1 WG1

Simulation support to wargame for multi-domain operations in urban environment concept validation

Jan Hodicky

Wargaming is experiencing renaissance in NATO and Nations. There is an increased demand on the execution of analytical wargames to support complex political and military problem domains. Modelling and Simulation (M&S) is independent discipline with variety of unique theories, techniques, best practices and standards applied to reduce the uncertainty in decision making, to support experimentation and to deliver individual and collective training. While wargaming brings mostly qualitative aspects into analysis, M&S enables quantitative view into the complex problem. Terminology wise, M&S is brought to wargaming (WG) through computer assistance. The paper deals with the symbiosis between WG and M&S and discusses a different form of computer assistance to WG design, execution and analysis. Second part describes a use case when simulation is used to a) support WG Planers during the WG rehearsal to understand the mechanism of the game and b) bring quantitative aspects to WG adjudication during its execution. The use case describes the validation effort on NATO operating concept of multi-domain operations in urban environment. Main take-away is a) visualization is the key enabler of any analytical WG activity, b) simulation can aggregate effects from the tactical level to the operational ones and c) Design of simulation based experiment needs to be employed to reduce computational power and undercity related to complex problem analysis.

2 CC1

A GAP ANALYSIS OF CBRN M&S: TOWARDS NEXT GEN M&S

Piergiorgio Ventura

CBRN and Environment M&S seems not to be fully exploited within its potential in the military domain, namely, Education and Training (Exercise), Support to Operations, Planning (Course of Action Analysis), Execution (Decision Support), Mission Rehearsal, Concept Development & Experimentation (CD&E) and Procurement. Many tools do exist, like the ones providing model to simulate the dispersion of CBRN Agents, or the wearing of IPE during training and many others.

However, there is not a full integration of these tools, and many are still missing. A comprehensive approach, which integrate all existing tools, providing also the missing ones, could be a powerful way to cover an important gap still existing in M&S.

The aim of this research is to provide NATO with a roadmap to perform a GAP analysis on CBRN M&S whilst deeply investigate the existing resources and opportunities, which could lead to improvement in the CBRN and Environment M&S applications.

3 ST1

The use of NATO M&S Standards and Services in the VIKING 22 Exercise

Björn Löfstrand

The Viking Exercise is a distributed computer-assisted (CAX) command post exercise (CPX) conducted regularly since 1999 in the spirit of NATO's Partnership for Peace (PfP). It is a multidimensional, multifunctional, and multinational exercise with an emphasis on realism and current operational concepts to prepare civilians, military, and police together for deployment to a peace or crisis response mission area.

The exercise is supported by Modelling and Simulation (M&S) applications and services to create a realistic representation of the scenario. In addition, services for the generation and distribution of intelligence reports are used to stimulate the C2 systems used by the training audience from 50+ nations and 90+ organizations at 10 sites around the world.

NATO standards for Distributed Synthetic Training have been applied in the design and implementation of the Viking M&S environment which includes more than 130 federated simulation services executed at 5 different sites over 10 days of execution.

In this presentation we will share the Viking 22 technical challenges, the overall design of the federated system and the lessons identified.

5 SN1

M&S Standards in NATO Federated Mission Networking

J Mark Pullen and Kevin Galvin

We propose a one-hour session, updated from our Workshop "C2SIM and Related Standards for FMN" which was very well received at NATO TIDE Sprint Spring 2022. We can package this as two half-hour talks or compress it to a shorter talk if needed. However, given the importance of FMN as the future training environment, the topic is an important one for CAX in NATO and deserves a full hour for presentation and attendee discussion. Outline follows:

a. Why M&S in FMN

b. NMSG-201 in FMN Spiral 5 Syndicates: role and challenges

c. Early Operational Requirement: Mission Rehearsal at Operational Level

d. Operational Coordination: Mission Threads and Procedural Instructions for Mission Rehearsal

e. Capability Planning: Service Instructions for Modelling and Simulation

f. Validating Spiral 5 proposed M&S standards and practices in CWIX

g. Spiral 6 Operational Requirements: Collective Training and Decision Support

h. attendees discuss the above

6 CT1

Enhancing Wargames and Training Simulations with Accurate Logistics

Michael Hugos

Wargames need a way to accurately integrate logistics without requiring players to go through complicated, time-consuming calculations before they can make a move. Based on work over the last two years with the U.S. Air Force, we show how a commercial-off-the-shelf (COTS) supply chain modeling and simulation (M&S) application can add accurate logistics to wargames without adding complexity or slowing down the pace of game play. This enables wargames to rigorously explore the logistics required to support different battle strategies.

Additionally, we show how a COTS supply chain M&S application can connect to a federation of real-time virtual reality (VR) training simulations used in computer assisted exercises (CAX). This enables people to see, understand and manage the supply chains that would be required to support operations happening in the other VR training simulations. It adds a new layer of reality to other simulations, and enables realistic training of logistics personnel in a way not previously possible.

The COTS supply chain M&S application employs a geospatial and map-based user interface (UI). Players define logistics entities such as warehouses, vehicles, and transportation routes, and the entity icons appear on a digital map. Then, in the same manner as placing game pieces on a game board, people drag and drop the icons to place them on the map. The map shows the same geographical area as the game board for the wargame. Zoom in on the digital map and turn on satellite view to place icons in exact locations.

By defining and placing icons on a digital map, people define rigorous mathematical models of supply chains that are then run in simulations. But people are not burdened with additional complexity, and do not need advanced math or engineering skills because the computer handles the math. AI algorithms can also be used to find optimal facility locations, delivery routes and frequencies. This makes the application usable by a wide range of military, government, business, and academic people.

Our presentation will include a hands-on demonstration where people do what logistics officers are doing currently in two U.S. Air Force logistics training programs. They will model and simulate supply chains to support different strategies and missions. We'll use strategy scenarios based on the current Russian invasion of Ukraine, and mission scenarios based on humanitarian disaster response missions in Nepal and Ecuador.

7 CD3

Development, Programmatic Transition, and Sustainment of VR Medical Simulation Training for TCCC Responders: The Virtual Advancement of Learning for Operational Readiness (VALOR) Program

Karthik Sarma, Michael Barrie, John Dorsch, Talia Weiss, Jennifer Polson and Ryan Ribeira

In future multi-domain combat operations against near-peer competitors, efforts to achieve the "Golden Hour" (the doctrinal requirement to provide definitive care within 60 minutes of sustaining traumatic injuries) are likely to be overwhelmed by casualty counts incurred from the use of highly effective weaponry employed by powerful nations on a scale not seen in combat by NATO nations in recent decades. The rapidly evolving geopolitical climate requires nations to develop solutions to address this limitation in order to maintain optimal readiness for such a conflict.

This presentation will discuss ongoing efforts to develop and sustain such capabilities though the United States Air Force-funded Virtual Advancement of Learning for Operational Readiness (VALOR) program, a large-scale XR for medical simulation training research program which has developed capabilities and training curricula in the areas of Tactical Combat Casualty Care (TCCC), Advanced Resuscitative Care, En-Route Care, and more, including live test and evaluation, as well as current deployments and sustainment efforts.

Particular detail will be paid to the VALOR CORE curriculum, a 25-scenario TCCC VR medical simulation training curriculum spanning TCCC, Prolonged Casualty Care, Small Unit Care, Chemical, Biological, Radiological, Nuclear and high Explosives medical response, and medical certification readiness. Additionally, the core design principles of the VALOR project will be discussed, which were developed to address drawbacks and limitations of prior virtual simulation efforts.

8 ST2

Simulating the Whole Picture with Distributed Mixed LVC

Emilie Reitz, Sander Cruiming and Kevin Seavey

Bold Quest (BQ) is a Joint Staff J6 coalition capability demonstration, and assessment event focused on improving joint fires interoperability in a coalition environment. It provides a rich operational environment for assessing new training and simulation technologies, both as stand-alone demonstrations and integrated with live command and control systems.

During BQ21.2, Live, Virtual and Constructive (LVC) mixed reality simulation operations provided new opportunities to demonstrate and assess methods to create multinational interoperable simulation capabilities. BQ21.2 was conducted at the Indiana National Guard's Muscatatuck Urban Training Center (MUTC) in central Indiana. The MUTC allowed many opportunities to experiment with LVC environments and demonstrate new technologies that address current LVC shortfalls, such as Augmented Reality (AR), Virtual Reality (VR), and simulated Digitally-Aided Close Air Support (DACAS). The distributed simulation scenarios included several participants connected via different networks, spanning from the Iowa Air National Guard Distributed Training Operations center to the USAFE/AFAFRICA Warfare Center; these distributed participants were augmented by constructive forces from the Royal Netherlands Army and Canadian Army ground forces using the Netherland's Tactical Engagement Simulation System(TESS) to integrate into the LVC Environment.

This presentation describes the lessons learned in conducting mixed LVC events, proposes some long-term implications of this kind of distributed mission training, and outlines future ways to improve coalition force interoperability and readiness.

11 OD1

VALORENS, predictive analysis : capturing the enemy's mind

Aurélien Brucher and Quentin Liguori

A major challenge for land forces is to understand and anticipate the tactical situation. The project focus on the ability to exploit more information in a highly constrained time, in order to provide decision making elements for tactical leaders.

The ValoRens project is included into an operative context which started in 2021 with a study lead by MASA Group and the French Digital office of the Army headquarters service. This study aimed to produce a tool able to estimate the future enemy positions based on a report of enemy detections, goals, movements and capacities. This project mainly focusses on battalion and company levels.

This study relies on the simulation software SWORD and on artificial intelligence algorithms. It also generates initial data and display the analytics results used to test our solution.

Later, it will be integrated as an analytic component into the informative combat system SCORPION.

First, we will remember the doctrinal bases, hypothesis, and used cases we considered. We will detail the work achieved and the results of the first evaluation. Later, we will explain the next steps of the project, especially enemy’s ORBAT recognition and behavior analysis.

12 LL2

Moving CAST into a secure cloud environment: Lessons learnt

Peter Meyer zu Drewer, Ralph Michel and David Sonntag

Information security is an increasing challenge in today's computerized world. This applies to computer systems 'on premises' and even more to cloud-based environments. A security incident can have a wide-range of negative impacts, including loss of data, loss of trust in data and organizations, injection of false data and many more.

