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ALLIED COMMAND TRANSFORMATION
NATO Modelling and Simulation Vision

This ACT Modelling and Simulation (M&S) Vision increases the understanding of M&S benefits to ACT undertakings, ensures the best use of M&S resources in support of the ACT’s mission and guides actions and decisions regarding the governance, development, resourcing, and employment of M&S across the ACT enterprise. Achieving the vision’s goals and objectives will ensure effective employment of M&S, raise significantly the profile of M&S in ACT and foster a coherent integration of this technology within the overall ACT and NATO business model.

Admiral Luciano Zappata, Italian Navy
Deputy Supreme Allied Commander Transformation
EXECUTIVE SUMMARY

The Modelling and Simulation (M&S) Vision is an ACT high-level document engendered by the NATO Modelling and Simulation Master Plan (NMSMP) and drafted in accordance with the current NATO and ACT policy and guidance in the area of modelling and simulation.

It underpins the efforts to coordinate M&S activities in ACT and the relations with external stakeholders. It will also increase the understanding of M&S benefits to the application areas of defence planning, operations, training and capability development and ensure the best use of M&S resources in support of the ACT’s mission. Finally, it will guide actions and decisions regarding the governance, development, resourcing, and employment of M&S across the ACT enterprise.

The ACT’s M&S Vision is to exploit modelling and simulation to enable NATO transformation wherever it can enhance capability, increase interoperability, save resources or reduce risk in the ACT application areas of training, support to operations, defence planning and capability development.

To successfully attain this vision, ACT must determine its role and responsibilities with regard to the five primary objectives of the NMSMP (foster interoperability and reuse, provide common services, develop and employ simulations and incorporate technology advances); ACT will coordinate with the NATO M&S Group (NMSG) on the achievement of these objectives. In addition, ACT pursues to support the NATO M&S Policy, to collaborate with NATO stakeholders to produce a strong NATO M&S Business Model, to improve the current ACT M&S Business Model and to contribute as fully as possible to the ongoing work of the international M&S community.

This document defines and sets guiding principles for the realization of the M&S Vision. Primarily, it establishes the intent to produce an ACT M&S Roadmap to plan for the implementation of the Vision. This Roadmap will describe how the vision will be achieved by determining: M&S requirements, capabilities and gaps, as well as what M&S activities will be performed and why they are necessary. The plan will determine when the activities will be executed and who will be accountable, who has the authority to release resources, who are the users and who will monitor and audit the process and deliverables.

The complexity of realizing this vision is compounded when considering the size of the ACT enterprise and diversity of work, the variety of M&S application areas, the number and nature of M&S stakeholders, and their roles and responsibilities on the M&S enterprise from the perspective of ACT.

Achieving the vision’s goals and objectives will ensure effective employment of M&S, maximize the allocation of available M&S resources, raise significantly the profile of M&S in ACT and foster a coherent integration of this technology within the overall ACT and NATO business model.
1. INTRODUCTION

1.1 BACKGROUND

The continuously challenging Alliance strategic environment, coupled with the changing nature and increased complexity of operations, demand a fresh approach to preparing for and executing NATO activities. In order to improve the military effectiveness of the Alliance to address these emerging challenges the Allied Command Transformation (ACT) has the mission to lead transformation of NATO military structures, capabilities, and doctrines. In this respect, ACT pursues a transformational model where concept development and experimentation, research and technology, and interoperability combine to promote and support the development of capabilities.

Modelling and Simulation (M&S)\(^1\) has tremendous potential to support the ACT’s mission. M&S is an enabling technology that can enhance training, defence planning and the support to military operations. Furthermore, M&S can assist the capability development process which ACT utilizes as its main tool for transformation.

ACT is already making a considerable effort to support training by equipping the Joint Warfare Centre (JWC) and Joint Force Training Centre (JFTC) with appropriate M&S assets required to perform their missions. There are also existing plans, under the Snow Leopard program, and with the support of NC3A, NATO M&S Group (NMSG) and other stakeholders, for future synergetic and collaborative provision and utilization of M&S across NATO and the national M&S centres involving a variety of constructive models, virtual simulators and live participants using application purposed systems. Additionally, the NURC develops and uses M&S extensively to support their research activities.

In spite of these achievements, ACT’s initiatives to provide M&S support to capability development, defence planning and operations have been limited due to a lack of defined requirements, an analysis of needed capabilities, and available resources. Moreover, ACT currently lacks a common strategy, vision, and governance plan for how to use M&S in support of NATO transformation. The NATO M&S Master Plan (NMSMP), approved by the NATO Secretary General in 1998, well before the existence of ACT, is the capstone implementation guide for NATO in the area of M&S and the only available policy document available to ACT to assist in the articulation of its M&S vision.

During the past 10 years, the NATO M&S Group, supported by the NATO M&S Coordination Office (MSCO), has been the NATO body responsible for overseeing the implementation of the NMSMP. In this respect, NMSG has coordinated NATO M&S activities through a series of strategy and business plans and has achieved a great number of the NMSMP objectives. However, the NMSMP was conceived before the

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\(^1\) In the context of this document, M&S is understood as a practice that deals with all activities related to the life cycle of Models and Simulations including research and technology, development, exploitation, management, policy and organization.
structure of the Alliance was renovated during the Prague Summit creating SACT with a dramatic change of mission from that of its operational predecessor SACLANT.

