

# SIMULATION OF MULTI COALITION JOINT OPERATIONS INVOLVING HUMAN MODELLING

Agostino Bruzzone<sup>(a)</sup>, Alberto Tremori<sup>(a)</sup>, Marina Massei<sup>(a)</sup>  
Francesco Longo<sup>(b)</sup>, Letizia Nicoletti<sup>(c)</sup>, Simonluca Poggi<sup>(d)</sup>

<sup>(a)</sup>DIME, University of Genoa, Italy - [www.itim.unige.it](http://www.itim.unige.it)

<sup>(b)</sup>MSC-LES, Mechanical Dept, University of Calabria, Italy – [www.msc-les.org](http://www.msc-les.org)

<sup>(c)</sup>CAL-TEK srl - [www.cal-tek.eu](http://www.cal-tek.eu)

<sup>(d)</sup> Lio Tech Ltd UK – [www.liotech.co.uk](http://www.liotech.co.uk)

<sup>(a)</sup>[agostino@itim.unige.it](mailto:agostino@itim.unige.it), [alberto.tremori@simulationteam.com](mailto:alberto.tremori@simulationteam.com), [massei@itim.unige.it](mailto:massei@itim.unige.it),  
<sup>(b)</sup>[f.longo@unical.it](mailto:f.longo@unical.it), <sup>(c)</sup>[l.nicoletti@cal-tek.eu](mailto:l.nicoletti@cal-tek.eu), <sup>(d)</sup>[simonluca.poggi@liophant.org](mailto:simonluca.poggi@liophant.org)

## ABSTRACT

In this paper are presented on-going researches to investigate usage of modeling and simulation for the creation of scenarios multi-coalition joint operations scenario with civilian, refugees and non military organizations heavily involved (Governmental and Non). Over the last 20 years this is the most diffuse kind of theater where Western Armed Forces are involved.

The researches will be focused on interoperable simulation to federate different models to represent different layers of the reality and the use of agent driven simulation based on human behavioral models; this allows to recreate very complex and extended scenarios with population and other non conventional agents with a reduced effort (in terms of personnel and budget).

As first steps a group of military Subject Matter Experts is under creation and the early suggestions from user community is to focus, considering the original scope of the project, also on simulation of medical operations and units.

In this paper it will be described the main goals and the approach that will be adopted for the development of models and the creation of the federation that will represent a demonstrator for the main outcomes of the research. It will be also described the international partners that will be involved to bring models for the federation among the main research centers and companies active in the M&S world.

Keywords: Intelligent Agents Computer Generated Forces (IA\_CGF), Human Behavioral Models, Interoperable Simulation

## 1. INTRODUCTION

Evolution of Scenarios where our Forces are involved, new non conventional threats (i.e. insurgency, guerrilla warfare, terrorist attacks, CBRN attacks...)

and the involvement of forces and coalitions of different nature and different countries have a strong impact on strategies and approaches.

In particular researches addressed the study of new solutions for the use of C2 (Command and Control), consistent with the hypothesis of NCW (Net Centric Warfare), are confronted today with the need to operate in areas with several commands (i.e. NATO, EU, U.S., Russia, Japan, China) with similar goals and missions, but with different rules of engagement (i.e. Piracy in Gulf of Aden or operations in Libya). Often in these contexts human behavior are predominant both due to strong involvement of civilians in theater (i.e. refugees, evacuation countrymen, civil protection, interaction with local populations, CIMIC, etc..) and for the need to consider human factors in evaluation of the effectiveness of the tools, resources and technologies available from military units involved.