Security, sovereignty and resilience are key words to describe reliable IT systems that meet the highest data protection requirements. Exactly for these demands, secunet and IBM, together with Red Hat, have developed a cloud solution for classified information. It is the first and currently only cloud platform that is in the approval process by the Federal Office for Information Security (BSI) in Germany.

Integrating simulation for training in such an environment is a logical step. By optimizing the use of hardware and personnel, the cloud-based simulation supports a more economical execution of training. Sensitive data on the other hand is optimally protected in a secure cloud.

The presentation outlines the lessons learnt from integrating CAE's constructive simulation system GESI in the secure cloud environment developed by IBM, secunet and Red Hat. The presentation provides a quick overview of the technologies being used, the steps to integrate GESI CAST in this cloud environment and the new capabilities and use cases that such a setup can support.

At the end of the presentation, an overall lessons learnt summary will be provided including challenges and solutions and the way forward.

13 LL1

Imperfect Storm - Lessons Learned From A Difficult Exercise

Ellen Roland

Putting on a successful Computer Aided Exercise (CAX) is a monumental task. It requires weeks of coordination and planning between the exercise audience, supporting commands, and the simulation experts responsible for the model that will be used to create the realistic decision environment. Part of the planning function includes developing the processes and procedures needed to handle catastrophic failures, whether these incidents are model crashes, communication interruptions, or hardware malfunctions. What lessons can be learned from an exercise that experienced all three failures at once.

No organization wants to admit non-success, but failures exist, and it is imperative that an honest evaluation of the entire process is accomplished. This talk will look at the lessons learned from a difficult exercise and hopefully provide insight to others. Only through an honest and complete lessons learned evaluation can everyone involved in the exercise move forward and correct the underlying causes to create a more successful environment for the next CAX.

14 ET3

DESIGN, IMPLEMENTATION AND PRELIMINARY TESTING OF A VIRTUAL REALITY SYSTEM USED TO TRAIN MILITARY PERSONNEL ON A SIMULATED BATTLEFIELD

Gl.Bg.Prof.Univ.Dr.Ing. Ghita Barsan, Vesa Dumitru Claudiu and Gaitan Marius

In this article, we present the design, implementation, and testing of a virtual reality-based training solution for military personnel. The aim of using virtual reality instead of traditional training processes is to simulate battlefield conditions as realistically as possible and to save financial resources that could be directed to other educational processes. The system was implemented using the Virtual Battlespace 4 (VBS4) virtual simulation software application, interconnected with Virtual Reality Headset and Controllers, to provide an enhanced simulation training experience. A wireless network has also been set up and tested for increased flexibility and quick setup during multiplayer simulation. Cost and time savings, the ability to conduct training remotely, motor skills practice, simplification of complex situations and creative experiences make virtual reality training an increasingly suitable tool to replace traditional training processes, even for the military. The main contribution of this paper is a comprehensive study analysis of the unique challenges and potential solutions for VR networks connected via wireless for military training. This work represents a preliminary stage and a source of research into optimizing solutions for virtual reality using wireless networks.

15 CT2

The Case for Defence Use of Commercial Gaming Solutions

Jason Jones

Commercial gaming software provides effective, low-cost and easily accessible tools that can support, augment or replace government provided modelling and simulation (M&S) tools.

Despite the availability and ease of use of commercial wargames, skepticism about their value persists. While there is validity for some of that skepticism, not every defence activity requires a defence-provided solution. Defence-provided M&S solutions focus on training critical warfighting tasks and principally supporting either individual skill or large-scale staff training. And that is where this skepticism is poorly aimed. It disregards the fact that many defence tasks, including the areas of education, training, and analysis, are poorly or not at all supported by those defence-provided tools.

Commercial gaming solutions can fill those gaps without incurring a lengthy procurement process and bringing the advantage of supporting a specific need. It is incumbent on the requirement holder to identify commercial products and assess them for fit to the task. And once selected, users find commercial products are easy to use and require little to no external support; have little to no additional costs beyond licensing; are purchased only if they meet the need; and can provide capabilities that don't exist in defence-procured tools.

Commercial gaming solutions provide a low-cost, high-value return that fills designated M&S gaps with an investment far lower than a defence-procured simulation.

Key Takeaway for Attendees: Strategies to make the case for using commercial gaming solutions for defence organization needs.

16 CY1

"QUANTUM" EVOLUTION IN THE FUTURE OF TELECOMMUNICATIONS & CYBERSECURITY: A DUAL USE APPROACH

Giovanni Gasbarrone

Next generation "QUANTUM" technologies represent a revolution in military operations that will change in the future the way of operations, from cybersecurity to communications in tactics, operational and warfare strategies in modelling & simulation. Quantum technologies are dual-use technologies, and therefore are of interest to the defence and cyber security industry and military.

A fundamental role in this new scenario is “hyper connectivity” in the military framework as a digitization of the battlefield where all military elements are connected. The Defense Science Board (DSB), an independent Department of Defense (DOD) board of scientific advisors, has concluded that three applications of quantum technology hold the most promise for DOD: quantum sensing, quantum computers, and quantum communications. Today, European critical infrastructures and public safety communications and cloud are vulnerable to cyber-attacks.The recent RADAR systems and the 5G and 6G antennas have contiguous or even overlapping operating principles that allow the development of solutions in a dual use perspective.

The convergence between radar and telecommunications can be glimpsed in the use of electronically scanned antennas that for 5G and 6G transmissions use "smart antennas" MIMO - Multiple Input Multiple Output. In the future, we begin to glimpse the evolution towards quantum radar while the "quantum" revolution in 6G with cognitive radio will be the next generation architecture thanks to quantum computers that already allow in 5G the optimal cellular planning of frequencies and transmission network. We are now working on the fusion of technologies with Quantum Machine Learning for 6G networks.

17 WG3

Computer Assisted Wargaming

Panagiotis Balaskas

"Computer Assisted Wargaming" is a special type of wargaming that differs from other types. The most significant difference is the usage of the simulation systems that provide advantages but also limitations.

During the CAX Forum, the organization of a roundtable discussion or workshop gives the opportunity to NATO - national specialists and companies to share their ideas about this domain.

The discussion will be focus in three separated phases: Preparation - Execution - After Action Review, considering the most important factors: People - Systems - Information.

There will be initial slides from the author side that will guide the whole discussion.

18 CT3

MANAGEMENT OF MODELLING AND SIMULATIONS SYSTEMS FOR TRAINING AND EXERCISE MANAGEMENT

David Paterson and Duncan Parkinson

NATO's next generation modelling and simulation (NG M&S) capability will want rapid user uptake, ease of management, self-service options, global collaboration, and the ability to programme and plan multiple M&S events through a common interface. Based on this understanding, it is our firm belief that an appropriately integrated, and capable, management tool is critical to ensure the qualities of usability that will make NG M&S successful.

We will illustrate this with our Exonaut Training and Exercise Management System, a commercially available, highly adaptable, and easily configurable product. With a 22 year pedigree supporting militaries delivering programming and scheduling, exercise management, evaluation, lessons, wargaming and experimentation solutions, Exonaut is well placed to provide a common management interface to support NG M&S.

When integrated into an M&S federation, Exonaut becomes an exponentially powerful tool with the capability to manage multiple simulations, models, and/or scenarios in a persistent and collaborative way – ultimately providing the flexibility and efficiency necessary to deliver a dynamic M&S ecosystem.

Exonaut architecture has been designed to work as part of an M&S federation through standards-based integration (e.g. DIS or HLA); but can also work in a wider platform-based architecture where a more extensive Open API approach may be appropriate. This will provide interoperability and simplify/de-risk future changes as models and simulations are updated. Additionally a data stream based backend will increase the potential richness of integrations and enable performance and scalability to handle large numbers of concurrent users across simultaneous training events.

Two-way integrations can now be used to specify and verify a wide range of parameters (e.g. PMSEII or weather) that can be passed to models and simulations during initiation and can be altered during execute to vary the difficulty of training audience experience.

Authoritative data, such as national force and capability structures, can be pulled in from other live systems. Live simulation data can be collected, transformed and stored in raw or aggregated formats. All of this data can be contextualised alongside objective and subjective observations used within wider ETEE evaluation and validation processes. This approach provides a step change from traditional 'observing' and opens up many possibilities to add AI/ML automation to significantly increases the overall training value.

The presentation will look at NG M&S from the perspective of a training management tool in the context of an integrated and interoperable NATO M&S capability and seeks to inform the development of requirements in that regard.

19 CDX

APPLICATION OF TRANSFORMER MODELS ON UNSTRUCTURED MILITARY ASSESSMENTS

David Paterson, Duncan Parkinson and Daniel Smith

A 4C Strategies led research project investigated the application of Generative Pre-Trained Transformer (GPT) models for summarisation tasks relating to performance observations recorded during historic UK MoD Collective Training events. GPTs are a family of Machine Learning (ML) models which have exhibited state of the art performance when used for a number of Natural Language Processing (NLP) tasks. GPT models are supplied 'pre-trained' on large, unstructured text datasets in order to achieve baseline language comprehension. By conducting further 'fine-tuning' training steps model performance on domain specific language (in this example - military collective training) can be dramatically improved.

During this research the open source GPT-Neo family of models were successfully trained using a dataset containing ~12000 training examples, consisting of Observations (Inputs) mapped to Assessments (Outputs) in a hierarchical Entity (military unit) and Objective (training objective) structure. Evaluation of these models for summarisation tasks using industry standard metrics illustrated that the performance of the trained models met, and in some cases exceeded, state of the art model performance. Of particular note was the ability of the trained models to use military language, acronyms and mnemonics in their correct context even when trained on the relatively small dataset available.

The findings of this research have immediate application to summarisation tasks in the Military Collective Training domain, and 4C Strategies intend to continue development of these trained models in order to provide functionality improvements to the Exonaut platform, as used by the UK MoD's Collective Training Group (CTG) to record unit performance during all major collective training events. Exploitation paths include:

- Providing descriptive (qualitative) outputs of quantitative inputs (such as those generated by Modelling and Simulation (M&S) systems

- Alleviation of time-intensive text generation tasks (for example report writing)

- Summarisation of very large doctrinal publications in order to answer dynamically posed questions.

Generation After Next (GAN) applications of the GPT family of models or their successors could include contribution to Artificial Intelligence (AI) in military exercise management and enable automation and control of these exercises.

The presentation will present our findings in detail and illustrate the unexpectedly positive outcomes based on the sample data used in the study. Such a capability has clear utility in supporting NATO's Evaluators, Capability Development and Experimentation, and Lessons management domains.