Therefore, as the existing documents do not recognize ACT, its missions, or subordinate organizations it is incumbent upon ACT to develop and promulgate its own M&S Vision, which, while supporting the goals of NATO M&S, also recognizes the unique requirements and challenges facing ACT.

1.2 PURPOSE and SCOPE

The purpose of this document is:

- To establish the ACT M&S Vision and the associated goals and objectives;
- To recognize the support that M&S can provide to the ACT application areas;
- To identify the M&S stakeholders, both internal to and external from ACT;
- To set the guiding principles for the implementation of this M&S vision.

The scope of this document is the ACT's vision for M&S over the next five years. Following this document, an M&S Roadmap will be produced to identify M&S requirements, capabilities, gaps and priorities. The Roadmap will then specify which M&S activities ACT will perform during this period to achieve the objectives of the Vision. A phased approach will be applied to determine the timelines for the selected activities in accordance with the established priorities of ACT. However, in recognition of the evolving missions of ACT and the rapidly changing technology of M&S, mid-course corrections to this plan are to be expected. Furthermore, this Vision should stimulate a process of continual improvement to guide actions and decisions regarding the governance, development and employment of M&S across ACT.

The following paragraphs describe the support M&S can provide to the application areas and identifies the various M&S stakeholders. Part 2 of this document contains the ACT M&S vision, goals and objectives and provides considerations regarding governance, prioritization and resourcing required for the implementation of the Vision. Annexes I to V are provided as supporting documents which should be considered when evaluating the M&S Vision.

1.3 BENEFITS OF M&S FOR THE CAPABILITY DEVELOPMENT PROCESS

ACT has responsibility to support the first five phases of the capability development process (See Figure 1.1) and M&S can enable all of them to some extent. The use of M&S for capability development and experimentation is not new. Before computers and networking technologies, analysts mathematically modelled the effect that new or improved defence systems would have on warfighting capability, engineers built physical models of systems, testers simulated combat in field tests and exercises, and wargames moved models across simulated battlefields.
Specifically, ACT can use M&S to support analysis, experimentation, and test and evaluation by enabling sponsors to better understand capability requirements and identify and evaluate capability solutions. The employment of battle space laboratories (battlelabs), equipped with M&S assets, to support these activities has proven to be very useful and the potential to increase their value to ACT is significant.

1.4 BENEFITS OF M&S FOR THE CAPABILITY DOMAINS

M&S can benefit the capability domains of defence planning, training and operations in which ACT is involved and has an important role to play within NATO and ACT as evidenced by the following:

Defence Planning ensures that operational commanders have access to capabilities required to initiate, sustain, and successfully conclude NATO operations. Every aspect of defence planning (force, armament, resource, logistic, C2, civil emergency, etc.) can benefit from the use of M&S. For example, M&S can:

- Enable better assessment of the effectiveness of the available forces by taking into account their readiness and core capabilities;

- Support the evaluation of the impact of new concepts, systems and technologies without actually absorbing the cost of testing them in the field;

- Assist the planners in optimizing the allocation and use of the available assets.

Training includes collective training, individual education, exercises and mission related training. Employing M&S through various distributed training architectures (e.g., the proposed NATO Live, Virtual and Constructive - NLVC) the trainees are exposed to processes and equipment that they normally encounter during a real situation. This “safe”, adaptive and immersive training environment enables the audience to gain knowledge and proficiency on Techniques, Tactics and Procedures (TTPs), decision-making, information management, concepts, doctrine and the use of systems.

As NATO trains operational and tactical NATO headquarters, M&S enhances the ability to federate with National M&S capabilities, thus facilitating NATO/National
training events. Also, due to its inherent flexibility M&S enables the focus on a specific training audience allowing a joint headquarter to train without committing subordinate headquarters (i.e., Deployable Joint Task Force – DJTF).

Generally, the M&S support for training should:

- Expand the scale of the learning experience by increasing the event’s force structure, making the opposing force (OPFOR) more interactive and the topic coverage more general, enlarging the geography of the event, stimulating real-world fielded NATO’s C2 systems and decision support tools, increasing the mix of effects and the realism of the weapon systems and scenario vignettes;

- Increase the learning value by compressing the timeline, allowing more repetition, adding after-action review, or making trainee performance measurable;

- Make an event possible by making it more economical and less risky.

In all these initiatives and capabilities, the commanders’ training objectives must remain paramount. Accordingly, M&S can provide a suitable toolkit for the NATO training centres to use in crafting the training environment which bets addresses these objectives.

**Operations** support encompasses situation awareness and understanding, operational planning, force generation, mission rehearsal, courses of action (COA) analysis and wargamming. M&S can provide a better understanding of the complex command and control and decision-making relationships between the operational command HQs, NATO HQs, political and military leadership of nations and governmental and non-governmental organizations. M&S can facilitate the development and modification of plans, enhance decision-making and shorten the decision cycle in a rapidly changing situation, as well as to aid to determine force structure and conduct rehearsals. In addition, M&S can provide tools to support course of action analysis.

M&S, in support of Operations can:

- Provide a representation of the battle space for mission rehearsals and planning;

- Provide stimulation to C2 devices that will enable leaders to practice command and control procedures;

- Provide situational awareness and visualization capability to operations centres;

- Provide stimulation to all levels of command to enable training on the complexities of military and non-military organizations operating in the same geographical space.
1.5 COMMON VS. SPECIFIC M&S SUPPORT TO APPLICATION AREAS

From an M&S perspective the support can be either unique to a specific application area or common to several areas (See the vertical and horizontal axis of figure 1.2). Whenever possible, M&S assets should be developed and used as common services in order to increase interoperability and to save resources. In many cases however, individual solutions for specific applications are still necessary, and may be more effective and efficient, to reach the required level of performance and to meet operational demands.

