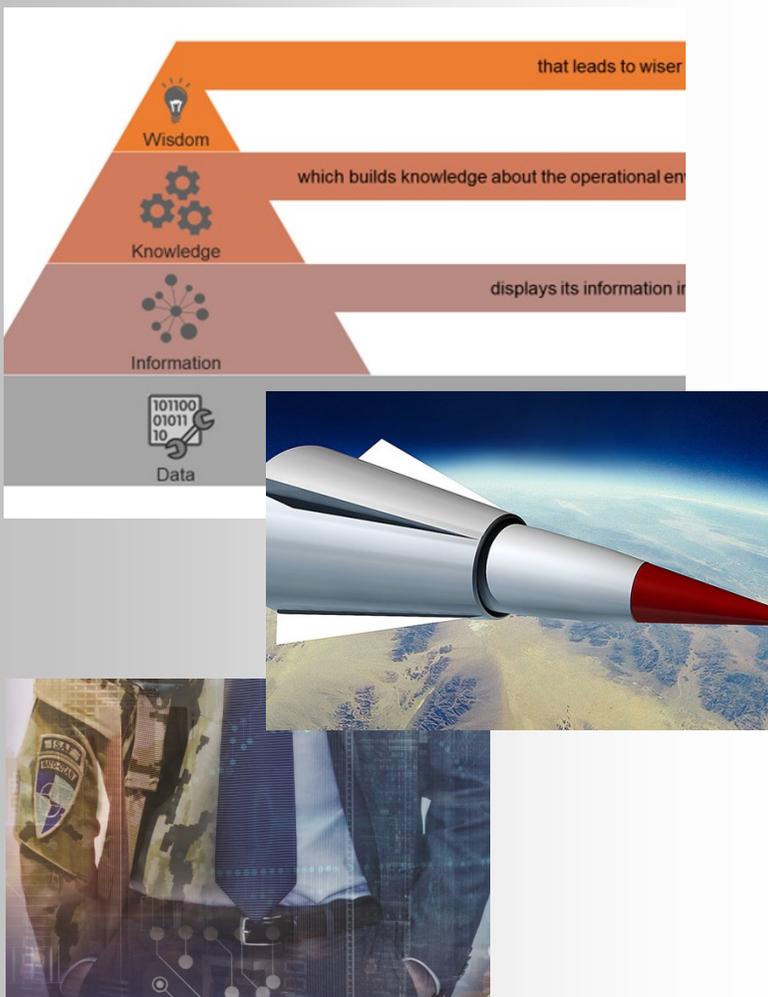


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NATO
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Centre of Excellence

NATO M&S COE



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Preface

Dear readers,

It is a great pleasure for me to present you our annual review related to the documents, studies and research that have been produced during 2020.

This annual review has a strategic relevance for our Center considering that together with the collection of papers developed during the annual CA2X2 Forum 2020, it represent all our scientific and editorial production. The Annual review 2020 highlights the research activities and topics developed during the year in favor of the M&S Community of Interest. The material, edited with the collaboration and approval of their authors, will enhance our and your background in some of the most important topics related to the EDTs - Emerging Disruptive Technologies and M&S in NATO's new technological and strategic challenges.

The collection also represents for NATO M&S COE a moment of scientific production that materializes the effort to be able to develop research and study activities to promote the knowledge and use of simulation in the Alliance to underline the importance of M&S as service architecture and efforts to define tools for IT training and support of autonomous system domains.

M&S becomes more and more preponderant and accentuates its adaptability exponentially due to its atypical and transversal nature which can be applied to many doctrines. The application of M&S into the Open Innovation will allow for faster implementation to have more credible studies and capability tests to obtain value as soon as possible.

2020 was a particular year, characterized by a lot of smart working due to the COVID-19 pandemic. we did not stop and despite the natural slowdown in activities we continued to work in M&S to support and to aid the development of advanced technologies in NATO's effort to maintain and advance the military and technological advantage over its competitors.

Proud to promote our publication to your attention, considering all the care and devotion that our crew has devoted to this collection to stimulate more research and experimentation in M&S, I wish you a good read that encourages and inspires your daily work.

Col. (ITA Army) Michele TURI

Rome, Italy

May, 2021

Acronyms

ACT	Allied Command for Transformation
C2	Command & Control
CAX	Computer Assisted Exercise
COE	Centre of Excellence
CPX	Command Post Exercise
ETOC	Education and Training Opportunities Catalogue
M&S	Modelling and Simulation
MDMP	Military Decision Making Process
MESAS	Modelling and Simulation for Autonomous Systems
NATO	North Atlantic Treaty Organization
ORBAT	Order of Battle
STO	Science and Technology Organization

1. THE THREAT OF HYPERSONIC BALLISTIC INTERCONTINENTAL MISSILES, THE SPACE DOMAIN AND THE USE OF MODELLING & SIMULATION

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1.1 The Threat and Strategic Equilibrium

The concept of the ballistic intercontinental missile is not new in the field of military applications, but the new technologies that have transformed this weapon into hypersonic devices, have ensured to some Superpowers very powerful and important offensive tools on the global battlefield. In this historical moment in particular, Russia and China have a partial supremacy over the US, because they already have some operating system, close to entering them “on duty” or in an advanced stage of development. These missile systems represent major threats because Western defenses are not yet prepared to deal with them: they can travel at speeds above Mach 5. In fact, a cruise missile that flies at hypersonic speed at low altitude, or an HGV warhead capable of flying at lower altitudes than those of the classic re-entry vehicles born with this technology in the 70-80s, make ineffective every strategy and even the best current defense systems such as the Patriot,



Figure 1-1: Russia’s new Avangard hypersonic weapon system

THAAD or the GMD. A cruise missile directed at hypersonic speed against a target is therefore difficult to detect by the flight profile radars and can easily overcome missile and anti-aircraft defenses.