20 WF1

Training for Modern War – Incorporating Trends From Recent Conflicts into Training

Jay Ballard

By incorporating the most impactful trends of recent conflicts with different simulation/training methods a military or organization will be able to prepare a more agile and combat effective force. This presentation will identify those trends and align them with different ways to train for success in major combat operations.

The topics will include: Will to Fight; Major Combat's Impact on Logistics; Inability to Hide from the Enemy; Why Air Superiority Will be Hard to Achieve; Social Media - incorporated into all aspects of war fighting; the Urban Fight; and finally, Fighting an Opponent Who Seeks to Increase Civilian Casualties Instead of Avoiding Them.

21 OD7

MODELLING AND SIMULATION SUPPORT TO GEOSTRATEGIC ANALYSIS AND DEFENCE PLANNING

Erdal Cayirci, Ramzan Alnaimi and Alhanoof Mohammed Althani

The contemporary setting is characterized with volatility, complexity, uncertainty and ambiguity; therefore, it becomes more and more challenging a task to develop strategic foresights and scenarios for which defence capabilities are transformed. New modelling and simulation tools and approaches are required for geostrategic foresight development, defence planning, concept and doctrine testing.

We use an extensive form Bayesian geostrategic game with imperfect information to quantify the state vector (i.e., political, military, economic, social, infrastructure and information) and instruments (i.e., diplomatic, information, military, economic, financial, intelligence and law enforcement) of state and non state actors. We also wargame with these actors. A set of strategies are available to actors when they satisfy the required conditions. As new strategies are employed by the actors, the setting changes and when the conditions for predefined scenarios are met, the game generates warnings about the potential future scenarios.

These scenarios become the input for a static and deterministic computer model, which calculates the optimum set of military capability requirements to counter hostile capabilities. The model also supports the analysts with sensitivity analysis.

Finally, a constructive, continuous, dynamic and stochastic model is used for computer assisted experimentations where concepts and doctrines for the future settings can be tested.

We introduce our models and give results from the experiments with them.

22 ED1

ELMO (Electromagnetic Layer for Multi-domain Operations)

Salvatore De Mattia

The electromagnetic dimension is an essential element for the understanding and conduction of future military operations, in which the use and interconnection of complex systems take on a significant value for operational advantages. The transversal characteristic of the electromagnetic dimension permeates the operational scenario in a multi-domain perspective and, therefore, comprehension and management of this physical dimension is a crucial point.

The NATO Modeling & Simulation Center of Excellence (M&S CoE) is conducting a project called "ELMO" (Electromagnetic Layer for Multi-domain Operations), which aims to create a synthetic environment for the virtualization of the so-called EMSO (Operations on the electromagnetic spectrum). In this context, M&S is a fundamental technology that expresses versatility characteristics for the implementation of complex electromagnetic multi-domain scenarios, able to virtually characterize the dimension and make visible what in the real environment is not directly perceived by our senses. This factor would make it easy to understand not only the main electromagnetic spectrum parameters, but would also enhance the characterization of the operational and informative technical impacts that the electronic assets provide within the context of Electronic Warfare.

23 OD3

Automated terrain assessment to accelerate the military decision-making process

Jens Schetelich and Rene Streifer

Ground forces of the future will be able to operate with fewer personnel in much larger spaces, at a higher operational tempo and with drastically shorter decision cycles under multidimensional threats. However, all technological innovations to achieve these capabilities will ultimately be ineffective if they are paired with today's decision-making and command process. Supporting the military decision-making process with intelligent assistants will neutralise this potential bottleneck.

The German Army Headquarter is working with industry partner Rheinmetall and the Fraunhofer IOSB research institute on possible solutions as part of the R&D study “Automated terrain assessment to accelerate the military decision-making process”

The project is characterized by its holistic view of the military decision-making and command process. A core task is the identification of process steps that are invariant to the technological development of the armed forces per se (e.g. terrain assessment), can be bottlenecks in the decision-making process (e.g. information management) or represent a high mental burden without significant creative potential (e.g. calculating the availability of forces according to time and space).

Assistance functions will be developed for the identified sub-steps and tested together with military users as early as possible in order to gain feedback for further development and to mitigate the risk for development of applications with low usability within the decision making process. In each case, the entire spectrum of the operation of the combined forces is taken into account.

In the current phase of the project, the following military tasks are addressed in this way:

- Operation planning in the intermediate tactical command level,
- battle management in the intermediate tactical command level,
- interaction with the assistance system in the lowest tactical command level as well as the individual vehicles,
- and the use of the procedures as a tactical autonomy function in unmanned systems.

The core function in the current project phase is the automatic assessment of the terrain using digital geodata in order to provide immediately usable tactical information.

24 SN2

Modeling, Simulation & Training (MS&T) and Operational Technology (OT) Interoperability

J Schlesselman and Thijs Brouwer

This presentation will describe and demonstrate advances in open standards-based interoperability between Operational Technology (OT) and Modeling, Simulation and Training (MS&T) systems. In this case, OT refers to functional production systems that are intended for deployed use. We shall highlight an air domain use case, showing interoperability between applications based on Unity and Epic Unreal gaming engines, flight simulators, the Future Airborne Capability Environment (FACE) and Sensor Open System Architecture (SOSA) specifications, and applications using the RTI Connext TSS. Connext TSS is the first certified conformant FACE Transport Services Segment (TSS) based upon the open Object Management Group (OMG) Data Distribution Service (DDS™) standard. OMG DDS is an important standard used across many MS&T and OT domains such as radars, electronic warfare, missile defense, satellites and ground vehicles.

This particular demonstration consists of two drone simulators, one using the Unity gaming engine and the other using the Epic Unreal gaming engine. The drone flight simulator publishes location, video and Lidar through a SOSA aligned plugin using the SOSA Interaction Binding to publish data. The Lidar data is displayed using the RVIZ, a ROS2 application. Location is fed into different User Interface (UI) applications and the Ansys FACE conformant A661 server. Interoperability of the RTI Connext TSS product is proven between an Ansys Cockpit Display Systems (CDS), an ENSCO IData CDS, and a Presagis CDS.

The goal of this demonstration is to show the utility of using the same NATO-mandated standards-based technology used in operational systems to connect distributed next-generation MS&T systems enabled with security, quality of service, application portability and wire-level interoperability.

25 CT4

Introduction to the DDS databus for multi-domain simulations

J Schlesselman and Thijs Brouwer

This tutorial covers the fundamental technologies, terms and concepts of the Object Management Group (OMG) Data Distribution Service (DDS™) for Modeling, Simulation and Training (MS&T).

Integrating simulation and training systems can be a formidable challenge. Legacy systems often use differing standards for data, voice, and video, while modern data centric architectures demand the use of cloud-based and/or distributed assets. Additionally, new security requirements force system integrators to become experts in information assurance.

Attend this tutorial to learn how the OMG DDS can ease integration, while also delivering tested security for distributed training systems over any transport.

DDS also is used in many hundreds of deployed operational technology (OT) systems. DDS seamlessly stitches together legacy simulations, while adding humans and hardware in the loop, to create new secure Live Virtual and Constructive (LVC) environments that can share real, augmented and virtual realities. These environments can run in a single lab or across multiple sites and due to its peer-to-peer nature, DDS is still able to deliver physics-speed response times.

This tutorial gives a solid introduction to the DDS and DDS Secure standards. Attendees will learn how to use DDS Secure to secure real-world Hardware-In-Loop (HIL) systems that already communicate over DDS to distributed LVC Simulations. The tutorial will further describe how to integrate DDS with existing simulation-based standards like HLA, where DDS adds a wide range of Quality of Service (QoS) settings to tune performance and scalability, while also providing robust security. Finally, the tutorial will highlight recent user experiences with DDS, and offer an overview of deployed systems using DDS in simulators today. This tutorial is intended for all audiences, though some familiarity with distributed computing is recommended.

The proposed format is two classes of 90 minute each. The first 90 minute class introduces DDS core concepts plus DDS Security. Short presentations outlining the main concepts will be interlaced with a fun downloadable demo used as a training aid. Attendees may use their downloaded demo or watch the instructor. No programming is required for the first class.

In the second 90 minute class, attendees will build small test applications to get a ‘hands on’ feeling for what DDS and DDS Secure offers. For the optional 90 minute ‘hands-on’ class, an x64 laptop with Windows OS and .NET framework 5 installed, or Ubuntu Linux 20.04 with the ‘build-essential’ packages installed as well as download and install of the https://rti.com/free-trial are recommended.

26 CD5

Wargaming-Simulation Synthetic Environment SWORDOM (RAS use case)

Vincenzo Brucato and Salvatore De Mattia

Analytical Wargames and Simulations usually address different categories of data analysis with their focus more on quantitative data or qualitative data. They are both crucial to the success of any data research and analysis and their collection methods are focused/oriented respectively more on Simulation or more on Wargaming.

In order to capitalize the NATO Modelling & Simulation Centre of Excellence experiences on Wargaming and Simulation it has been proposed SWORDOM, an Integrated Synthetic Environment between two tools, WISDOM and MASA SWORD. The first one has been used to enable digital traditional wargaming activity and the latter has been used to develop a proof of concept simulation for conceptual and capacitive development of RAS within the future operational context. To enable a technical integration between the two tools, High Level Architecture (NETN FOM) and Application Programming Interface have been used.

The presentation is about the proposed SWORDOM (SWORD- WISDOM) Synthetic Environment that can use and leverage assets from both MASA SWORD and WISDOM in order to enhance and create a positive circle between Modelling & Simulation and Wargaming for concept development and for exploring new doctrines with a focus on RAS.

28 WG2

Wargaming

Thomas Tabaka

Wargaming is the artificial replication of a situation in competition or conflict not involving actual military forces, and is characterized by human decision making which impacts the course of events throughout the game. Wargames usually revolve around the interaction of two or more opposing forces guided by predetermined objectives, rules, data, and procedures designed to depict an actual or assumed real world situation. It is important to note that wargames are not validation tools [1].

Wargaming tests and evaluates courses of action associated with a plan and are further evaluated and validated in planning for and executing of exercises.

