

# MODELLING AND SIMULATION AS A SERVICE (MSaaS) - EVOLUTION OF THE ALLIED FRAMEWORK WITHIN NATO

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**Abstract:** NATO Modelling and Simulation Group (NMSG), the Alliance's modelling and simulation body, has focused its efforts in recent years on developing the concept of Modelling and Simulation as a Service (MSaaS), which aims to solve the difficulties in terms of cost and interoperability between existing modelling and simulation systems within Member States. The concept is based on cloud computing and Service Oriented Architecture (SOA) and its main objective is to assure improved flexibility, better accessibility and scalability, with lower costs for modelling and simulation applications. Advances in service-oriented architecture (SOA) and cloud computing are an opportunity to improve the use of modelling and simulation capabilities within NATO. MSaaS is based on the idea of being able to use a computer product without a major investment in hardware, software, staff and infrastructure. Thus, the military user can be situated in a central location, while the services offered can be available through the network. The research and development activities of MSaaS within NATO were undertaken by the NATO Modelling and Simulation Group (NMSG) on the basis of a multi-stage structured strategy, which started in 2013. At present, the implementation strategy is in MSaaS Specification and Validation phase, to be completed in 2022.

**Keywords:** modelling; simulation; service; interoperability; network; architecture.

## Introduction

Modelling and simulation is a major element of military interest because, given the characteristics of the current operational environment: high complexity, uncertainty, massive technology, hybrid threats, large number of non-state actors, correlated with the unprecedented technological advance of the last period, it has provided states with a fast, flexible way, with minimal risks and costs, to adapt to the environment and deal with threats.

Modelling and simulation in the military field has as main areas of applicability individual and collective training, operational planning, assessment of conflict situations, acquisition of equipment, development of tactics, doctrines and alternative force structures.

At national level, the importance of modelling and simulation in the training process is recognized in the Romanian Military Strategy: The training of the force structure will be carried out by conducting training activities in conditions as close as possible to those of the modern combat space and the hybrid environment, with the integration of simulation-modelling capabilities, at all hierarchical levels (Strategia Militară A României 2021)

The use of modelling and simulation has a number of advantages, but it also has limitations. A problem facing the field of modelling and simulation in the military environment is generated by the increased time and costs required to develop models for all elements that will be part of the simulation, a problem that stems from the complexity of the current operational environment and how quickly it changes. Also, another shortcoming is the problem of compatibility and accessibility between the modelling-simulation tools of different states, which represents a major impediment in the case of multinational exercises and operations.

Within NATO, the field of modelling and simulation is managed by NATO Science and Technology Organization (STO) through NATO Modelling and Simulation Group (NMSG) whose mission “is to promote co-operation among Alliance bodies, NATO member nations and partner nations to maximise the effective utilisation of M&S.” (NATO Science and Technology Organization n.d.)

NATO's modelling and simulation objectives are set out in the *NATO Modelling and Simulation Master Plan* (NATO Modelling and Simulation Master Plan 2012): establishing a common technical architecture to ensure interoperability and reuse, coordination and joint services to increase cost-effectiveness, develop models and simulations, use simulations to increase the effectiveness of NATO missions and integration of new technologies.

NATO's response to the problems of cost and accessibility in the field of military modelling and simulation is the introduction of a new concept - Modelling and Simulation as a Service (MSaaS).

## **1. Modelling and Simulation as a Service – defining the concept**

A variety of hardware, software components, and skilled personnel are required to implement the models and simulations, which in most case can be expensive and difficult to deploy. The solution is the concept of cloud computing which is based on the idea of being able to use a computer product without a major investment in hardware, software, staff and infrastructure. Thus, they can be located in a central location, while the services offered can be available through the network.

Through cloud computing you get improved flexibility, better accessibility and scalability, increased trust in the services provided that will benefit both the user and the provider. By pooling resources, costs will be reduced, allowing providers to ensure services to multiple customers at the same time. Another advantage “is that individual services can be easily combined to efficiently form new, more complex services (proper design of the service landscape provided), leading to a reduction in development cost and time.” (TR-MSG-131 2015)

Advances in service-oriented architecture (SOA) and cloud computing are an opportunity to improve the use of modelling and simulation capabilities within NATO. Modelling and Simulation as a Service (MSaaS) is a concept that is based on service orientation and the use of cloud computing in order to provide simulation environments and simulation elements that can be implemented and executed on demand.

