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STO TECHNICAL REPORT **TR-MSG-085**

Standardisation for C2-Simulation Interoperation

(Standardisation pour l'interopération SIC-simulation)

Final Report of MSG-085.

Published November 2015

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The NATO Science and Technology Organization

Science & Technology (S&T) in the NATO context is defined as the selective and rigorous generation and application of state-of-the-art, validated knowledge for defence and security purposes. S&T activities embrace scientific research, technology development, transition, application and field-testing, experimentation and a range of related scientific activities that include systems engineering, operational research and analysis, synthesis, integration and validation of knowledge derived through the scientific method.

In NATO, S&T is addressed using different business models, namely a collaborative business model where NATO provides a forum where NATO Nations and partner Nations elect to use their national resources to define, conduct and promote cooperative research and information exchange, and secondly an in-house delivery business model where S&T activities are conducted in a NATO dedicated executive body, having its own personnel, capabilities and infrastructure.

The mission of the NATO Science & Technology Organization (STO) is to help position the Nations' and NATO's S&T investments as a strategic enabler of the knowledge and technology advantage for the defence and security posture of NATO Nations and partner Nations, by conducting and promoting S&T activities that augment and leverage the capabilities and programmes of the Alliance, of the NATO Nations and the partner Nations, in support of NATO's objectives, and contributing to NATO's ability to enable and influence security and defence related capability development and threat mitigation in NATO Nations and partner Nations, in accordance with NATO policies.

The total spectrum of this collaborative effort is addressed by six Technical Panels who manage a wide range of scientific research activities, a Group specialising in modelling and simulation, plus a Committee dedicated to supporting the information management needs of the organization.

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These Panels and Group are the power-house of the collaborative model and are made up of national representatives as well as recognised world-class scientists, engineers and information specialists. In addition to providing critical technical oversight, they also provide a communication link to military users and other NATO bodies.

The scientific and technological work is carried out by Technical Teams, created under one or more of these eight bodies, for specific research activities which have a defined duration. These research activities can take a variety of forms, including Task Groups, Workshops, Symposia, Specialists' Meetings, Lecture Series and Technical Courses.

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List of Acronyms

2R	Requirements and Recommendations
AAO	Autonomous Air Operations
AAR	After Action Review
ACM	Air Control Measure
ACMR	Airspace Control Means Request
ACO	Airspace Control Order
ADatP-3	Allied Data Publication-3
AMPHIB	Amphibious
AMSO	Army Modeling and Simulation Office (US)
APLET	Aide à la Planification d'Engagement Tactique terrestre
AST	Abstract Syntax Tree
ASUW	Anti-Surface Warfare
ATO	Air Tasking Order
BML	Battle Management Language
C2	Command and Control
C2IEDM	Command and Control Information Exchange Data Model
C2IS	Command and Control Information System
C2LG	Command and Control Lexical Grammar
C2PC	Command and Control Personal Computer
C2SIM	C2-to-Simulation
C4I	Command, Control, Communications, Computers and Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
C4ISTAR	Command, Control, Communications, Computers, Information/Intelligence, Surveillance, Targeting Acquisition and Reconnaissance
CAN	Canada
CAPES	Combined Arms Planning and Execution System
C-BML	Coalition Battle Management Language
CBMS	Coalition Battle Management Services
CC	Communication Coordinator
CD&E	Concept Development and Experimentation
CGF	Computer-Generated Forces
CIG	Common Interest Group
CITT	C-BML Industry Task Team
COA	Course of Action
COAA	Course of Action Analysis
COI	Community of Interest
CONEMP	Concept of Employment
CONOPS	Concept of Operations
COP	Common Operational Picture
COPD	Comprehensive Operations Planning Directive
CP	Change Process
CSO	Collaboration Support Office
CST	Concrete Syntax Tree
DIS	Distributed Interactive Simulation
DISTAFF	Directing Staff
DSEEP	Distributed Simulation Engineering and Execution Process