The ACT M&S support staff must clearly understand the commander’s priorities and requirements before recommending an M&S solution for any exercise, training event, experiment or capability. ACT will be very careful to insure that limited resources will be optimized to insure that ACT priorities take precedence over nice-to-have but not mission critical M&S development.

![Figure 1.2 – M&S Support to Application Areas](image)

1.6 M&S STAKEHOLDERS

The community of M&S stakeholders has been identified from among NATO and non-NATO organizations in accordance with their roles on the M&S enterprise from the perspective of ACT. In the context of this document, a stakeholder is a current or potential user, facilitator, or provider of M&S.
The diagram in figure 1.3 provides a simple and preliminary portrait of the NATO M&S stakeholders. For the point of view of ACT, these have been divided in three groups: those who provide M&S requirements and include the Strategic Commands; those who provide support and coordination such as NC3A, NCSA or NURC; and, finally, those who provide advice like nations, NMSG or COEs. Some stakeholders could perform more than one role. Also, there could be other stakeholders not included in this picture and they will be indentified based on future developments.

Due to the large number of M&S stakeholders involved, their diversity, the complex relationships among them, and the fact that the NMSMP has not been updated since 1998, NATO has to establish a new and more robust M&S business model. Accordingly, ACT has to revise its internal M&S business model.

Initially, the NATO M&S stakeholders established the baseline-requirements which were subsequently translated into M&S high-level requirements and then used by ACT to derive this M&S vision. (See Annex II for a snapshot of M&S requirements).
2. ACT VISION REGARDING MODELLING AND SIMULATION

2.1 ACT M&S VISION

ACT exploits modelling and simulation to enable NATO transformation wherever it can enhance capability, increase interoperability, save resources or reduce risk in the ACT application areas of training, support to operations, defence planning and capability development.

2.2 M&S GOALS AND OBJECTIVES

2.2.1 M&S Goals

The goals that ACT expects to achieve using M&S are:

Enhance Capability. ACT is heavily involved in the first five steps of the capability development process (Figure 1.1) from understanding the future strategic environment to identifying and assessing possible solutions. M&S can enable the development of new training, operations support, and defence planning capabilities by facilitating the evaluation of doctrine, organization, training, materiel, leadership development, personnel, facilities and interoperability (DOTMLPFI) issues.

Increase interoperability. Interoperability in NATO is the ability to operate together. M&S can be used to increase NATO interoperability at all levels (force, HQs, organizations, systems, etc) by supporting, for example, training, education, exercises, mission rehearsal, test and evaluation, CD&E or certification. In particular, M&S can be used to improve interoperability in multinational operations by distributed, networked utilization of NATO and national M&S centres and systems.

Save Resources. Resources can be material, fiscal or labour. For example, the use of M&S to examine and/or validate possible solutions offers an alternative approach from the traditional costly test and evaluation methodology. Also, military forces and resources are limited and M&S can be used to provide synthetic environments to compare options and courses of action enabling more efficient and cost-effective defence planning and operational performance. Finally, M&S solutions based on distributed, networked use of NATO and national assets will assist in accomplishing this goal.

Reduce Risk. There are many categories of risk, some of them being risk to human life or material. For instance, in military training, experimentation, and operations there is inherent risk due to the dangerous nature of the environment. M&S may substantially reduce risk by providing a safe synthetic environment in which all or part of the event is conducted. M&S can also provide tools for analysis to foster a more complete understanding and appreciation of both military and non-military aspects of an operational situation, thereby helping commanders make more informed decisions by offering comparisons of alternative courses of action thus reducing risk or saving resources.
These goals can be interrelated. For example, when enhancing capability, risk may be reduced as well. Also, these goals provide criteria to test if ACT decisions on the use of M&S are in accordance with this vision.

2.2.2 M&S Technical Development Objectives

To successfully attain the NATO M&S goals ACT must determine its role and responsibilities with regard to the five primary objectives of the NMSMP (See Annex I) and it will coordinate with NMSG on their achievement. The five objectives are:

- Pursue a Common Technical Framework to Foster Interoperability and Reuse;
- Provide Common Services to Increase Cost-Effectiveness in NATO M&S activities;
- Develop Federations/Simulations;
- Employ Simulations to Enhance NATO Mission Effectiveness;
- Incorporate Technological Advances.

In addition, ACT pursues the following particular objectives:

- Support the NATO M&S Policy. For example, support the update of the NATO M&S Master Plan, and ensure that NATO military requirements (e.g., technical, operational, training, etc.) are used to influence the NATO M&S Policy;
- Collaborate with NATO and partner nations, NATO Modelling and Simulation Group (NMSG), other NATO bodies, Centres of Excellence (COEs), international organizations, industry, and academia to build a strong NATO M&S Business Model;
- Improve the current ACT M&S Business Model;
- Contribute as fully as possible to the ongoing work of international M&S community.

Achieving these objectives will ensure more effective employment of M&S, raise significantly the profile of M&S in ACT and foster a coherent integration of this technology within the overall ACT and NATO business model. However, in recognition of the limited M&S resources, ACT must insure that any and all M&S technical development is only supported if it can be determined that it will increase ACT M&S capability to satisfy the ACT requirements.
2.3 IMPLEMENTATION OF THE VISION

The complexity of implementing this vision is better understood after the review of the breadth of the possible M&S support to application areas and the number of stakeholders involved that was provided earlier in this document.

