) of the United States as the cornerstone for US Training Transformation. The United States observed over the recent years that many operational requirements observed in their operations (such as Afghanistan) was not part of the training, and that many requirements focused on during training were never used within the operations. JNTC is designed to close the observed gaps by targeting a global network of live, virtual and constructive components proving a seamless synthetic environment that supports a broad spectrum of joint and training requirements. One core idea of JNTC is the reuse of existing M&S components and supporting organisations by migrating useful solutions and integrating them into JNTC. Although JNTC is a national effort of the United States, the applicability for joint and combined training is mandatory, as it is very unlikely that one NATO nation will conduct military operations completely isolated from the other partners in the alliance. Another reason to evaluate the JNTC concepts regarding lessons learned for NATO support is the organisational constraint that JNTC must use exercises of the services (Army, Navy, Air Force, Marines) as joint exercise resources are limited. Instead of designing its own events, JNTC uses service exercises and adds a joint context to the event; potentially merging two service exercises into one joint event. This idea is definitely applicable in the NATO context to add the combined component to national exercises.

DECISION SUPPORT TOOLS

Paper 4 presented a topic, which was reformulated by later papers several times. The French M&S effort APLET (Aide à la Planification d'Engagement Tactique terrestre) demonstrates the use of M&S functionality for tactical decision-making, using the example of course-of-action analysis on brigade headquarter level. In order to be applicable to fulfil this military requirement, M&S must be robust,

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[1] North Atlantic Treaty Organisation (1998). NATO Modelling and Simulation Master Plan. NATO Document AC/323 (SGMS)D/2

[2] North Atlantic Treaty Organisation (2002). NATO Code of Best Practise for C2 Assessment (Revised 2002). Research & Technology Agency (RTA) Studies, Analysis and Simulation (SAS) Panel. NATO Document RTO-TR-081

reliable, fast and easy to use. The timeframe of the brigade decision-making process are particularly challenging requiring constructive simulation in order to support many repetitions and effective use without too much personal involved in the simulation application. Paper 1 furthermore distinguished between two main parts in order to enable the use of M&S functionality to support real operations: (a) technical interoperability deals with the technical information exchange between C3I and M&S systems; (b) conceptual interoperability is based on validity of the implemented support.

To facilitate the coupling of the Command and Control infrastructure with the simulation functionality, in other words to insure technical interoperability, APLET followed the recommendation given in the NATO M&S Conference proceedings[3] of 2003. In order to facilitate the information exchange, the use of the Command and Control Information Exchange Data Model (C2IEDM) was recommended. C2IEDM is also used in the Multilateral Interoperability Programme (MIP) of NATO to couple command and control information systems. The same approach was recommended in papers 1, 7, 8, 12 and 13 and was implicitly recommended by paper 10 as well.

Although not immediately connected with decision support, paper 5 introduced new technology capabilities supporting decision support in the granularity needed for urban operations, precision strikes and similar ideas: new sensor modelling technologies and data processing examples. The technology presented in paper 5 is ready to be used to generate the necessary high-resolution environment necessary for C3I and M&S systems. Although the solution presented is proprietary, the adaptation of applicable open standards, such as SEDRIS[4], is feasible and would contribute to a better use within NATO.

A new approach to support the application of M&S functionality for mission analyses is presented in paper 6. The key question answered in the presentation is "What capabilities will be needed in future missions?" As new factors, very often not obviously connected to military operations, the paper identifies among others the following: perception of intention, shades of hostility and collateral damage effects. In particular, when analysing the effects of own alternatives within the perceptions of hostile – but also allied forces – this new idea then becomes crucial. It is shown that threat perception is more critical to the decision making process than the real threat. In order to support this sort of analysis, the model must become aware of the perception of all participating parties. Paper 6 presents a future directed prototype allowing scenario descriptions comprising conflicting rules and perceptions; in other words: the models allow the user to see the situation unfold through the eyes of culturally different allies or even through the eyes of potential enemies. Application domains of the new approach with the "Zoran Sea" scenario can be easily mapped to real world challenges coping with anti terrorist warfare and effect based operations in culturally different environments.

