NATO MODELLING AND SIMULATION GROUP (NMSG)

NORTH ATLANTIC TREATY ORGANIZATION
SCIENCE AND TECHNOLOGY ORGANIZATION

"Modelling and Simulation contributes to saving lives, saving time and money and preparing the war fighter better and faster"
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**Related Activity**
- HFM-202, HFM-220, HFM-209, MSG-107

**Projected First Meeting Location**
- The Hague - Aug 2013

**Lead Nation**
- Germany

**Team Leader**
- ALEXANDER, Thomas (Dr) Germany
- To be determined

**Nations/orgs. Who Endorsed The Activity**
- DEU NLD GBR USA CMRE CAN FRA

**Nations/orgs. Interested In The Activity**

**Non-nato Nations/orgs. Authorized To Participate**

**Nations/orgs. Desired To Participate**
- PfP GP

**Nations Actually Participating**
- DEU NLD CAN FRA ITA USA

**Activity Classification**
- Public Release (UU)

**Keywords**
- Architectures, Human behaviour modelling, Intelligent Agents, Interaction between Live and Simulation, Standardization, Training

**National + STO Resources Required**
**ABSTRACT**

Human behaviour modelling (HBM) includes the quantitative representation of performance, decision making and behaviour of individuals and small groups. It is an emerging technology with both wide a range of applications and the commensurate challenges to put these models reliably into practice as indicated in NATO Symposia (eg HFM-202) and Specialist Team meetings (eg MSG-107).

A particular area of interest is the seamless interaction of Live players with realistically simulated human characters. This capability has broad applications, ranging from training for urban operations, to red force representation in tactical Air-to-Air training. The required level of fidelity in such models may vary considerably across uses. However, they are all intended to represent important characteristics of human cognition and performance.

There is a need for standards for operational model architectures wherein humans and virtual humans can work together. These virtual humans should adequately model behaviour based on general human aspects (eg cognition, emotion, physiology) as well as on cultural background and role in society. The behaviour should be validated and fit-for-purpose to meet the requirements for military training. There is also a need for support of more natural interaction between human trainees and simulated characters (e.g. gestures and speech rather than keyboard and mouse).

**BACKGROUND**

Human behaviour modelling (HBM) includes the quantitative representation of performance, decision making and behaviour of individuals and small groups. It is an emerging technology with both wide a range of applications and the commensurate challenges to put these models reliably into practice as indicated in NATO Symposia (eg HFM-202) and Specialist Team meetings (eg MSG-107).

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Significant research is ongoing in this field (eg HFM-128). However, the NATO RTO, NATO armaments groups and the NATO military modelling, analysis and simulation communities would be well served by a consensus Reference Architecture for HBM. This would provide a common framework for developing HBMs for training, facilitating model reuse and information exchange, and ultimately savings in time and resources for development of particular training applications.

The challenge is the integration of science based models, that describe (only) part of human behaviour, into complex military training settings. The scope and limitations of currently developed models and architectures need to be investigated and the best approach for a consolidated Reference Architecture must be decided. Exploration of the state-of-the-art in human behaviour modelling, architectures and implementations requires a cross-disciplinary approach that should involve NATO experts from HFM (Human view), NMSG (architectures and standards), academia and industry.

**MILITARY RELEVANCE**

A human behaviour model (HBM) can be applied for a variety of military purposes: training, policy development (e.g. “which doctrine is most effective?”); organizational design (e.g. “which task allocation in a team has the most acceptable workloads?”) or system and interface design (e.g. “evaluating new military systems for usability and human performance”). This group wants to investigate seamless interaction of Live players with realistically simulated human characters. Applications range from training for urban operations (e.g. patrols, road-blocks, house searching) to red force representation in tactical air-to-air training.

**SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS**
ACTIVITY SUMMARY

The development of a Reference Architecture (RA) for human behaviour modelling of individual players intended for use in military training applications.

MSG-127 adopts a broad perspective in pursuing the objectives. An HBM architecture must be able to address a variety of factors potentially affecting behaviour, like physical properties (e.g. strength, endurance); cognitive properties (e.g. perception, memory, reasoning); and social properties (e.g. cultural norms, role in social group). Whether a particular factor is relevant or not depends upon the task and purpose of the model. All behaviour determining factors and their interactions must be captured in an appropriate architecture to represent and generate behaviour adequately for the selected military training application.

SCIENTIFIC TOPICS TO BE COVERED
• Analysis of relevant training applications
• Conceptual Modelling of individuals
  - Social and cultural influences on behaviour
  - Cognition, including decision making, error and planning, emotions
• Investigation of (Sub)model architectures and hierarchies
• Development of Reference Architecture capturing model integration and model interface standards
• Training provision validation and implementation
• Guidelines for tailoring the Reference Architecture to specific applications and implementations

SYNERGIES AND COMPLEMENTARIES
Significant research is ongoing in this field (eg HFM-128). However, the NATO RTO, NATO armaments groups and the NATO military modelling, analysis and simulation communities would be well served by a consensus Reference Architecture for HBM. This would provide a common framework for developing HBMs for training, facilitating model reuse and information exchange, and ultimately savings in time and resources for development of particular training applications.

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EXPLOITATION AND IMPACT
Given the increasing demand for realistic HBMs, there is a need for flexible and generic architectures that support behaviour generation across a diverse set of tasks, domains, and applications. A flexible architecture as envisioned by MSG-127 allows for easy inclusion and exclusion of such factors in the development and use of HBMs.
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<td>NATO Distributed Simulation Architecture &amp; Design, Compliance Testing And Certification</td>
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<td>Team Leader</td>
<td>RUIZ, José (ICT) France</td>
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<td>National + STO Resources Required</td>
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ACTIVITY SUMMARY

ABSTRACT
The integration of distributed simulations and tools into interoperable federations is a complex and time consuming task requiring extensive testing of individual components, interfaces and the integrated solution. To support this task, NATO relies on standards and agreements on their use. The Allied Modelling and Simulation Publication AMSP-01, NATO M&S Standards Profile, provides a list of recommended M&S related standards. The NETN Federation Architecture and FOM Design Document (NETN FAFD) developed by MSG-068 and MSG-106 provides additional agreements on the use of standards to support distributed simulation.

STANAG 4603 is identified as one of the cores standard for distributed simulation. It states that Participating nations agree to utilize the HLA Compliance Certification Process established by the NATO Modelling and Simulation Group (NMSG). The current software used for the HLA Federation Compliance Test Tool (FCTT) was developed by the USA and released to NATO in 2004. Since that time, the USA has made updates to the FCTT but has been unable to release the updated FCTT due to export restrictions. MSG ET-035 has investigated the feasibility of developing an open source version of the FCTT that would be available to all NATO and Partner nations but it was determined that the FCTT cannot be used as a foundation for a future certification tool. MSG ET-35 also concluded that HLA compliance testing needs to be extended beyond the HLA interface and data exchange testing and to address more complex federation agreements and requirements.

BACKGROUND
The integration of distributed simulations and tools into interoperable federations is a complex and time consuming task requiring extensive testing of individual components, interfaces and the integrated solution. To support this task, NATO relies on standards and agreements on their use. The Allied Modelling and Simulation Publication AMSP-01, NATO M&S Standards Profile, provides a list of recommended M&S related standards. The NETN Federation Architecture and FOM Design Document (NETN FAFD) developed by MSG-068 and MSG-106 provides additional agreements on the use of standards to support distributed simulation.

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Standards, federation agreements, compliance test and certification are important tools that will reduce integration risks, increase reuse of existing systems and support procurement of new interoperable simulation components.

This TAP covers (1) the maintenance and update of the NETN FAFD and (2) development of procedures and Integration Verification and Certification Tools (IVCT) to support compliance testing and certification of NETN FAFD compliant simulation components including certification of STANAG 4603.

MILITARY RELEVANCE
Using the Integration Verification and Certification Tools (IVCT) the cost, risk and integration time for networked simulations will be significantly reduced. The interoperability, reliability and stability of multinational distributed simulation systems will increase significantly.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
-Coordination with other MSG task groups to promote use of FAFD and incorporation of MSG task group results
-Maintenance of NETN FAFD including update and release of new versions of the technical specification
-Dissemination of NETN FAFD through presentations, papers and standardization activities within NMSG, SISO and other venues
ACTIVITY SUMMARY

- Provision of persistent test and integration network to support FAFD development and test, verification and certification activities
- Development of test, verification and certification procedures
- Design and implementation of IVCT to support certification, integration and verification of federates in specific federation.
- Development of IVCT tests to support NETN FAFD test, verification and certification

SCIENTIFIC TOPICS TO BE COVERED

- Update and maintain NETN FAFD based on user feedback
- Develop NETN FAFD compliance testing procedure and test cases
- Design IVCT based on available Use Cases and Requirements
- IVCT implementation in three one-year phases
  - 1st year: Implement the first prototype able to test Conformance statement
  - 2nd year: Implement test cases for Integration and Verification purposes
  - 3rd year Implement the whole IVCT infrastructure
- Setup data flow among all entities in IVCT processes

SYNERGIES AND COMPLEMENTARIES

Standards, federation agreements, compliance test and certification are important tools that will reduce integration risks, increase reuse of existing systems and support procurement of new interoperable simulation components.

This activity covers (1) the maintenance and update of the NETN FAFD and (2) development of procedures and Integration Verification and Certification Tools (IVCT) to support compliance testing and certification of NETN FAFD compliant simulation components including certification of STANAG 4603.

EXPLOITATION AND IMPACT

Using the IVCT the cost, risk and integration time for networked simulations will be significantly reduced. The interoperability, reliability and stability of distributed simulation systems will increase significantly. The NATO Training and Education community will heavily rely on IVCT as an up-to-date standard setter and certification tool.
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<td>Modelling and Simulation as a Service (MMaaS) Rapid Deployment Of Interoperable And Credible Simulation Environments</td>
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<td>Team Leader</td>
<td>SIEGFRIED, Robert (Dr)</td>
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ABSTRACT
NATO and the nations regularly use distributed simulation environments for various purposes (e.g., training, mission rehearsal, or decision support in acquisition processes). Achieving interoperability between participating systems and ensuring credibility of results require still today enormous efforts with regards to time, personnel, and budget. This is a result of current standards which focus mainly on technical, syntactic and to a limited degree on semantic interoperability. Missing are simulation standards, agreements, and reference architectures that focus on higher levels of interoperability and simulation credibility.

This activity is a follow-on of the MSG-131 Specialist Team (Modelling and Simulation as a Service: New concepts and Service Oriented Architecture) that provides the baseline for this activity. Amongst others, MSG-131 provides a draft Reference Services Oriented Architecture and investigates possible solutions as input for this follow-on activity.

To enable rapid deployment of high-quality simulation environments (with regards to interoperability and credibility as well as required resources) this task group addresses the following two topics:

1. Improve simulation interoperability and credibility by using M&S domain services, using the recommendations from MSG-131. The Specialist Team investigated a number of use cases for M&S as a Service, for example:
   - Synthetic Environment Service (SES) to enable rapid initialization of participating simulation systems with correlated synthetic environment data.
   - Scenario management services to reduce development time by using a library of typical scenarios that may be re-used with minimum efforts.
   - Weapon Effects Services and Communication Effects Services to improve fair-fight conditions.
   - C2 Planning Support Services to provide decision support to C2 planning activities.