Wargaming is a key step in force development. Wargaming is very different from exercises and experimentation. Wargaming is fundamentally about decision making in the context of a conflict. Wargaming provides a venue to examine new and untested ideas without having to invest substantial resources or put personnel and equipment at risk. Wargaming can be utilized for multiple purposes, including training and course of action analysis but is most often employed to asses and refine new concepts, identify capability requirements, and inform priorities and strategies. Results inform further concept development, experimentation, or additional wargaming, all of which contribute to innovation [2].

(1) Perla, P., The Art of Wargaming (2012)

(2) Marine Corps Gazzette (2016)

30 OD6

Enhancing Resilience: Model-based Simulations

D'Artis Kancs

Two developments with a global character and dynamically interrelated across industries and countries have accelerated in recent years: increasing vulnerability of global production networks. In the same time, the landscape of hybrid threats is expanding and its intensity accelerating. In the age of globalisation and increasing cross-border production, fragmentation raises vulnerability of domestic industries, which increasingly participate in global supply chains. These risks are acknowledged by the Secretary General Stoltenberg: "over-reliance on the import of key commodities, like energy exporting advanced technologies, like Artificial Intelligence can create vulnerabilities and weakened resilience".

How to ‘achieve the necessary resilience’ while doing as little damage as possible to society’s socio-politico-economic fabric’? Indeed, the challenge is to achieve long-term security goals without neglecting the short- and medium-term economic needs of society. In the context of our study, the challenge is to ensure resilient and diversified supply chains in place to allow for a continued flow of essential goods and avoid shortages in the short-, medium- and long-run. Our analysis investigates this trade-off formally by framing it as a constrained optimisation problem with two constraints – a resilience/robustness constraint on the one side and a society’s/economy's tolerability constraint on the other side. Model-based simulations provide interoperable and directly comparable quantifications of positive and normative effects of counterfactual resilience and robustness policy choices in critical and non-critical sectors. Further, the parsimonious model we employ

allows to identify strategies for addressing Alliance's vulnerabilities arising from global production networks.

The present study builds on and complements the existing Science & Technology Organisation (STO) strategic analytical support, including the Multi-Dimensional Data Farming, Causal Reasoning, the Resilience Data Analytics Tool of the ACT's Innovation Hub and the Aggregated Resilience Model. The Resilience Model provides a holistic framework for simulating a wide range of Political, Military, Economic, Social, Information, and Infrastructure (PMESII) shocks (e.g. electricity blackout, cyber attack, martial law enforcement, big human movement, state of war, armed conflict), and allows assessing both resilience domains (civil support to the military, continuity of government, and continuity of essential services) as well as risk (command and control, protection, movement/maneuver, and sustain). The Joint Warfare Centre (JWC) leverages the Joint Theatre Level Simulation (JTLS). Our modelling framework is complementary to the existing resilience modelling and simulation tools, as i

t is specifically designed to account for the increasingly interconnected GSCs, and to study allies' resilience and robustness in the presence of exogenous shocks.

31 OD5

Force Comparison to Support Decision

Joseph Merrill and Gerald Thompson

In the winter of 2021, as Russia built up forces on the Ukrainian border, much of the world was busily analyzing the situation. As we worked to apply rigor to the analysis to support planning and leader decision, we found that despite the advancements in the simulation tools available, none had the flexibility to be adjusted as quickly as conditions were changing. Furthermore, the available tools had not been developed to consider engagements between forces both using former Soviet equipment.

Work on a solution to support operational planning had been underway for some time in our headquarters. It focused on simplifying the analysis of combat forces to focus on easily measurable criteria to provide a basis for comparison that could be altered quickly. The tool compares firepower at the system level and aggregates it to the unit level, providing a consistent basis to compare combat potential of units. Due to its simplicity, were able to adapt it to include Ukrainian forces and provide a correlation to support planning and Commander decisions.

32 AI2

Artificial Intelligence in AirC2 Planning & ETEE

Deniz Yilmaz

As a part of the NATO ACT Autonomy Programme, we have been finalizing a multinational project called "AI in AirC2 Planning and ETEE". The primary goal of the study is to develop concepts which utilize Artificial Intelligence (AI) technology to support AirC2 planning and Education Training Exercise Evaluation (ETEE) processes. The methodology of the study is based on the Human-centered AI canvas, which requires to identify the jobs-to-be-done and achieving human reinforcement by collaborating human activities with machine activities. During the ideation phases of the concept development, Design Thinking principles were followed. A workshop about these principles were demonstrated in a NATO workshop called "Methods to Develop Artificial Intelligence in ETEE" in NATO International Concept Development & Experimentation Conference, in Madrid 2019. In addition, NATO Architecture Framework (NAF) 4.0 has been used to create architectures of the proposed AI concepts of the project.

The project has started with creating an AI portfolio with a two-step search strategy. The first step was identifying the human activities performed during the planning and ETEE processes. Then, the second step was collecting the AI technology literature correlated with these activities. In addition, a major set of foundations for AI systems to be utilized was identified.

Totally nine AI concepts were developed, three per each distinct area; Planning branches in the Combat Plans Division (CPD), the opposing forces cell in the Exercise Control (EXCON), and the training branches for preparing exercise-ready trainees with identified competencies.

As a part of the project, an AI demonstrator was developed to support the human planner. The position to be assisted with AI technology was determined by structured surveys and observations conducted in a NATO exercise. An AI training environment was developed by using a powerful AI training hardware, and an off- the-shelf software with adequate air operation simulation fidelity. Together with the Subject Matter Experts (SMEs), training scenarios were developed and utilized within the AI training environment which contains two distinct AI algorithms; Supervised Learning (SL) and Deep Reinforcement Learning (DRL). After the training period, the AI agent containing both algorithms was deployed in a multi-national NATO exercise. It has showed very promising results, and praised by the human planners.

Finally, the project is concluded with a roadmap, and a vision for a broader future considering the potential emerging technologies with AI technologies to provide new (or enhanced) capabilities for the AirC2 planning and ETEE processes.

33 ED7

The role of M&S to support introduction into service, V&V and training of modern EW systems

Giovanni Scialanca and Luca Pascale

Modern warfare systems and warfighting doctrines rely on the usage and availability of the Electromagnetic Spectrum (EMS). The primary role of Electronic Warfare (EW) is to dominate the EMS.

The lifecycle of a modern EW system includes identification of the operational requirements, design, prototyping, development, Verification & Validation (V&V), training and operational support. All these phases require the ability to generate complex EMS environments that emulate medium to large exercises with multiple emitters, receivers and EW assets, operating at different levels of command, in different potential operating terrains, environments and scenarios. On the other hand, such a complex EMS cannot be generated and transmitted Over-The-Air (OTA) as it would interfere and disrupt signals used every day by commercial and military users. It would also provide opponents with highly valuable information about the technological status and the operational doctrines of its own forces and EW assets. In other words, Operation Security (OPSEC) would not be maintained.

The scope of the presentation is to show the Modelling and Simulation (M&S) framework developed by LOG.IN to simulate complex EMS and EW assets in high-fidelity operational scenarios. The presentation analyses, from a scientific and engineering perspective, the technical challenges faced and the solutions identified for generating in real-time several independent signals; for modelling the electromagnetic propagation and the effect of the 3D terrain; for modelling large operational scenarios with multiple assets. Moreover, the presentation shows the Hardware-In-the-Loop (HIL) architecture implemented using distributed simulation standards, such as the High-Level Architecture (HLA).

Note for the Reviewer: in order to provide a wider operational content to the audience, it is the intention of LOG.IN to add to the presentation a summary of the Lessons Learned from a Five Eyes Country which has recently introduced such an EW M&S COTS capability in its EW branch. This part of the presentation must be vetted first by the Country's Government before LOG.IN can disclose it to the public. For this reason it has not yet been included in the abstract.

34 CD8

Battlespace Visualization & Interaction as a Service

Nico de Reus, Tom van den Berg and Charles Amburn

The Battlespace Visualization and Interaction (BVI) architecture is a US Army Combat Capabilities Development Command (DEVCOM) project focused on researching and developing improvements and innovations in the way humans understand, interact with, and share complex data. BVI leverages commercial off-the-shelf hardware such as projectors, mixed reality devices, tablets, and physical sand tables to display interactive geospatial visualizations in the domains of military training, research, and mission command. The architecture can be run locally or accessed via a cloud-based environment, and is extensible, supporting collaboration through the integration of externally-provided modeling and simulation technologies. BVI can be provided from the cloud by using various client modalities, such as the browser-based 3D viewer and mobile tablet.

BVI provides services for importing all kinds of data, for example, weather forecasts, maritime traffic data, and military unit data into its displayed scenarios allowing for different layers of data. Example layers include weather data with temperature, humidity, and wind velocity, and layers with maritime traffic. BVI imports weather data from the Army Research Lab (ARL) Military Information Sciences (MIS) provided weather model and is able to import maritime traffic from external providers, such as the Netherlands' TNO Institute for Applied Physics.

In a collaboration between DEVCOM, ARL, and TNO to investigate the M&S as a service concept by integrating the ARL weather service and the TNO maritime traffic service with BVI. In this collaboration the maritime traffic service provides Automatic Identification System (AIS) data, which is produced by a simulator (VR-Forces), running in a cloud environment. In this way, two innovations are realized, namely the as a service provisioning of maritime traffic to BVI, as well as the fact that BVI is enabled to view AIS traffic data and weather data using different client modalities. The BVI system, as well as the weather and maritime traffic services, will be presented and demonstrated.

35 WF2

Intelligent operational decision support for the military engineer

Maarten Schadd and Nico de Reus

This paper describes a proof-of-concept application that aims at providing timely decision support for the military engineer. Abstracting the characteristics of the terrain and integrating these elements into a simulation environment enables the use of AI methods such as genetic algorithms and Monte-Carlo simulations for finding optimal (opponent) behaviour. The experiments show that a good obstacle location strategy can be found that exploits weaknesses of the opponent. Further development should investigate co-learning, vary additional opponent aspects such as the intent, and investigate adequate visualisation of the results.

36 ST3

Scalable Simulation-Based Training with JCATS and JLOD

Mark Piscotty

The demands for computer-aided training for national and multinational conflict and peacetime operations continue to grow in complexity and scope, while budgets and implementation times are simultaneously being reduced. The Joint Conflict and Tactical Simulation (JCATS) and the JCATS Low Overhead Driver (JLOD) systems developed at the Lawrence Livermore National Laboratory (LLNL) provide entity-based simulation capabilities that enable training from the low-level tactical fight up through operational and strategic levels. This presentation will present recent advances in JCATS and JLOD that are enabling training exercise planners to develop and execute effective training scenarios at small and large scales with current and future military systems. Among some of the advances to be discussed are the JCATS web-browser client, a collaborative scenario data generator, and multiple HLA federation support features provided through JLOD. Potential future modeling and simulation features to be discussed include new kinetic and non-kinetic effects across multiple domains such as space, cyber and directed energy systems.