“The MSaaS paradigm supports stand-alone use as well as integration of multiple simulated and real systems into a unified cloud-based simulation environment whenever the need arises.” (TR-MSG-136-Part-VI 2019)

The concept of Modelling and Simulation as a Service is defined in the final report of the MSG-131 team of specialists entitled *Modelling and Simulation as a Service: New Concepts and Service-Oriented Architectures* as follows: “M&S as a Service (MSaaS) is a means of delivering value to customers to enable or support modelling and simulation (M&S) user applications and capabilities as well as to provide associated data on demand without the ownership of specific costs and risks.” (TR-MSG-131 2015) The value is determined by the customers, in the case of a service it is correlated with what allows the user to achieve. Thus, MSaaS is an organizational and architectural approach that is based on abstraction, reuse and discovery of new modelling-simulation services. The main objective of MSaaS is to assure the fulfillment of operational requirements and to improve the development, operation and maintenance of modelling and simulation applications.

## **2. Advantages and disadvantages of MSaaS**

NATO specialists have identified a number of advantages and disadvantages, general or specific to the military environment, of MSaaS. (TR-MSG-131 2015)

The general advantages identified are:

- Self-Service- users can have automatic access to a database or applications without the need for interaction with an operator;
- Capabilities can be found on the network and can be accessed through client platforms (phones, laptops, workstations);
- Resources are allocated dynamically at the request of the consumer and can be used by a large number of customers simultaneously;
- Resource utilization can be monitored and reported;
- The supplier can perform the updates automatically, the updated version being made available to the customer in real time;
- Services can be used as components in other more complex services;
- The services can be reused;

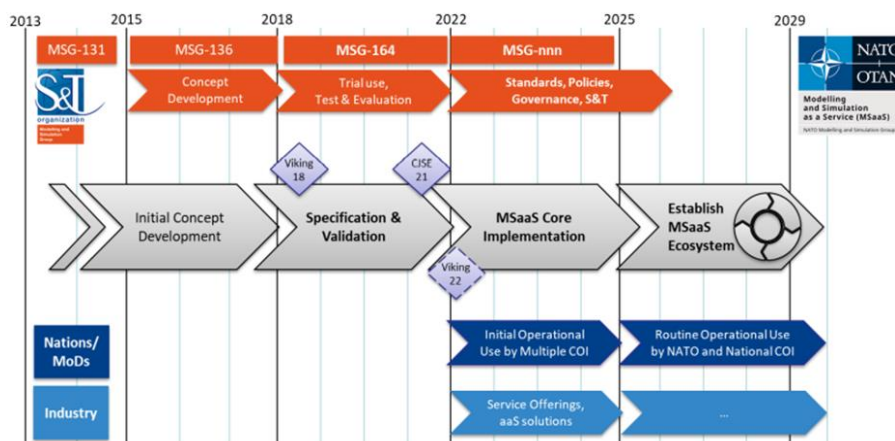
The advantages of MSaaS in the military are that it eliminates the need to use large hardware components, the end user does not have to perform complex maintenance activities, resources are accessible from anywhere, can be used by more people and provide flexible solutions to suit needs.

The disadvantages of MSaaS are:

- Security, confidentiality, accountability and risk management are more difficult in a distributed and heterogeneous environment with a large number of users;
- Dependence on network connections increases vulnerability;
- Adapting existing M&S applications to be used as services and uploaded to the cloud can be difficult and costly;
- Resources are managed by the provider which reduces the degree to which the user can modify them;
- Updates to the components of a complex service will require it to go again through the validation phase;
- The network infrastructure provided to the military user is often precarious, which will make it difficult to use M&S services in certain situations;
- Human interaction is reduced.

### 3. The stage of MSaaS development within NATO

NATO has found that it is necessary to undertake MSaaS research by NATO Modelling and Simulation Group (NMSG) specialists to better understand the concept. The strategy for implementing MSaaS at NATO level is presented in Figure no. 1.



**Figure no. 1.** MSaaS implementation strategy within NATO  
(Source: Siegfried n.d.)

The first working group in the field of MSaaS was MSG-131 which carried out its activity in the period 2013-2015 resulting in the elaboration of *TR-MSG-131: Modelling and Simulation as a Service: New Concepts and Service-Oriented Architectures*. The main focus of the working group was to gather and integrate Member States experiences and expertise in the use of cloud computing and service-based architecture in modelling and simulation, concluding that MSaaS will provide a number of benefits.