2. Establish sustainable and efficient management of M&S services in NATO by analyzing the organizational M&S services perspective, for example:
   - Establishment of a Defense cloud (e.g., nation-wide, NATO-wide, coalition-wide)
   - V&V services.
   - Certification and compliance testing services.
   - Training needs analysis services.
   - Catalog services.

M&S domain services aim to harmonise specific characteristics of simulation models (e.g., providing terrain information, or calculating weapon effects) and to improve simulation interoperability on higher levels, namely on the pragmatic and conceptual interoperability level. Harmonisation increases fair fight with regard to a specific domain and improves simulation quality as well as credibility. M&S domain services also significantly increase reusability and reduce verification and validation efforts.

M&S domain services as described above need to be complemented by an analysis of the organizational M&S services perspective. Organizational M&S services include the organization, the processes, the infrastructure, the policies and procedures, etc. of providing M&S services to NATO and the nations. Without proper organizational support, NATO and the nations will not be able to provide M&S services in a sustainable and efficient way. The activities of this task group will be aligned with further NATO activities and will especially take into account the results of ET-34 and MSG-131, as well as related ACT activities regarding M&S as a Service.

BACKGROUND
NATO and the nations regularly use distributed simulation environments for various purposes (e.g., training, mission rehearsal, or decision support in acquisition processes). Achieving interoperability between participating systems and ensuring credibility of results require still today enormous efforts with regards to time, personnel, and budget. This is a result of current standards which focus mainly on technical, syntactic and – to a limited degree – on semantic interoperability. Missing are simulation standards, agreements, and reference architectures that focus on higher levels of interoperability and simulation credibility.
ACTIVITY SUMMARY

MILITARY RELEVANCE
NATO and the nations regularly use distributed simulation environments for various purposes (e.g., training, mission rehearsal, or decision support in acquisition processes). Achieving interoperability between participating systems and ensuring credibility of results require enormous efforts with regards to time, personnel, and budget. A new “M&S ecosystem” will provide M&S products, data and processes simultaneously and spontaneously to as many users as often as possible for their individual purposes. This M&S eco-system will have to support stand-alone use as well as integration of multiple simulation systems and real systems into a coherent (perhaps distributed) simulation environment whenever the need arises.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
To investigate, propose and evaluate standards, agreements, architectures, implementations, and cost-benefit analysis of Modelling and Simulation (M&S) as a Service (MSaaS) approaches. Specifically, with regards to:

1. Evaluating the use of (M&S domain) services to improve simulation interoperability and credibility.
2. Analyzing the organizational M&S services perspective to establish a sustainable and efficient management of M&S services in NATO.

Specific M&S domain services for detailed investigation are selected by the task group and may include (but are not limited to):

- Enabling rapid initialization of simulation systems with correlated synthetic environment data by using a Synthetic Environment Service (SES).
- Reducing development time significantly by scenario management services (including library of typical scenarios that may be used with minimum efforts).

MSG-136 is divided in three sub-groups that produce individual, but interrelated results. Key deliverables of MSG-136 will be:
- Operational Concept Document for a Future M&S as a Service Eco-System (OPS sub-group)
- Draft AMSP “M&S as a Service” (GOV sub-group)
- MSaaS Reference Architecture, Service Specifications, Change Requests to existing M&S standards to capture MSaaS-specific topics (TEK sub-group)

SCIENTIFIC TOPICS TO BE COVERED
The following topics will be covered by this activity:

1. M&S Domain Services (depending on the selected services) and Service Landscape
2. Organizational M&S Services Perspective

Additionally, the task group will

- Collaborate with standards bodies and
- Inform stakeholders concerning the results

SYNERGIES AND COMPLEMENTARIES
This task group continues the efforts started by ET-34 and MSG-131. It directly addresses the following objectives of the NATO M&S Master Plan v2.0 of September 2012:

Objective 1.1 Develop NATO standard interoperability architecture and supporting material

Objective 1.2 Establish recommended standards pertaining to data interchange for M&S and C2 systems, promotion of true interoperability, pursue trust in M&S

Objective 2.1 Develop common process and procedures to guide actions and decisions regarding M&S application

Objective 2.4 Promote the sharing of M&S resources through a knowledge management process and system

EXPLOITATION AND IMPACT

11
Results of MSG-136 are presented at the NATO CAX Forum, ITEC, SISO events, and at national conferences. MSG-136 successfully organized a workshop at SimTecT to improve engagement of the South-East Asian M&S Community. Experimentations and demonstrations are conducted at CWIX and I/ITSEC. A special issue of the Journal of Defense M&S (JDMS) is published.
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<td>M&amp;S Use Risk Identification And Management</td>
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**Related Activity**: NCIA, NIAG, ACT

**Projected First Meeting Location**: Orlando (USA)

**Lead Nation**
- Team Leader: United States
- YOUNGBLOOD, Simone (Ms)
- To be determined

**Nations/orgs. Who Endorsed The Activity**: CAN FRA DEU NOR

**Nations/orgs. Interested In The Activity**

**Non-nato Nations/orgs. Authorized To Participate**: AUS NZL

**Nations/orgs. Desired To Participate**: PfP GP

**Nations Actually Participating**: DEU USA CZE FRA GBR CAN NOR ITA

**Activity Classification**: Public Release (UU)

**Keywords**: Cost-Benefit, M&S data, Quality Assurance, Re-usability, Use Risk

**National + STO Resources Required**
MSG-139 is focused on developing a commonly accepted methodology for M&S use risk identification, calculation and management using methods that balance M&S use risks against the amount of resources and efforts needed to establish confidence in the M&S and its results.

BACKGROUND
The general issue of Verification and Validation (V&V) and Acceptance (VV&A) of Models, Simulations, and Data has been already addressed in several working groups inside NATO (such as by NMSG-019 “VV&A of Federations”, NMSG-054/TG-037 “Risk-Based Tailoring of the Verification, Validation, and Accreditation/Acceptance Processes”, NMSG-073 “GM-VV”) or outside (e.g. SISO-PDG “GM-VV”) and significant progress has been achieved over the past two decades. But still missing are internationally accepted methods, guidelines and tools which allow to determine kind and amount of quality assurance measures and associated level of effort required to limit use risk to a certain, acceptable level. While there is general consensus on the importance of this topic, and some internationally accepted guidelines or standards on VV&A are available, no commonly accepted methodology for M&S use risk calculation or for balancing use risk versus level of effort needed to establish confidence in the M&S.

As the application of increasingly complex and often interoperable M&S and associated data inherits the risk of using erroneous, invalid or unsuitable models, simulations and data, there is a need for an internationally accepted technical framework that enables the identification and management of M&S use risk. This generic technical framework could be applied in future NATO and national projects.

MILITARY RELEVANCE
Regarding the permanently increasing importance and usage of Models, Simulations, and Data for military operation, training, acquisition and decision making, on one side, and regarding the increasing complexity of those tools, on the other side, this TG will provide approaches for M&S use risk versus cost-benefit analyses and a technical framework for application of a wide range of quality assurance measures.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
• Define the collection and application of V&V evidence that supports the identification of M&S use risk,
• Define and document parameters and methods for M&S use risk calculation
• Develop and document measures and guidelines for M&S use risk and associated efforts evaluation
• Develop a generic technical framework for M&S use risk identification and management,
• Assemble confidence in the proposed methodology on the basis of ‘real’ case studies,
• Provide education and training based on an established methodology.

S&T expected achievements from MSG-139 include providing generic methods and guidance for M&S use risk identification, providing a set of methods and techniques for M&S use risk analysis, defining M&S use risk remediation solutions, as well as analysis solutions applicable to the various M&S technologies and system life-cycle paradigms.

SCIENTIFIC TOPICS TO BE COVERED
Main outputs of the TG will provide approaches for M&S use risk versus cost-benefit analyses and a technical framework for application of a wide range of quality assurance measures.

SYNERGIES AND COMPLEMENTARIES
Contributions of current guidelines, standards and tools for Verification and Validation (V&V) support acceptance decisions of models, simulations and data. Following these guidelines and standards like the above mentioned ones offers opportunities and an important source of information regarding use risks analysis. Despite the consensus in the M&S community on the importance of this topic, there are no accepted methods available for qualification or quantification of M&S use risk taking into account project specific M&S requirements and constraints. Amount and intensity of documentation, testing, verification and validation efforts for decreasing M&S use risks below a desired risk level requires additional resources and generates costs. Therefore, methods for balancing use risk versus costs have to be researched
ACTIVITY SUMMARY

in this context. A common set of complementary and state-of-the-art M&S use risk identification, analysis and management methodologies will help facilitate future NATO and national M&S projects with respect to quality, credibility and utility assurance by:
Providing generic methods and guidance for M&S use risk identification,
Providing common understanding and knowledge of M&S use risk issues solutions,
Providing a set of methods and techniques for M&S use risk analysis,
Providing more methods and a guideline for use risk versus cost-based tailoring risk-based tailoring),
Providing M&S use risk identification and analysis solutions applicable to the various M&S technologies and system life-cycle paradigms
Providing a basis for dissemination, maturing and management of M&S use risk

Military benefits
Increasingly, M&S is being exploited as an enabling technology to support tactical, operational and strategic objectives within the military domain. The use of M&S provides those within the military domain with a powerful and resource-efficient capability for, but is not limited to:
Training and education;
Mission analysis and rehearsal;
Decision support in various fields of application (Capability analyses and management;
Investigation of leading-edge technologies;
Support of acquisition processes;
Concept Development and Experimentation (CD&E)

M&S Life Cycle Management

There are inherent risks associated with using erroneous or unsuitable models, simulations and data. For example, within the training domain, negative transfer of training results could cause server safety problems among other unintended or undesirable results. As more and more decisions will be based on interpretation of M&S results, M&S deficiencies could cause wrong decisions which can lead to safety-critical or expensive decisions. Verification and validation of M&S is intended to assess the correctness, validity and suitability of models and simulations thereby reducing the cost and risk of both their development and deployment. But VV&A does not provide precise indicators for potential use risks and consequences. Currently available guidelines, standards and tools for VV&A provide a solid basis, but are not sufficient for sound M&S use risk analysis. This TG will work on closing this gap.

Many military decisions are based on M&S results. One of the aims of application of M&S use risk identification, analysis and management methodologies is to provide an argumentation which will permit the military authorities to make decisions with an understanding of the use risks and required resources involved in using such quality assurance measures.

The indirect benefits touch on every phase of the M&S life cycle - design, development, operation and maintenance processes of military systems and weapons by armament companies and their customers.

EXPLOITATION AND IMPACT

Given the increasing importance and usage of M&S for military operations, training, acquisition and decision making, expected main impact of the MSG-139 activities is an internationally accepted technical framework that enables the identification and management of M&S use risk.
## ACTIVITY SUMMARY

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<td>MSG-140</td>
<td>Urban Combat Advanced Training Technology - Live Simulation Standards (UCATT-LSS)</td>
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**Related Activity**

**Projected First Meeting Location**

**Lead Nation**

**Team Leaders**

**Panel/Group Mentor**

**Nations/orgs. Who Endorsed The Activity**

**Nations/orgs. Interested In The Activity**

**Non-nato Nations/orgs. Authorized To Participate**

**Nations/orgs. Desired To Participate**

**Nations Actually Participating**

**Activity Classification**

**Keywords**

**National + STO Resources Required**
ACTIVITY SUMMARY

ABSTRACT
Multinational instrumented live training is becoming more important in the preparation for missions now that operations within a coalition is often required. To conduct training exercises with a “train as you fight” philosophy an instrumentation system with appropriate fidelity and interoperability of the live simulation training equipment is vital. A series of Urban Advanced Training Technologies (UCATT) Task-Groups have worked this issue and have developed a functional architecture, identified a set of interfaces and the definition of interoperability standards. The first UCATT Standard, accredited by SISO will be released in Nov. 2015. This marks a milestone in Live Simulation interoperability. UCATT-Live Simulation Standards (UCATT-LSS) is tasked to support this standard and to enhance it with new interface-standards over time.

