NORTH ATLANTIC TREATY ORGANIZATION

SCIENCE AND TECHNOLOGY ORGANIZATION

AC/323(MSG-063)TP/591

www.sto.nato.int

STO TECHNICAL REPORT **TR-MSG-063**

Urban Combat Advanced Training Technology

(Technologie avancée d'entraînement au combat urbain)

Final Report of Task Group 063.

Published July 2015

Distribution and Availability on Back Cover

NORTH ATLANTIC TREATY ORGANIZATION

SCIENCE AND TECHNOLOGY ORGANIZATION

AC/323(MSG-063)TP/591

www.sto.nato.int

STO TECHNICAL REPORT **TR-MSG-063**

Urban Combat Advanced Training Technology

(Technologie avancée d’entraînement au combat urbain)

Final Report of Task Group 063.

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.

The content of this publication has been reproduced directly from material supplied by STO or the authors.

Published July 2015

ISBN 978-92-837-2011-9

Table of Contents

List of Figures

List of Tables

Table **Page**

List of Acronyms

3G	3^{rd} Generation
4G	4^{th} Generation
5G	5^{th} Generation
AAR	After Action Review
ACT	Allied Command Transformation
AGDUS	Ausbildungsgerät Duellsimulator / Tactical Engagement Simulator in German Language
AVT	Applied Vehicle Technology
BWB	Bundesamt für Wehrtechnik und Beschaffung
C2	Command and Control
C2IEDM	Command and Control Information Exchange Data Model
C4I	Command, Control, Communications, Computers and Intelligence
C-BML	Coalition Battle Management Language
CAS	Close Air Support
CDT	Code Discriminator/Translator
CI	Central Interface
CIMIC	Civil Military Cooperation
CJTF	Combined Joint Task Force
CP	Change Proposals
CTC	Combat Training Centre
CTIA	Common Training Instrumentation Architecture
DIS	Distributed Interactive Simulation
DO	Dynamic Object
DOI	Dynamic Object Instrumentation
DOU	DO Unit
ER	Effects Representation
EHQ	European Headquarters
EU	European Union
EXCON	Exercise Control
ExDir	Exercise Director
FIBUA	Fighting In Built-Up Areas
Gp	Global position
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
H&S	Health and Safety
HFM	Human Factors and Medicine
HLA	High-Level Architecture
IED	Improvised Explosive Devices
IFF	Identification Friend Foe
IHU	Integrated Harness Units
ILU	Integrated Laser Units
IO	International Organisations

IP	Intellectual Property
IPR	Intellectual Property Rights
IR	Infrared
ISR	Intelligence Surveillance and Reconnaissance
IST	Information Systems Technology
IT	Information Technologies
IUC	International User Community
JC3IEDM	Joint Consultation, Command and Control Information Exchange Data Model
JCTF	Joint Coalition Task Force
JRTC	Joint Readiness Training Center
JRTC-MOUT-IS	Joint Readiness Training Center Military Operations in Urbanised Terrain Instrumentation System
LAN	Local Area Network
LG/8	Land Group 8 (Group under NAAG)
LO2020	Land Operations in the Year 2020
M&S	Modelling and Simulation
MCO	Modeling and Simulation Coordination Office
MEMS	Micro Electro-Mechanical System
MILSTD	Military Standard
MIP	Multinational Interoperability Programme
MOD	Ministry Of Defence
MODAF	Ministry Of Defence Architectural Framework (UK term)
MOE	Measures Of Effectiveness
MOP	Measures Of Performance
MoU	Memorandum of Understanding
MOUT	Military Operations in Urban Terrain
MRE	Mission Rehearsal Exercise
MSDL	Modeling Simulation Design Lab
MSMP	Modelling and Simulation Master Plan
NAAG	NATO Army Armaments Group
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological and Chemical
NC3A	NATO Command, Control and Communications Agency
NGO	Non-Governmental Organization
NL	Netherlands
NLOS	Non-Line-of-Sight
NMSG	NATO Modelling and Simulation Group
NTD	Non-Target Designating
O/C	Observer Controller
OPFOR	Opposing Forces
ORD	Operational Requirements Document
OSAG	Optical Interface Specification for the German CTC
PAS	Personal Audio System
PDA	Personnel Digital Assistant
PDD	Personnel Detection Device
PDG	Product Development Group
PfP	Partnership for Peace
PI	Pulse Interval