To plan for the implementation of this vision, an ACT M&S Roadmap will be produced. The roadmap will describe how the vision will be implemented and address the following key questions:

- What M&S activities will be performed and why they are necessary, in relation to the ACT vision, goals and objectives;
- When and where the M&S activities will be performed;
- Who will be accountable to oversee the activities, who has the authority to release resources, who are the users and who will monitor execution and audit results to insure the implementation of the vision.

To develop the roadmap ACT should:

- Understand the prioritized requirement of the stakeholders;
- Determine current M&S capabilities;
- Perform a gap analysis to determine the necessary M&S activities to achieve the objectives of the vision. For this task, ACT may benefit from the current work of NMSG in this area;
- State ACT responsibilities, roles and priorities with respect to these activities;
- Establish the ACT level of ambition, based on available resources, and select the activities to be performed;
- Create project mandates of the selected activities and establish timelines;
- Determine the evaluation plan criteria which will be used to monitor and audit results.

2.3.1 Resources

The following principles apply to the way in which ACT will implement this vision:

- ACT M&S resources will likely be constrained, thereby necessitating the implementation of a prioritization process to determine M&S activities. This process will insure that precedence is given to accomplishment of ACT’s highest priorities for stakeholder support;

2 Reference “Prince2 Project Management Method”
- ACT intends to assist nations to leverage NATO M&S support but maintaining a basic set of NATO core M&S support elements;

- The vision does not pursue special ACT M&S funding, but, when common funding is required, will capitalize on projects promoted through the R&D POW (e.g., M&S Program Area), the EPOW and the NSIP (e.g., Core Services, Functional Services, Core Communication Network Services, future M&S Capability Packages).

2.3.2 Organization

When determining roles and responsibilities to create the ACT M&S Roadmap, important considerations are:

- NMSG is the M&S NATO organization that provides ACT with a direct link at the national level and has the mandate to oversee the implementation of the NATO M&S Master Plan through its annual NMSG Strategy & Business Plan. In addition, it has been invested by CNAD as the authority for the development, production and maintenance of NATO M&S STANAGs and allied publications (APs). Thus, coordination and alignment with NMSG is required to successfully implement the vision;

- An ACT M&S Steering Board chaired by a HQ SACT Flag or General Officer (FOGO) with the responsibility of overseeing all M&S activities in ACT must be considered as a way to achieve cohesion on ACT M&S policy, POW and to accomplish the vision;

- HQ SACT (M&S Coordination Section) roles include development of ACT M&S policy and business model, M&S planning and budgeting. HQ SACT will be the POC for ACT interactions with NMSG, the nations, and other international organizations. In addition, the M&S Coordination Section will insure coordination with ACT C4I to align with the NNEC.

- JWC and JFTC roles are implementation, maintenance and utilization of M&S solutions. JWC and JFTC will provide annual M&S requirements to HQ SACT (M&S Coordination Section). Specific JALLC and NURC roles in ACT M&S business model are to be determined;

- ACT should ponder how to use national and industry battlelabs to better achieve the objectives of this vision;

- ACT should also consider the opportunity to encourage the debate with nations on the establishment of a NATO M&S COE.
NATO M&S VISION

The NATO M&S vision is to provide a readily available, flexible and cost-effective means to enhance NATO operations in the application areas of defence planning, education, training, exercises, support to operations, research, technology development and armaments acquisition. This will be achieved by a NATO-wide co-operative effort that promotes interoperability, reuse and affordability.

NATO MODELLING & SIMULATION OBJECTIVES

Objective I - Establish a Common Technical Framework to Foster Interoperability and Reuse. This objective establishes a common (open standard) technical framework (CTF) to promote the interoperability and reuse of models and simulations across the Alliance. The technical framework consists of a common technical architecture and data standards that promote common understanding of data across models, simulations and live systems, (e.g., Communication and Information Systems (CIS), weapon systems on instrumented ranges, hardware-in-the-loop, etc.).

Sub-objective 1.1 - Adopt the High Level Architecture (HLA) as the NATO standard technical architecture for simulation applications;

Sub-objective 1.2 - Establish recommended data interchange standards for M&S applications.

Objective II - Provide Common Services to Increase Cost-Effectiveness in NATO M&S Activities. The objective of providing common services is to improve the cost-effectiveness of NATO M&S activities by satisfying common requirements by a common means. To meet NATO requirements, to discourage unnecessary duplication of effort and to encourage maximum efficiency in the use of NATO resources rather than develop new capabilities, the Alliance should leverage existing NATO and national capabilities and pursue the cooperative provision of common services.

Sub-objective 2.1 - Compile and synthesize widely required M&S information, to include lessons-learned, impact assessments and recommended practices for critical processes such as federation development, verification, validation and accreditation (VV&A) practices, etc.

Sub-objective 2.2 - Provide M&S-related education to the NATO community.

Sub-objective 2.3 - Promote the sharing of M&S resources through a simulation resource library (SRL).
**Sub-objective 2.4** - Establish a help desk to facilitate the development and use of M&S.