BACKGROUND
The NATO Research and Technology Organisation (RTO) 1999 Technical Report “Land Operations in the Year 2020” (LO2020) and the 2003 “Urban Operations in the Year 2020” (UO2020) concluded that NATO forces would potentially have to conduct future operations in urban areas. These led to the first UCATT TG (MSG-032, also known as UCATT-1) and follow on UCATT-2 TG (MSG-063). The UCATT Architecture TG (MSG-098) and the UCATT Standards TG (MSG-099) have just completed and UCATT-LSS is the fourth mandate. The first meeting takes place in Stockholm in late Sep 2015.

MILITARY RELEVANCE
NATO studies indicate that urban areas are the most likely battlefields in the 21st century. Multinational instrumented live training is becoming more important in the preparation for missions now that operations within a coalition is often required. To conduct training exercises with a "train as you fight" philosophy an instrumentation system with appropriate fidelity and interoperability of the live simulation training equipment is vital. UCATT has developed a generic functional architecture for live simulation training systems and is essentially a blueprint of a live combat training centre design. Using a common Laser-engagement interface, UCATT has developed the first international interface standard in live simulation.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
UCATT-LSS continues the standardization work of MSG-098/099. It will form the formal SISO Product Support Group for the first standard and develop or identify new standards for the remaining interoperability interfaces. Also, maintenance and review of the functional architecture will be undertaken to ensure it reflects valid actual and future military use cases. Perhaps uniquely within NMSG, UCATT has, from the outset, drawn members from active duty military, government acquisition staff and industry directly involved in instrumented live training and simulation, UCATT has become a valuable focal point for those in this business area and a useful networking opportunity to share knowledge and facilitate information exchange within NATO and PfP on live simulation. The continuation of the UCATT activities within MSG-140 UCATT Live Simulation Standards TG secures not only a vehicle for continued work on standardization within the live simulation community, but also one to embed and support the goals already achieved.

UCATT has developed a generic functional architecture for live simulation training systems and is essentially a blueprint of a live combat training centre design. This architecture serves as a foundation to all interface-standardization activities. Using a common Laser-engagement interface, UCATT has developed the first international interface standard in live simulation. UCATT-LSS will continue the work by creating more standardized interfaces and by supporting the standards put in place.

SCIENTIFIC TOPICS TO BE COVERED
Operational Concepts: continuous maintenance of the comprehensive list of developed Generic User Requirements in conjunction with NATO Training Groups and Military Users on the live, virtual and the constructive domain. Further Standardization through the SISO process of UCATT defined and prioritized interfaces following the functional architecture. Maintain the UCATT functional architecture for LIVE training&simulation. Establishment of a PSG to maintain the UCATT Standards.
SYNERGIES AND COMPLEMENTARIES
UCATT-LSS intends to review applicability of other (standardization) activities like e.g. JC3I EDM, CBML or HLA as potential candidates for the UCATT interface-standards. The goal is to ensure close cooperation with the relevant groups; by exchanging information or via invitations to Subject Matter Experts to attend selected UCATT meetings to avoid duplication of effort.

EXPLOITATION AND IMPACT
A set of standardized live simulation interfaces will place Military users and Acquisition organizations in a better position to define requirements for new projects, show industry where to target investment, open tendering opportunity and bring interoperable training to a new level. There is already first evidence of adoption of the UCATT Laser standard.
**ACTIVITY SUMMARY**

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<td>Reference Number</td>
<td>MSG-145</td>
<td>Operationalization Of Standardized C2-Simulation Interoperability</td>
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<td>France</td>
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<td>Team Leader</td>
<td>KHIMECHE, Lionel (Mr.) France</td>
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<tr>
<td>Panel/Group Mentor</td>
<td>HUISKAMP, Wim (Mr) Netherlands</td>
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<td>Nations/orgs. Who Endorsed The Activity</td>
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<td>Keywords</td>
<td>Architecture Framework, C2SIM, C2-Simulation Interoperability, C-BML, Information Model, MIM, MIP, MSDL, NAF, Standard, Systems Engineering</td>
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<tr>
<td>National + STO Resources Required</td>
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ABSTRACT
Command and Control to Simulation (C2SIM) interoperability standardization efforts have been undertaken for over a decade within the NATO Science and Technology Organization (STO). These activities have identified the military need for nations to not only interoperate and enhance command post forces readiness, but to provide C2SIM support on operations for military planning, mission rehearsal, control of autonomous systems, and to the acquisition life cycle process in nations. Methods for connecting C2 systems and simulations need to be cost-effective and efficient for these applications.

BACKGROUND
Force readiness (education and training), execution and support to operations (planning, mission rehearsal, control of autonomous systems) and Defense Acquisition (capabilities development, systems qualification) heavily lean on C2 to Simulation interoperability.

To enable information exchange in a timely, efficient and cost-effective manner in turn requires a standardized representation and interfaces that allow C2 and simulation systems (C2SIM) to interoperate. The C2SIM standard is being developed for this purpose.

Standardizing the exchange of digitized military information for C2SIM interoperation will lead to realizing a number of benefits that include:
- Enhanced realism and overall effectiveness by faster, more consistent information exchange among systems.
- Decreased cost and risk by reducing manual input (the swivel chair effect), reduced number of supporting personnel and equipment.
- Reduced preparation and response time with rapid configuration, initialization of systems and validation of scenario.

MILITARY RELEVANCE
As we are living in a world where this training have to include people from different Nations or branches within a coalition, it is required to work in some standards to enable interoperation of Command and Control and Simulation systems. NMSG has worked in two standards in the past to allow this interoperability. Coalition-Battle Management language (C-BML) is an standard that defines an unambiguous language to describe order, report and request for the exchange of digitized military information among command and control (C2), simulation and autonomous systems. In parallel to the development of C-BML, NMSG has worked in Military Scenario Definition Language (MSDL) standard to develop the scenario and to reduce scenario development time and cost, with the additional goal of being able to use the resulting scenario across multiple simulations. So, it is necessary to merge both standards in only one (C2SIM).

This group has started their activity to exploit C2SIM through an operational, conceptual and executable scenario development process. This new standard will allow to enhance realism and overall effectiveness by faster, more consistent information exchange among systems, to decrease cost and risk by reducing manual input (the swivel chair effect), to reduce the number of supporting personnel and equipment, and to reduce the preparation and response time with rapid configuration, initialization of systems and validation of scenario.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
The high-level technical objectives of MSG-145 are as follows.
- Exploit C2SIM with use cases developed through an operational, conceptual and executable scenario development process.
- Enrich the C2SIM Logical Data Model Core (logical definitions of initialization, tasking, and reporting business elements).
- Inform the standards development process and motivate suppliers to develop products by demonstrating C2SIM in operational military context.
- Educate the community of practice on C2SIM technology employment and encourage nations to use the standard.
- Make recommendations for "covering" the C2SIM standard with a STANAG.

The technical success of MSG-085 left the C2SIM community eager to pursue operationalization under MSG-145. The NATO future force will need to meet uncertain and hybrid nature of threats and operational environments. To this
ACTIVITY SUMMARY

end, MSG-145 is looking at a number of use cases that include:

- Cyber Warfare and Information Operations,
- Autonomous Systems and Robotics,
- Joint and services Mission Planning, Training and Battlespace Management,
- NATO Mission Threads and Tactical Data Link.

Key deliverables of MSG-145 will be:

- A “sandbox” testbed for C2SIM that will be a continually available environment, for national teams to demonstrate and assess C2SIM.
- Experimentation evaluation of C2SIM extensions performed with NATO and national operational military.
- Proposal for a STANAG.

SCIENTIFIC TOPICS TO BE COVERED

1. Outreach to military stakeholders.
2. Use case extensions (e.g. acquisition) and associated information exchange.
3. Development process, products and tools for implementation.
4. NATO Architecture Framework (NAF) and other methods to describe scenarios and interoperability requirements.
5. Automation of M&S initialization.
6. Experimentation and validation of the standard.
7. Services to enable persistent C2SIM interoperability (e.g. C2SIM as a service on mission networks).
8. STANAG development.
9. Progress demonstrations and workshops.
10. Tutorials.

SYNERGIES AND COMPLEMENTARIES

The S&T work relies heavily on web conferences to meet cost and time requirements. 9 nations, 3 NATO bodies and 40+ subject matter experts are working together to improve M&S capabilities.

EXPLOITATION AND IMPACT

Operational demonstration to showcase selected use cases will be organised during major simulation and C2 events such as I/ITSEC, ITEC, NATO Computer Assisted Exercise (CAX) Forum and ICCRTS or exercises such as Viking and the Coalition Warrior Interoperability Exercise (CWIX).
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<td>Reference Number</td>
<td>MSG-146</td>
<td>Simulation For Training And Operation Group-Land (STOG-L)</td>
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**Related Activity**

**Projected First Meeting Location**


**Lead Nation**

Switzerland

**Team Leaders**

PRICE, Ulrich (LTC)

**Panel/Group Mentor**

**Nations/orgs. Who Endorsed The Activity**

BEL BGR CAN NLD NOR SVN USA CHE DNK SWE DEU CZE MKD

**Nations/orgs. Interested In The Activity**

Non-nato Nations/orgs. Authorized To Participate

AFG AUS IRQ JPN NZL PAK KOR

**Nations/orgs. Desired To Participate**

PIP GP

**Nations Actually Participating**

BGR CAN CZE DNK DEU NOR SVN COE-CBRN COE-MS CSO JFTC MK

**Activity Classification**

NATO Unclassified (NU)

**Keywords**


**National + STO Resources Required**
ABSTRACT
MSG-146 is a group of military experts working in Simulation at their national Simulation Centers, in Training. The main focus of the group is to exchange knowledge and experiences and finally bring up solutions on getting standards throughout the alliance for cooperation in training and preparation.

BACKGROUND
"I want intuitive ways for commanders to execute their plan - in simulator or in real". This the idea of STOG-L. In the past every nation had its own development, based on their financial situation and the needs were based on what they also were able to spend for training. But for training it doesn't have to be only a national issue, no, within NATO the chance has be taken to develop together and to help each other in training needs – and therefore the exchange of knowledge, technology and finally also the chance to exercise together has to be a main focus, so synergies can be found and used.

MILITARY RELEVANCE
As we are living in a world where this training have to include people from different Nations or branches within a coalition, it is required to work in some standards to enable interoperation of Command and Control and Simulation systems. NMSG has worked in two standards in the past to allow this interoperability. Coalition-Battle Management language (C-BML) is an standard that defines an unambiguous language to describe order, report and request for the exchange of digitized military information among command and control (C2), simulation and autonomous systems. In parallel to the development of C-BML, NMSG has worked in Military Scenario Definition Language (MSDL) standard to develop the scenario and to reduce scenario development time and cost, with the additional goal of being able to use the resulting scenario across multiple simulations. So, it is necessary to merge both standards in only one (C2SIM).