Hypersonic technologies are those in which it is necessary to use new engine design features, structures, aerodynamics, propellants and driving systems with requirements and objectives that are difficult to obtain because they require considerable costs to be incurred and experimentation activities to be carried out on the materials, although development activities are decades old. These evolutions, due to the exponential evolution of technology in general, have included new hypersonic technologies as an important sector of EDTs¹, in which all superpowers are investing billions. Clearly, the development and implementation of EDTs have important implications for civil society but for example hypersonic technologies, applied to the defense's sector, can modify the strategic equilibrium due to their unpredictability, the difficulty of interception, the maneuverability and the high speed, reducing evacuation time, defense application and especially response times.

1.2 Past and Future

In the recent past, a classification of ballistic missiles had based taking into account three main types of missiles, looking at their range: short (from 200 to 1000 km), medium and long range (from 1000 to 5500 km) and intercontinental (from 5500 km up to over 10,000 km).

A modern ICBM² consists of three stages and a MIRV³ reentry vehicle on the top, capable of carrying a certain number of multiple and independent warheads, equipped with an autonomous guidance and aiming system to hit multiple targets simultaneously. These devices optimize the launches to perform, exponentially increasing the destructive capabilities of individual missiles and keeping the number of carriers unchanged into the level of international treaties against proliferation.

The recent generation of hypersonic missiles are the result of complex and expensive technologies that travel at very high temperatures and very great pressures using the SCRAMJET⁴ propulsion systems that are activated only after exceeding the speed of sound. The technological difficulties

¹ EDT – Emerging Disruptive Technologies

² ICBM – Intercontinental Ballistic Missile

³ MIRV – Multiple Independently Reentry Vehicle

⁴ SCRAMJET – Supersonic Combustion Ramjet

despite the availability of suitable materials, have made it possible so far, to develop only two types: the GLIDER module which is very similar to the MIRV but has ample ability to maneuver and modify the path until it hits the target; the other which is very similar to a cruise missile but equipped with a SCRAMJET engine that uses another vector that brings it to the speed of sound to activate it.

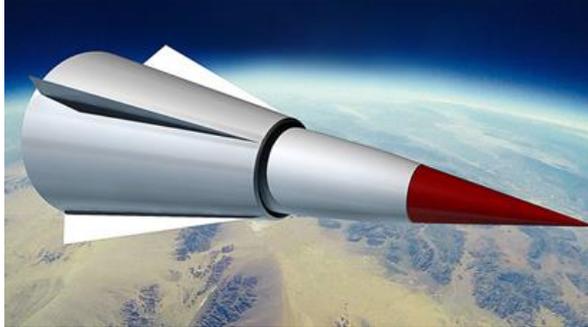


Figure 1-2: An artist's rendering of what the DF-ZF could look like. The DF-ZF is a Chinese hypersonic glide vehicle (HGV).

In recent years, Russia and China have focused their technological research on these carriers, sometimes taking advantage of traditional ballistic carriers (such as the Russian RS-18 model or the SS-22) that can carry a GLIDER that in descending phase can maneuver like a glider even with speeds close to 20 mach. The SS-27s on the other hand, are slower in the initial phase (boost) and therefore more visible and interceptable. The 2013 Russian test launches flew over areas bordering Norway and the Caucasus creating panic and reminding us of the looming threat. China has developed a new medium-range missile that can carry a GLIDER with reentry speeds between 5 to 10 mach that can also carry conventional warheads or other types of cargos. India and France are also conducting sector's studies.

The United States has not highlighted the presence of hypersonic missile models despite the large investments of Defense money for the development of this technology. The focus has rather been on other EDT technologies such as satellite constellation architectures for advanced tracking and discovery equipped with HBTSS⁵, MFOV⁶ vision and OPIR⁷ sensors or as energy weapons (LASER cannons) although some Russian missiles they appear to be effectively shielded against current directed energy weapons.

⁵ HBTSS – Hypersonic Ballistic Tracking Space Sensor

⁶ MFOV – Medium Field Of View

⁷ OPIR – Overhead Persistent Infrared

1.3 Space Domain

The space domain has forcefully entered into the order of operational dimensions together with the cyber domain to flank the traditional terrestrial, air and naval domains. This represents the strategic multidimensionality of the threats that western defensive organizations will have to face in the coming decades even if the cyber domain precisely due to its nature, adaptability and inconsistency is destined to dominate all the other operational domains that are irrevocably transitioning to digital technologies.

The awareness of the reborn intercontinental ballistic threat, reinforced by the use of hypersonic technologies, has prompted many nations to establish, into their defensive structures, HQs and entities to manage their space domain. This trend was really born after the 11th September, focused on the needs to monitor missile threats, airspace, satellites' control, space surveillance, C2 operations for leadership and strategic communications. Today this trend is further established in the areas of communication, positioning, navigation and GPS data, meteorology and ballistic threat detection capabilities.