**Objective III - Develop Simulations**

NATO must maximize the cost-effectiveness of simulated mission space development by reusing and federating existing capabilities whenever practical. In many cases, cost-effective solutions to Alliance requirements may be found in the evolution (modification) of existing simulations. Whenever practical, new development projects should be cooperative in nature. Simulated mission spaces for NATO’s diverse requirements may also be developed by pooling resources to build a single application or by cooperatively developing a multi-organization and/or multinational federation.

**Sub-objective 3.1** - Identify and prioritize M&S requirements.

**Sub-objective 3.2** - Identify the most cost-effective strategies to satisfy each simulation requirement, with a preference for reuse, federation of existing capabilities and co-operative development.

**Sub-objective 3.3** - Allocate resources to satisfy the highest priority simulation requirements.

**Sub-objective 3.4** - Execute the selected and resourced development strategy.

**Sub-objective 3.5** - Provide information to the larger NATO community regarding the resultant simulations and any lessons-learned during development.

**Objective IV - Employ Simulations to Enhance NATO Mission Effectiveness**

Employing simulations that effectively allow the Alliance to realize its M&S goal will substantially enhance NATO operations in the principal application areas. To maximize the effective employment of simulations, NATO must address planning, resourcing, database preparation, operating and assessment issues.

**Sub-objective 4.1** - Plan employment.

*Note:* The class of actions to be considered should include: scenario definition, security provisions, phase-out of old simulations, federation development, communication provisions, equipment maintenance, training audience indoctrination, database preparation, initialization, simulation exercise control/management, data collection, after action review and post-exercise documentation.

**Sub-objective 4.2** - Provide resources to operate simulations.

**Sub-objective 4.3** - Provide databases.

**Sub-objective 4.4** - Operate simulations to improve all aspects of NATO operations, including armaments acquisition.
Sub-objective 4.5 - Conduct impact assessments and document lessons-learned to guide further development/investments.

**Objective V - Incorporate Technological Advances**

M&S-related technology advances are expected to occur frequently and will provide opportunities to increase functional capabilities, performance and overall M&S effectiveness. To assist M&S users in maintaining awareness of such M&S-related technology developments, NATO needs a process to monitor technology developments by others and to conduct its own technology-development activities in key areas not addressed elsewhere.

Sub-objective 5.1 - Monitor M&S-related technological advances.

Sub-objective 5.2 - Conduct research and development, experiments and pilot projects, as needed, to support Alliance requirements.

Sub-objective 5.3 - Share information on realized advances to facilitate incorporation.

Sub-objective 5.4 - Implement technological advances.
ANNEX II

M&S REQUIREMENTS AND CURRENT M&S SUPPORT

TOP-LEVEL M&S REQUIREMENTS

The top-level M&S requirements discussed in this annex represent only a snapshot of the complete set of NATO M&S needs related to ACT. They are presented in this annex to support the statements in the body of the document. The various levels of detail in regard to application areas do not indicate the importance or level of necessity, but they are only a consequence of the challenging process of collecting the M&S requirements. Detailed M&S requirements will be collected as needed for the implementation of this vision and incorporated into the M&S Roadmap.

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<th>APPLICATION AREAS</th>
<th>M&amp;S REQUIREMENTS</th>
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<td>Defence Planning</td>
<td>M&amp;S to support planning for the NATO Network Enabled Capability (NNEC), Stabilisation &amp; Reconstruction (S&amp;R), Interoperability, C2 &amp; Reach-back and Cyber-warfare.</td>
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<td>Training</td>
<td>Training requirements are addressed by the Snow Leopard (reference Snow Leopard Vision) program which includes:</td>
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<td>- Individual Education – (Advanced Distributed Learning - ADL)</td>
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<td>- Shared Scenarios</td>
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<td>- M&amp;S Tools – NATO Training Federation (NTF) and NATO Live Virtual and Constructive (NLVC)</td>
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<td>Operations</td>
<td>- Models to support all Functional Areas (Js)</td>
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<td>- Effects Based Approach to Operations (EBAO)</td>
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<td>Capability Development</td>
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<td>- Demonstration of concepts and solutions</td>
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<td>- Operational Analysis &amp; Lessons Learned support</td>
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<td>- Education in M&amp;S field for non-M&amp;S experts &amp; decision makers</td>
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<td>- Information Assurance / Information Security</td>
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<td>- Avoidance of stovepipe systems orientation through Service Oriented Approach (SOA)</td>
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CURRENT M&S SUPPORT

This assessment provides an initial high-level overview of current M&S support within NATO related with ACT roles and responsibility on the application areas.

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<thead>
<tr>
<th>APPLICATION AREAS</th>
<th>STAKEHOLDERS</th>
<th>CURRENT M&amp;S SUPPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defence Planning</td>
<td>SEE, IS, NC3A</td>
<td>NC3A tools</td>
</tr>
<tr>
<td>Training</td>
<td>JET; JWC &amp; JFTC</td>
<td>Snow Leopard Program M&amp;S support to NATO School (Gamma)</td>
</tr>
<tr>
<td>Operations</td>
<td>ACO / JFCs</td>
<td>Assessment tools and Data-Base NC3A tools ex. GAMMA, ADAMS</td>
</tr>
<tr>
<td>Capability Development</td>
<td>JEEA, SCPI FCRT, JALLC</td>
<td>Simple stand-alone tools for analysis support Maritime models produced by NURC Experimention is not systematically supported by M&amp;S</td>
</tr>
</tbody>
</table>

M&S SHORTFALLS

The initial shortfalls assessment derived from the current M&S support and requirements above indicate important gaps in M&S support to application areas.