In summary, support to operations already is reality in NATO. New technologies and techniques have to be improved to make the use of M&S functionality safe and efficient for the military user.

JOINT TRAINING

Originally it was planned to present an update on a high-level study addressing a way forward following the termination of the United States efforts on the Joint Simulation System (JSIMS). Due to the fact that the US Congress had not been officially briefed on the results of this study, the presentation was postponed for this conference. However, US representatives agreed to present an update on JSIMS and usable components as soon as possible.

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[3] North Atlantic Treaty Organisation (2003). C3I and M&S Interoperability. Proceedings of the NMSG Conference 2003, Antalya, Turkey. NATO Document RTO-MP-MSG-022

[4] Synthetic Environment Data Representation and Interchange Specification (SEDRIS), International Standard (Draft) supported by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), http://www.sedris.org

The current paper 7 presents an example of a successful joint combined collaboration based on the application of open standards. Using the idea of applying the C2IEDM as a common information exchange model assuring unambiguous information exchange, the UK C3I system BOWMAN and the US M&S system ABACUS (Advanced Battlefield Computer System) are currently coupled to enable efficient and effective training. Beside the technical challenges, expectation management was, in particular, the main contributor to the presented success.

Another similar approach was presented in paper 8 giving an update on the Simulation and C2 Info System Connectivity Experiment (SINCE), which is conducted as a US/GE collaboration between the US Communication-Electronics Research Development & Engineering Center (CERDEC) and the German Wehrtechnische Dienstelle 81. The objective of SINCE is to couple a synthetic environment with C3I systems, in other words: coupling real world command and control with a virtual battle. The goal of SINCE is the definition of an object-oriented design for the battle space applicable to cope with ground truth presentations within the synthetic environments as well as with the perceived truth in the participating C3I systems. SINCE supports three levels of communications, aligning technical and organizational processes: (1) a web-based collaboration tool, (2) a C2IEDM/MIP oriented interface layer for command and control and (3) an HLA layers for simulation system coupling. SINCE was successfully tested with prototypes in Germany as well as in the United States demonstrating the feasibility to merge real C2 and virtual forces. Although the approach is reasonably similar to APLET presented in paper 4 and Battle Management Language (BML) presented in paper 12, the discussion showed clear differences: while APLET and BML both focus on the coupling and integration aspect of information exchange between C3I and M&S system enabling training and decision support, SINCE is presented to cope with academic questions, in particular on how to establish the common object representation between perceived real data and simulated crisp data (ground truth).

The last presentation is summarized in paper 9. The System Interoperability Simulation Environment (SISE) conducted by US scientist from CERDEC and specialist of the Swedish Armed Forces is the consequent application of the High Level Architecture IEEE 1516 standards (including the Federation Development and Execution Process, FEDEP, IEEE 1516.3) for a combined project. Solving the problem of blue force tracking, also know as "Combat ID", this prototype shows the applicability of standard-based solutions in the context of NATO, although security questions and the use of real C3I systems were not currently addressed.

In summary, training will remain one of the most important application domains of M&S within NATO. Proprietary system-to-system interfaces are more and more being replaced by standardised solutions.

DEVELOPMENT OF NEW CONCEPTS

Many new concepts were at least implicitly dealt with in earlier papers, in particular paper 2, 4 and 6. The session on the development of new concepts was opened with a paper summarising the results of a high-level study conducted in Canada. Concept Development & Experimentation (CD&E) has been identified as an enabler to armed forces transformation in NATO and in particular in Canada. The main idea is to apply experimental science to explore new ideas. Among the applicable techniques, M&S is recognised as an enabler to achieve cost-effective integration and collaboration. In other words: the "story telling" component supporting efficient communications between experts of various domains is perceived to be equally important to the technical capabilities. As realised in earlier papers, the topic of technical subject matter experts having to work hand in hand with operational subject matter experts in order to generate synergy is a core finding of this study. Consequently, paper 10 presents R&D results on how to conduct R&D. The major findings support similar results presented previously:

- Until recently, technology pushes were driving R&D. In order to cope with the new military requirements of NATO, capability driven R&D is necessary.