37 OD4

M&S in Operational Decision Support

Jan Mazal

The contemporary highly dynamic operational environment brings many new challenges, which were not apparent before. One of today's significant trends in the military is the continuous pursuit of effectiveness and its improvement in the context of a lack of qualified personnel. Increasing dynamics and complexity of the operational environment will seriously impact human performance in various decision-making tasks, which were intuitively solved in the past with vast application of the human experience and estimation.

Operational problem complexity depends on a variety of other assumptions and criteria, which could be mathematically described and modeled. This gives the motivation for the generic solution development, which could be further optimized and automated, saving human effort and increasing effectiveness in mission management.

38 CC2

NUMERICAL SIMULATIONS TO PREDICT THE DIFFUSION OF CHEMICAL-BIOLOGICAL-RADIOLOGICAL AGENTS IN CASE OF INTENTIONAL OR UNINTENTIONAL RELEASES: THE USE OF FREE LICENSE CODES

Alba Iannotti, Riccardo Quaranta, Daniele Di Giovanni, Federico Baldassi, Piergiorgio Ventura, Pasquale Gaudio and Andrea Malizia

Emergency and crisis situations causing the intentional or unintentional diffusion/dispersion of Chemical, Biological or Radiological substances in the atmosphere nowadays is increased because of the industrialization, the flux of people all around the world due to the globalization, the national and international conflicts, and the risk of terrorist actions. The international scientific community, involved in the safety and security aspects related to those events, is requested to work on the reduction of the related risks. To reduce risk, it is necessary to operate on the reduction of the magnitude related to an event and to the probability that a certain event can become real. These aspects can be approached by predicting release scenarios through numerical simulations. In this work, the authors have used: the HotSpot code, which is a free license code to predict the consequences of a radiological release, Aloha, and Marplot codes to predict the consequences of a chemical release, and the SpatioTemporal Epidemiological Modeler (STEM) code to predict the spread of pandemics, and the Infectious Diseases Seeker (IDS) application, developed by the Quantum Electronics and Plasma Physic group of the University of Rome Tor Vergata, for biological events. The results of several case studies as well as the advantages and disadvantages of using those free codes to simulate dispersion/diffusion scenarios will be presented by the authors to demonstrate that, with the proper expertise, the support of these instruments can be remarkable in reducing risks for the population.

39 CC3

UAV measurements to detect CR agents in case of intentional or unintentional releases and to predict their diffusion

Pasqualino Gaudio, Andrea Chierici, Francesco d'Errico, Daniele Di Giovanni, Francesca Fumian, Luca Martellucci, Andrea Malizia, Riccardo Rossi and Piergiorgio Ventura

In the last decades, we have assisted in the rapid evolution of UAV technologies. Many civil and military applications support the first responders in critical areas and these technologies' dual-use can be useful also in environmental applications. The combination with UAV and the use of Chemical and Radiological sensors can certainly solve many environmental monitoring problems in case of CBRNe events.

The use of UAVs and ad hoc sensors box to detect C/R threats developed by Quantum Electronics and Plasma Physics Groups (QEP) of the University of Rome Tor Vergata and the University of Pisa contribute to reducing human exposure to the “red zone” environment. Data collection is important both to detect and identify threats and to determine the hot spot and it is helpful to determine the diffusion of contamination through numerical simulations. These data (experimental and numerical) give a prospect of the contamination helping the advisors to select the proper PPE for the first responders entering the contaminated area with an impact on the risk reduction during the rescue operations

The multi-sensors mobile platform for application in the civil and military environment will be presented with the possible use of swarm drones to improve the capability to identify the emission point of C/R and track the plumes.

40 CC4

VERTIgO project – A PUBLIC-PRIVATE INITIATIVE FOR THE IMPLEMENTATION OF VIRTUAL ENHANCED REALITY FOR THE INTEROPERABLE TRAINING OF CBRN MILITARY AND CIVILIAN OPERATORS

Daniele Di Giovanni, Grace Xerri, Alba Iannotti, Riccardo Quaranta, Andrea Malizia, Piergiorgio Ventura and Pasquale Gaudio

In the last few decades, an increasing number of threats associated with Chemical Biological Radiological Nuclear (CBRN) agents, has driven the need to develop new tools to improve the safety and security of societies and those who employ their protection.

In the context of CBRN scenarios, improving the preparedness of First Responders (FRs) represents the first and most fundamental strategy in pursuing risk mitigation.

Therefore, the definition and development of targeted training activities that are as immersive and realistic as possible is a key objective in improving the future of CBRN protection and response measures. Recent advancements in-game engine technology and in the development of Virtual Reality (VR) hardware and software components, can significantly improve CBRN training through realistic simulations specifically designed for both military and civilian FRs.

In this work, the authors presented the VERTIgO project (Virtual Enhanced Reality for the Interoperable Training of CBRN Military and Civilian Operators), a project funded under the EU's European Defence Industrial Development Programme (EDIDP). Project VERTIgO aimed to develop and implement a multinational training platform for disseminated use among both military and civilian FRs across Europe.

The work presented by the authors discussed the steps followed in the VERTIgO project to perform the study, design, and validation of a European Exercise Simulation Platform (EESP) for the application of VR to CBRN training, complemented by the prototyping of an ad-hoc hardware solution which integrates a VR headset and CBRN mask for enhanced realism and user experience.

41 ST4

Unmanned Aircraft System, Command and Staff Training via Modeling and Simulation in Support of Military Exercises

James Bowman

The need for training via modeling and simulation continues to increase for militaries around the globe. The increase of technological advancements such as parallel processing and increased memory on Graphic Processor Units has enabled high fidelity and high resolution products which supports immersion for the trainees, thereby increasing operator efficiency. The intent of the presentation will be to share with the audience how technologies have been leveraged to support training for the US and its partners and how modeling and simulation not only reduces costs but allows for After Action Review capability as well as training of specific emergencies and situations that could not otherwise be trained.

42 SP1

Global stability and security pass through space SDA, SSA and SST to safeguard people and resources

Filippo Gemma

Defending the population, maintaining democracy, and preventing conflict also comes through stability and security in space: both to preserve and prevent threats to orbiting objects.

The development of space technology and the exponential growth of objects in orbits around Earth has not been accompanied by adequate regulation of the use of space, especially regarding the management of orbits and space debris. This issue, together with the increase of institutional and commercial actors able to access space and interested in using it, could lead to dramatic scenarios and conflicts, inhibit future access to space and limit the expansion of humankind beyond planet Earth.

In the scenario of instability and challenges for NATO member countries and partners, we need to manage this resource as best we can: identify who populates it, understand how it changes, and save our strategic resources in orbit, also considering that some of the most critical activities in planning and executing military operations take place nowadays in space itself.

GMSPAZIO deals with Space Domain Awareness (SDA) and its declinations: Space Situational Awareness (SSA) and Space Surveillance and Tracking (SST), which are essential to locate, track, identify and assess threats that affect the security of on-orbit assets and their performance, to help safeguard, in the short and long term, space infrastructure, assets and services of strategic importance to the nations involved. A complex challenge but necessary for protecting our future and the investments made in this direction.

Knowing space objects, identifying them, establishing their orbits, measuring their operations, and predicting their future positions in space and time are necessary actions to acquire, evaluate and calculate all information inherent to the space environment. Thus, the first requirement is the need to accurately monitor orbiting objects to assess whether they should be maneuvered to safety or avoided by saving fuel on board and consequently extending the operational life of the mission to which they belong. Without forgetting, however, that it is also necessary to work to counter the proliferation of space debris, keeping track of the effects of collisions or explosions so that we have an updated real-time map of potential hazards during the increasingly frequent launches of space launchers and monitor uncontrolled re-entries into the atmosphere.

Our mission is to support our stakeholders in managing complex situations to ensure the maximum efficiency of their systems while protecting the community's safety against potential risks from the uncontrolled use of space resources.

43 CDY

Rapid Development of Terrain Databases for Use in Synthetic Scene Generation

Matthew Rigney, Thomas Etheredge, Brad Seal and Christopher Porter

High-fidelity, physics-based modeling and simulation for imaging sensor systems requires data inputs and scene generation capabilities of sufficient fidelity to support accurate evaluations of sensor performance. Additionally, the proliferation of AI/ML based algorithms has increased the need for synthetic imagery to augment existing datasets for training. Traditionally, agencies have used empirically collected scene data for both EO/IR and RF system development and performance assessments. However, this limits the developer to scenarios where data can be collected, both temporally and spatially, leading to datasets lacking the high degree of real-world variability of scene data needed to support system design and evaluation.

To address this limitation, the US Army's Combat Capability Development Command (CCDC) Aviation & Missile Center (AvMC) has developed a unique suite of data and scene generation software tools. First, a rapid terrain generation toolset allows for the quick development of large-scale (> 100 km2), high-resolution (0.25 meter, with higher resolution insets) terrain databases for any location in the world and includes terrain geometry, vegetation and manmade objects, and material descriptions. Additionally, CCDC AvMC has developed the Highly Optimized Terrain Thermal Solver (HOTTS), a novel, physics-based thermal solver that includes numerous environmental models, comprehensive shadowing capabilities, and dynamic material variability. This tool allows the rapid generation of background clutter, manmade objects, and target signatures at large scales. Finally, these tools provide the inputs and data for use in CCDC AvMC's Common Scene Generator (CSG). CSG is a multi-spectral, co-registered scene generator with additional libraries including an IR sensor model, countermeasure capabilities, source reflections, maritime capabilities, as well as a simulation framework that allows integration of external component models to create closed-loop simulations.

CCDC AvMC designed each of these tools to work in concert with one another and address the current physics-based modeling and simulation needs for sensor based systems. They have been designed to run on platforms ranging from a local desktop machine to large high performance computing clusters. This paper will outline the unique contributions that CCDC AvMC's suite of tools provides to the modeling and simulation community. These unique capabilities include massive, high-fidelity terrain databases, rapid signature generation for any available terrain database, and the ability to leverage a co-registered scene generator in applications including hardware-in-the-loop, all-digital closed-loop system performance assessments, and AI/ML dataset generation.