- There is no systematic approach to the use of M&S to support the capability development process. The need for M&S tools for experimentation and test & evaluation to compare, validate and assess concepts and solutions has been recognized by the stakeholders.

- Defence Planning requires more specialized tools to determine the necessary resources in the future, taking into account the new and future environments in which NATO forces will have to operate. For example, there is a necessity of models for cyber-warfare, stabilization and reconstruction or NNEC.

- Training is the domain in which ACT and nations have spent significant resources and M&S support is more prominent. Within the framework of the Snow Leopard program, ACT will be able to foster the kind of M&S support to training NATO needs. However, it will be challenging for ACT and stakeholders to provide training and education to meet the requirements for NATO forces interoperability, NRF certification, and mission related training for real NATO operations like ISAF in which PMESII or C-IED for example are relevant factors.

- To support operations, ACT is involved in several NATO initiatives (e.g., TOPFAS, etc). However, M&S models and tools need to change to allow the decisions makers to better address current and emerging operational environments.
As a general shortfall, across all application areas, the lack of common data formats, repositories, policy and organization means to allow for data sharing (including scenarios) is considered by many the biggest obstacle to achieve M&S interoperability.
ANNEX III

EXAMPLES OF M&S POTENTIAL SUPPORT TO CURRENT ACT INITIATIVES

To better illustrate the benefits of M&S to the application areas this annex provides examples of potential M&S support to some ongoing ACT initiatives (IPTs, ICTs and WGs). The list of examples provided here is not inclusive or exclusive of all ACT initiatives.

<table>
<thead>
<tr>
<th>CAPABILITY DEVELOPMENT</th>
<th>TRAINING</th>
<th>OPERATIONS</th>
<th>DEFENCE PLANNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Superiority &amp; NATO Network Enabled Capability (NNEC)</td>
<td>Provide analysis support to ongoing development of the concept including comparison and evaluation of possible solutions</td>
<td>Provide capability to train in situ on real systems.</td>
<td>Provide support to the utilization of NNEC and various knowledge development and decision enabling tools</td>
</tr>
<tr>
<td>Maritime Situational Awareness (MSA)</td>
<td>Test and evaluation of algorithms for anomalous track detection. Visualize expected results.</td>
<td>Train in new processes</td>
<td>M&amp;S could be part of the decision support tool to identify anomalous tracks</td>
</tr>
<tr>
<td>Counter Improvised Explosive Device (C-IED)</td>
<td>Test and evaluation of future capabilities and Techniques Tactics and Procedures (TTPs)</td>
<td>Training on TTPs</td>
<td>Mission rehearsal and planning. Evaluation of anomalous traffic patterns based in surveillance data (satellite or UAVs)</td>
</tr>
<tr>
<td>NATO Response Forces (NRF)</td>
<td>Investigate further integration efforts to allow more effective training solutions. Certification of NRF</td>
<td>Assist in the preparation effort for Joint training opportunities</td>
<td>Tool for planning and execution of operation, including mission rehearsal</td>
</tr>
<tr>
<td>Friendly Force Tracking (FFT)</td>
<td>Explore future uses and analysis of those capabilities Test and evaluation on FFT solutions</td>
<td>Training on TTPs</td>
<td>Tools to perform FFT during operations</td>
</tr>
<tr>
<td>Snow Leopard (SL)</td>
<td>Advise on the implementation and interoperability of federates</td>
<td>Enhance training and aid interoperability of the federates</td>
<td>Provide the analysis needed to capture lessons learned</td>
</tr>
</tbody>
</table>