Figure 1-3: First test of the Russia's Tzirkon hypersonic missile

These military entities, depending on their size and the ballistic capabilities expressed by the nation, are committed to organizing, training and equipping their “space forces” to counter potential threats, guarantee the freedom of space manoeuvre and provide to the joint forces on the ground with the support deriving from space technologies (reconnaissance, communications, aiming, forecasting and in-depth analysis). The ability to recognize that “space is no longer an inconsistent and benevolent domain” and that adversaries have achieved important capabilities in that sector, has amplified

the awareness of the value that space domain brings in a joint context and includes areas without precise boundaries in which even opponents can operate undisturbed. This awareness has highlighted the gaps in the training programs for space specialists that have to plan, operate, and manage the domain. We are not talking about training “astronauts” but specialists with extensive digital and IT knowledge, able to manoeuvre swarms of satellites on different orbits, manage constellations of orbiting devices, acquire information and manage data, receive alarms and direct communications to carry information and intelligence⁸ where it is needed.



Figure 1-4: USALGM-118A Peacekeeper ballistic Missile

The example comes from the USSF (US Space Force) command which has developed a training plan at the STARCOM (Space Training Readiness Command). This HQ prepares space forces to live and fight in degraded contexts and in deteriorated operational environments to ensure satellite equipment working and guaranteeing the alarm level for ballistic threats through the application of the most advanced technologies, protected from cyber and kinetic attacks. The focus of this training is carried out through M&S⁹ or through accurate models of the systems (satellite, communications, missile, etc.) without approximations, which are used in simulators capable of making them operate in a synthetic multidomain environment where is possible to test their skills and resilience. Virtual systems can act and react in the same way that the real systems should do, training specialists to use resources effectively and apply procedures.

⁸ IMINT, MASINT, GEOINT, SIGINT

⁹ M&S – Modelling & Simulation

1.4 Missile Threat and M&S

The latest Russian anti-satellite weapons tests of last December 2020 were perceived as a further threat in contrast with the efforts to be able to track hypersonic missiles and the will to build units to manage space. The test used a kinetic capability against low-orbit satellites that demonstrated the efficiency of specific systems and also the ability to launch objects from satellites versus ground targets and other satellites. Beyond the defensive approach adopted by Western nations to counter Russian and Chinese interference in the space domain, the response wants mainly to establish a generation of specialists with a real ability to fight in the space and where M&S plays a decisive role.



Figure 1-5: The Dongfeng-41 nuclear-capable intercontinental ballistic missile at a military parade in Beijing (2019)

M&S purpose in this environment, is not only training but also to support decisions, improve the analysis and allow to experiment new systems and procedures to effectively counter the opponents. Technically, a minor strategic capacity a nation can express and the more effective training systems such as M&S should be used for its operators, specialists and managers. M&S allows specialists and commanders to be stressed by showing them volatile, uncertain, ambiguous and unpredictable operating environments where there is a real opponent capable of a precise strategy. Three-dimensional scenarios, in addition to taking into account an evident, real and contextualized strategic situation, must allow the staff to be prepared to intervene promptly through the use of techniques, tactics and evaluation processes to operate the routine in the space. The establishment of “Space Range” is also a characterizing element of this education where satellite control centers are sided by side with “Training Space Centers” where the orbiting assets can be trained and evaluated meanwhile they are using volumes of space for specific operational activities.

These simulation centers represent the compromise between the operational needs of the operators and what happens every day in space, bringing the problems of the real space-operating environment into a synthetic three-dimensional operating environment. Another important aspect is the distributed and federated capacity which can assemble multiple simulators of different types among different sites and allow to use all the tools in a single synthetic environment. The simulation exercises for the space domain respond to the classic organization of a CAX¹⁰ where the response cells have different types of missions to complete (engagement of orbital maneuvers, maintenance of space superiority against threats, missile warning, Intelligence, Space domain awareness, space EME, etc.). The exercise direction cells provide the Command and Control functions while the opposing cells simulate the adversary's will to attack space domain and their skills. The M&S is therefore crucial to guide the defensive and offensive response's capacity to manage the space domain and allows studying the moves and countering moves in a critical and current scenario such as the space one. The distributed capacity also allows involving multiple entities and organizations operating in the space, involving various systems and units to manage a complex environment that does not belong to a single operational capacity but involves all the forces in the field and is reflected from space overall nation.

1.5 The Bursting Model

One of the best known models for the ICBMs' modeling is the sensitivity analysis of the BURSTING¹¹, that is the need to evaluate the results of the observation of repeated launches of ICBM, to obtain the optimal result to achieve a target set at 8000 km, varying the launch variables, the missile configuration and some parameters/variables, taking into account turbulence and arbitrary values. The model can be used in a simulator in order to perform the number of launches necessary to study the trajectories. The ballistic carrier must meet specific requirements. The main one is to bring the MIRV ballistic load to a certain exo-atmospheric altitude to make it re-enter the earth's atmosphere and to hit a contemporaneity of targets at a high distance with an acceptable error (the more negligible the error is great power of the ballistic load). The design of the carrier must therefore respond to parameters that must take into account the features of the missile and its composition in stages, the electronics necessary for the guidance systems,

¹⁰ CAX - Computer Assisted eXercise

¹¹ BURSTING – Ballistic Rocket Simulation Testing Interactive Numerical Grinder

its transportability, management and the military requirements for use. The main physical characteristics of a ballistic missile are summarized in: type and quantity of stages, mass and quantity of fuel transported, the release times of the stages, expressible power (trust), while the launch variables are the weight of the MIRV launch angle, air turbulence and atmospheric conditions.