44 WF3

Should we be fully committed to Multi-Domain Integration?

Philip Penney, Martin Reinhardt, Roland Bals and Marija Kukolj

As the complexity of the modern battlespace becomes increasingly complex, Global Armed Forces admirably continue to make adaptations in order to perform in the most difficult of circumstances. More must be done to meet the challenges of the developing and changing landscapes however: traditional approaches to both training and operations must be modified.

Historically, platforms work separately. Units plan in isolation. People train alone.

This individualistic mindset restricts military potential: information is being gathered on every platform including satellite; aircraft; drone; ship or land-based systems however we are not leveraging the collective benefits of the data gathered. This data stream must be brought together to produce a single, simplified, yet complete picture of the battlespace. Integration is not about using every capability, every time an enemy is engaged. Integration is about giving a Commander detailed knowledge and awareness of their options so that they can make a fully informed decision when prosecuting operations.

Available technology now enables Multi-Domain Integration. However, for this integration to work, militaries need to support behaviour change. They must begin to integrate by instinct. When staff are training, planning, or conducting operations, a collaborative approach must be sought.

We are best when we think beyond the single platform constraints in which we have worked for far too long.

Emerging technologies with Computer Assisted eXercises containing Artificial Intelligence driven support to decision making, can be developed to re-train the warfighting functions. A single synthetic training platform enables full virtual mission rehearsal. The interoperability between heterogenous simulators can be built upon to allow all the assets involved to be fully prepared and unified. The singular aircrafts; tactical command and control units; and cyber systems will combine to become a fully integrated warfighting machine.

Education and training across all Nations, Services and specialities must ensure that the future warfighter has all the tools to be able to combine the right capabilities, at the right time, to achieve the mission intent. That is why we should all be fully committed to Multi-Domain Integration.

45 AI3

How Model-Based Engineering is Enabling Digital Engineering

Beaudouin Alexandra and Petrella Vincenzo

Modelling and Simulation enable the virtualization of the system design as well as the system environment, from the component or sub-systems levels, and can be expanded up to the system and higher. It is this higher level where we usually hear about digital engineering. The expected benefits of digital engineering include better-informed decision making, enhanced communication, and increased confidence in the system design, aiming at an overall more efficient engineering process.

Following the path of digital engineering, we can envision new challenges but also communication channels to enable the right choices and increase understanding and confidence in the system design. Using Model-based System and Software Engineering offers an engineering process based on two main pillars: automation and having an authoritative Source of Truth – those pillars can define what is the truth, and who is responsible for it and how it produces the required artifacts automatically.

46 WG4

Distributed Wargaming for a COVID 19 World – A best practises guidebook for NATO (SAS-170)

Uwe Gaertner

The output of NATO SAS-170, a best practices guide for distributed wargaming, is presented. Since the start of the COVID 19 pandemic in early 2020, NATO and allied wargamers have had to focus on the use of distributed wargaming to continue their work. With members from xx countries and yy NATO organisations, SAS-170 has endeavoured to collect and consolidate best practices for distributed wargaming from the wargaming community. Ideas for best practices have been analysed and fit into a framework that describes the elements of distributed wargaming covering the domains of (1) Communications (2) Environment (3) Control and (4) Engagement. This presentation discusses SAS-170, how its data was collected and how the ideas for best practices have been written into a best practises guidebook for NATO.

47 CC5

Refinement of risk assessment models: toward a more sustainable management of contaminated sites

Renato Baciocchi, Iason Verginelli and Daniela Zingaretti

Risk assessment is a useful and widely applied tool for the management of contaminated sites since it provides a rationale and objective starting point for priority setting and decision making. Its application in most advanced countries has been prompted by applying the Risk-Based Corrective Action (RBCA) framework, based on the corresponding ASTM standards. The main strength of the RBCA procedure relies on its capacity to evaluate risks to human health through relatively simple fate and transport and exposure models. However, the experience and the increasing knowledge gained over the years have highlighted some critical issues of the RBCA application to contaminated sites. In particular, it is well known that the ASTM fate and transport and exposure models are often too simplified, leading to an overestimation of the risks. In this work, we propose some simple possible refinements that, while keeping the intrinsic simplicity of the ASTM-RBCA approach, could allow a more realistic risk assessment and thus more sustainable management of contaminated sites.

48 CD1

Technology, gameplay and human streams; a framework to support the development of simulation-based wargames

Thomas Mansfield, Pilar Caamaño, Alberto Tremori, Serge Da Deppo and Girish Nandakumar

The Dynamic Messenger (DYMS) operational experimentation exercise, scheduled September 2022, marks a new era in NATO's approach to assessing the effectiveness of emerging and disruptive technologies. As part of this new approach, DYMS22 will utilise the latest version NATO's Disruptive Technology EXperimentation (DTEX) approach to provide an immersive, scalable and adaptable M&S based wargaming capability to support decision making in complex and uncertain environments by blending human, technology and data aspects.

DTEX's ability to be rapidly configured, deployed and made available to support wargaming in DYMS22 stems directly from the project's long-term focus; to reduce configuration time while increasing scalability. This paper documents the design, development, implementation and refinement of a versatile framework that supports the rapid deployment of M&S based wargames in NATO.

The development framework focuses on three parallel lines of effort; the technology stream, the gameplay stream and the human stream. The technology stream focuses on the implementation of tool-sets that not only allow the technologies of interest to be simulated, but also on the agile and incremental design and development of scalable interfaces that allow the players to configure the scenario and analyse data in a range of formats. The gameplay stream focuses on providing players with the right information at the right time, balancing motivation and a desire to win with the need to encourage discussion and elicit insights into the decision making process. Finally, the human stream recognises the fact that the motivational and communication elements of each event need to be tailored to optimise engagement among diverse player communities.

Using DYMS22 as an example of the latest application of the DTEX in NATO, the structure, content and observations that led to the development of a robust wargaming development framework will be presented, discussed and made available to enhance the wider field of M&S based wargaming in NATO.

49 ED2

Combat Model Experimentation on US DoD HPCs

Charles Timm

As part of the broader cloud efforts within the US Army, The Research and Analysis Center (TRAC, of Army Futures Command), is investigating methods to efficiently and economically run their combat simulations in cloud architectures. Additionally, increasing TRAC mission requirements are pushing TRAC to seek larger and more capable classified computing resources to meet demand for increasing study scope and decreasing time available for execution. One promising architecture are the US Department of Defense (DoD) High Performance Computing (HPC) assets. The DoD HPCs are multi-core supercomputers available to all US DoD organizations and select partners. This presentation will provide an overview of an effort to efficiently conduct experimentation using two combat models, the Combined Arms Analysis Tool for the 21st Century (COMBATXXI) and One Semi-Automated Forces (OneSAF), on DoD HPC assets by a team of TRAC and Army Research Laboratory (ARL) analysts. The results of the testing showed a significant time and resource savings over traditional on-premises servers through dynamic load balancing across the HPC's more numerous computer cores. These results will have implications for how TRAC and the US Army will potentially conduct studies and analysis in the future.

50 CT5

Game-Like Terrain, On-Demand: Solving Terrain Challenges Through Enterprise Terrain Management

Peter Morrison

Traditionally, making terrain for high-fidelity simulation is challenging. Acquiring good source data, storing that data, building correlated terrain for multiple runtimes, synchronizing data between different simulation clients (e.g. dynamic terrain updates) and editing data “on the fly” are all difficult terrain-related tasks that, historically, have resulted in expensive development and long lead teams for delivering high fidelity terrain data to the point of need. New, cloud-enabled technologies are solving these problems, funded through initiatives including the US Army's One World Terrain (OWT) program. Mantle ETM (Enterprise Terrain Management) is a custom-built platform based on proven COTS components and expert design/development services for creating simulated terrain for training, mission rehearsal, visualization and terrain analysis. This presentation will describe how Mantle ETM solves terrain challenges and will present several case studies showing how terrain development is moving to the Cloud.

51 CC6

CBRN decision making

Erik Juel Ellinghaus and Luca Pinciarelli

A look at the use of simulation to train decision making in a CBRN environment

CBRN – chemical, biological, radiological and nuclear – defence is often equated with respirators and sensors. These are indeed important tools of the trade, but the effects of a CBRN incident, be it weapons based or of a toxic industrial nature, have an impact far wider than what can be solved by correct use of the tools at an individual level.

To limit the operational impact of a CBRN event the training must also address the decision making at higher levels. What are the procedures that are initiated when the first sensor alarms, how is the alarm validated, how should the recce assets be deployed? These decisions and a myriad of others can be played out in the context of software-based table-top exercises where the CBRN effects are only gradually becoming apparent to the players just as they would in real life and where the player actions taken determine the extend to which the true situation is realised, and operations can be adapted and continue.

A case study based on Bruhn NewTech's commercially available CBRN-Sim software is used to describe how realistic CBRN effects can be added to exercises and result in better preparedness.

52 ET1

Extended Reality, Cloud Connectivity and Simulation for Digital Trasformation of (Remote) Training

Giovanni Tonelli

In the increasingly demanding sectors of Aerospace, Defense and Security, the objective of guaranteeing the operation and excellence of the systems cannot be achieved regardless of the quality of the training process of both instructors and operational and maintenance personnel who must guarantee such goals.

The technology can heavy help in reaching this excellence: new paradigms promoting full interconnectivity, such as Modeling & Simulation as a Service (MSaaS) and Training as a Service (TaaS), can be implemented to guarantee efficiency, effectiveness and associated cost reduction, while emerging technologies such as virtual, augmented and mixed reality (VR/AR/MR) provide revolutionary approach to training.

Leonardo, driving the digital transformation of the Group, is developing innovative solutions adhering to these new concepts. Morpheus XR and OCEAN, are examples of interesting solutions to satisfy highly standardized procedures and complex tasks allowing both instructors and operators to have access to increasingly complex and varied content in which simulations and simulators play a great role.

In fact, distributed simulations and shared simulators, managed by OCEAN to provide Virtual Constructive capability, give a great boost to training, enabling new learning methods (both for operational and maintenance purposes), where operators are immersed in a secure immersive virtual scenario using Morpheus XR. The results of simulation, exploiting the HLA / DIS architecture, is used to recreate normal condition or also extreme situations in which operators learn to operate in single or collaborative way being fully assisted in operation by remote connection with experts and accessing all relevant documentation stored and referenced securely on a cloud.