PID	Player Identity
POC	Point Of Contact
POE	Point Of Embarkation
PSO	Peace Support Operation
PTS	Precise Tracking Sensors
R&D	Research and Development
RAD	Room Association Device
RDE	Rheinmetall Defence Electronics
RF	Radio Frequency
RFID	Radio Frequency Identifier
RPG	Rocket-Propelled Grenade
RTA	Research and Technology Agency
RTB	Research and Technology Board
RTO	Research and Technology Organisation
SaaS	Software as a Service
SAF	Semi-Automated Forces
SAS	System Analysis and Studies
SAT	Small Arms Trainer
SC	System Control
SCI	Systems Concepts and Integration
SE	Synthetic Environment
SES	Structure Effects Simulator
SET	Sensors and Electronics Technology
SHAPE	Supreme Headquarters Allied Powers Europe
SID	Structure Information Device
SISO	Simulation Interoperability Standards Organisation
SOA	Service-Oriented Architecture
SOR	Statement Of Requirement
STANAG	Standardisation Agreement
STWG	Simulation Training Working Group
TA	Technical Activity
TA	Training Analyst
TAP	Technical Activity Proposal
TENA	Test and Training Enabling Architecture
TES	Tactical Engagement Simulation
TG	Task Group
TOE	Team Of Experts
TOR	Terms Of Reference
TSWG	Training and Simulation Working Group
TTP	Tactics, Techniques and Procedures
UAV	Unmanned Aerial Vehicle
UCATT	Urban Combat Advanced Training Technology
UHU	Universal Helmet Units
UN	United Nations
UO	Urban Operations
UO2020	Urban Operations in the Year 2020
UOWG	Urban Operations Work Group
USECT	Understand, Shape, Engage, Consolidate and Transition
WES	Weapon Effects System
WG	Working Group

Terms of Reference

I. ORIGIN

A. Background and Justification

NATO Studies SAS-030, Study on Urban Operations 2020 and Land Operations 2020 clearly indicate that urban areas are the most likely battlefield in the 21st century.

The problems and limitations associated with developing the first generation of Military Operations on Urban Terrain (MOUT) training facilities are only just beginning to be understood.

A team of experts from NATO NAAG completed a feasibility study in 2002. The conclusion was that a number of potential interoperability areas were identified and assessed to be worthy of further investigation.

TG-032 of NMSG started to identify and investigate some areas and reported them in their final report for the live domain. A number of areas such as the constructive and virtual training domains were not addressed and may become part of the UCATT development of MOUT standards. Also there is a need to further develop standards in laser and data communication plus audio and visual effects utilized during live training exercises.

To be done: Tables of Lethality and Vulnerability. A generic set of data for lethality and vulnerability is required to enable interoperability of Nations' simulation systems when country-specific classified data is not to be shared.

NATO's FIBUA/MOUT Working Group and Topical Group 3 of the NAAG recognize the work done by the UCATT and endorse UCATT's continuation to maintain and complete its work.

UCATT deliverables to date: Site register, research needs, interoperability specification, functional architecture and best practices.

To date UCATT has delivered: Site register of all current MOUT training facilities, research needs list defining specific technology focus areas for industry, functional architecture for an overall live instrumentation system for MOUT training and a list of best practices assembled from active military forces training methods.

In the last couple of years UCATT has become NATO's focal point for MOUT training technology and exchanging information with the military community.

II. OBJECTIVES

A. Area of Research and Scope

The overall objective of this effort is to foster greater compatibility and interoperability of MOUT training systems and thus enables sharing of national facilities among members of the Alliance. The TG will leverage previous work accomplished by the Team of Experts from NAAG Land Group 8 and the previous UCATT Working Group. The TG will fulfil this objective through the collaborative efforts of simulation experts from participating member countries, industry partners, and appropriate NATO Training Groups and military users.

B. Specific Activities to be Performed by the TG

- Identify limitations and constraints on MOUT development with a view toward identifying areas for future research.

- Validate the applicability of JC3IEDM as the C4I standard for interfacing to the simulation environment.
- Provide a standard for laser and data communication, audio and visual effects.
- Organize an interoperability demonstration to validate the feasibility of developing instrumentation standards for the live training domain.
- Define a generic set of data for lethality and vulnerability to enable interoperability of Nations' simulation systems without requiring sharing of classified information.
- Produce the UCATT Technical Report.