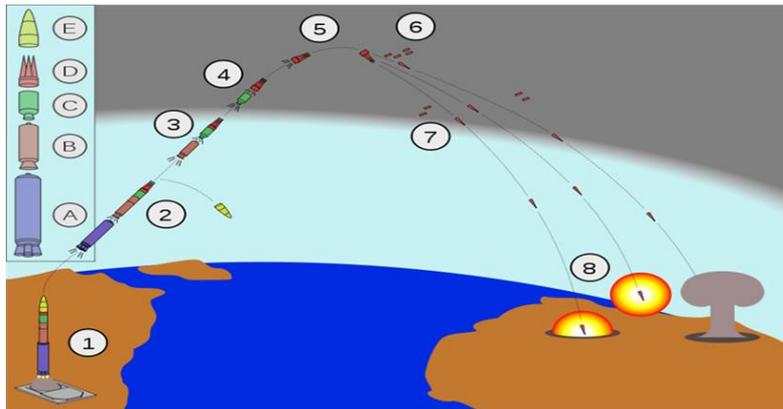


Figure 1-6: Minuteman-III MIRV ballistic missile launch sequence

The ANOVA¹² statistic study technique was born in experimental research to evaluate the effect of certain factors, independent variables of a continuous or categorical type or on the dependent variable of a continuous type. The objective of the model is to compare averages of two or more samples while taking into account several variables in order to accurately determine the achievement of the goal.

1.6 Conclusions

Hitting a hypersonic aircraft does not seem easy now, due to the time it takes for the defense systems to process a response as well as their actual effectiveness. The detection and tracking as well as the solution of fire still takes time which, given the hyper-speed, would not be sufficient to avoid contact. The countermeasures for traditional ballistic warheads were based on prediction and on the calculation of the trajectory with statistic mathematical models such as ANOVA but the presence of multiple warheads and hypersonic speed partially cancels this predictive ability considering that the new GLIDER systems glide at very high speed

¹² ANOVA – Analysis Of Variance

approaching the objectives with flat and low trajectories.

The contrast's systems available today such as the EKV¹³ are kinetic systems and have only a probability of 50% to hit without considering their expensive development programs that are still away before entering into a defensive architecture. The answer at the moment, therefore seems coming from a detailed and effective study of the adversary's abilities and an efficient contrast through effective detection's systems with high technological capacity, in order to discourage the adversary from using hypersonic systems. M&S can play a crucial role in this active defense strategy, where the representation of models and the use of suitable simulators, can allow to train personnel in the correct way and to better support the chain of command into the implementation of procedures and active tactics of contrast, discovery, tracking of threats and defense of the national operational space.

¹³ Exoatmospheric Kill Vehicle

2. MODELLING AND SIMULATION SUPPORTING CONCEPT DEVELOPMENT AND EXPERIMENTATION, A SHORT GUIDE

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2.1 Introduction

This article, developed with contributions from the NATO Modelling and Simulation Group (NMSG), Research Task Group for M&S supporting CD&E (MSG 150) is intended to provide to Concept Developers and Experimenters a quick reference about how to use M&S in CD&E activities.

2.2 M&S for Concept Development and Experimentation

M&S provides methods¹⁴, techniques¹⁵ and tools¹⁶ (table 2-1) that can be applied to support military Concept Development, Experimentation and Analysis from a mere visualization to a more rigorous approach to identify, refine and validate solutions.

M&S Methods	M&S Techniques	M&S Tools
Visualization	2D / 3D Modelling and Simulation	VBS, ARC GIS, ...
	Gamification	Unreal Engine, Unity 3D
Conceptual Modelling	Architectural Modelling, Mind Mapping Modelling, Math-based modelling (e.g. Stochastic Modelling)	Nato Architectural Framework (NAF) (System Architect, Aris EA), Mind Mapper, Math Lab
Simulation-based Experiment	Math-based Simulation (e.g. montecarlo), Discrete Event Simulation, Live, Virtual, Constructive (LVC) Simulation, System Dynamics	Math Lab, VBS3, JCATS, MILES

¹⁴Method: A particular procedure for accomplishing or approaching something, especially a systematic or established one (oxford dictionary)

¹⁵ Technique: A way of carrying out a particular task, especially the execution or performance of an artistic work or a scientific procedure (oxford dictionary)

¹⁶ Tool: A device or implement, especially one held in the hand, used to carry out a particular function (oxford dictionary)

Simulation-based Analysis	Data Farming and Data Mining modelling M&S-based computer assisted wargaming	Math Lab, LVC (Live) Virtual, Constructive SIM
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Table 2-1: M&S Methods, Techniques and Tools

It is always recommended to include a M&S practitioner or subject matter expert within the core concept development and experimentation team from the project’s initiation. For further information and support on Modelling and Simulation applied to Concept Development, Experimentation and Analysis.