In fact, all recent theaters (Afghanistan, Libya, Horn of Africa), have highlighted several of the critical issues mentioned above, among which:

- The importance of human factors (i.e. fatigue, stress, fear, aggressiveness) for military operations in complex scenarios;
- Joint coordination: Army, Navy and Air Force
- The presence of new actors interacting with the military not only as friends, foes and neutral forces, but as partners with specific characteristics including: police, Civil Protection, Governmental Organizations (GO) and Non-Governmental (NGO), paramilitary organizations, groups of influence, ethnic and religious groups, new political structures, etc. ...
- New types of threats operating side by side with terrorists and insurgents such as warlords, crime organizations, hackers and media warriors;
- Interaction between various military coalitions or groups with specific interests (i.e. NATO, EU, U.S. Commands, etc..), different rules of engagement and different assets both co-existing

and separated in terms of spatial, temporal or thematic.

Hence the need to study and develop the new models for Defense described in this paper. These innovative approach by using interoperable simulations should support, in similar contexts, a wide spectrum usage both for testing procedures, doctrines and operative analysis, and for training, or war gaming.

During the described researches will be created a federation of simulators to be used in training , as first step in experimentation phase, and later to investigate usage for operative planning, by creating complex scenarios as described above.

The simulator will be realized federating via HLA (High Level Architecture) different models (both developed specifically for the project and, if any, already existing ones) accordingly to technologies and standards state of art. In the federation will be federated models based on Intelligent CGF (Computer Generated Force) (such as IA-CGF), constructive simulators with different levels of aggregation (i.e. JTLS, JCATS etc.) and virtual simulators (i.e. VBS2, DI-GUI, ST\_VP).

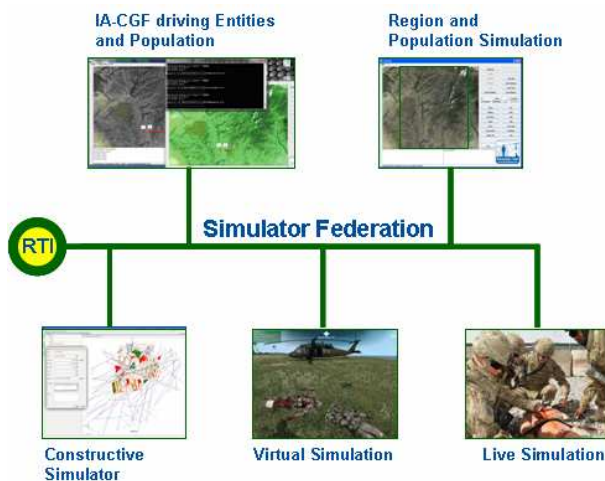


Figure 1. Example of Simulator Federation

As already mentioned, this federation will be executable and usable for different applications such as test & experimentation (o test & evaluation), training, operational planning. In this research will be identified a mission environment (i.e. Libya) and an hypothesis for use with military users for field testing and validation (i.e. training). During initial project steps authors are finalizing this aspect as well as the requirements for the federation and simulators to be integrated in. Furthermore authors are contacting military subject matter experts to create a project community for supporting and participating in requirements definition and the whole VV&A process..

Development phase for Federations and Models will be completed with the federation integration test and completion of the and statistical dynamic verification and validation phases based on execution of the federation. Finally, the simulation will be accredited by the involvement of the above mentioned military

users community during the testing phase to evaluate the effectiveness and efficiency and lead to the definition of requirements for a future advanced system based on this study that could be deployed as an operational decision support.

The federation developed for this research will be an usable and useful tool still in this prototypal solution, becoming a useful aid for Defense. Indeed, both the operational planners and analysts will be able to conduct further experiments with this tool to evaluate different approaches to C2 (Command and Control) in accordance with NATO Maturity Models (NATO NEC Maturity Models Command and Control - N2C2M2).

In this regard it should be noted that the Intelligent Agents Based Simulation will allow generation of the chosen complex scenario considering the influence of human factors and the attitude to cooperation and coordination in multi-joint coalition operations, in this manner will provide the opportunity to test quickly different alternatives based on quantitative data. A system based on this research results will reuse the models and simulators developed for other operating environments and mission environments and will add functionality that will enable a considerable impact, and impact.