This group has started their activity to exploit C2SIM through an operational, conceptual and executable scenario development process. This new standard will allow to enhance realism and overall effectiveness by faster, more consistent information exchange among systems, to decrease cost and risk by reducing manual input (the swivel chair effect), to reduce the number of supporting personnel and equipment, and to reduce the preparation and response time with rapid configuration, initialization of systems and validation of scenario.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
STOG-L has three (3) main objectives:
• Knowledge-hub for NATO with focus on installed Simulators and Exercises running within the different nations (Product: List of all known Simulators, categorized in L-V-C-G, installed and running);
• Information on Best practices and Lessons Learned out of used technology and in SimEx;
• GAP-Analyses from the point-of-view of a trainer / Sim Center, focused on the questions "What is missing or could help us be more efficient?" and "Couldn't this Simulator be better?". Aim is to help the industry develop towards the needs of the Armed Forces and to "trigger" the industry.

The members provide an overview of the national updates and best practices in education, training, preparation, execution and evaluation of the operational deployment to bring out an annual document of "Installed and Running Simulators". They look for new standards and try to get similar systems so it makes it easier to get a chance to exchange troops and train at different places. And, they also try to find out gaps to put together kind of a "request" for the industry, so the industry can research and develop what is needed.

SCIENTIFIC TOPICS TO BE COVERED
Support for other NATO bodies:
• Support MSG Activities
• Subject matter expertise for inside NMSG
• Support initiatives outside NMSG
• Best Practices

Support for NATO Members and Partners:
ACTIVITY SUMMARY

• Support to build up of Sim Centers
• Review of experiences with simulators and the work together with the industry
• Sharing of national requirements and Best Practices
• Use of simulation for training, for operations and for other purposes

Areas to be covered inside the group:
• Review of all simulation systems used for training
• Review of all databases used in the simulation systems
• Use of LVC for exercises
• Identify common approaches to the use of simulation in training
• C2 integration for Simulation
• Best practices for Serious Gaming
• Simulation supporting tools
• Monitoring development in Academia & Industry
• Feedback on international events (e.g. ITEC, I/ITSEC etc.)

SYNERGIES AND COMPLEMENTARIES
The exchange of information, best practices and experiences resulted in more reuse of models and terrain database. Visits of senior leadership of simulation centres help to get more awareness of simulation at that level of command.

EXPLOITATION AND IMPACT
The strength of STOG was and shall be in the future, that it is composed of experts and specialists, mainly military officers, working at their nations simulation centers dealing on daily basis with the operational needs of commanders and their units. The focus of the group is using modelling and simulation to support education, training, preparation, execution and evaluation of operational deployment.

Within the group all levels of simulation (Live, Virtual and Constructive as well as Serious Gaming) are discussed and covered in support of levels up to BDE command and operations.

What NATO needs and can be found in STOG is the following:
A NATO Knowledge Hub of Simulation to provide knowledge and expertise to the different nations and therefore get somehow compatibility for training with simulation within NATO (e.g. capability to run integrated, combined or even joint exercises).

The need of expertise of the use of simulation within the domains.
Achieve a compatibility on simulation with focus on constructive sim systems for training in a joint environment (e.g. joint staffs with their subordinated (national) staffs).

A POC for the industry to develop what the troops need and not be triggered vice-versa.
The possibility to exchange expertise on C2 Systems along the credo "Train as you fight", using e.g. 3D world of operation area and intuitive interfaces.
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<td>Reference Number</td>
<td>MSG-147</td>
<td>M&amp;S Support For Crisis And Disaster Management Processes And Climate Change Implications</td>
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<td>Activity End Date</td>
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**Related Activity**
- NCIA, ACT

**Projected First Meeting Location**
- Sofia, BGR, 17-18 Mar 2016

**Lead Nation**
- COE - Crisis Management and Disaster Response (CMDR)

**Team Leaders**
- NIKOLOV, Orlin (Col)

**Panel/Group Mentor**
- COE - Crisis Management and Disaster Response (CMDR)

**Nations/orgs. Who Endorsed The Activity**
- BGR DEU SVN USA AUT

**Nations/orgs. Interested In The Activity**

**Non-nato Nations/orgs. Authorized To Participate**
- STOEOP PfP GP

**Nations/orgs. Desired To Participate**
- COE-MS JFTC ACT COE-CBRN JWC NCIA

**Nations Actually Participating**
- CZE DEU COE-CMDR COE-CBRN COE-MS JFTC

**Activity Classification**
- Public Release (UU)

**Keywords**
- Command and Control, Data Analysis, Data Gathering, Decision Making, Distributed Simulation, Modelling, Simulation Environments, Simulation Interoperability, SOPs Implementation, Training, Training and exercise requirements

**National + STO Resources Required**
ACTIVITY SUMMARY

ABSTRACT
The responsibility for crisis management and disaster response is different for every nation and may involve several ministries and agencies. It is also a core task of the Alliance. Today the Alliance is able to take decisions in crisis and emergency situations, and to act under significant threat and time pressure. NATO develops capabilities to be ready, on a case-by-case basis and by consensus, to contribute to effective crisis management and disaster prevention. This enables the Alliance to actively engage in crisis management and disaster response, including through non-Article 5 crisis response operations. The Alliance is therefore encouraging the joint training of military and civilian personnel to help build trust and confidence.

The 2015 Gap Analysis Report serves as the foundation for the development of the 2015 Action Plan (AP) on M&S in support of military training. Science, Technology, Modelling & Simulation Branch NATO HQ SACT and CMDR COE staff realized, that there is a gap in NATO computer supported capabilities dealing with big events with negative impact over human society like crisis and disasters as well evaluation of Climate Change. A CMDR COE Staff started working on the project for creating of technical platform using M&S for conducting of experimentations, tests and CAXs and training in the area of CMDR and Climate Change.

The aim of the project is to develop a technical platform capable of supporting and conducting crisis management and disaster response exercises and analysis. It should be established with several crisis management and disaster response tools and simulations that are unique to NATO and enable non-military type operations. The software environment should enable to provide:
- automated data collection,
- engine for modeling with defined triggers,
- C2 logic and SOPs implementation;
- a dynamically generated plan for Crisis/Disaster Response,
- prognosticate and Climate Change analyses

The main purpose of the software environment is not to substitute the human of the crisis management. The main goal is to reduce the number of the problems on which the human should be focusing on.

BACKGROUND
The responsibility for crisis management and disaster response as well Climate Change influences are different for every nation and may involve several ministries and agencies. It is also a core task of the Alliance. Today the Alliance is able to make decisions in crisis and emergency situations, and to act under significant threats and time pressure. NATO develops capabilities to be ready, on a case-by-case basis and by consensus, to contribute to the effective crisis and disaster prevention. This enables the Alliance to engage actively in crisis management and disaster response, including through non-Article 5 crisis response operations. The Alliance is therefore encouraging the joint training of military and civilian personnel to help build trust and confidence.

MILITARY RELEVANCE
Our current security environment is marked by persistent conflicts and constant changes as the future brings uncertainty of man-made crises, where opportunistic actors take advantage of chaos, in addition to the increasing natural resource competition, disruptive impact of migration and violent extremism. As military action alone is insufficient to prevent or manage crises, success in operations requires enhanced interaction amongst the military and civil actors at all levels before and during engagement.

In order to improve the interrelationship between civilian and military organizations which are facing crisis and disaster a reference architecture and demonstration of a technical platform that enables prompt, reasonable and effective tests of Crisis/Disaster and Climate Change Implication (CCI) Response plans should enable to provide a distributed simulation environment to train the military in tasks they are not prepared.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
The aim of the project is to develop a reference architecture and demonstrate a technical platform that enables prompt,
ACTIVITY SUMMARY

reasonable and effective tests of Crisis/Disaster and Climate Change Implication (CCI) Response plans. The development includes researches, theory and concept creation, standardization and interoperability improvements.

The expected Deliverables are:
• Investigate, categorize and catalogue data sources available for Disaster Response (DR).
• Analyze existing standards in common vocabulary and investigate for new ones to adapt existing for NATO purposes.
• Categorize existing M&S solutions and develop missing ones.
• Computer formalization of Command and Control logic for Crisis/Disaster Response.
• Reference architecture/platform for proof of concept.
• Demonstration (contribution to multinational exercises) as a test bed for Analysis and Trainings in order to support Crisis/Disaster Management and Climate Change Implications.

SCIENTIFIC TOPICS TO BE COVERED
The project consists of following tasks, some of them enabling parallel development:
1. Database for storage and management of the information and data related with crisis and disasters.
2. Capability for determination of players, objects, infrastructures, systems. Should be defined: location, form, vulnerability, relations with other objects/systems. Capability for data import from different sources like GEO information.
3. Capability for implementation of control logic (command and control system, decision making and supporting system)
4. Capabilities for modeling and simulation of crisis and disaster events
   a. Module for modeling environment parameters under defined initial conditions
   b. Engine for model generation based on statistical data
   c. Replay the events using the stored information into the database.
5. Capability for education and training
6. Artificial intellect for simulating actions of individual or collective players
7. Report generating module for the environmental parameters
8. Integration with other used in NATO software tools.

SYNERGIES AND COMPLEMENTARIES
The project combines NATO Crisis Response Process with industrial theory for system control in predefined parameters. The task is of significantly large scale and could be easily divided into subtasks and spread among NATO Nations, bodies, organizations and partners.

EXPLOITATION AND IMPACT
The additional development of M&S environment and technical architecture specialized for CMDR Training and Climate Change preparedness would provide NATO with a unique comprehensive training and analytical capability unmatched anywhere in the world to enable non-military type operations. This M&S environment would be able to support large-scale CMDR and CCI distributed exercises and analysis with specific crisis management and disaster response tools and simulations.
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<th>MSG</th>
<th>Activity Title</th>
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<td>COE - Modelling and Simulation (M&amp;S)</td>
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ABSTRACT
Concept Development and Experimentation (CD&E) is one of the prime tools that enable military transformation through the structured development of creative and innovative ideas into viable solutions for capabilities development. Modelling and Simulation (M&S) offer a set of tools and techniques in order to enhance both operational and cost effectiveness in support to capability development.

BACKGROUND
NATO Allied Command Transformation, together with other NATO bodies, national organizations and Centers of Excellence form a key part of the generation and evolution of Transformational ideas and concepts. Initiatives like the CD&E working group, the International CD&E Conference and the relevant number of NATO publications and documents give to the Communities of Interest (CoI’s) the idea of the relevance of the CD&E within NATO. M&S supporting NATO CD&E MSG would promote and leverage efficiency in order to identify areas of possible applications of collaboration between Nations and/or among the Alliance to benefit both ACT and national CD&E programmes (ACT Directive 10-1).

MILITARY RELEVANCE
M&S supporting NATO CD&E process would promote and leverage efficiency proposing a guidance, recommendations, best practices and lessons learned regarding the adoption of M&S tools in support of CD&E phases and activities to improve synergy, interoperability, reuse and affordability and in order to identify areas of possible applications of collaboration between Nations and/or among the Alliance to benefit both ACT and national CD&E programmes.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
M&S supporting NATO CD&E MSG aims to:
• provide a recommended approach to NATO CD&E methodology adopting M&S technology in support of development of new or improved military capabilities.
• contribute to the improvement of the M&S Community of Interest (CoI) awareness, providing use cases, best practices and an education package regarding the adoption of M&S tools to support NATO CD&E methodology.

MSG 150 would bring advance in the area of the M&S applied technology, taking into consideration latest generation of M&S tools and techniques to support Concept Development and Experimentation activities for capability discovery.