2.3 M&S supporting Concept Development

M&S provides an approach to represent any problem statements in a formalized way in the form of a conceptual model. Conceptual models create the fundamental input for all CD&E phases (research, develop, refine and validate, approval), evolving through the phases with the pace of knowledge gained. Conceptual model helps to understand complex problems providing a common understanding to the stakeholders (Figure 2-1).

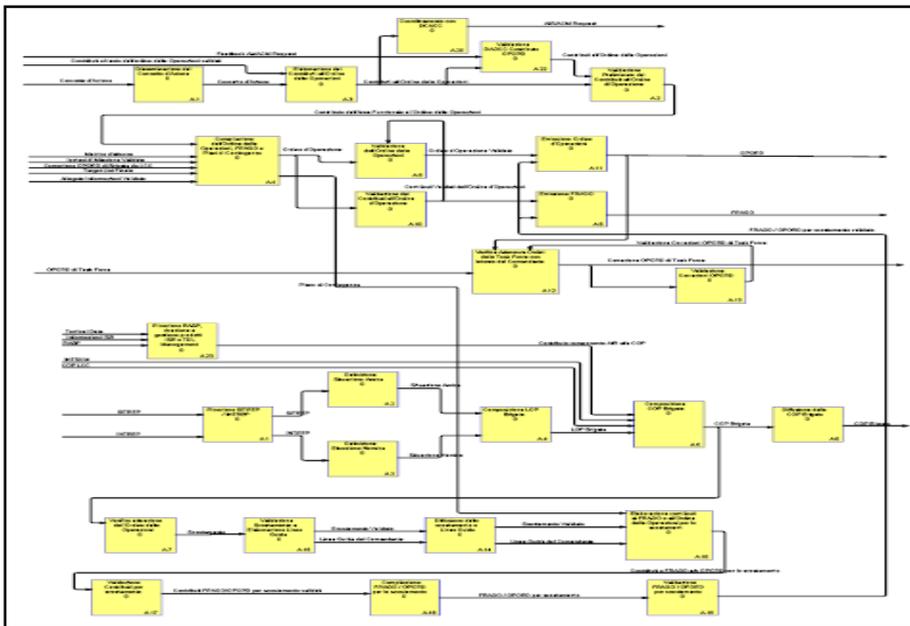


Figure 2-1: Conceptual Model.

Another interesting method to support Concept Development is Visualization applying 2D/3D M&S and gamification Techniques to represent and describe the concept in a visual and interactive way.

2.4 M&S supporting Experimentation

The validity of an experiment, in line with the four experimentation requirements, must be measurable and verifiable. M&S Methods, techniques and tools offer a scientific measurable and verifiable support. Furthermore M&S reduces experimentation lifecycle costs in terms of time and resources.

M&S enforces repeatability in defense experiments and also provides a controlled environment to run rigorous experimentation. M&S supports design of credible scenarios in operational environments and improves the experiment fidelity of warfighting capabilities and conditions. Common techniques are Live (L), Virtual (V) and/or Constructive (C) simulations, Serious Games, Discrete Event Simulation, System Dynamics, etc...

Under the LVC paradigm it is possible to run experiments with a mixed combination of different simulations with the military domains.

2.5 M&S supporting (Operational) Analysis

M&S-based Analysis uses M&S to create data that can be used for hypothesis testing and course of action evaluation and assessment.

As the concept is tested in more representative operational environments techniques such as wargaming and exercise-based experiments, both with the support of LVC simulation, will typically be used.

CDAG and DTAG analysis techniques can also be supported by M&S e.g. implementing computer assisted wargaming phases.

2.6 References

- [1] ACT, NATO CD&E Handbook, ed. 2018
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3. WISDOM – A M&S SOLUTION TO SUPPORT WARGAMING

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3.1 Introduction

NATO Modelling & Simulation Centre of Excellence (M&S COE), from 2014 – 2018, has developed an important capacity to support a major NATO project called the “Urbanization Project”. The developed virtual environment reproducing the complexity of an urban environment was instrumental to support the concept development and validation during three wargaming events (in Italy and UK). This model, known as ARCHARIA, based on the Naples 2035 megacity, was made available to a wide community of subject matter experts in 2D/3D versions. Archaria as a “system of systems” encompasses about 250 informative layers categorized using the PMESII (Political, Military, Economic, Social, Information, Infrastructure) format. Informative layers are complemented by a task force/ORBAT organization which includes land, naval and air assets. The utilization of the model during the wargaming events was essential to the success of the entire project and the availability of such an important enabling tool was widely considered successful by the different community of users.

M&S COE, in line with its mission, supported the NATO Defence College (NDC) - NATO Regional Cooperation Course (NRCC) during the Crisis Management Exercise (CMX), executed in April 2018. Subject Matter Expertise and best practices from the Centre were made available and were instrumental to develop and illustrate the digitalized scenario model RALEIGH used by tutors and students during CMX. Already available techniques and best practices gained during the ARCHARIA model design and implementation phase were reused for this project.

In order to capitalize on these enabler projects, based upon the successful usage of ARCHARIA and RALEIGH, and the experience in wargaming support, the Centre started to develop a new tool to enhance a wargaming visualization capability and to combine the different solutions in a single environment . The idea of Wargame-Interactive Scenario Digital Overlay Model (WISDOM) was born.