- Procedural Challenges (internal processes of corresponding organisations) and technical challenges (overcome technology limitations preventing immediate connection of participating subject matter experts, common infrastructure) are framing the R&D requirement.

It is necessary to improve the interfaces, or preferably replace interface driven solutions by common integrating infrastructures, in order to "conserve" the problem specification from the user to the problem solvers. One way to do this on the technical level is to establish a persistent infrastructure in form of web based collaboration tools, a knowledge repository and a persistent synthetic environment. The Model Driven Architecture (MDA) and the Extensible M&S Framework (XMSF) were seen as examples for initial core solutions. The national academic speaker presented many of these ideas as well, but paper 10 sets these recommendations in the context of national and NATO R&D definitions, e.g. by giving an example of the application of the MDA for the Canadian Air Force.

Paper 11 focuses on the thesis that the human side of net centric operations and warfare or net enabled capabilities is often more challenging than the technical side. Net-centricity is not so much about establishing a common net between two organisations, but to transform the organisations in a way that they share information and data in a net-centric way. Therefore, NATO and the nations need new concepts and tools to understand and evaluate the technical and human/organisational side of net centricity. Non-technical breakthroughs should be used to measure the success of the real performance when conducting the assigned task. If a headquarter needs more time to undertake an assigned task in a fully networked environment compared to a non-networked environment, there is obviously a problem. Consequently, a new set of measures of merit is needed (previous recommended by the NCOBP). Paper 11 recommends the use of the following five metric categories: workload, error, situational awareness, time and teamwork. This research field is very closely related to the work of the Command and Control Research Programme (CCRP)[5] of the United States Department of Defence.

Paper 12 presented various national efforts to establish a Battle Management Language (BML) and proposes to merge these national efforts into a NATO BML. Battle Management Language (BML) is an unambiguous language used to command and control forces and equipment conducting military operations and provides situational awareness and a shared, common operational picture. BML is being developed as a standard representation of a "digitised commander's intent" to be used for real troops, for simulated troops, and for future robotic forces. Again, the use of C2IEDM as the core information exchange data model between the participating components within the battle space is central. The paper presents the ongoing R&D in United States, United Kingdom and France. During the preceding NMSG business meeting, a NATO exploratory team on BML was launched by France. The French proposal was supported by all participating nations.

In summary, new concepts are already addressed by various nations. In order to deal with this challenge in the NATO context, additional exploratory efforts such as the new BML exploratory team will be necessary. The NMSG should conduct a survey study and prioritise the findings.

INTEGRATION OF NEW TECHNOLOGY

The consequent use of open and commercially supported standards to enable M&S interoperability and the integration of M&S functionality in real world systems, in particular C3I systems, is the credo of the previously mentioned Extensible M&S Framework (XMSF) group. XMSF is not a programme or a project, but an initiative building the core of various projects presented in paper 13. Kernel idea of XMSF is the rapid and dynamic development based on open standards. XMSF is not intended to replace the High Level Architecture (HLA), but to move HLA to the legacy corner and migrate its solutions enabling

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[5] Homepage of the Command and Control Research Programme: http://www.dodccrp.org

"smooth transactions" instead of throwing legacy solutions away. Paper 13 gives several examples of success stories, such as an HLA compliant federation viewer based on commercially available PC solutions (web enabled low cost viewer for HLA federations similar to the DIS viewers). All examples are mapped to M&S requirements derived from the NATO M&S Master Plans, the recent NATO summits and other relevant NATO requirement documents. XMSF is referred to in several other papers and will increasingly be of interested to NATO.