C. Products

Interim and final Technical Reports addressing operational concepts, systems architecture, terminology, and methodology for achieving the highest degree of compatibility and interoperability of MOUT training systems will be provided. Draft inputs for proposed standardization will be submitted to SISO in order to follow their established and endorsed methodology to develop final approved standards.

D. Overall Duration

The duration of the Task Group will be three years, starting as an approved activity in Spring 2007 with the final report submitted in Summer 2011.

III. RESOURCES

A. Membership

Participating Nations are initially Finland, Germany, Netherlands, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Ing. Jan Vermeulen, Defence Materiel Organisation from the Netherlands, will serve as chairperson of the TG.

B. National and/or NATO Resources Needed

Input to and participation in the meetings will be the responsibility of the Nations supporting the TG. The TG is expected to communicate on the specific topics highlighted above via email, SISO web forum and in 3 – 5 day meetings, 3 times a year.

C. RTA Resources Needed

Report publication and editing.

IV. SECURITY CLASSIFICATION LEVELS

PUBLIC RELEASE.

V. PARTICIPATION BY NATO PARTNERSHIP FOR PEACE (PfP) NATIONS

NATO PfP Nations are/will be invited to participate.

VI. LIAISON

The Task Group is to liaise with:

- SHAPE (User);
- Army Training Group, Training and Simulation Working Group (ATG-TSWG) (Simulation Requirements);
- Army Training Group, Urban Operations (UO) Working Group (Urban Operation Training Requirements); and
- Simulation Interoperability Standards Organization (SISO).

Acknowledgements

The Chairman wishes to thank all those members of the Task Group (TG) from both Government and Industry from each of the participating Nations for their hard work and endeavours in delivering this report and their contributions during the life of the UCATT-2 TG. In particular he extends his thanks to Mr. Hugo Herren (Swiss delegate) who will retire at the end of the UCATT-2 mandate, he was the driving force in the report structure.

Also, as a result of reorganisations/restructuring in companies and Nations a few of our members were redirected to different tasks and could not participate in the TG anymore (Ms. Randi Kahl (USA), Mr. Rainer Int Veen (DEU) and Mr. Eric Hasselström (SWE), Mr. Holger Böttcher (DEU) and Col. Max Fenner (CHE)). Mr. Rudi Gouweleeuw (NLD) missed a few meetings when he was deployed to ISAF in Afghanistan.

With sadness it should also be recorded and acknowledged that in the beginning of the mandate we lost Mr. Håkan Manley from Sweden who suddenly past away. Håkan was our good friend and we still miss him.

MSG-063 Membership List

Individual Nations that participated (representatives came from Government and/or Industry):

Finland	FIN	Sweden	SWE
Germany	DEU	Switzerland	CHE
Netherlands	NLD	United Kingdom	GBR
Spain	ESP	United States	USA

STEERING GROUP MEMBERS

Chairman: Mr. Jan Vermeulen, Defence Materiel Command, NLD (12)

Secretary: Mr. Osmo Forstén, National Defence University, FIN (12)

Other Steering Group Members: Mr. Gary Washam, CUBIC, USA (11), Mr. Armin Thinnes, GOV, DEU (12), Col. Max Fenner, CHE (8), Mr. Matt Wright, QinetiQ, GBR (9) and Mr. Holger Böttcher, RUAG, DEU (11)