3.2 WISDOM Methodology

WISDOM is a training portal, which can be seen as a big box, where it is possible to configure several different wargaming scenarios aimed to lead military, civilian or mixed audiences to make wiser decisions. The tool combines information using raw data that is available from different sources. Due to the analysis of this information with respect to the scenario you are able to build knowledge about the operational environment. This leads to better informed decisions.

Wargaming in general, and WISDOM in particular, can be utilized for very different purposes:

Training and exercises,

Planning process and mission rehearsal,

Concept development,

Concept validation and experimentation.

WISDOM helps to better understand a scenario or a complex operational environment through the use of a digital tool. It allows an easier way to interact with when looking for information about the different fields composing a scenario.

It is a user friendly digitalized tool able to speed up the process in order to understand, compare and gather all data of a setting and a training scenario previously uploaded on WISDOM. All the digital layers built in WISDOM can display grouped set of data. This gives the user the possibility to have an immediate and updated COP (Common Operational Picture).

WHAT IS WISDOM?

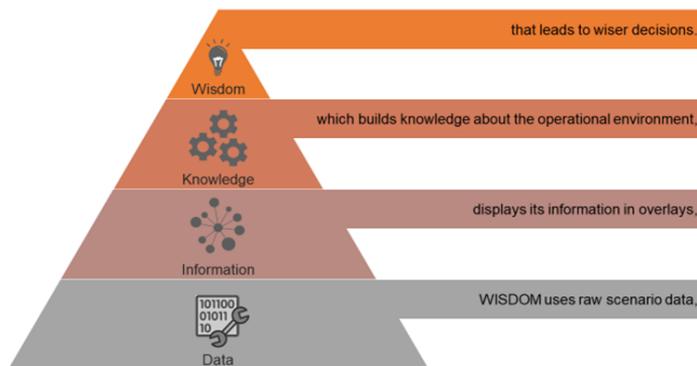


Fig. 3-1: The main concept behind WISDOM project.

WISDOM makes available:

- Apps,
- Training modules,
- Scenario digital tools and
- Scenario settings

aimed to build and facilitate the users knowledge about various operational or training environments.

The model comprises three different ready to use scenarios:

Future M&S City 2050: This is based on the urbanization project scenario ARCHARIA and includes about 250 ordered layers using the PMESII structure and Line of Sight tool (users can use the measure distance tool and the line draw tool to check line of sight between two points).

RALEIGH: A geo-referenced digitalized scenario of a virtual island in the middle of the Atlantic Ocean. It comprises easy to use descriptive narrative scenario sections complemented by geographic maps as well as multimedia content, which facilitates complex strategic scenario understanding and decision making processes.

TARABULUS: A new 2D city model based on the city of Tripoli (Libya).

3.3 Specifications

WISDOM is designed as a multipurpose tool able to display its information in digital overlays using raw scenario data and more. It has been developed using open source solutions and state of art data center configuration for distributed and federated users. This product does not depend on third-party licenses and can therefore be easily distributed if needed. It is designed to run on Linux (Ubuntu) Virtual Machine (VM) using a PostgreSQL database and NodeJS.

The end users will interact with the portal through a web application developed using the Vue2 JavaScript framework. Consequently, other than an up to date web browser, no other software is needed in order to access the user interface. The final user can use any kind of device to include laptops, tablets or smartphones.

It is a “big box” of different tools, models, apps, experiences and best practices coming from this Centre’s past developments. Moreover, the Centre is continuing to add improvements upon request.

HOW DOES WISDOM WORK?

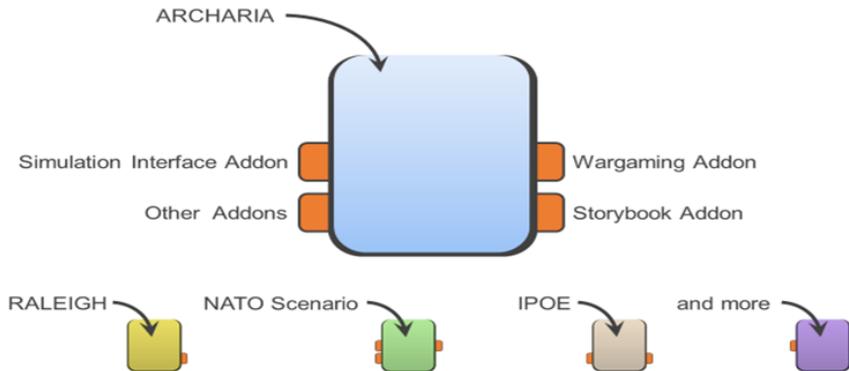


Fig. 3-2: WISDOM is based on the the best practices and effective solutions developed by M&S COE.

For example, a High Level Architecture addon is going to be implemented in order to enable WISDOM to participate in distributed simulations. Overall, WISDOM can be configured for use in different ways, exploiting already available scenarios like RALEIGH and ARCHARIA.

WISDOM is currently a M&S COE project funded by Italy. Customers who are asking to use it and looking for changes or addons are required to provide dedicated funds and time to its development and refinement. In addition, there is the need to consider contractor costs. Contractor involvement is needed for changes, customization, tailoring or engineering support. Furthermore, transportation, pre-deployment, testing and recovery are other aspects to be considered. These costs are variable and depend on the kind of activity and event location.