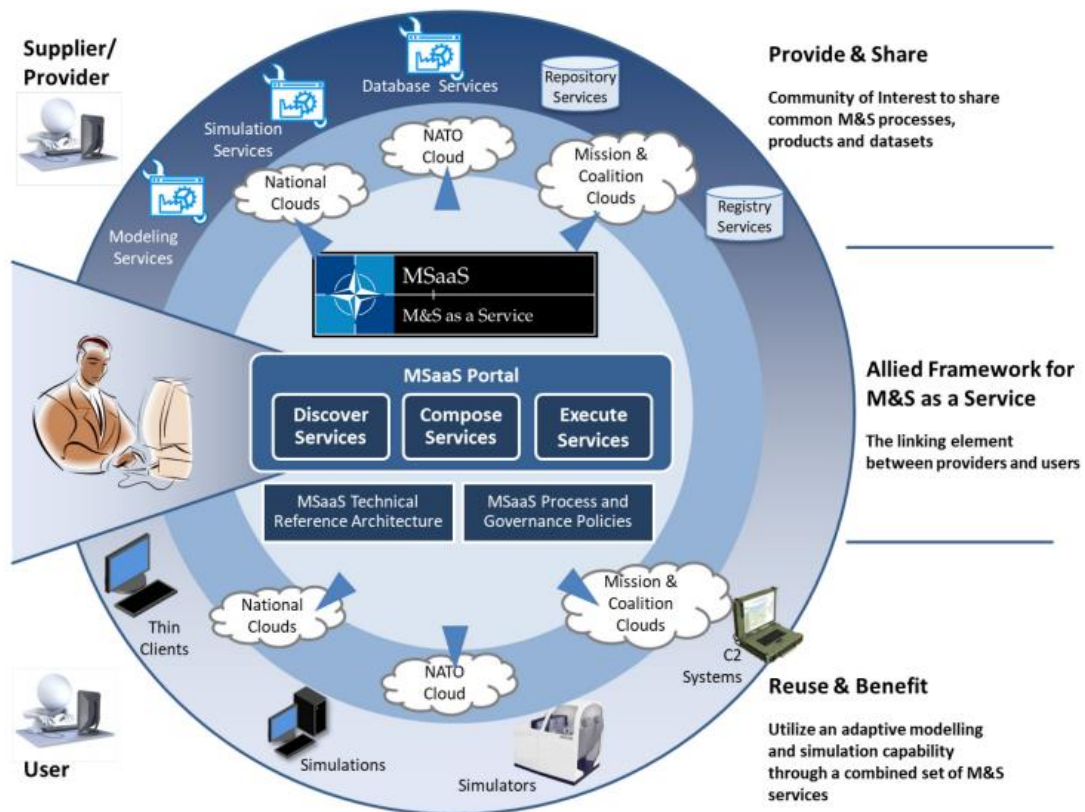
The conclusions brought by MSG-131 triggered the development stage of the initial concept which took place in the period 2015-2018 led by the MSG-136 working group. NATO's STO-TR-MSG-136 activity in the field of MSaaS had the following subgroups and research directions:

- a. R-MSG-136-Part-I (MSaaS – Rapid Deployment of Interoperable and Credible Simulation Environments);
- b. TR-MSG-136-Part-II (MSaaS Concept and Reference Architecture Evaluation Report);
- c. TR-MSG-136-Part-III (Operational Concept Document/OCD for the Allied Framework for MSaaS);
- d. TR-MSG-136-Part-IV (MSaaS, Volume 1: MSaaS Technical Reference Architecture);
- e. TR-MSG-136-Part-V (MSaaS, Volume 2: MSaaS Discovery Service and Metadata);
- f. TR-MSG-136-Part-VI (MSaaS, Volume 3: MSaaS Engineering Process);
- g. TR-MSG-136-Part-VII (MSaaS, Volume 4: Experimentation Report).” (Coman, Bârsan și Piele 2021)

The MSG-136 efforts laid the technical and organizational foundations of the common MSaaS framework in NATO, providing technical instructions, standards and architectural models. During the MSG-136 activity, a series of experiments were carried out with the aim of demonstrating that MSaaS is a viable solution to solve the cost and interoperability problems of modelling and simulation.