DSS	Decision Support System
DTG	Date Time Group
eCOA	enemy Course Of Action
EEL	Experimentation Event Lead
EEPG	Experimentation Event Planning Guide
ET	Exploratory Team
EXDIR	Exercise Director
FKIE	Fraunhofer Institute for Communication, Information Processing and Ergonomics
FOM	Federation Object Model
FRA	France
FRAGO	Fragmentary Order
FTRT	Faster Than Real-Time
FW	Fixed-Wing
GBR	Great Britain
GMU	George Mason University
GUI	Graphic User Interface
HLA	High Level Architecture
HN	Hosting Nation
HQ	Headquarters
I/ITSEC	Interservice/Industry Training, Simulation and Education Conference
ICC	Integrated Command and Control
ICCRTS	International Command and Control Research and Technology Symposium
IEM	Information Exchange Mechanism
IER	Information Exchange Requirements
IGS	Interactive Gaming Solution
ITEC	International Training and Education Conference
JADOCS	Joint Automated Deep Operations Coordination System
JC3IEDM	Joint Consultation Command and Control Information Exchange Data Model
JCHAT	Joint Chat system
JCW	Joint and Coalition Warfighting (US)
JMP	Joint Mission Planning
JSAF	Joint Semi-Automated Forces
JSON	Java Serialized Object Notation
LFG	Lexical Functional Grammar
LI	Lesson Identified
LL	Lessons Learned
LLI	Lessons Learned Information
LOCON	Low Controller
LVC	Live Virtual Constructive
M&S	Modelling and Simulation
MAGTF	Marine Air-Ground Task Force
MCBL	Mission Command Battle Laboratory
MDA	Model-Driven Architecture
MDMP	Military Decision-Making Process
MIL-STD	Military Standard
MIM	MIP Information Model
MIP	Multilateral Interoperability Programme
MOE	Measures Of Effectiveness

MOP	Measures Of Performance
MR	Mission Rehearsal
MSDL	Military Scenario Definition Language
MSG	Modelling and Simulation Group
MTWS	MAGTF Tactical Warfare System
NATO	North Atlantic Treaty Organization
NCIA	NATO Communications and Information Agency
NOR	Norway
NORTaC-C2IS	NORwegian Tactical and Combat C2IS
NSN	NATO Stock Number
OC	Operational Coordinator
OCD	Operational Concept Description
OCL	Object Constraint Language
ODM	Ontology Definition Metamodel
OIEG	Operations Intent and Effects Grammar
OLPP	Operational-Level Planning Process
OMG	Object Management Group
OneSAF	One Semi-Automated Forces simulation
OOB, ORBAT	Order of Battle
OPFOR	Opposing Forces
OPGEN	General Operational Message
OPORD	Operations Order
OPSTAT	Operational Statistics
OPTASK	Operational Task
OSG	Operational Sub Group
OTC	Officer in Tactical Command
OWL	Web Ontology Language
PDG	Product Development Group
PIM	Platform Independent Model
POW	Programme Of Work
PSM	Platform-Specific Model
RECCE	Reconnaissance
RIF	Rules Interchange Format
ROE	Rules Of Engagement
ROI	Return On Investment
RRS or 2RS	Requirements, Recommendations and Specifications
RW	Rotary-Wing
SA	Situational Awareness
SBML	Scripted Battle Management Language
SDA	System Design Agreements
SDEM	Simulation Data Exchange Model
SDF	Standard Development Framework
SE	Systems Engineering
SG	Study Group
SICF	Système d'Information pour le Commandement des Forces
SINEX	Scenario Initialisation and Execution
SIR	Système d'Information Régimentaire
SISO	Simulation Interoperability Standards Organization
SIW	SISO Interoperability Workshop
SME	Subject-Matter Expert
SOPES	Shared Operational Picture Exchange Services

SSS	System/Sub-system Specification
STANAG	STANdardization AGreement
TA	Technical Activity
TAP	Technical Activity Proposal
TBMCS	Theater Battle Management Core Systems
TC	Technical Coordinator
TOPFAS	Tools for Operational Planning Functional Area Service
TRL	Technical Readiness Level
TSG	Technical Sub Group
TTP	Techniques, Tactics, Procedures
UAS	Unmanned Air System
UAV	Unmanned Aerial Vehicle
UML	Unified Modelling Language
UN	United Nations
UN CEFACT	United Nations Center for Trade Facilitation and Electronic Business
US/USA	United States of America
USMTF	US Message Text Format
UVS	Unmanned Vehicle System
VMASC	Virginia Modeling and Simulation Center
VPN	Virtual Private Network
VV&A	Verification, Validation & Accreditation
WARNO	Warning Order
WISE	Widely Integrated Systems Environment
XML	Extensible Markup Language