Obviously the success of the project is strongly based on the considerable experience of authors's research team in the development of interoperable simulations in HLA federations, on the coordination of previous projects in this field and on the application of appropriate methodology for VV & A (Verification, Validation & Accreditation) and their conduction along the entire research period. All this must extend, for the different areas of expertise, to all project partners (see chapter 4).

## 2. PROJECT GOALS

The research objectives are to study simulation usage for generation of Joint and Multi-Coalitions scenarios, considering a strong involvement of human factors with a particular focus to issues of refugees, of natural disaster relief and civilians in the theater.

To complete the described research activities it will be developed an HLA federation of Agent Driven Simulators based on the use CGF managed by Intelligent Agents (I.e. IA-CGF), Virtual systems (ie VBS-2) and Constructive systems (ie, IA-CGF NCF, JTLS, JCATS or other ...) able to reproduce the complexity of the scenario and to consider human behavior constrains

Final goal of the project is to study innovative Verification, Validation and Accreditation procedures from goals definitions, thought simulators integration tests to experiments with the SMEs community in a scenario defined related to the evaluation of the different NATO levels of Maturity in Command and Control adoption for training and concepts and

doctrines experimentations. In particular this project , being focused on multi-coalition joint operations, will consider the higher levels of Maturity: Edge, Collaborative and Coordinated. This is an important evolution of previous researches led by authors: in these previous researches the focus was more on technological issues (Bruzzone A.G., Cantice G., Morabito G., Mursia A., Sebastiani M., Tremori A., 2009) or on different operative domains (Bruzzone et al 2009, 2010, 2011 2012). Applications of the results will be extended to training, operational planning, testing and experimentation, etc..

Specifically the federation will reproduce a scenario ( i.e. Libya) in which different coalitions will be involved with friends, foes, neutrals and with a strong presence of civilians and peculiar organizations in theatre. A special focus will be devoted to medical operations (see Chapter 3)

It will be also considered the possibility of investigating new technological solutions through integration test with other systems (i.e. C2, Communication Layer, etc....) with regard to the complexity of the scenario.

For an effective representation of complex scenarios as is goal of this project, with involvement of military force and civilian, it necessary to define all the Political, Military, Economical, Social, Informatics and Infrastructural parameters (PMESII), therefore models to be developed this project shall include among their characteristics:

- Entities for representing Civilian Population with related familiar and social networks
- Socio-Economic-Ethnic-Religious... for every entity
- Defining actions that could have an impact on population

As already highlighted in the Project Objectives models and federations could be used for training but it will be possible to consider implementation also for operational planning. In both cases results of this project could have a positive impact on such typical constrains as:

- Decision Makers have access to partial or insufficient information
- Time is limited
- Resources are limited
- Multi-dimensional Boundaries for every decision:
  - Joint operations
  - Multi-Coalitions
  - Civilian Involvement

It is important also to underline models interoperability via HLA. For such complex scenarios considered in this project we can identify different benefits from this technological choice. First of we have all the possibility to integrate, in future cases, specific models to re-create particular phenomena: as sample we can use epidemics, events that can happen during military operations with big flows of refugees. Such phenomena are extremely complex and ask for specific models that could be integrated.

Furthermore, through the models and general architecture interoperability will be possible to obtain simulation availability on-demand, easily shared resources among different simulation sites or offices of the Ministry of Defense to start a new path to integrate Live-Virtual- Constructive simulation accordingly to Armed Forces goal.

Another goal of the researches described in this paper is to allow a rapid and easy creation of complex scenarios that could consider constrains deriving from interactions among different subjects (civilian and military), the different layers that represent social structures, different military elements and in particular different C2 approaches (but also Intelligence, Information, Logistics...) provide an exhaustive reference framework based on quantitative data deriving from simulation runs. This will be possible with a limited amount of resources (economical and personnel) due to the integration of agent based simulation where computer generated forces acted in an autonomous way. In fact it is important to underline that intelligent autonomous agents will allow to complete a higher number of simulation runs with a lower effort providing more accurate results to be used for operational planning and providing the possibility to have more exercise during a year.