Moreover, the success for implementation and operation of such dedicated solution is predicated on considerations including full connectivity, data ingestion and processing, cloud computing and cybersecurity, artificial intelligence to name a few.

53 SN3

MsaaS supporting interoperability and experimentation activities

Martina Bini

This year NATO M&S CoE provided services for CWIX M&S Focus Area and its international partners through Leonardo's MSaaS cloud Platform: OCEAN.

We worked to settle up a session, where all the provided services by COE were automatically installed, configured, launched and federated.

In particular during the NATO exercise CWIX 2022 we supported the activities within the NATO STO MSG-201 Research and Study Group,

that actually [PROPRIO] aims to introduce M&S services within NATO "Federated Mission Network" (FMN).

Creation, configuration and management of all the assets necessary for tests' preparation and execution were managed by OCEAN.

Its use to support planned activities and interoperability tests between the CoE and its partners brought many advantages:

- Time advantage. We could prepare in advantage. The biggest effort was to build the session: we use this term to indicated the synthetic environment

that is automatically provisioned and the software deployed on the top of it. Once this environment was correctly setup we just had to use it as many times as we needed.

- every day we would have a totaly brand new environment. Since everything was automated by OCEAN, every day with a minimal effort we would

create from scratch the environment and after tests we would just destroy it. So any mistake would therefore not affect or compromise anything.

- Freedom to risk. Since any mistake would have not have any negative consequences it was possibile to push forward experimentation limit because it would have always been

possibile to come back and restart everything in few minutes.

- Reuse. Everything that was prepare can be reused next years. Following activities will start from that point, there will be no need to setup everything

again, we can start building next activities from that.

Interoperability and experimentation activities can be improved thanks to the new MSaaS paradigm which exploits cutting-edge technologies in order to provide

on-demand services.

54 CD9

VR/AR/XR and Metaverse Technologies for Defense and Aerospace

Seppo Aaltonen and Cassie Syfrett

This presentation will cover the latest developments in virtual (VR) and mixed reality (XR) for defense and the "military metaverse". Key points include:

- Recent case studies of VR/XR implementation in defense and aerospace

- How VR/XR generates superior results in training over traditional methods

- Latest lessons learned and best practices

- Key benefits to be leveraged within the next few years

- Why metaverse technologies are important for M&S

- Market trends

55 ST5

Training Simulation for JOINT FIRES EXERCISE at Brigade Level

The main topics:

The Joint Fires Training Simulation in ITA Arty HQ;

The JFX CAX MEDUSA for BDE JFSE;

The JOINT FIRE EXERCISE STRUCTURE and ORGANIZATION;

PROBLEMS AND SOLUTIONS & Bi SC 75/3 ADJUSTMENTS;

56 OD8

Strategic Wargaming for Senior Decision Makers

Dr. Kathleen Robertson

Strategic Wargaming can be an invaluable tool to force the critical discussions that need to occur among the senior decision makers. Often the senior people are isolated from the reality of required decisions, not fully recognizing the potential impact on other organizatins/stakeholders, and the financial consequences of decisions.

Use cases will include a Port of New York/New Jersy Security wargame which involved senior leadership from the government, to include Coast Guard, Department of Homeland Security, FBI and industry (energy, rail, trucking, financial, pharma) which highlighted the importance of Supply Chain challenges that industry must manage while restricted by government decisions, or lack thereof. Second use case involves the true cost of sustaining a weapon system such as the F-35. As the Services focused on the production and delivery of the platform, the cost of sustainment accelerated to a level not anticipated by the Services and Partner Countries.

57 SP2

ELINT Simulator for detection and localization of a RF signal sources using a swarm of Cubesats

Ernestina Cianca and Mauro De Sanctis

The presented simulator has been developed for assessing the performance of a swarms of Cubesats in terms of detection and localization capabilities of RF signals. Such RF signals could be:

• radar signals or unintentional RF interferers

• intentional interferers such as jammers, located in territory that are not under our control

• occasional unintentional interferers for terrorism attacks

Using a swarms of cubesats for ELINT applications has the following advantages:

• The possibility to work in swarms allow to have better localization accuracy than with a single satellite, and also higher redundancy (case of failure of one satellite);

• Less complex sensors are distributed over different spacecrafts rather than having one single complex spacecraft; data fusion can be performed on the ground in post-processing. This allows a reduction of the marginal costs with same aggregated performance and higher availability;

• possibility to launch them rather fast.

The simulator has been developed to assess the performance of a specific type of swarms, with specific characteristics, but it it flexible enough to be use also for constellations. As a matter of fact, it could be a useful tool also for the design of a constellation as it allows to assess quickly the performance of different type of constellations, with different orbital parameters, number of satellites etc.

The presentation will first explain the context in which it has been developed and then it presents the simulator, its main characteristics, limits and flexibility.

The simulator has been developed in Matlab and implements a satellite propagator. It takes in input:

• Orbital parameters (position and speed);

• Target information (position on the Earth, randomly generated);

• An error model for the orbital parameters;

• An error model for the synchronization of satellites:

In each step of the propagation, it runs detection algorithms, estimate the target position using TDoA or FDoA or hybrid TDoA/FDoA algorithms; it calculates the error in the target position estimation. At the end of the propagation, an average of the positioning error is provided. The presentation will also show some of the achieved results in different application scenarios.

58 ET4

Explaining Simulation to NATO: The Exercise Use Case

Ryan Squires

Military leaders and staff officers outside of the computational simulation realm often do not have a strong understanding of computational simulation. These individuals often bring strong uninformed biases and fundamental misunderstandings, leading to wasted effort and dissatisfaction with simulation. How can we better explain simulation and the differences in its use cases to leaders and their staff? Focusing on the exercise use case, we propose the concept of the virtual environment. Finally, we offer a few operational level examples as a means to explain key computational simulation processes.

59 CT6

Lockheed Martin - Prepar3D, Extended Reality, & Training at the Point of Need

Adam Breed

Leveraging the best gaming technologies, commercial software, and defense-oriented integrations - Lockheed Martin is developing new ways to train anywhere and anytime. By combining an open architecture and by building on an advanced simulation engine foundation, a new generation of training devices are emerging that support Extended Reality with an unprecedented level of technical fidelity. Presentation will highlight Prepar3D and how it is being used around the world to develop point of need training devices. Topics include introductions on how to integrate real subsystems, how to get started collecting data to support artificial intelligent integrations and virtual instructors, and how to begin creating immersive training scenarios. By using these concepts and their backing technology, developing high-fidelity training at the point of need is now possible.

60 AI4

Innovative Computer Vision techniques for person reidentification

Gianluca Pompei

The Decision Support Systems, originally based on a-priori knowledge and operational research models, are moving toward the use of data-driven approaches, developed through machine learning techniques. The performance of such systems is thus proportional to the volume of available data and the ability to collect it in a real-time manner to make early decisions. However, a common issue in DSS lies in a restricted vision of the ordinary world's complexity: each system specializes in a particular area of interest, processing its own domain of data and is unlikely to exchange valuable insights with other components. In this paper, a holistic approach to the problem is introduced, where several computer vision models, each having different scopes, are applied on-edge to video streams from both standard fixed cameras and moving devices, in order to interpret a massive amount of data and give a complete understanding of what is happening in a given environment, from a real-time perspective. To achieve this, computer vision models need to operate in at least three domains: the detection of people and their re-identification across different cameras and contexts (People-Focused); the analysis of objects, infrastructures, and their surroundings (Things-Focused); the identification of particular events or behaviors performed by people (Actions-Focused). Moreover, there is a need for a single, high-reliability central system designed to receive and interpret data and make reasonable decisions. The paper illustrates three examples of models applied to the above areas, proving the importance of such a multi-domain approach, and shows an innovative approach for the reidentification in a multi camera environment, with different lighting, point of view and overall conditions.

61 WF4

The use of simulation and C2 in the Danish Army

Per Klembo

The Danish Army uses a variety of different simulation models to train individual soldiers and up to Brigade level leader training. For most of the training, the simulation connects to a C2 system to stimulate it with BLUEFORCE tracks.

This presentation will describe how The Danish Army uses and integrates simulation models and C2 systems.

62 OD9

Using Simulation to Better Inform Decision Making for Warfare Development, Planning, Operations and Assessment. A New Approach to Sharing Models and Simulations Across the Alliance

Wayne Buck

Using Simulation to Better Inform Decision Making for Warfare Development, Planning, Operations and Assessment. A New Approach to Sharing Models and Simulations Across the Alliance

STO-TR-MSG-SAS-178

Modelling and Simulation (M&S) has been successfully used to support decision-making within NATO for decades. M&S is used in many areas, including, advanced operational planning, capability-based planning, capability and concept development, and to support experimentation and wargaming. M&S takes many forms, from large complex Campaign Simulations designed to be used repeatedly over many years, to simulations built quickly for a single purpose. M&S is a key tool for NATO, but it can be costly to develop and maintain, and requires specialist expertise that is in short supply. M&S is an area where the Alliance's collective capabilities and willingness to collaborate should give NATO the advantage

63 ST7

US Joint Training exercises using M&S

Amy Grom, Stephen Banks and Jessica Camacho

A panel led by the US Joint Staff J7 Chief of Environment Operations Division, US Army Colonel Steve Banks. The panel members will present current and future exercises using distributed joint simulations for Joint Force Development and Design. Joint Staff J7 continues to use JCATS and JTLS for Combatant Command exercises and will address the program management and funding of these simulations.

64 LL3

M&S in CWIX 2022 - Lessons Learned

Stefano Izzo

The Coalition Warrior Interoperability eXploration, eXperimentation, eXamination eXercise (CWIX) is an annual NATO event designed to bring about continuous improvement in interoperability for the Alliance.

Allied Command Transformation (ACT) provides direction and management to the program, while NATO and Partner Nations sponsor interoperability capabilities with specific objectives defined by ACT and National Leads.

The CWIX program focuses primarily on testing and improving the interoperability of NATO and National C4I systems, particularly those deployed within a NATO Response Force (NRF) or Combined Joint Task Force (CJTF).

CWIX provides a venue to conduct technical testing of fielded, developmental and experimental systems in the context of a coalition scenario.

In this context, Modelling and Simulation is one of the Focus Areas for interoperability testing.