SCIENTIFIC TOPICS TO BE COVERED
- Modelling and Simulation
- Concept Development and Experimentation
- Capability Development and Innovation

SYNERGIES AND COMPLEMENTARIES
One of the possible way of complementarities in CD&E project is ACT CD&E organization who could provide Concept Development and Experimentation projects to delivery new capability and NATO M&S CoE who could provide modelling and simulation tools and techniques to support ACT Concept Development and Experimentation projects.

EXPLOITATION AND IMPACT
MSG 150 looks at collaborating with ACT providing support in the review process of the NATO CD&E handbook, providing contributes about the application of M&S to NATO ACT CD&E process. Contributions by participating nations, academia, industry and defence organizations are required.
### Activity Summary

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<th>Activity Title</th>
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<td>Reference Number</td>
<td>MSG-152</td>
<td>NATO Modelling and Simulation Professional Corps Development</td>
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**Panel Approval Date:** 18 Oct 2016  
**Board Approval Date:** 18 Jan 2017  
**Activity Start Date:** 16 May 2017  
**Activity End Date:** 19 May 2020

**Related Activity:** ACT

**Projected First Meeting Location:** Q1, Rome, ITA

**Lead Nation:** COE - Modelling and Simulation (M&S)  
**Team Leader:** JONES, Jason (LTC) COE - Modelling and Simulation (M&S)  
**Panel/Group Mentor:** To be determined

**Nations/orgs. Who Endorsed The Activity:** CAN CZE DEU ITA NLD ROU TUR GBR USA COE-MS

**Nations/orgs. Interested In The Activity:**

**Non-nato Nations/orgs. Authorized To Participate:** AUS NZL KOR

**Nations/orgs. Desired To Participate:** PfP GP

**Nations Actually Participating:** GBR COE-MS ROU USA

**Activity Classification:** Public Release (UU)

**Keywords:** Certification, Education, Modelling, MSG, Professional, Simulation, Training

**National + STO Resources Required:**
ABSTRACT
There is a recognized requirement to define a certification process for NATO modelling and simulation professionals that incorporates education, training and experience along with NATO Modelling and Simulation Group agreed procedures. This program will increase interoperability, standardization and develop a professional M&S corps within NATO.

BACKGROUND
Since the start of the information age, NATO and Nation modelling and simulation systems have provided support to the alliance for training; education; decision-making; procurement; concept development and experimentation and other areas. In spite of the high degree of reliance on these systems, there has been no formalization of NATO qualifications for the NATO and Nation personnel planning and managing the use of these systems. Defining essential knowledge and establishing professional standards for NATO modelling and simulation improves NATO and Nation performance and provides the greatest benefit to the alliance.

MILITARY RELEVANCE
The outlined process of collection and sharing the M&S educational opportunities within Nations and NATO together with the NATO and National M&S E&T Catalogue allows to increase the awareness on M&S and to demonstrate its potential to become a military discipline. Established NATO M&S E&T Roadmap defines the track and General and NATO M&S competencies needed for being certified as the NATO M&S Professional.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
Develop a professional M&S Education and Training portfolio and certification process that more effectively supports NATO and national modelling and simulation requirements. Expand knowledge of modelling and simulation, increase awareness and contribute to the increased standardization of M&S activities across NATO.
MSG-152 proposes a framework for developing and defining M&S professionals in NATO and Nations. This work will improve the quality of modelling and simulation usage throughout the NATO Enterprise and its member Nations and partners.

SCIENTIFIC TOPICS TO BE COVERED
• Develop and implement the NATO M&S Professional Certification Process
• Complete M&S E&T Opportunities Catalogue for evaluation of E&T opportunities available in the Nations, with special focus on matching the competencies with the course content developed by ET-40
• Define the NATO M&S Code of Ethics
• Develop and implement the NATO M&S Certification Process and its management
• Identify required competencies for different levels of certification in the NATO M&S E&T Road Map
• Align identified competencies against European Union Educational Framework
• Develop course development timelines and priorities ensuring most critical courses are developed first based on identified NATO M&S competencies.
• To define NATO M&S educational courses and layout general syllabi and its content when feasible.
• Explore the best methodologies for delivering content: online, classroom, lecture series, self-study, hybrid approaches, etc.

SYNERGIES AND COMPLEMENTARIES
Expanding on the work initiated by a prior exploratory team (ET-040), MSG-152 leverages the experience of modelling and simulation professionals from Nations and partners; the NATO M&S COE; NATO and Nation Simulation and Training Centres and other NATO bodies.

EXPLOITATION AND IMPACT
The development of a M&S certification process, to include the competencies for various levels of certification and both courses that exist or are needed, provides NATO, Nations and partners a more effective use of M&S tools. While M&S for
training and education will be key components of this certification, the portfolio will consider all aspects of M&S. This broad view of M&S ensures practitioners throughout the spectrum of the M&S community will benefit.
## ACTIVITY SUMMARY

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<td>Reference Number</td>
<td>MSG-154</td>
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| Related Activity | SAS, SCI, SET |
| Projected First Meeting Location | Rotterdam, NL - APR 2017 |
| Lead Nation | Italy |
| Team Leader | PROIETTI, Paolo (Mr.) |
| Panel/Group Mentor | To be determined |

| Nations/orgs. Who Endorsed The Activity | CAN CZE ITA PRT GBR USA |
| Nations/orgs. Interested In The Activity | |
| Non-nato Nations/orgs. Authorized To Participate | AUS NZL KOR |
| Nations/orgs. Desired To Participate | PIP GP |
| Nations Actually Participating | USA TUR ITA CZE |
| Activity Classification | Public Release (UU) |
| Keywords | Autonomy, CUAV, flight profiles, LSS, Modelling, MSG, signature, Simulation, UAV |

| National + STO Resources Required | |
ACTIVITY SUMMARY

ABSTRACT
The aim of the study is to develop models for commercially available Low, Slow and Small (LSS) aerial vehicles and make these models available for analysis and design of Counter-LSS systems, both for detection and neutralization.

BACKGROUND
Recent World events have highlighted that the rapid proliferation of Low, Slow and Small (LSS) platforms is bringing with it a new and rapidly increasing threat for national defence and security agencies. Whilst many of the reported LSS incidents seem to indicate that there was no malicious intent behind the incident, it is not unreasonable to assume that it may not be long before LSS platforms are being employed regularly by terrorists or other criminal organisations. The flight characteristics of many of these mini and micro platforms present challenges to current ground based systems and infrastructures. In order to develop and deploy appropriate defensive measures to counter future LSS threats, nations and NATO are embarking on a series of programmes to identify cost effective measures for the detection, classification, tracking and neutralisation of any potential LSS threats.

In the future, defence planners must consider plausible LSS attack missions and flight profiles that could be transferred from a national military to a terrorist organization, particularly, those that can be operated by a small number of people and do not require a large support infrastructure.

LSS systems are becoming increasingly capable and more readily available. Some types of LSSs are available for “off-the-shelf” procurement and systems with limited capabilities, such as those technologies employed by the hobbyist-driven markets for model aircraft, have long been widely available at a relatively low cost. However, systems with larger payload capacities and improved capabilities are now becoming more readily available.

Recently LSS technology has proliferated and matured in the civilian/commercial sector leading to wide commercial and leisure use of LSS platforms. In addition to the demonstrated military application of UAV platforms, the employment of small and possibly modified commercial off-the-shelf UAVs by non-state or terrorist organizations poses a real and significant threat to high profile domestic and international events. To date, the emphasis has been on the use of LSS class of UAVs in an ISR mode, but attack modes e.g. in the form of flying IEDs are very possible. The rapid evolution and worldwide spread of the technology, coupled with the ease in purchasing the platforms off-the-shelf, has made NATO defence against the LSS threat of real concern.

LSS aerial platforms are now recognised as posing a significant threat to NATO member nations and also to deployed coalition forces. The primary LSS threat come from three classes of UAV - Micro, Mini and Small.

The variety of unmanned vehicles/system shapes, sizes and capabilities reflects the diversity of the missions they are designed for or capable to perform. Their use was initially conceived for reconnaissance and surveillance operations, but slowly their use is becoming focussed more and more on offensive and combat operations.

Many experts consider that the small and mini drones have the greatest potential to impact national security and privacy, because they can be easily acquired, transported anytime and anywhere and can be almost undetectable when they fly due to having a very low signature. Small and mini drones are already a military operational reality but micro-drones are increasingly being used with their unique features. As technology continues to advance, it will become easier and less expensive to build ever smaller drones.

MILITARY RELEVANCE
LSS aerial platforms are now recognised as posing a significant threat to NATO member nations and also to deployed coalition forces. The primary LSS threat come from three classes of UAV - Micro, Mini and Small. The variety of unmanned vehicles/system shapes, sizes and capabilities reflects the diversity of the missions they are designed for or capable to perform. Their use was initially conceived for reconnaissance and surveillance operations, but slowly their use is becoming focussed more and more on offensive and combat operations. Many experts consider that the small and mini drones have the greatest potential to impact national security and privacy, because they can be easily acquired, transported anytime and anywhere and can be almost undetectable when they fly due to having a very low signature. Small and mini drones are already a military operational reality but micro-drones are increasingly being used with their unique features. As technology continues to advance, it will become easier and less expensive to build ever smaller drones.
ACTIVITY SUMMARY

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
The aim of the Task Group is to take into account the variety of the commercial available LSS aerial vehicles (hereinafter “LSS”), commonly identified as “drones”, in order to define LSS models from different points of view in order to make the models available for being utilised for analysis and design aspects applied to Counter LSS (C-LSS) systems, both from detection and neutralisation points of view.

The LSS can be modelled with respect to:
• the behaviour during the fly, describing the related flight profile, including the available manoeuvres and the meteorological conditions (wind, rain, etc.) impact on them. This because the commercial drones are able to fly in open space without any constraints and their small size and the light weight make them easy to manoeuvre and easily affected by the environmental conditions;
• the signature against different type of detectors since it has been asserted the need of a multiple sensors to have the capability, and the probability, to detect such small objects. As above, the environmental conditions (day, night, fog, rain, etc.) could change considerably the detection capability;
• the threat itself, in order to model suspicious behaviours which could help the identification as foe object;
• the defence tactics to be simulated for a proper neutralisation of the threats.

The study results could be exploited by other C-LSS studies within NATO

The LSS need to be modelled with respect to their military relevant behaviour during the fly; the signature against different types of detectors; the threat behaviours for identification as foe object; and the defence tactics to be applied for neutralization of such threats.

SCIENTIFIC TOPICS TO BE COVERED
• LSS categorization in order to summarise the variety of aerial systems available on the market with respect to different characteristics and parameters
• LSS physical modelling:
  o Flight Profile
  o kinematics affected by wind and other meteorological effects
• LSS detectability modelling:
  o signature (radar, acoustic, thermal, etc.)
  o visibility in different conditions (day, night, fog, etc.) and environment (open space, urban, etc.)
• LSS intelligence modelling:
  o suspicious manoeuvring
  o hazards payloads
• Tactics modelling:
  o Rules Of Engagement

SYNERGIES AND COMPLEMENTARIES
The MSG-154 derives its activity from dedicated NIAG Studies to Counter LSS, where specific technologies for detection and neutralisation were identified, and it is in cross-relation to SCI-301 on “Defeat of Low Slow and Small (LSS) Air Threats”. Members from both study groups are involved in this study in order to maximise the synergies. Moreover, this study would be beneficial from other studies on the topic, such as SET-ET-099 on “EO/IR Detection and Tracking of Small UAVs in an Urban Environment”, SET-180 on “Analysis and Recognition of Radar Signatures for Non-Cooperative Identification of UAVs”, and SET-200 on “Electromagnetic Scattering Prediction of Small Complex Aerial Platforms for NCTI Purposes”.