PARTICIPANTS

Nation	Rank/Title	Name	Department/Company	Timeframe*
CHE	Ms	Buchanan, Nancy	TENETEC Innovations Inc.	2007 – 2010 (11)
CHE	Mr	Cichowski, Sebastian	RUAG	2010 (1)
CHE	Col	Fenner, Max	Swiss Armed Forces	2007 – 2010 (8)
CHE	Mr	Herren, Hugo	Swiss MoD	2007 – 2010 (12)
CHE	Mr	Luethi, Roland	RUAG	2007 (1)
CHE	LtCol	Uebersax, Jan	Swiss Armed Forces	2007 (1)
CHE	Mr	Zielinski, Tomek	TENETEC Innovations Inc.	2009 – 2010 (2)
DEU	Mr	Apitz, Jörg	Jenoptik AG	2007 (1)
DEU	Mr	Backeberg, Christian	Rheinmetall Defence Electronics	2010 (1)
DEU	Mr	Böttcher, Holger	RUAG	2007 – 2010 (11)
DEU	Mr	Eisenhauer, Joachim	Rheinmetall Defence Electronics	2007 – 2010 (10)
DEU	Mr	Ehrlicher, Christian	Rheinmetall Defence Electronics	2009 – 2010 (2)
DEU	Mr	Int-Veen, Rainer	EADS/SAAB Training Systems	2007 – 2008 (5)
DEU	Mr	Müller, Dirk	Rheinmetall Defence Electronics	2009 – 2010 (2)
DEU	Mr	Schaefer, Stephan	RUAG	2009 – 2010 (2)
DEU	Maj	Schierl, Herman	German Army	2007 – 2008 (3)
DEU	Mr	Thinnes, Armin	German Federal Office of Defence Technology and Procurement	2007 – 2010 (12)
DEU	Mr	Wittwer, Ingo	RUAG	2010 (1)
ESP	Maj	Vazquez Ayerra, Luis	Spanish Army	2007 – 2008 (2)

Nation	Rank/Title	Name	Department/Company	Timeframe*
ESP	Capt	Belinchón Pinedo, Carlos	Spanish Army	2008 – 2010 (5)
FIN	Mr	Forstén, Osmo	Finnish Defence Forces	2007 – 2010 (12)
FIN	Maj	Hollmen, Jyri	Finnish Defence Forces	2007 – 2008 (4)
GBR	Maj	Joyce, Paul	UK Army	2008 (2)
GBR	Mr	Kearse, James	QinetiQ	2007 (1)
GBR	Maj	Wakelin, Naomi	UK Army	2008 (2)
GBR	Mr	Wright, Matthew	QinetiQ	2007 – 2010 (9)
NLD	Mr	Bloem, Micha	TNO	2007 (2)
NLD	Maj	Bos, Henk	Royal Netherlands Army	2008 (1)
NLD	Capt	de Weert, Dennis	Royal Netherlands Army	2008 – 2010 (6)
NLD	Mr	Gouweleeuw, Rudi	TNO	2007 – 2010 (9)
NLD	Mr	Vermeulen, Jan	Netherlands Defence Materiel Command	2007 – 2010 (12)
SWE	Mr	Blomberg, Jakob	SAAB Training System	2009 – 2010 (3)
SWE	Mr	Erhardsson, Stefan	NSC	2009 – 2010 (2)
SWE	Maj	Gullstrand, Johnny	Swedish Armed Forces	2007 – 2010 (9)
SWE	Mr	Hasselström, Eric	NSC	2007 – 2009 (7)
SWE	Mr	Holmquist, Anders	SAAB Training System	2007 – 2010 (10)
SWE	Mr	Nyfelt, Leif	NSC	2008 – 2010 (6)
SWE	Mr	von Rothstein, Niclas	Swedish Armed Forces/FMV	2007 – 2010 (7)
USA	Mr	Castro, Ryan	CUBIC Defence Applications, Inc.	2009 (1)
USA	Mr	Hoppenfeld, Robert	CUBIC Simulation Systems, Inc.	2008 – 2010 (5)
USA	Ms	Kahl, Randi	PEO/STRI	2007 – 2008 (3)
USA	Mr	Washam, Gary	CUBIC Simulation Systems, Inc.	2007 – 2010 (11)

* Number of Meetings attended shown in brackets

MEETING LOCATIONS

2007	2008	2009	2010	2011
Koblenz (DEU)	Stockholm (SWE)	The Hague (NLD)	Farnborough (GBR)	Helsinki (FIN)
Fairbanks (USA)	Helsinki (FIN)	Walenstad (CHE)	Marnehuizen (NLD)	
Orlando, (1) (USA)	Orlando (2) (USA)	Orlando (3) (USA)	Orlando (4) (USA)	

Urban Combat Advanced Training Technology

(STO-TR-MSG-063)

Executive Summary

The Urban Combat Advanced Training Technology (UCATT-2) Task Group (TG) is the successor of the first UCATT Working Group within the NATO Modelling and Simulation Group (NMSG) created in 2007 as MSG-063 TG-040. The UCATT-2 TG was tasked to continue the work of the previous UCATT Working Group to exchange and assess information on Military Operations in Urban Terrain (MOUT) facilities and training/simulation systems with a view toward establishing best practice. In addition, it was required to organize an interoperability demonstration to prove standards and also start the process of defining standards for laser and data communication, audio and visual effects. Uniquely the UCATT TG from the outset drew its members from active duty military, government and industry.