Two fundamental features of WISDOM are flexibility and modularity. Those characteristics can facilitate and allow swift adaptation to meet new challenging requirements.

The M&S COE, within its Modelling & Simulation Service Branch (MSS Branch), has also identified and grouped WISDOM desired final capabilities, giving different priorities and weight to the different aspects, and in particular, those that will constitute the final version of WISDOM. ARCHARIA methodology will be improved, implemented and of course exploited with WISDOM. That is why it supports and displays all the layers and information from ARCHARIA, which includes ORBAT information and unit positions on the map. Conceptually, WISDOM is built to support a 2D view of a scenario, but will soon add a 3D visualization capability.

As we started projecting the box, WISDOM must support wargaming like ARCHARIA did in the past with multiple cells, different teams and using various vignettes. Virtual views show only the team related information space and hide the ground truth of the scenario forcing conceptual thinking and better decision making.

It is also projected to exploit the past experience with RALEIGH. In other words, WISDOM supports storybooks able to digitalize scenario information. This allows more flexibility and granularity of a standing scenario and allows users to get familiar with new scenarios.

3.4 Summary and Conclusion

WISDOM, as every other project of this kind, has to go through several steps and milestones.

Identified Milestones for WISDOM are:

- Initial definition of requirements,
- Development of version 1.0 of the project,
- Implementation of customer procedures,
- Interoperability with other LVC simulation systems (JCATS, JTLS etc.).

The NATO Modelling & Simulation COE, within its MSS Branch, has also identified and grouped WISDOM desired final capabilities, giving different priorities and weight to the different aspects and, in particular, those that will constitute the final version of WISDOM.

WISDOM is designed to evolve over time in order to support other kinds of scenarios and new emerging technologies. It is built to always leave an open door to incorporate new concepts, technologies and operational requests announced by (non-)military users. Every audience needs to meet their own training objectives through the use of a digitalized platform of tools able to facilitate wargaming events, mission rehearsal, MDMP and CPX.

WISDOM is the future venue where all training objectives can be met and the model able to facilitate units exploring new scenarios during different kinds of events.

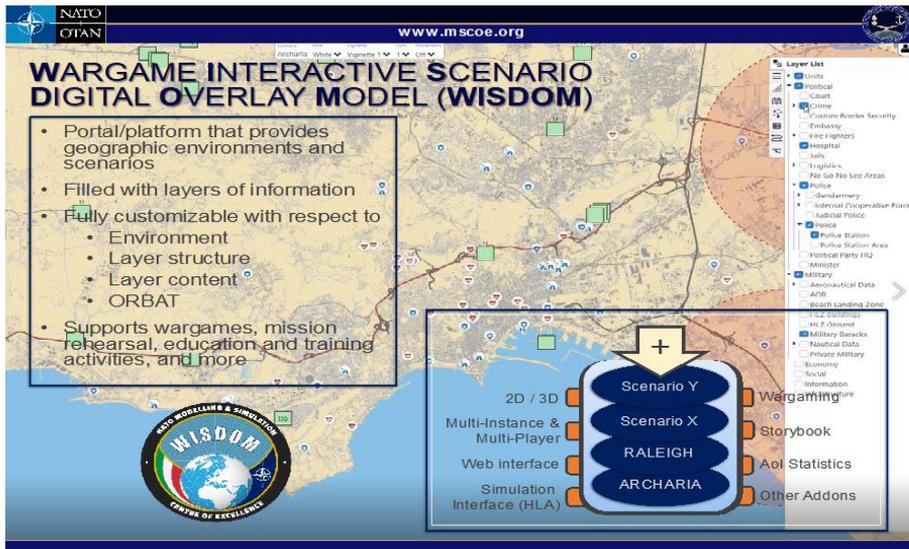


Fig. 3-3: WISDOM overview

4. DOCTRINE, EDUCATION & TRAINING BRANCH

The Doctrine, Education and Training (DET) Branch is responsible within the NATO M&S COE for providing Education and Individual Training through courses, conferences, seminars and workshops on M&S for military decision makers, exercise planners and Staff in cooperation with Strategic Commands and NMSG.

DET Branch general duties are provide E&T support to NATO and Nations' M&S community, plan, design and develop courses that address NATO and Nation requirements in the field of M&S and manage the delivery of M&S courses.

DET Branch is responsible for application of NATO's Quality Assurance System (QAS); Quality Assurance Programme (QAP); and their core processes, products and deliverables.

In 2020, the ongoing COVID-19 pandemic presented significant challenges to the activities of the E&T. Currently the M&S COE provides three residents which are approved, published in e-Prime, and ETOC and one "NATO listed" e-learning course. To earn graduation certificates, students are required to pass a final course examination.

a) The NATO M&S Basic Course provides an introduction to M&S applications, procedures and technologies. The course objective is to deliver basic knowledge about M&S usage in the military context. This course was held online with live virtual classrooms.

b) The NATO CAX Specialist Certification Course provides students with knowledge of NATO exercises and training with a focus on the simulation used by the Joint Warfare Centre (JWC). This course helps to create a pool of CAX specialists aware of the CAX support tools used in the Response Cells during NATO JWC exercises.

Although this course is using a blended approach, the 13th edition did not take place for the COVID-19 pandemic restrictions as this residential course cannot be turned into an online delivery due to the level of knowledge (300), restrictions on the licensed SW installed in M&S Classroom/LAB and specific HW that are required for practical activities.

c) The NATO M&S Integration Specialist Course provides advanced knowledge on the integration of constructive simulation systems used for training below the Joint/Operational level in NATO.