EXPLOITATION AND IMPACT
ACTIVITY SUMMARY

The main exploitation envisioned is related to the capability that M&S will provide for testing, evaluating and experiment new Counter LSS systems to support Nations and NATO that are embarking on a series of programmes for developing and deploying appropriate defensive measures, in terms of detection, classification, tracking and neutralisation of current and future LSS threats in a cost effective manner.
# ACTIVITY SUMMARY

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ABSTRACT
Data Farming combines the rapid prototyping of simulation models with the exploratory power of high performance computing to rapidly generate insight into “what-if?” questions. Data Farming has been codified through the efforts of MSG-088 and proof-of-concept applications have been provided by MSG-124. This task group plans to produce practical means of decision support using data farming through the integration of data farming services developed by the task group.

BACKGROUND
The methods and processes of Data Farming have been developed in the six areas of model development, rapid prototyping of scenarios, design of experiments, high performance computing, analysis and visualization of large simulation data output, and collaborative processes. These six domains of Data Farming have been documented as part of the work of the MSG-088 Task Group that codified the data farming concept. In addition, the follow-on MSG-124 Task Group turned the concept into actionable data farming decision support in part by developing a cyber simulation model and a decision support tool. These activities have proven Data Farming ready for application and implementation. Now Data Farming can be made accessible and usable by NATO through MSG-155 efforts to develop the groundwork for analysis and simulation-based decision support.

MILITARY RELEVANCE
Data Farming is a simulation-based methodology that supports military decision-making throughout the development, analysis, and refinement of courses of action. By performing many simulation runs, a huge variety of alternatives can be explored to allow decision makers to make more informed and robust decisions. Paradoxically, this method can be used to declutter the immense amount of information known and allow commanders and staff improved situational awareness. Data farming allows for the consideration of uncertainties and the discovery of unexpected outcomes that may lead to findings that allow NATO military decision makers in the domains of defence planning, operations, training and capability development to reduce surprises resulting in more robust solutions.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
Through co-operation among Alliance bodies, NATO member nations and partner nations participating in this task group, the overall goal is to establish the effective utilisation of data farming within appropriate areas of application using decision support tools for the ultimate purpose to assist NATO decision makers. The general objective of this Task Group is to extend data farming capability and accessibility through developing Data Farming Services (DFS) in accordance with the Modelling as a Service concept (NMSG 136) for analysis, wargaming, other simulation-based decision support, and training.

The specific objective is to develop a road map for what needs to be done in order for NATO to provide DFS. This road map would show the way for developing a technical concept for DFS through an integrated toolset. Additionally, the work would produce and refine technical prototypes useful for implementation of the road map. DFS would support the application and execution of the Data Farming process as codified in MSG-088 and as applied in MSG-124 in a mature, productive and user-friendly way. The architecture of DFS would consider recommendations of the NATO MSG-136 Task Group “Modelling and Simulation as a Service” where appropriate. The intent is for DFS to support many different application use case areas for data farming. Some possible use cases, or branches emanating from the core data farming capabilities, are listed in the topics to be covered.

Methods and techniques of data farming have been developed and documented in various ways since the inception of the idea in 1997. MSG-088 codified the process and MSG-124 provided proof-of-concept in two application areas. The MSG-155 program of work is structured to produce means to improved decision support through the integration of data farming services developed by the task group. The specific progress will be determined as work continues, but the work has been planned to achieve a technical architecture for DFS and results from demonstration use cases.

SCIENTIFIC TOPICS TO BE COVERED
A common core for data farming services beyond that codified in MSG-088 and applied in MSG-124 would be developed. This common core allows processing M&S applications across the spectrum of NATO needs. The advanced simulation
service capability includes developing the groundwork for DFS through efforts in each of the six data farming domains. In order to develop a Data Farming core service that will support the road map, this work is broken down into the separate data farming domains as follows:

1. Rapid Scenario Prototyping: Scenario definition and adaptation may be supported independently of a specific simulation model by providing, for example, scenario editors supporting SISO-standards.
2. Model Development: The creation of models is performed outside of the core. DFS would provide generic I/O interfaces to support service-based integration of existing models.
3. Design of Experiments (DOE): Different available DOE need to be available within the core toolset. In addition it might be valuable to support optimization approaches in conjunction with fixed DOEs.
4. High Performance Computing (HPC): The Data Farming core needs to provide a generic service approach to handle different HPC systems.
5. Analysis and Visualization: The DFTOP prototype of MSG-124 is to be integrated, enhanced and further developed as well as to implement new innovative approaches such as techniques of the big data computation area.
6. Collaboration: A process description for Data Farming experiments within M&S process and MaaS standards, e.g. DSEEP, needs to be developed.

SYNERGIES AND COMPLEMENTARIES
Much of the work of MSG-155 has synergies and complementarities with other activities. As mentioned earlier, DFS could benefit from the work MSG-136 Task Group. Also, potential MSG-155 use case work in the cyber domain would have connection to MSG-117 which had the objective to investigate and recommend what aspects of cyber defence can be supported with Modelling and Simulation. In addition, data farming methodology can be used to explore questions in other areas important to NATO such as operations planning and wargaming.

EXPLOITATION AND IMPACT
This task group will extend core data farming capability and include demonstration and testing of data farming use cases. The use cases will be chosen to directly support NATO topics and goals. These use cases will be fully integrated with the DFS efforts providing examples to contribute to the development of the road map for DFS. The purpose of this work is to support the delivery of an advanced core. A limited selection of use cases will be undertaken and will depend on the number of participants and the interest of nations. Some potential use case areas discussed so far include comprehensive operations planning, tactical level operations planning, cyber defense, emerging global futures and technology trends, early synthetic prototyping and wargaming support.
## ACTIVITY SUMMARY

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<td>MSG-156</td>
<td>Dynamic Synthetic Environments for Distributed Simulation</td>
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<td>Activity Type</td>
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<td>GERRETSEN, Arno (Mr)</td>
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ABSTRACT
Contrary to real world environments, synthetic environments used in distributed military simulations are often static and unable to adapt to changes caused by e.g. deteriorating weather conditions or combat engineering during scenario execution. To better train and prepare our military personnel for dynamic real-world conditions, the synthetic environment needs to support such dynamic modifications in a standardized and interoperable way to provide a consistent representation across dissimilar simulation systems. The objective of MSG-156 is to define best practices, required methodologies and technologies and requirements for standards needed to achieve a correlated dynamic SE in future distributed simulation exercises.

BACKGROUND
Military operations are performed in a world that is dynamic and where weather and climatic conditions have an impact on the environment. The dynamic nature of the environment affects how military operations are performed, e.g. changes in weather (such as rain and wind) impact the mobility of vehicles, and damages to infrastructure during an operation limits available routes. To better train and prepare for dynamic real-world conditions, the Synthetic Environment (SE) needs to support this in a standardized and interoperable way to provide a consistent representation across dissimilar simulation systems.

Current best practices, standards and technologies already struggle to achieve correlated static representations of the operating environment. The inclusion of dynamic aspects will make this struggle even more challenging, thereby underlining the need for more extensive methodologies and technologies to achieve correlated environments in distributed simulation systems, including Computer Generated Forces (CGFs) and sensor simulations. To ensure that simulations can be setup and used efficiently in the future by NATO and NATO Nations, it is important that correlated dynamic SEs can be effectively produced and maintained.

The NATO MSG Exploratory Team ET-045 has investigated this topic and identified the main challenges of introducing correlated dynamic SEs. These challenges are the starting point of MSG-156.

MILITARY RELEVANCE
The real world in which defence operations take place is subject to change due to the effects of weather and force behaviour. Despite the pursuit for more realism in simulation systems, there is little deployed capability of dynamically modifiable environments. Achieving such an environment over heterogeneous simulation systems in a distributed exercise is currently not possible. To provide improved readiness of defence resources relevant for current and future national and multi-nation operations, a more common and consistent representation of these environmental effects needs to be available across simulation systems. This research group will investigate solutions to improve the synthetic representation of rapidly changing operational environments. Thereby enabling simulations to represent the complex and challenging real world environment and prepare soldiers for operational success.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
• Define best practices, required methodologies, technologies and inform requirements for standards needed to achieve a correlated dynamic SE in future distributed simulation exercises;
• Evaluate methodologies and technologies through concept experimentation where needed.
• Technical Report (including an evaluation of algorithms, technical infrastructures and standards, etc.), and recommendations for achieving dynamic SEs.
• Concept Demonstrators of methods and techniques to achieve a correlated dynamic SE.

SCIENTIFIC TOPICS TO BE COVERED
Dynamic terrain
How to achieve a dynamic terrain that can be shared between different participants? Topics to be addressed are:
• Methods and technologies to deform terrain/terrain features (cultural features, 3D models), in a common and consistent manner across Virtual and Constructive (synthetic forces) simulation systems, i.e. visual and non-visual sensors domains;
• Methods and technologies to deform littoral features (e.g. effects of sea state), in a common and consistent manner.
ACTIVITY SUMMARY

across Virtual and Constructive (synthetic forces) simulation systems;

• Natural effects on the environment, specifically effects of rainfall/flooding, temperature, ocean tides, surface weathering and drainage;

• Human geophysical effects on the environment, e.g. dredging, digging, tunnels, river diversion;

• Force engagement effects on the environment, e.g. effect of ordnance (including craters, damage to buildings, bridges, roads, airfields).

Weather

Besides the terrain, representation of realistic weather is also an important element of SEs. In most current simulations weather is static in both time and space, whereas real-world weather can be very dynamic and have major effects on operations. Items to be considered include:

• Which methodologies and technologies are needed to easily specify and integrate consistent weather and its variations into distributed simulation systems;

• Which weather variations should be represented in SEs;

• What should be the effects of these weather variations on SEs, re: natural terrain features, 3D models, platform performance;

• How to ensure that weather variations affect different elements of SEs in a common and consistent way;

• Which data sources are suitable to introduce realistic weather in SEs.

Effective correlation

For the participants of distributed simulation, a ‘fair-fight’ is an important aspect. Therefore correlation of a dynamic SE is required. It should be realized that the assets in a distributed simulation will have different (technical) capabilities and that 100% correlation may not be achievable or necessary. Items to be considered include:

• How to specify the amount of correlation of the synthetic environment that is needed for the purpose of a distributed simulation?

• How to assess if different simulation assets meet the required level of correlation?

• Which methodologies and technologies are needed to effectively manage correlation within a distributed simulation?

SYNERGIES AND COMPLEMENTARIES

It is foreseen that the task group will cooperate and/or build upon the results of the following other activities:

• MSG-128 Mission Training through Distributed Simulation (MTDS) and a potential follow-on activity of MSG-128, since the topic of a correlated terrain has been raised as an import item there.

• MSG-136 Modelling and Simulation as a Service (MSaaS) and a potential follow-on activity of MSG-136, especially around the topic of Synthetic Environment services.

• SISO, especially with the SISO RIEDP PDG.

• MSG-147 M&S Support for Crisis and Disaster Management Processes and Climate Change Implications, since dynamic changes to the environment are of importance to crisis and disaster management as well.