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# Annex IV

## Acronyms and Glossary of Modelling and Simulation Terminology

### Part I: Acronyms / Glossary

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACO</td>
<td>Allied Command Operations</td>
</tr>
<tr>
<td>ACT</td>
<td>Allied Command Transformation</td>
</tr>
<tr>
<td>Bi-SC</td>
<td>Bi-Strategic Command (ACO &amp; ACT)</td>
</tr>
<tr>
<td>CAX</td>
<td>Computer Assisted Exercise – A means of using computer simulations and models in support of exercises</td>
</tr>
<tr>
<td>C2</td>
<td>Command and Control</td>
</tr>
<tr>
<td>C4I</td>
<td>Command, Control, Communications, Computers and Intelligence</td>
</tr>
<tr>
<td>CD&amp;E</td>
<td>Concept Development and Experimentation (Evaluation)</td>
</tr>
<tr>
<td>CGF</td>
<td>Computer-Generated Forces</td>
</tr>
<tr>
<td>C-IED</td>
<td>Counter Improvised Explosive Device</td>
</tr>
<tr>
<td>CIS</td>
<td>Communication and Information System</td>
</tr>
<tr>
<td>CNAD</td>
<td>Conference of National Armaments Directors</td>
</tr>
<tr>
<td>COE</td>
<td>Centre of Excellence</td>
</tr>
<tr>
<td>COTS</td>
<td>Commercial Off-the-Shelf</td>
</tr>
<tr>
<td>CP</td>
<td>Capability Package</td>
</tr>
<tr>
<td>DIS</td>
<td>Distributed Interactive Simulation</td>
</tr>
<tr>
<td>DOTMLPFI</td>
<td>Doctrine, Organization, Training, Materiel, Leadership, Development, Personnel, Facilities and Interoperability</td>
</tr>
<tr>
<td>EBAO</td>
<td>Effects Based Approach to Operations</td>
</tr>
<tr>
<td>EPOW</td>
<td>Experimental Programme of Work</td>
</tr>
<tr>
<td>FCRT</td>
<td>Future Capabilities, Research and Technology</td>
</tr>
<tr>
<td>FFT</td>
<td>Friendly Force Tracking</td>
</tr>
<tr>
<td>FOC</td>
<td>Final Operational Capability</td>
</tr>
<tr>
<td>FOGO</td>
<td>Flag or General Officer</td>
</tr>
<tr>
<td>FOM</td>
<td>Federation Object Model</td>
</tr>
<tr>
<td>HLA</td>
<td>High Level Architecture</td>
</tr>
<tr>
<td>HQ</td>
<td>Headquarters</td>
</tr>
<tr>
<td>ICT</td>
<td>Integrated Capability Team</td>
</tr>
<tr>
<td>IOC</td>
<td>Initial Operational Capability</td>
</tr>
<tr>
<td>IPT</td>
<td>Integrated Project Team</td>
</tr>
<tr>
<td>IS</td>
<td>International Staff</td>
</tr>
<tr>
<td>JAALC</td>
<td>Joint Analysis and Lessons Learned Centre</td>
</tr>
<tr>
<td>JCATS</td>
<td>Joint Conflict and Tactical Simulation</td>
</tr>
<tr>
<td>JEEA</td>
<td>Joint Experimentation, Exercises and Assessment</td>
</tr>
<tr>
<td>JET</td>
<td>Joint Education and Training</td>
</tr>
<tr>
<td>JFCs</td>
<td>Joint Force Commands</td>
</tr>
<tr>
<td>JFCOM</td>
<td>Joint Forces Command</td>
</tr>
<tr>
<td>JFTC</td>
<td>Joint Force Training Centre</td>
</tr>
<tr>
<td>JJJ</td>
<td>JALLC, JWC, JFTC</td>
</tr>
</tbody>
</table>
JMRM  Joint Multi-Resolution Model
JTLS  Joint Theatre Level Simulation
JWC  Joint Warfare Centre
JWFTC  Joint War-Fighting Training Centre
M&S  Modelling and Simulation
MSA  Maritime Situational Awareness
MSV  Modelling and Simulation Vision
NC3A  NATO Consultation, Command and Control Agency
NCSA  NATO Communication and Information Systems Services Agency
NGO  Non-governmental Organization
NLVC  NATO Live, Virtual, Constructive
NMSG  NATO Modelling and Simulation Group
NMSMP  NATO Modelling and Simulation Master Plan
NNEC  NATO Network Enabled Capability
NS  NATO Secret
NSA  NATO Standardization Agency
NSIP  NATO Security Investment Program
NTF  NATO Training Federation
OPFOR  Opposing Force
PMESII  Political, Military, Economic, Social, Infrastructure, and Information
POC  Point of Contact
POW  Programme of Work
R&D  Research and Development
RTO  Research and Technology Organization
SACEUR  Supreme Allied Commander Europe
SACLANT  Supreme Allied Commander Atlantic
SACT  Supreme Allied Commander Transformation
SAF  Semi-Automated Forces
SHAPE  Supreme Headquarters Allied Powers Europe
SCPI  Strategic Concepts, Policy and Interoperability
SEE  Staff Element Europe
SISO  Simulation Interoperability Standards Organization
SPOW  Scientific Programme of Work
SRL  Simulation Resource Library
STANAG  Standardization Agreement
TOPFAS  Tools for Operational Planning, Force Activation and Simulation
TTPs  Tactics, Techniques and Procedures
VV&A  Verification, Validation and Accreditation
VV&C  Verification, Validation and Certification
WG  Working Group
Annex IV

Part II
Definitions

(Selected set from the NATO M&S Master Plan)

Accreditation. The official determination that a model or simulation is acceptable for use for a specific purpose.

Aggregate Level Simulation Protocol (ALSP). A family of simulation interface protocols and supporting infrastructure software that permits the integration of a limited set of simulations and war games. Combined, the interface protocols and software enable large-scale, distributed simulations and war games of different domains to interact at the combat object and event level.

Architecture. The structure of components in a programme/system, their interrelationships and the principles and guidelines governing their design and evolution over time.

Data. The properties of an entity expressed in discrete parametric values describing its attributes.

Distributed Interactive Simulation (DIS). (1) A government/industry initiative to define an infrastructure for linking simulations of various types at multiple locations to create a realistic, complex, virtual environment for the simulation of interactive activities. This infrastructure brings together platforms from different military services and systems built by various vendors using different technologies for different purposes and permits them to interoperate. (2) A time and space coherent synthetic representation of world environments designed for linking the interactive, free play activities of people in operational exercises. The synthetic environment is created through real-time exchange of protocol data units between distributed, computationally autonomous simulation applications in the form of simulations, simulators and instrumented equipment interconnected through standard interfaces.

Entity. A distinguishable person, place, thing, event, or concept about which information is kept.

Environment. (1) The texture or detail of the domain, that is terrain relief, weather, day, night, terrain cultural features (such as cities or farmland, sea states, etc.); (2) the external objects, conditions and processes that influence the behaviour of a system (such as terrain relief, weather, day/night, terrain cultural features, etc.).

Environmental Representation. A representation of all or part of the natural or man-made environment, including permanent or semi-permanent man-made features.
**Federate.** A member of an HLA federation. All applications participating in a federation are called federates. In reality, these applications may include simulations, federate managers, data collectors, live systems, or passive viewers.