### 3. FOCUS ON MEDICAL OPERATIONS

In the early stages of the project a clear request has emerged from the SMEs military community: investigate, in the general framework, medical operations. Here below are summarized a list of possible areas of research that could be investigated with the requested specific focus on medical activities, considering the multi-cultural, multi-coalition scenarios that are the general objective of the research:

- Management of Medical Units both Military and Civilian in the crisis scenario (Constructive Simulation)
- Integration of Human Behavioural Libraries in a Virtual Patient (Virtual Simulation)
- LVC (Live, Virtual Constructive) HLA Federation of Models from different partners, here below a possible sample:
  - Constructive system: with IA\_CGF Non Conventional Framework from Simulation Team (Italy),
  - Virtual Simulation from Army Research Laboratory (USA),
  - Live Simulation CAE (Germany),
- Use of Serious Games Technologies for training and Education in Medical sector:
  - Serious Games and Contextual Learning for Coupe D'oeil (translation *At a Glance*) medical operators training
  - Creation of an Avatar for educating medical personnel to take care of its "Virtual Patient" in coalition operators

From a National point of view, it is important to underline that the application of Simulation to the

Medical Sector, both for defence and civil applications, has had and is having a huge evolution creating for sure a new frontier for research and development in Modelling and Simulation.



Figura 2. Examples of Medical Virtual Simulation

#### 4. PARTNERS AND INTERNATIONAL COLLABORATIONS

Collaborations are envisaged at national and international levels, with different agencies, research institutions and companies. In particular, as regards industrial partners authors plan to involve CAE Elektronik GmbH (the German branch of famous the Canadian simulation company) to bring their expertise in tactical constructive simulation and also for medical training based simulation. The involvement of CAE GMBH could also bring the experience of the German Civil Protection Agency that represents an interesting case study of application of military simulation tools for civilian application involving CAE GMBH itself, the German Armed Force and the German Federal Office for Civil Protection and Disaster Assistance (BBK – Bundesamt für Bevölkerungsschutz und Katastrophenhilfe).

At national level different M&S and R&T (Research and Transformation) Italian MoD offices are involved or are going to. Authors plan also to work with main national industrial partner (i.e. Finemccanica Group companies) to maximise the expected impact in the Modelling and Simulation area for our country.

Authors have also strong linkages and on going collaborations with Roland & Associates producer of that level constructive system JTLS. It has to be underline that that DIME (former DIPTM), MAST, (and LSIs Marseille) are the only non-military users in possession of JTLS licenses for researches and development projects over the past 5 years (i.e. PIOVRA project, Haiti Scenario for the former US-JFC, ...).

Within NATO is expected to interact with different Centers. With ACT in Norfolk several collaborations are active with synergies related to this project (eg Project ECECI), with NC3A for the M-CMI (Multinational Civil Military Interoperability) and with the Multinational CIMIC Group of Motta di Livenza. There are also several active project activities with the nascent NATO M&S COE on various issues of M&S (interoperability, Education & Training ...).

Always at international level but with individual countries the researches could benefit of collaborations with, among others, the U.S.-JCW (former U.S. Joint Force Command) on modeling of humanitarian support

scenarios (i.e. Haiti Earthquake Scenario), with US Dartmouth College for modeling a Katrina-Like Scenario, with the French DGA for CIMIC modeling (CAPRICORN project), etc...

In the area of Virtual Simulation applied to the medical sector it will be involved the US Science & Technology of the Army Research Laboratory led by Dr. Robert Sottilaire, Ph.D.

#### 5. CONCLUSIONS

This is an extended and ambitious project with the goal of simulating the extreme complexity of military joint operations where different nations and agencies are involved: this represents *de facto* reality of almost every operation but, despite this, no industrial product and still very limited research experiences are, nowadays, available or running. Authors aim is not only to investigate and develop M&S innovative solutions but also to create a community of users and international and national partners that could support the creation of a scenario for demonstration and participate in all the steps of the VV&A (Verification, Validation and Accreditation) process.

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