The subject presentation aims to provide an overview of the M&S Focus Area role in CWIX, an outcome from the recent CWIX 2022 exercise, including objectives and achievements, as well as some high-level identified lessons learned from the conducted testing activities.

65 ST6

Opportunities and Challenges of Technical Interoperability

Heath McCormick

After the annexation of Crimea in 2014, and over a decade of fighting in Iraq and Afghanistan with a focus on Counter-Insurgency Operations, NATO realized that it was not adequately prepared to fight a large-scale coordinated land battle in Europe. Interoperability with partners and allies is critical in conflict; but it starts with interoperability in the training of a multinational, multi-echelon, distributed force. This panel will propose some of the opportunities that interoperability can provide, but also address the realistic challenges that we face bringing technical interoperability in distributed training to fruition.

Each panel member will be given 10-12 min to discuss the opportunities and challenges of interoperability that they see from their perspectives and experiences. Then COL McCormick will moderate an open discussion on the topic.

Panel Members will be:

Colonel Heath McCormick

Colonel Mark Maden

Mr. Wim Huiskamp

Colonel Steve Banks

66 WG6

Computer Assisted Wargaming discussion

Uwe Gaertner, Panagiotis Balaskas

The panel discussion will be a continuation of the previous wargame presentations.
Original theme of discussion: What wargaming is now and where it is going/where the military 'wants' it to go.
Way ahead:
o Develop focus areas to steer the discussion
o Develop/submit desired or relevant questions to get the discussion started
Possible questions:
o How can Wargaming benefit from the integration of simulation?
o What are possible use cases for simulation during wargaming events?
o NATO NexGen M&S is also supposed to provide support to wargaming. What kind of elements / capabilities should be available to be beneficial.
o What kind of technical support is suitable for higher operational and strategic wargames?
Questions from auditorium always welcome to be discussed by the panel.

Moderated by Mr. Balaskas. Assisted by LTC Gaertner.

Panel Members will be:
o LTC Tabaka (EUCOM) – Wargame definition, use cases, general info
o Mr. Balaskas (JFTC) – Computer Assisted Wargaming (general introduction to CAW comparing CAX, WG for education and analytical WG)
o LTC Gaertner (COE) – SAS-170: Distributed Wargaming Guide (more general presentation on this topic)
o COL Stinchfield (AWC) – Wargaming & Education (Educational WG)
o Dr. Hodicky (ACT) – MDO-EU use case/ Wargaming in a synthetic environment (Sim for analytical WG)
o LTC Martin (AWC)
o COL Bates (AWC)

67 CY2

CERERE - Modeling & Simulation for an unlimited technological progress

Andrea Pompili, Vittorio Vitello and Riccardo Rossi

Cyber security methods are continually being developed. To test these methods many organizations utilize both virtual and physical networks which can be costly and time consuming.

Cy4Gate, as Italian leader in cyber security and cyber defence, keeps concentrating efforts on technological development related to Modeling & Simulation theories.

CERERE (Cyber Electromagnetic Resilience Evaluation on Replicated Environment) Project was born to supply an automated testing environment to evaluate the cyber resilience of a given system.

68 SP3

Space Weather Models Embedment in Military Simulations

Kostadin Lazarov and Orlin Nikolov

The article describes part of the technical applications as a result of scientific research focused on Space Weather – Earth Processes correlations. One of the aims of the research is to develop models of the Space Weather Influence and to embed them in software, HLA networked to federation of simulations. The main goal is to assess comprehensively the Space Weather Influence over Military Operation.

70 CY4

Cyber and electronic warfare: Review of U.S. Army capabilities

Chad Bates

Future battlefields will be complex, constantly evolving, and congested. Modeling and Simulation is the only way for our commanders, staffs, and personnel to provide the intellectual environment for them to better understand the challenges they will encounter. They need to better understand the realistic capabilities of cyber, how electro-magnetic attacks and defense will be critical, and how they need to defend against mis/disinformation on a modern battlefield. This presentation will layout some of the foundational problems, gaps, and potential solutions the U.S. Army and Department of Defense are currently working on to assist our forces in preparing for these future difficulties.

71 LL4

Lessons from NATO MW Concept Experiment

Igor Brinar and Aljosa Miljavec

NATO MW COE execute in last two years Concept Development Experimentation Process with preparation of NATO MW Concept. Part of CDE process is also Experiment which we did with support of M&S COE and Slovenian Armed Forces Simmulation Centre.

Main Observations and Lessons from experiment and the way how we execute the whole experiment we'd like to share with participant of NATO CA2X2 Forum.

72 CY5

Digital Transformation and Cybersecurity Challenges : a dual use approach

Giovanni Gasbarrone

Digital Transformation in Defence and major industries: 5G technologies and solutions meet a growing applications demand for ultra- broadband-enabled data applications within vertical market segments including Finance, Defence, Public transportation, Energy.

Cyber security is a critical issue.

How to protect against asymmetric Cyber Warfare will be a high priority task.

Key findings from ANUTEI webinar "The strategic role of technological surveillance in military operational scenarios"

Hypothesis in communication structure between land and sea in a Smart Land perspective

73 CY3

TACTICAL CYBER OPERATIONS IN LAND OPERATIONS

Fabio Biondi

This presentation will focus on Cyber Operations at tactical level in land operations, up to battalion level. In particular we'll analyse the different types of Cyber OPS to be conducted in a land defensive posture and in a offensive one. Then we'll investigate which kind of support is possible to give to a terrestrial unit in order to have a better understanding of the enemy posture into the battlefield.

Finally we'll see how this cyber posture could be represented in a M&S system

74 LL5

SFA Operator Profile Analysis Report

Jetnor Zogu

The SFA Operator Profile seeks to offer a profile definition for advisors, mentors and trainers in the SFA environment, in support of NATO Allied Command Operations (ACO) and ACT, documenting lessons identified and best practices to enhance NATO HQs and NATO nations' ability to select, recruit, train and deploy personnel in SFA operations.

The project focuses on the job descriptions and human and professional requirements to define, in a strategic, operational and tactical environment, the psychological traits and competencies necessary for an advisor, mentor or trainer. Overall, the project seeks more broadly to maximise human capital capabilities to perform SFA activities.

Following the SFA Operator Profile analysis report the NATO SFA COE is developing Remote SFA project that is the integration of the assistance by remote, with the lighter footprint as possible, and supporting the capacity building process from the home state.

It would be a great pleasure to present the SFA Operator Profile & Remote SFA Project during the 17th CA2X2 forum due to the fact that the Computer Assisted Technologies and Digital Infrastructure is one of the most important part in providing Remote SFA.

75 CY6

Cyber and Physical Security Convergence enabling effective Cyber Situational Awareness in Industry and Defence environments

Salvatore Sambati and Antonio Peter Tamborino

Today's threats landscape is showing a result of hybrid attacks targeting both physical and cyber assets. The adoption and integration of civilian, but also military, assets with embedded Internet of Things (IoT) and Industrial Internet of Things (IIoT) devices have led to an increasingly interconnected mesh of cyber-physical systems (CPS). Such complex environment expands the attack surface and blurs the once clear functions of cybersecurity and physical security.From the Power and Energy Industry to the Telecommunication systems up to the Healthcare and Military applications on the battlefield, is becoming crucial to achieve a Cyber and Physical security convergence. To achieve such convergence is fundamental to have tools able to monitor network and physical systems with the capability to fuse the information form each domain. Furthermore, to present a common shared picture to provide to analysts the needed pieces of information to provide a very close to real situational awareness. In this environment, the implementation of cyber threats ranking models and Artificial Intelligence (AI) tools is a game changer if such solutions are able to process and analyse a huge amount of data to support analysts, Managers or Commanders in their decision-making processes. In addition, providing a certain kind of automation to support the tailoring and escalating of the relevant pieces of information from the technical to the tactical, operational up to the strategic levels.Modelling and Simulation may help in setting up Security Operation Centres (SOC) test bed architectures and environments to experiment latest convergence solutions and interoperability issues between physical and cyber systems, with the aim to provide a cyber/physical "operational" situational awareness, augmented by AI and innovative Cyber Threats models both for Industry and Defence use cases.

76 CY7

Modelling Cyber Guerrilla Attacks improving Threat Intelligence and Situational Awareness Automation

Christian Catalano and Mario Angelelli

The ranking of cyber vulnerabilities based on their severity is a major decision-making problem in the digital society. This ranking is often based on information related to intrinsic properties of the cyber-vulnerabilities, but contextual factors (diffusion of a vulnerable technology, available resources to exploit a vulnerability, cost of exploits, average time to fix the vulnerability, and so on...) may have an impact on the effects of actual risk attributed to cyber-incidents. In addition, different business models, specific needs and several kinds of software and systems implementations may discriminate the prioritization of preventive actions in different organizations according to their structure and core business.

In the defence domain an effective ranking system, augmented with contextual and operational factors, could be considered a game changer in decision support activities at technical, tactical, operational and strategic levels.

This presentation illustrates an on-going work on the definition of mathematical and statistical models to enhance the integration of multiple information sources to analyse the type of cyber vulnerabilities. Authors combine official rankings provided by NIST with external information on available resources that can characterize cyber guerrilla attacks according to a specific taxonomy model. This approach let us cluster cyber vulnerabilities based on both official and underground information, analyse unknown vulnerabilities, and propose a model for rankings. This model can support prioritization decisions of security operators, also considering their risk perception level.

The focus on explainable and interpretable models will support the presentation of relevant information tied to the implementation of a certain level of automation to improve the situational awareness perception conditioned to the user’s decision criteria and to availability of innovative software tools and services.

77 CT8

A view on next gen cloud based massive simulation

Sebastien Loze and Máté Koch

With the technology trends convergence we observed in the last years and stimulating NATO ambitious views about simulation as a service, it is important to get a snapshot of where the industry part of the community is today. A presentation by CAE and Epic Games during which Mate Koch, Innovation and Technology Lead at CAE and Seb Loze, Unreal Engine Simulation business director at Epic Games will be sharing with the audience the most recent technology evolutions allowing large entity count and efficient cloud distribution.

78 CT9

U.S. Army LOR to LOA process

Andrew Echols and Gary Cline

This presentation is derived directly from the U.S. Army Security Assistance Management Manual (SAMM). It outlines the process and communication between the multiple U.S. Government Organizations and U.S. Partner Nations from the pre-Letter of Request (pre-LOR) phase through the Letter of Offer & Acceptance phase of the Foreign Military Sales (FMS) process.