**Federation.** A set of interacting simulations, real-world ("live") systems (e.g., Communication and Information Systems - CIS), weapon system hardware, instrumented ranges) and utilities (e.g., federation managers, data collectors, passive viewers), collectively termed "federates," which together provide users with a simulated mission space in which they can accomplish their objective. High Level Architecture federations interact over a Runtime Infrastructure (RTI) in accordance with a Federation Object Model (FOM).

**Federation Object Model (FOM).** An identification of the essential classes of objects, object attributes and object interactions that are supported by an HLA federation. In addition, optional classes of additional information may also be specified to achieve a more complete description of the federation structure and/or behaviour.

**Fidelity.** The accuracy of the representation when compared to the real world.

**High Level Architecture (HLA).** The High Level Architecture is composed of three parts: the HLA Rules, the HLA Interface Specification, and the Object Model Template (OMT). The HLA Rules describe the general principles defining the HLA, and delineate ten basic rules that apply to HLA federations and federates. The HLA Interface Specification defines the functional interface between federates and the Runtime Infrastructure (RTI). The Object Model Template Specification provides a specification for documenting key information about simulations and federations. Use of the OMT to describe Simulation and Federation Object Models (SOMs and FOMs) is a key part of the HLA.

**Live, Virtual and Constructive Simulation.** The categorisation of simulations into live, virtual and constructive is problematic because there is no clear division between these categories. The degree of human participation in the simulation is infinitely variable, as is the degree of equipment realism. This categorisation also suffers by excluding a category for simulated people working real equipment (e.g., robotics).

a. **Live Simulation.** A simulation involving real people operating real systems.

b. **Virtual Simulation.** A simulation involving real people operating simulated systems. Virtual simulations inject human-in-the-loop (HITL) in a central role by exercising motor control skills (e.g., flying an airplane), decision skills (e.g., committing fire control resources to action), or communication skills (e.g., as members of a CIS team).
c. Constructive Model or Simulation. Models and simulations that involve simulated people operating simulated systems. Real people stimulate (make inputs) to such simulations but are not involved in determining the outcomes.

Model. A representation of a system, entity, phenomenon, or process. Software models of specific entities are comprised of algorithms and data.

M&S Reuse. The use of M&S resources, (e.g., models, simulations, databases, algorithms, tools) for purposes beyond those for which they were originally developed. Reuse can occur within an organization or in different organizations, or in different application areas.

Object Model. A specification of the objects intrinsic to a given system, including a description of the object characteristics (attributes) and a description of the static and dynamic relationships that exist between objects.

Real-World. The set of real or hypothetical causes and effects that simulation technology attempts to replicate. When used in a military context, the term is synonymous with real battlefield to include air, land and sea combat.

Representation. The portrayal of an entity or process provided by a model, simulation, or federation.

Representational Resource. Knowledge about the real world (raw materials) used to develop a model, simulation, or federation. Representational resources fall into one of three categories:

d. Functional Description of the Mission Space (FDMS). An operator’s view of the entities, actions, relationships, interactions and environmental factors associated with a mission. Mission spaces may include any aspect of the real world, to include military operations, medical treatment, manufacturing, electrical power distribution, etc.

e. Characteristics and Performance Descriptions (C&PD). An expert’s identification of the entity’s nature, which are comprised of (1) attribute definitions, (2) algorithms and (3) data limits.

f. Scenario-specific Data. The particular information used by a given model, simulation or federation execution so that it may provide its representations in the context of a set of real-world circumstances. Scenario-specific data include terrain databases, order of battle, weather, plans and other state data.
**Resolution.** The level of detail of a model or simulation.

**Runtime Infrastructure (RTI).** The general purpose distributed operating system software that provides the common interface services during the runtime of an HLA federation.

**Scalability.** The ability of a distributed simulation to maintain time and spatial consistency as the number of entities and accompanying interactions increase.

**Scenario.** (1) Description of an exercise ("initial conditions" in military terms). It is part of the session database that configures the units and platforms and places them in specific locations with specific missions. (2) An initial set of conditions and time line of significant events imposed on trainees or systems to achieve exercise objectives.

**Simulation.** The execution over time of models representing the attributes of one or more entities or processes. Human-in-the-Loop simulations, also known as simulators, are a special class of simulations.

**Simulation Object Model (SOM).** A specification of the intrinsic capabilities that an individual simulation offers to federations. The standard format in which SOMs are expressed provides a means for federation developers to determine quickly the suitability of simulation systems to assume specific roles within a federation.

**Validation.** The process of determining the degree to which a model or simulation is an accurate representation of the real-world from the perspective of the intended uses of the model or simulation.

**Verification.** The process of determining that a model or simulation implementation accurately represents the developer’s conceptual description and specification. Verification also evaluates the extent to which the model or simulation has been developed using sound and established software engineering techniques.

**Verification, Validation & Certification (VV&C).** The process of verifying the internal consistency and correctness of data, validating that it represents real world entities appropriate for its intended purpose or an expected range of purposes, and certifying it as having a specified level of quality or as being appropriate for a specified use, type of use, or range of uses. The process has two perspectives: producer and user process.
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1. SACT’s Strategic Plan 2008 (Draft)


3. NATO Modelling and Simulation Master Plan, AC/323(SGMS)D/2 Version 1.0, August 1998