Two NATO studies have been fundamental to taking the work of the UCATT-1 TG and UCATT-2 TG forward: the NATO Research and Technology Organisation (RTO) 1999 Technical Report, Land Operations in the year 2020 (LO2020) and their 2003 Urban Operations in the year 2020 (UO2020). Report LO2020 concluded that NATO forces would potentially have to conduct future operations in urban areas. The UCATT-1 TG report contains the previous work completed under the first chartered UCATT TG.

Over a three-year period, the UCATT-2 TG held 12 meetings and although in its terms of reference it was required to liaise with a number of groups both within Supreme Headquarters Allied Powers Europe (SHAPE) and outside of NATO, who included the Training and Simulation Working Group (TSWG), the Urban Operations Working Group (UOWG), Topical Group 3 from the NAAG and the Simulation Interoperability Standards Organisation (SISO), the major contact group was the Urban Operations WG.

In conclusion, the work to date has provided NATO with usable (draft) standards for laser engagement (sub-set of functional architecture E1) interface a standard for system level information (functional architecture E8) interface based on USE CASES agreed by the military user community in NATO and Partner Nations and a standard approach on battle field effects (as agreed by the Urban Operations Work Group and the Training Simulation Work Group). Work on identifying best practice, however, has been limited. The amount of work in the LVC (Live – Virtual – Constructive) domain where limited due to time constraints but there was a demonstration of a virtual – live UAV demonstrator during the UCATT demonstration.

As a result of the work, the following key recommendations are made:

- To use the functional architecture defined by UCATT and demonstrated as the basis for developing a laser engagement code and physical standard within SISO to be followed for the development of future Tactical Engagement Simulators (TES) equipment for training for urban operations or instrumented FIBUA/MOUT sites.
- To work out in more detail standardization of laser codes, requirements for virtual and constructive MOUT training, Effects Representation (ER), data communication, the integration of LVC domains and further development of the functional architecture and defined standards following the SISO processes.
- To lay the foundation for the establishment of an urban instrumentation to follow on NMSG TG's: 1) Standards and 2) Architecture.

Technologie avancée d'entraînement au combat urbain

(STO-TR-MSG-063)

Synthèse

Le groupe de travail (TG) Technologie avancée d'entraînement au combat urbain (UCATT-2) est le successeur du premier groupe de travail UCATT créé en 2007 au sein du groupe OTAN sur la modélisation et la simulation (NMSG), sous le nom de TG-040 du MSG-063. Le TG UCATT-2 était chargé de poursuivre le travail du précédent TG UCATT, à savoir échanger et évaluer des informations sur les équipements et les systèmes d'entraînement / simulation d'opérations militaires en terrain urbain (MOUT) dans le but d'établir les meilleures pratiques. Par ailleurs, le TG a été prié d'organiser une démonstration des normes d'interopérabilité et de lancer le processus de définition des normes relatives aux communications laser et de données et aux effets sonores et visuels. Dès le départ, le TG UCATT a recruté ses membres au sein du personnel militaire en service, des gouvernements et de l'industrie, ce qui est unique.

Deux études de l'OTAN ont été essentielles à la progression des TG UCATT-1 et UCATT-2 : Les rapports techniques de l'Organisation pour la Recherche et la Technologie (RTO) de l'OTAN de 1999, Opérations terrestres à l'horizon 2020 (LO2020), et de 2003, Opérations en zone urbaine à l'horizon 2020 (UO2020). Le rapport LO2020 a conclu que les forces de l'OTAN pourraient avoir à mener des opérations en zone urbaine à l'avenir. Le rapport du TG UCATT-1 contient les travaux précédemment réalisés dans le cadre du premier TG UCATT.