• AVT-248 Next-Generation NATO Reference Mobility Model (NRMM) Development, since such models could be using the dynamic SE data in simulations.

EXPLOITATION AND IMPACT

The results of the task group will be concepts of required methodologies, technologies and tools to address the issue of a correlated dynamic synthetic environment. These results can feed future standardization activities and can be developed into solutions to be used in distributed simulation exercises.
### ACTIVITY SUMMARY

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ABSTRACT

BACKGROUND
In accordance with the NATO Policy, “The Alliance will use suitable civil standards to the maximum practicable extent” – [Ref C-M(2004)0009 – NATO Framework for Civil Standards].

As a result, all NATO Delegated Tasking Authorities were requested to identify not-for-profit civil Standards Developing Organizations (SDOs) in their domains and to start cooperation on standards of interest for NATO.

NATO experts shall participate to the development and maintenance of such standards in the framework of these SDOs. The Simulation Interoperability Standards Organization (SISO) is the civil Standards Developing Organization of interest for M&S standards in NATO, with which NATO MSG has signed a Technical Cooperation Agreement [Ref AC323-NMSG(2007)TCA-01] in 2007. Since then multiple standardization efforts were undertaken by NMSG in cooperation with SISO. Developing a standard creates the obligation of its maintenance for the interested parties. In addition, several NMSG Task Groups developed M&S resources (e.g. Missionland dataset, NATO M&S Glossary of Terms, etc) that need maintenance.

The proposed Task Group is intended to gather the MSG experts involved in the development and maintenance of M&S resources and related standards of interest for NATO in a STO formal framework.

MILITARY RELEVANCE
By supporting the development and maintenance of M&S standards of interest to NATO, the task group will significantly contribute to improving M&S interoperability across the Alliance. Standards in general reduce costs, including development, lifecycle, and implementer training costs; standards are a natural way to share investments avoiding duplication of efforts on new technologies while reducing risk linked to their use. Moreover, the group will also perform maintenance of reusable resources which leads to the same above mentioned benefits.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
• Ensure continuity in development and maintenance of M&S resources and related standards of interest for NATO;
• Ensure compliancy with NATO requirements of those standards during the development and maintenance process;
• Dissemination throughout NATO M&S Community of Interest.

SCIENTIFIC TOPICS TO BE COVERED
• M&S interoperability;
• Reuse of M&S resources;
• Gaps identification in M&S standardization;
• Maintain awareness of the NMSG community on M&S standardization issues.

SYNERGIES AND COMPLEMENTARIES
The task group is intended to work in coordination with the NMSG’s permanent M&S Standards Subgroup (MS3) by undertaking the expert type of work required by this subgroup. Examples include: development and maintenance of AMSP series of standards, STANAGs, STANRECs in NMSG’s portfolio.

EXPLOITATION AND IMPACT
- allow people working with different systems to cooperate and promote collective training or experimentation;
- reduce costs, including development, lifecycle, and implementer training costs; standards are a natural way to share investments avoiding duplication of efforts on new technologies while reducing risk linked to their use;
- improve operational capabilities by supporting higher reliability and facilitating new technology insertion;
- protect investment; for example, scenario descriptions, models and databases may be reused in a variety of applications; standards also allow upgrading to newer systems or changing to systems from another vendor;
ACTIVITY SUMMARY

- allow access to the best of the technology (standards are supposed to represent the state-of-the-art; standards are built on experience and are generally based on more recent technological developments);
- since standards require a large consensus and are developed in open organizations (SDOs) there is less reluctance and risk to their use;
- can reduce complexity and produce more modular and reconfigurable implementations thus reducing development risk.
# ACTIVITY SUMMARY

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**Related Activity**

MSG-ET-039

**Projected First Meeting Location**

Lisbon (PRT)

**Lead Nation**

United States

**Team Leader**

THOMAS (TOM) WALROND, Joseph (Col (Ret))

**Panel/Group Mentor**

To be determined

**Nations/orgs. Who Endorsed The Activity**

CAN DEU NLD NOR JFTC COE-MS USA

**Nations/orgs. Interested In The Activity**

ACT NATO

**Non-nato Nations/orgs. Authorized To Participate**

PIP GP

**Nations/orgs. Desired To Participate**

PIP STOEOP AFG JPN KOR IRQ NZL PAK AUS FIN SWE

**Nations Actually Participating**

USA

**Activity Classification**

NATO Unclassified (NU)

**Keywords**

Command Control, Distributed Simulation, future MS, Information security, Simulation Environments, Simulation Interoperability, Training, Training and exercise requirements

**National + STO Resources Required**

1. Standard support for STO Research Task Group in accordance with the current edition of the STO Operating Procedures and WEBEX capabilities. 2. Support for cooperative meetings or events in conjunction with major events related to Simulation, Training and Education
ABSTRACT

BACKGROUND
In January 2015, the NMSG commissioned Exploratory Team (ET)-039 to identify key M&S areas that the NATO Modeling and Simulation Group (NMSG) needs to focus their current and future technical activities in order to develop timely solutions and standards that support the rigorous and dynamic operational training required to meet current and future NATO missions and readiness objectives. The primary deliverables for this activity was a Training Interoperability Roadmap, a collaborated requirements framework, and a procedures for capturing, analyzing and prioritizing M&S requirements.

The ET-039 final report recommended that the ET-039 process be re-accomplished every two years in order to keep the Roadmap current and ensure that the NMSG continues to focus on the training interoperability issues that are most relevant to NATO and partner forces. This RTG is the proposed follow-on activity to meet ET-039’s recommendation.

Issue: NATO and partner forces must be able to train and operate together, but challenges remain to ensure training interoperability.

a. NMSG activities must continue to align, synchronize, and converge on delivering standards and solutions that enable training interoperability.

b. MORS continue to improve procedures and governance that will continue to enhance alignment of operational requirements (i.e. training, analysis, testing...) with technical activities and culminate in potential impact/exploitation of the activity expected results, links to NATO S&T priorities, and possibly relevance to NATO Interoperability and Standardization activities.

MILITARY RELEVANCE
NATO, multi-national, and coalition forces must be able to train and operate together, but challenges remain to ensure training interoperability. NATO Modelling and Simulation Group (NMSG) activities must align, synchronize and converge on delivering standards and solutions that enable training interoperability.

SCIENTIFIC OBJECTIVE(S) AND EXPECTED ACHIEVEMENTS
The NMSG conduct operationally relevant and synchronized technical activities that deliver the means (simulations, information, data, and network standards and services) for Allied forces and headquarters to train and operate together in a manner that enhances mutual interoperability at both the tactical and operational level.

The primary objectives of this effort is to:
• Revalidate ET-039 requirements
• Identify new requirements
• Provide a reprioritized list of TA areas for the NMSG to support to the training community by Dec 2018
• Improve the requirements capture and analysis process as outlined in the ET-039 final report.

SCIENTIFIC TOPICS TO BE COVERED
At a minimum, requirements in the following areas will be captured and analyzed:
- Federating M&S (Connected Forces)
- Sim-C2 Connectivity (Connected Forces)
- Multi-Level Security/Releasability (Connected Forces)
- Simulation Performance
- EXCON Support
- Tool Accessibility & Capacity
- Scenario Data
- Physical Environment
ACTIVITY SUMMARY

- Air & Space Domain
- Land Domain
- Maritime Domain
- Cyber Domain
- Cross-Environment—requirements that cross multiple operational domains
- Human Social Behavior
- M&S Policy
- Operational Planning

SYNERGIES AND COMPLEMENTARIES
The following NATO and NMSG efforts are synergistic/complementary to the MSG-158:
- MSG-146 Simulation for Training and Operation Group-Land (STOG-L)—provides requirements and operational insight.
- MSG-ET-042 NATO M&S Technology Roadmap—technology focus areas of MSG-158 will inform this roadmap development.
- MSG-ET-045 Dynamic Synthetic Natural Environments for Distributed Simulation—informs/resolves current training requirements.
- MSG-136 M&S as a Service Rapid deployment of interoperable and credible simulation environments—the follow activity informs/resolves current training requirements.
- CoreSim 2020—MSG-158 covers a sub-set of the requirements managed under this initiative. CoreSim is a primary source for operational training requirements.

EXPLOITATION AND IMPACT
MSG-158 partners with the NATO/National operational communities in identifying/prioritizing operationally relevant NMSG technical activities focused on developing timely solutions/standards that enhances training, exercises and mission rehearsal interoperability required to meet current and future NATO missions and readiness objectives. It provides the NMSG guidance in developing a programme of work and supporting technical activities that aligns NATO/National operational training requirements and culminate in relevant solutions to warfighter problems.
Evolution of NATO Standards for Federated Simulation

Abstract

Author information

Technical Team Leader(s)
BEHNER, Horst (MSc in Physics), CENSORI, Roberto (LtCol)

Military Relevance
Simulation is critical for many activities in NATO context such as training of headquarters and soldiers, or experimentation of new Command & Control Information System. The use of distributed simulations offers extended modelling of military operations (complex environment, large terrain, various units, joint logistics…).

Interoperability standards are needed, even mandatory to build relevant federations of simulations. Taking care of standard improvements could contribute to enhance the efficiency of simulation interoperability. Furthermore, open tools to support the integration of simulations in federations, to check the conformance of the standard specifications, and to evaluate/certify the interoperability capabilities through predefined scenarios (i.e. test cases) are a great benefit to the preparation of exercises and experiments. For example, better understanding of interoperability capabilities for each simulation, reduction of integration time, and evidence for the issue-free execution of a federation.

Background
NATO and the Nations regularly use distributed simulation based on the High Level Architecture (HLA) interoperability standard. The current release is IEEE 1516TM-2010.

In the NATO context, several official documents are available to standardize the use of HLA:
- STANAG-4603 describing the HLA standard.
- STANREC-4800 describing the NATO Education Training Network Federation Object Model (NETN FOM) and the associated Federation Architecture and FOM Design (FAFD). The STANREC is still being processed and the results will be available by end-2017.
- Certification process (including Capability Badges for Simulation Interoperability), certification framework and tools (Integration Verification Certification Tool and Executable Test Cases). The work is still in progress by MSG-134 and the results will be available by the end of 2017.

NATO NMSG has a close relationship and a Technical Agreement with the Simulation Interoperability Standards Organization (SISO) with respect to Simulation Interoperability Standards and has provided significant input to SISO standards development over the years. E.g. MSG-068 and MSG-106
provided significant input on the modularization of RPR-FOM v2.0, and other MSGs have provided significant input on C-BML, MSDL and UCATT SISO standards. NATO is also a user of SISO developed standards including IEEE 1516TM (HLA) series of standards which is covered in STANAG 4603.

NATO nations and partner nations have successfully applied SISO and NATO standards when developing Federated Simulations to support Education, Training, Exercise and Evaluation (ETEE). E.g. the Swedish Viking Exercises are based on Federated Simulation using STANAG 4603 and NETN FAFD. Other NMSG Task Groups apply the SISO and NATO standards to support different aspects of M&S, e.g. MSG-147 is developing NETN FAFD FOM modules for Crisis Management and Disaster Response, MSG-136 is developing the concept of Modeling & Simulation as a Service (MSaaS) to manage Federated Simulation etc.