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The authors wish to express their acknowledgements first and foremost to CSO and NMSCO who were very supportive throughout the execution of the MSG-085 Technical Activity (TA). They provided helpful recommendations, materials and facilities to perform demonstrations during multiple international events, including the means to advertise these demonstrations and thereby reach a large audience of key stakeholders. This support was beneficial and key to the TA success.

The successful completion of the TA is also due to the real involvement of military organizations and experts who shared their knowledge and experience with the other TA members in order to augment the operational relevance and rationales of C2SIM interoperability. Special thanks go to the United States Mission Command Battle Laboratory who offered to host the final TA demonstration and provided a team of senior military experts to support this event.

Finally, the involvement of the MSG-085 Technical Group members also was significant in meeting the TA objectives and achievements. Their considerable technical contribution allowed for defining a C2SIM exchange infrastructure. Also, the extensive work performed by the group to adapt national systems during demonstration preparation was key to demonstrating the benefits of C2SIM interoperability over a great number of events that targeted large audiences.

Key Audiences

1) NATO Partners	ACT NATO Consultation, Command and Control Agency (NC3A) NATO Industrial Advisory Group (NIAG) NATO Underwater Research Centre (NURC) Allied Command Operations (ACO)
2) National Representatives	Conference of National Armament Directors (CNAD) Agile Mission Group (NRF) NATO Military Committee Nations (customers) National Modelling and Simulation Coordination Offices
3) NATO RTA bodies whose activities largely depend on M&S as a lead investment in various capabilities as well as Net-Enabled Capabilities	Applied Vehicle Technology (AVT) Panel Human Factors and Medicine (HFM) Panel Information Systems Technology (IST) Panel NATO Modelling and Simulation Group (NMSG) System Analysis and Studies (SAS) Panel Systems Concepts and Integration (SCI) Panel Sensors and Electronics Technology (SET) Panel
4) The warfighters and national representatives associated with M&S of any NEC, from "start to finish"	Warfighters at all levels, including planners, decision-makers, analysts/scientists, involved in the following: CD&E Acquisition, T&E, Logistics Operations Training and Exercises Joint Multi-national and Inter-Agency Activities Force Development, Force Generation, Force Employment
5) International C2 and Simulation Interoperability Standards Organizations	MIP SISO C-BML Product Development Group SISO MSDL Product Development Group SISO C2SIM Product Development Group

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13. Keywords/Descriptors

Autonomous air operations	Joint mission planning	MSDL
C2SIM	Land operations	OCD
C-BML	Maritime operations	SINEX
DSEEP	Messaging infrastructure	SISO
ICCRTS	MIM	STANAG

14. Abstract

The interoperation between Command and Control (C2) systems and simulation systems is a common theme in the transformation of modern military forces. This is required to support the military enterprise in the execution of business activities and mission threads such as forces readiness, decision support and acquisition. This implies the ability to seamlessly integrate C2 and simulation systems and to provide the means for a meaningful and unambiguous information exchange. This applies to systems of systems functioning toward a common goal at different levels: 1) within services; 2) across services; (i.e. joint) and 3) across Nations in a multi-national or coalition context.

In 2010, the NATO Research and Technology Organization started the three-year Modeling and Simulation Task Group "Standardisation for C2-Simulation Interoperation" to assess and document the C2 and Simulation interoperability standards developed by SISO to be used for multiple military applications. This final report documents the completed work of this Task Group, designated MSG-085. It includes the continued progress made to demonstrate the utility of C2-Simulation interoperability. This report leverages the knowledge of C2-Simulation experts to merge current standards towards a unified, more manageable and easier to deploy C2SIM interoperability.

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