Paper 14 shows the mandate for users to be educated and trained in new functionality and available IT services using M&S as well as in using M&S functionality immediately. While paper 1 already recommends replacing attrition oriented M&S with manoeuvre oriented M&S, paper 14 goes one step further by asking for information oriented M&S. Together with the recommendations of papers 2 and 6, paper 14 formulates the requirement for a new socio-military environment with high-resolution of information, sensors and environmental effects. Although paper 14 only describes a first step into this direction, it contributes valuably to the overall trend.

A new way to do business is presented in paper 15, which supports joint combined operations, by the consequential use of standards facilitating the integration of new and additional systems into a NATO open framework. The use of web-based collaboration tools based on information-push technologies solves the security problem by shifting it to the information producers; however, the Coalition Aerial Surveillance and Reconnaissance (CAESAR) solution distributed the released information near real time to all participating users. It goes without saying that future M&S functionality should make use of this data source for initialisation and result dissemination purposes as well. The basic idea of CAESAR is the use of a common web based repository in the form of the CAESAR Shared Database (CSD), which is available to all users via a web portal. CSD is a first step into M&S supported analyses of operations research centric questions on how M&S can support net analyses, such as; "who owns the data and the copyright, what are the effects on operational success when changing dissemination paradigms from push to pull?" So far, no M&S support is available to answer this sort of questions. In particular, when looking at current developments in the domain of the Global Information Grid (GIG)[6] and discussions on changing the paradigm from Task, Process, Exploit, Disseminate (TPED) to Task, Post, Process, Use (TPPU), non-M&S functionality is needed to support the evaluation of the effect of such decisions and paradigm shifts.

In summary, web-based open standards are pointing into the right direction. However, these can be regarded as necessary technologies for integration, but not being sufficient. Operational know-how must complete technical competence to deliver applicable frameworks for the operational user. While the technical side is well addressed, the operational side is still in its infancies, despite valuable contributions from various experts.

RESPONSE TO NEW THREATS

The final session was opened by a summary of the current MSG 026 results on the concept of a simulation based diagnostic support tool for terrorism threat awareness. The purpose of the targeted Early Warning System (EWS) is to collect information relevant to terrorism, to analyse and simulate that information to predict emerging threats and to visualise the EWS information. Paper 16 consequently applies open standards of the software engineering domain, in particular artefacts of the Unified Modelling Language (UML), as they are used to model and visualise the operational architecture and the system architecture within the NATO C3 System Architecture Framework[7], which can be mapped nearly one-to-one to the US

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[6] US Department of Defence (2002). DoD Directive 8100.1: Global Information Grid (GIG) Overarching Policy. The Pentagon, Washington, D.C

[7] The NATOP C3 Architecture Framework is part of the NATO C3 Technical Architecture, which is mandatory for operational NATO C3I systems

DoD Architecture Framework[8]. This will facilitate the application of results to support the definition of architecture view for systems supporting the war against terrorism. The mathematical sound approach defined in paper 16 will in the future furthermore allow the generation of values needed for approaches as proposed in papers 2 and 6.

Paper 17 goes back to the original roots of M&S. In the heart of every simulation system, systems behaviours are modelled using mathematical equations as the basis for algorithms. The paper on mathematical modelling of problems of control theory, elasticity theory, hydro-thermodynamics and statistics connected with terrorist attacks and defence against terrorism gives several examples of physical models necessary to cope with terrorism or the effect of terror events. In addition to theoretic concepts, various approaches for calculation of effects of terror acts (non-ordinary pollution of water and soil, damage of hydropower plants) are given in the paper. One of the most alarming analyses given in the paper addresses official data of accidents, spilling of oil and their related effects in the Black Sea between 1996 and 1999. New M&S systems must implement these and other respective algorithms.