Experiences and feedback on these standards are collected by nations and provided either directly to SISO or through NATO NMSG activities. MSG-134 has been tasked to support MS3 in maintaining and collecting feedback on the use of NETN FAFD (AMSP-04/STANREC 4800). This feedback includes proposed updates to existing NETN FAFD modules and proposals for entirely new modules identified by NATO and partner nations.

As IEEE standards should be updated every ten years, a dedicated Product Development Group (PDG) for further development of the HLA standard was established by SISO in 2016. This PDG collects all comments on the existing standard and execute SISO processes to develop the next version of HLA, identified as HLA 4. At the same time, an NMSG Exploratory Team (ET-046) was established to provide input to the SISO HLA PDG based on NATO and partner nation’s experiences in applying STANAG 4603 and the NETN FAFD. Comments and recommendations were developed by contributing nations (FRA, DEU, NLD, SWE and USA), documented in a final report and provided to SISO.

There is a continued need for NATO to experiment with, update and further evolve NATO Standards for Federated Simulation to meet new and evolving simulation interoperability requirements and to harmonize with new and evolving SISO standards.

Objectives

The objective of this Technical Activity Proposal is to further evolve the NATO standards for Federated Simulation. This includes the evaluation of the future HLA 4 standard and update of the NETN FAFD (AMSP-04/STANREC 4800) based on existing input, verification and validation in experimentation. The aim is to harmonize NATO standardization agreements, recommendations and standards profiles, by:
a. Collaborating with SISO to contribute actively to the new version of the HLA standard
b. Evaluating the new features of the evolving HLA standard
c. Improving the NATO data products regarding HLA (Federation Object Model, Federation Architecture and FOM Design, etc.)
d. Improving the NATO HLA Certification Service
e. Updating the NATO reference documents regarding HLA (STANAG, STANREC and AMSP, etc.)

The expected deliverables and end products are the following:
• Technical Report, including recommendations about the implementation of the new HLA standard
• New release of the certification process and tool (IVCT) introduced by MSG-134
• New release of NETN FAFD introduced by MSG-134
• Proposals to update STANAG-4603, STANREC-4800 and AMSP-01
• Papers and publications (e.g. ITEC, I/ITSEC, SISO SIW, NATO CAX Forum and NMSG BM)

S&T Achievements

Synergies and Complementarities
The results of ET-046 provide some comments on the HLA standard which will be used as inputs for topic a1 (see section IV).
The results of MSG-134 provide the certification process and tools which will be used as inputs for topics c1, d3 and d4.
The results of MSG-136 provide hosting and delivery mechanisms which will be used as inputs for topic d6.

Exploitation and Impact
The certification process and tools will be used by the M&S Centre of Excellence, acting as the NATO Certification Entity.
These process and tools could be also used by NATO and PfP nations to accomplish its national endorsing of certification in aim to enable cost effective and reliable Plug & Play of simulations for the war fighter.

Conclusions

Pull Quote
Modelling and Simulation as a Service - Phase 2

Abstract
MSG-164 will mature MSaaS from a lab environment to an operationally relevant environment and conduct necessary research and development efforts. Through close cooperation with the operational user community and participation in exercises, this activity contributes to realizing the MSaaS vision that “M&S products, data and processes are conveniently accessible and available on-demand to all users in order to enhance operational effectiveness”.

Author information
Dr. Robert SIEGFRIED (DEU), Mr. Jonathan LLOYD (GBR), Mr. Tom VAN DEN BERG (NLD), Mr. Christopher MCGROARTY (USA)

Technical Team Leader(s)
Military Relevance

NATO and its Partners extensively use simulation for various purposes (e.g., training, mission rehearsal, or decision support in acquisition processes). Setting up simulation environments today still requires enormous effort with regards to time, personnel, and budget. Improving efficiency in simulation use and better utilization of valuable simulation resources is a critical factor to sustain the asymmetrical advantage that simulation provides to NATO and its Partners. This activity will mature MSaaS from a lab environment to an operationally relevant environment and conduct necessary research and development efforts. Through close cooperation with the operational user community and participation in exercises, this activity contributes to realizing the MSaaS vision that “M&S products, data and processes are conveniently accessible and available on-demand to all users in order to enhance operational effectiveness”.

Background

MSG-131 and MSG-136 teams provided initial proof that M&S as a Service (MSaaS) has great potential for NATO to benefit from commercial developments, and to efficiently realize future simulation environments for NATO and its Partners.

Objectives

Building upon the Allied Framework for M&S as a Service developed by MSG-136 this activity addresses three main objectives:

1. To advance and to promote the operational readiness of M&S as a Service;
2. To align national efforts and to share national experiences in establishing MSaaS capabilities;
3. To investigate critical research and development topics to further enhance MSaaS benefits.

This activity will specify and test an MSaaS infrastructure that is suitable for use in operationally relevant environments and will support continued MSaaS experimentation and evaluation efforts. This activity will also deliver a Technical Report and recommendations with regards to the organizational perspective of introducing MSaaS in NATO and in the Nations. Additional deliverables (e.g., interface specifications, prototype implementations) will be defined by activity members in the final Program of Work.

A Technology Demonstration is foreseen for 2019 and 2020, potentially as a Cooperative Demonstration of Technology (CDT).

S&T Achievements

- Service discovery/metadata
- Data services
- Cloud federation and infrastructure
- Simulation architecture and protocols
- Composition/decomposition
- Cyber security in cloud environments
- Service management and control

Synergies and Complementarities
This activity seeks close collaboration with the following NMSG and NATO efforts:
- UCATT;
- Data Farming Services;
- Mission Training through Distributed Simulation (MTDS);
- C2Sim;
- Crisis Management and Disaster Recovery;
- ACT CoreSim 2020;
- M&S COE MSaaS Platform efforts (“OCEAN”) and M&S Enclave Initiative;
- CMRE M&S capabilities.
In the MSaaS spirit of sharing and reusing simulation resources, it is expected that the above mentioned efforts contribute resources and benefit from resources provided by members of this activity.

Exploitation and Impact
- Significant contributions to national simulation policies and ACT CoreSim 2020;
- Use of MSaaS in CWIX event;
- Establishment and promotion of M&S Enclave Initiative to establish permanent MSaaS capabilities;
- Enlargement of MSaaS Community of Interest, including outreach to industry;
- Contributions to existing standards and recommendations for new standards and guidelines

Conclusions
MSaaS and Cloud-Based M&S will impact all future simulation environments and acquisition programs. This activity demonstrates that MSaaS and Cloud-Based Simulation is not only an idea existing on slides, but actually works (today!) in operationally relevant environments.

Pull Quote
Incremental Implementation of Mission Training through Distributed Simulation for Joint and Combined Air Operations

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<td>Task Group</td>
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Abstract
NATO needs an MTDS capability to provide mission training and operational assessment of air and C2 systems in all core airpower roles, including Maritime Air, Land Air and JISR (AGS, UAV) components. This joint extension to Air MTDS represents a huge challenge in scenario scalability and variability. Technically new standards will be required to interface operational C2 databases to scenario generators, additional Tactical Data Links are to be considered, LVC federation, Multi-Level Security Gateways, federation execution supervision and mission planning and debriefing tools will be also be required in order to support operational NATO exercises such as VIRTUAL MAGIC, SPARTAN WARRIOR, or any other tactical training exercise of medium size. The objective of MSG-165 is the incremental implementation of an initial MTDS capability in coordination with relevant MTDS exercises.

Author information
Mr. Timothy STEFFEN (USA), Mr. Arjan LEMMERS (NLD)

Technical Team Leader(s)
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Military Relevance
NATO needs an MTDS capability to provide mission training and operational assessment of air and C2 systems in all core airpower roles, including Maritime Air, Land Air and JISR (AGS, UAV) components. This activity has to be part of the ACT M&S action plan on Air Operation Training (systems level) and will improve the (initial) MTDS capability provided by MSG-128.

Background
In October 2013 the NATO task group MSG-128 ‘Incremental Implementation of NATO MTDS operations’ was stood up with the objective to establish essential elements for a permanent NATO MTDS capability and validate these elements through initial multinational exercises (NAEW, CAN, DEU, FRA, NLD, NOR) with AWACS and small Air-to-Air missions using legacy simulators, and growing in scenario complexity, including C2 and Ground targets.
In October 2016, NAFAG defined the need for a study as a result of the MSG-128 and requested a NIAG study (SG-215) on Future Combined / Joint Distributed Tactical Training through Simulation for Joint and Combined Tasks and Operations in order to provide a roadmap for how technological innovations can improve NATO and national Distributed Tactical Training through Simulation while
leveraging existing simulation technologies. In particular, NATO aims to provide mission rehearsal and operational assessment of air and C2 systems in all core airpower roles and types of air operations for aircrews, controllers and CAOC/JFAC staff. This should include Maritime Air components, Land Air components and JISR components (AGS, UAV, etc.).

The MSG-128 and the NIAG SG-215 recommend pursuing simultaneous effort; 1) on R&T to extend the initial MTDS capability, and 2) on NATO/Multinational operational exercises and training events to validate MTDS capability.

Objectives
- Based on the work of previous NATO and (multi-)national studies (MSG-128 & NIAG SG-215) and projects extend NATO MTDS essential elements to include Maritime, Land, JISR simulations.
- Refine MTDS Reference Architecture and interoperability solutions based on recommendations from NIAG SG-215
- Develop concept for interfaces for integration of Live assets in MTDS and validate.
- Develop a common approach to multi-level security in MTDS based on NIAG SG-215 recommendations
- Recommend MTDS Exercise Management set of tools, based on available COTS and GOTS products and C2.
- Validate these elements through initial operational tests and evaluation in a classified network or when possible in non-classified network.
- Participate in NATO/Multinational operational exercises and training events.
- Organize specific exercise when required

S&T Achievements
- Technical Report (including an evaluation of NATO/Multinational exercises, technical infrastructures and interfaces, interoperability standards, etc.), and recommendations for achieving a full operational capability (FOC) for NATO MTDS.
- Initial Operational Capability for NATO MTDS.
- Multi-Level Security approach for a NATO MTDS architecture.
- MTDS Reference Architecture.

Synergies and Complementarities
The results of MSG-128 are used for the development of the MTDS Reference Architecture.
The results of MSG-134 (NATO Distributed Simulation Architecture & Design, Compliance Testing and Certification) and its successor provide the certification and accreditation processes and tools that can be used for the test and integration of system elements.
The results of MSG-156 (Dynamic Synthetic Environments for Distributed Simulation) will be used for correlated terrain/radar/visual databases as well for harmonized weather simulation.
The results of MSG-136 (MSaaS) should be used to provide simulation services such as database repository, terrain/weather servers, testing, etc.

Exploitation and Impact
The MTDS architecture, the multi-level security solutions, and other results as developed by this Task Group will be used by NATO and nations to implement MTDS capabilities. Yearly tests & experiments
follow-on by operational exercise organization/ participation will aim to initiate persistent MTDS capability for NATO Joint and Combined Air Operations training. The NAFAG will work with NATO and nations on a Smart Defence Initiative to realize and maintain this MTDS capability.

Conclusions
NATO needs a MTDS capability to provide mission training and operational assessment of air and C2 systems in all core roles related to air operations, including relevant land and maritime components, as well JISR (AGS, UAV) components. This joint extension to Air MTDS represents a huge challenge in scenario scalability and variability. MSG-165 will incrementally build, exploit and maintain an initial MTDS capability in coordination with relevant MTDS exercises.

Pull Quote
Coalition troops must be able to train anytime, anywhere in a realistic and challenging environment increasing readiness and interoperability.