Unlikely the 2020 edition did not take place for the same reasons of the

NATO CAX Specialist Certification Course.

d) The NATO ADL M&S Cadet Course is an e-learning introduction to the M&S domain. The course covers the origin of military M&S, basic terminology used in the M&S domain and classification of M&S applications according to the NATO Modelling and Simulation Master Plan. This course is available on the M&S COE E&T Portal and on the NATO Joint Advanced Distributed Learning programme (JADL).

In 2020, the DET branch also collaborated in the preparation, organisation and evaluation of NATO CA2X2 forum and the MESAS conference and fulfilled all tasks related to the activities NATO M&S COE.

5. BEHIND THE SCENES: SUPPORTING THE NATO M&S COE

Abstract

The core function of the Support Branch (SB) is enabling the NATO M&S COE personnel to be able to operate and carry out the COE's mission both within and outside the Center's structure. In a nutshell the SB "works in the background allowing for the seamless functioning of the COE's branches".

The Support Branch, composed of eight out of the 33 staff members, and in close coordination and cooperation with the Framework Nation (FN) support element, is responsible within the NATO M&S COE for the Communication and Information Systems (CIS) and networks, as well as for Administrative, Personnel and Logistic/Infrastructure Support. Among other responsibilities, the Support Branch contributes to the logistics planning of operations, training and exercises providing equipment and supplies in coordination with outside agencies and commands. The Support Branch also cooperates with the other NATO M&S COE branches and personnel in the preparation, finalization and submission of tasks within the Centre.

5.1 Supporting the CoE's main events and activities

The Support branch is also responsible for organizing the logistics of the Centre's "diamond" events, which include the NATO CA2X2 (Computer Aided Analysis, Exercises, Experimentation) Forum and the meeting of the COE's international decision board (Steering Committee – SC).

The NATO CA2X2 Forum is the international event where military users, industry and academia meet and discuss the M&S Discipline, Exercises, Experimentation, Wargaming and Analysis. The event, which takes place annually, allows the participants to share the lessons learned, and take part in presentations and demonstrations on the latest technologies and trends in the field.

The SC is the biannual meeting of the decision-making authority of the COE, composed of the representatives of the NATO participating Nations. This three-day meeting provides an opportunity to discuss the previous and in-progress activities, together with the adoption of the future lines of action for the COE's "Program of work" (POW) and related financial planning.

The Support Branch, offering all-inclusive support to the COE's activities, works and cooperates with several organizations. These organizations include the Supreme Headquarters Allied Powers Europe (SHAPE) and the Allied Command Transformation (ACT), which is NATO's main interface with the COEs. The ACT interfaces with all COEs in order to update them on NATO's capacitive development objectives. The branch also operates in close contact with the Framework Nation (Italy), specifically the VI Department of the Defence General Staff (Italian Army Barracks "Adriano De Cicco"), and with the NATO Allied Joint Force Command (JFC). The latter is a NATO Military Command based in Naples, which, being recognized by the Authorities of the Framework Nation, verifies and guarantees the activities of the NATO's entities on the Italian soil.

The M&S COE Support Branch also takes advantage of the support offered to the COE's projects and initiatives by Academics and Universities, mainly Genova and Tor Vergata.

5.2 The challenges of the 2020 COVID-2019 pandemic

The main effort of the Support Branch in the past 12 months was enabling the NATO M&S COE personnel to operate and carry out the COE's mission, both within and outside the Centre's structure, despite the effects of the COVID-19 pandemic.

The SB, in close cooperation with the FN support elements, continued to guarantee all the needed COE support services (Communication and Information Systems- CIS, personnel support, administrative and logistic/infrastructural support).

In this framework, an adaptation to the process of the support procedures and operating methodologies were needed and implemented to continue to allow the COE to run its institutional activities. Strict measures, to include a maximum of 50% of the personnel working in the COE, forced the Support Branch to provide a hybrid model for supporting personnel in the office and those working from a distributed location.

The SB helped secure 57.000€ from the FN for sensitive infrastructure improvement of the COE main building, which will be executed in 2021 with the coordination of multiple host nation support entities. These projects will contribute allowing the M&S COE to continue to provide the most cutting-edge technology for the advancement of modelling and simulation to NATO and the Alliance.

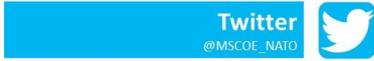
The SB was instrumental in organizing and reshaping multiple COE events for distributed delivery, to include the M&S Basic Course, 2020 NATO CA2X2 Forum, MESAS 2020 and the Steering Committee meetings.

Additionally, the SB, in coordination with the FN's Prevention and Protection Service, supported the COE's personnel with all COVID-19 related issues. The SB secured surgical masks, sanitizing gel, specialized advice from medical professionals and free COVID-19 tests for the staff.

The contributions, behind the scenes, of the M&S COE's Support Branch were immeasurable during a challenging year in 2020. The Support Branch met all requirements for support and allowed the M&S COE to function and provide their expertise to NATO within the restrictions of the pandemic. The Support Branch quickly adopted new techniques for distributed support and continues to be the backbone of the COE system.

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