The development of the Allied Framework for M&S as a Service is the main focus of NATO's efforts to ensure the efficient and timely implementation of the MSaaS within the Alliance.

The Operational Concept of the Allied Framework for M&S as a Service is presented in Figure no. 2. “The Allied Framework for MSaaS defines the user facing capabilities (Front-end) and underlying technical infrastructure (Back-end). The Front-end provides access to a large variety of M&S capabilities from which the users are able to select the services that best suit their requirements, and track the experiences and lessons learned of other users.” (TR-MSG-136-Part-III 2019)



**Figure no. 2.** Operational Concept of the Allied Framework for M&S as a Service  
 (Source: TR-MSG-136-Part-III 2019)

Within the Allied Framework the user has the possibility to discover the modelling and simulation services and resources, to compose complex simulation applications based on the discovered services and to execute the resulting simulation.

The Allied Framework for M&S as a Service is composed of:

• **Operational Concept Document (OCD):** The OCD describes the intended use, key capabilities and desired effects of the Allied Framework for M&S as a Service from a user’s perspective.

• **Technical Reference Architecture and Associated Volumes:** The Technical Reference Architecture describes the architectural building blocks and patterns for realizing MSaaS capabilities.

• **Governance Policies:** The MSaaS Governance Policies identify MSaaS stakeholders, their relationships and provide guidance for implementing and maintaining the Allied Framework for M&S as a Service as a persistent capability.” (TR-MSG-136-Part-III 2019)

The Allied Framework for Modelling and Simulation as a Service will provide Member States with the opportunity to improve their modelling and simulation capabilities through the efficient use of resources and time resulting from the incorporation of individual requirements into the Alliance's common modelling and simulation applications. The Allied Framework will provide new opportunities for NATO member states in terms of joint training and joint operations, while also facilitating their access to modelling and simulation service providers.

The Specification and Validation phase is carried out by the MSG-164 working group in the period 2018-2022 and has as 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.” (Modelling and Simulation as a Service - Phase 2 fãrã an)

The MSG-164 working group aims to demonstrate the operational relevance of MSaaS applications by conducting experiments based on the integration of these applications in multinational exercises and in the process of developing new simulations. The group is also responsible for implementing MSaaS governing bodies within NATO and increasing the number of members of the MSaaS community of interest, both among Member States and stakeholders.

This activity will develop and test an appropriate MSaaS infrastructure to be used in relevant operational environments and to support ongoing MSaaS testing and evaluation efforts. At the end of the MSG-164, it is expected that the MSaaS will move from the prototype stage to a well-defined operational system, the activity ending with the preparation of a technical report and recommendations regarding the operational perspective of integrating MSaaS within NATO and the member states.

In the period 2022-2025, the basic implementation of MSaaS will be carried out, which involves the acquisition of the initial operational capability by adapting a large number of existing simulation systems to the reference architecture of MSaaS.

## **Conclusions**

The dynamism of the current operational environment and the emergence of new threats to states and international organizations have led the latter to focus their efforts on developing new capabilities that will allow them to adapt quickly and achieve their goals. Thus, one of the areas that has attracted the attention of international actors is modelling and simulation.

The field of modelling and simulation has developed considerably due to the unprecedented technological advancement, and the analyzes performed on it revealed two major shortcomings: the increased cost and time required for model development and interoperability issues between existing modelling-simulation systems. Thus, NATO has focused its efforts on developing the Modelling and Simulation as a Service (MSaaS) concept to address the identified shortcomings and to improve the Alliance's modelling and simulation efforts.

The research and development activities of MSaaS within NATO were undertaken by the NATO Modelling and Simulation Group (NMSG) on the basis of a multi-stage structured strategy, which started in 2013. At present, the implementation strategy is in MSaaS Specification and Validation phase to be completed in 2022.

The stage of development of MSaaS within NATO is defined by the fulfillment of the following objectives: development of the initial concept, defining specifications, development of experiments to demonstrate the usefulness and applicability of MSaaS, development of a technical reference architecture and MSaaS infrastructure to introduce it into the Alliance.

The next step is to achieve the basic implementation of MSaaS within NATO by developing the initial operational capability and adapting the existing modelling-simulation capabilities to MSaaS. Standards and reference documents will also be developed to facilitate the implementation of MSaaS and emphasis will be placed on creating infrastructures to support MSaaS in areas of interest.

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