Finally, paper 18 shows an example on how to incorporate other disciplines and results to cope with new and existing military requirements for the modelling of crowds. Cognitive and behavioural psychology of crowds are the basis to implement a reusable, HLA compliant crowd federate, as being required for urban operations and operations other than war. The definition is based on an extensive research of literature, event videos and exercises. The target is a crowd component that can be used to add realistic crowds and their behaviour to existing simulations and federations. In contrast to the agent-based approach presented in paper 2, the approach of paper 16 uses established M&S interface and interoperation standards to enrich existing M&S systems without the necessity of re-implementation.

In summary, first methods to cope with new threats are formulated and prototypes with limited functionality are implemented. As before, a coordinated approach within NATO is recommended.

SUMMARY AND RECOMMENDATIONS

This section shows the major trends as observed in the papers as well as in the discussions following the presentations. Each paragraph summarises a main trend and gives a recommendation on how NATO in general and the NMSG in particular should act regarding the results of the technical evaluation.

Common and co-sponsored events, such as the "First Wave" event conducted supported by NMSG and SAS, must become and example of future collaborations. For the effective proposed solutions to meet existing and new military requirements of NATO, the efforts of NMSG, SAS and other Research and Technology panels, such as Information Systems Technology (IST), Systems Concepts & Integration (SCI) and Human Behaviour & Medicine (HBM), must be aligned and orchestrated. In addition, commercially supported and viable solutions must become the core of embedded and integrated solutions. A common event bringing all related Panels of RTO together and the cross-domain peer-review of study reports is highly recommended.

It is also recommended to base future integration frameworks on open and commercially viable solutions, such as web services and XML, and extend proposed commercial standards to meet M&S needs and constraints instead of using M&S specific solutions. A strong dialog with industry and standardisation organisations is necessary to insure the applicability of commercially viable and supported solutions as a core for future NATO IT frameworks. It is already evident that proprietary system-to-system interfaces are replaced with standardised solutions. The C2IEDM – as already used for C3I system coupling in the

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[8] Department of Defence Architecture Framework Working Group (2003). Department of Defence Architecture Framework. nline available under http://aitc.aitcnet.org/dodfw/

MIP – has a tremendous potential in the NATO context and must be evaluated further. Education of the NATO M&S community regarding these emerging commercial and cross-domain standards is necessary.

The necessity to connect M&S functionality with operational needs was another common topic of several presentations. Future M&S support is needed for modelling of processes, information flow, decision-making and effects of operations. However, M&S is not a value per se. Only when connected with a user's requirement, will M&S make an operational difference. Therefore, M&S R&D must focus on fulfilling users' requirements as well as on supporting the user to formulate new requirements within possible future scenarios. M&S will and must become the communication facilitator between military experts, future operations analysts, operations research experts and subject matter experts of related fields, such as human behaviour experts, crowd behaviour experts or fields related to special questions like dispersion, toxic gas distribution, etc. A workshop addressing future operational M&S support functionality, bringing experts of related fields together, can facilitate to frame the horizon of topics of interest to NATO.

It is unlikely that NATO will conduct its own exercises unrelated to any national efforts. It is therefore highly recommended to establish a NATO Exercise Campaign Plan (similar to the Campaign Plan of the US JNTC) to identify potential contributions of national events to combined experiments. Instead of designing its own scenarios and events, NATO could make use of national efforts by "adding the combined context" making the national effort applicable to NATO R&D. While this is feasible, the organisational framework of official roles and procedures has yet to be established. A workshop with JNTC experts to summarise lessons learned for NATO is recommended.

In summary, the NATO M&S community needs to connect with the operational community more intensively than before, not only on a technical basis. M&S needs the connection to the user to fulfil his operational needs (solve the problem of the operational M&S user, not of the M&S community) and to meet the operational requirements and constraints. Exploratory teams such as the recently launched team on NATO Battle Management Language applicability are a first way to address the new and existing military requirements of NATO. Expert workshops and education of the M&S community are also necessary precursor steps. The technical evaluation of this workshop and its papers shows that NATO is on the right track concerning the use of M&S to address its new and existing military requirements.