En trois ans, le TG UCATT-2 a organisé douze réunions et bien que son mandat prévoie qu'il assure la liaison avec un certain nombre de groupes à la fois au sein du Grand Quartier général des Puissances alliées en Europe (SHAPE) et hors de l'OTAN, ce qui incluait le groupe de travail Simulation et entraînement (TSWG), le groupe de travail Opérations en zone urbaine (UOWG), le groupe thématique 3 du NAAG et l'Organisation en charge de la normalisation pour l'interopérabilité de la simulation (SISO), à cette occasion le principal groupe contacté a été le groupe de travail Opérations en zone urbaine.

En conclusion, les travaux ont à ce jour procuré à l'OTAN des (projets de) normes utilisables pour l'interface d'engagement laser (sous-ensemble de l'architecture de fonctionnement E1), une norme pour l'interface d'information au niveau du système (architecture de fonctionnement E8) basée sur des CAS D'UTILISATION convenus avec la communauté des utilisateurs militaires de l'OTAN et des pays partenaires et une approche standard des effets sur le champ de bataille (convenue entre le groupe de travail Opérations en zone urbaine et le groupe de travail Simulation et entraînement). Les travaux sur l'identification des meilleures pratiques ont toutefois été limités. Le volume des travaux dans le domaine LVC (Réel – Virtuel – Constructif) a été limité par manque de temps, mais un simulateur d'UAV virtuel – instrumenté a fait l'objet d'une démonstration pendant la démonstration de l'UCATT.

A l'issue des travaux, les recommandations essentielles suivantes ont été faites :

- Utiliser l'architecture de fonctionnement définie par l'UCATT, et dont la démonstration a été faite, comme base pour développer un code d'engagement laser et une norme physique (au sein de la SISO) qui sera ensuite appliquée au développement de simulateurs d'engagement tactique (TES) destinés à l'entraînement aux opérations en zone urbaine ou aux sites FIBUA/MOUT instrumentés.

- Approfondir la normalisation des codes laser, détailler les besoins d'entraînement MOUT virtuel et constructif et travailler sur la représentation des effets, la communication des données, l'intégration des domaines LVC et le développement de l'architecture de fonctionnement et de normes définies suivant les processus de la SISO.
- Poser les bases permettant d'établir une instrumentation urbaine pour faire suite aux groupes de travail du NMSG : 1) Normes et 2) Architecture.

Chapter 1 – OVERVIEW

1.1 INTRODUCTION

This is the second report on the work of the Urban Combat Advanced Training Technology (UCATT) Task Group (TG) which was established within the NATO Modelling and Simulation Group (NMSG) in 2003 as MSG-032 TG-023 and got its continuation in 2007 as MSG-063 TG-040. It was established in order to continue the work of the first UCATT group to further define interoperability issues, investigate LVC interoperability, organize a demonstration and define standards on laser data communication, audio and visual effects.

1.2 BACKGROUND

Urban operations are not new and despite Sun-Tzu's rule, military forces throughout history have been confronted with the need to conduct some form of urban operations. The NATO Research and Technology Organisation's (RTO) Technical Report Land Operations in the Year 2020 (LO2020) and Urban Operations in the year 2020 (UA2020) came to the conclusion that NATO forces would potentially have to conduct future operations in urban areas. This had been made evident by events that had taken place in locations like Panama City, Kuwait City, Mogadishu, Port-au-Prince, Grozny, Sarajevo and Kinshasa. A number of papers in the last decade have made this point and they argue that this is because, "urban warfare is relatively cheap and low tech making it particularly appealing to non-state actors and unconventional forces" and that "… soldiers are often described as ill-prepared (in equipment, doctrine, training and psychology) for the type of fighting that will occur if an enemy chooses to fight in urban terrain".

1.3 FUTURE OPERATING ENVIRONMENT

LO2020 stated that urban operations will be characterised by their physical structures, the presence of non-combatants and both complex well-developed infrastructure on one hand and poorer infrastructure in areas like shanty towns on the other (as illustrated in Figure 1-1 and Figure 1-2), and that such operations would pose significant challenges for NATO Allied forces.

Figure 1-1: Typical Urban Area (NLD Defence Image Library).

Figure 1-2: Patrolling in Afghanistan (NLD Defence Image Library).

To follow up on these findings, Supreme Headquarters Allied Powers Europe (SHAPE) established a Military Application Study to examine the need for joint and combined doctrine and concepts for operations in urban areas. Seven NATO Nations agreed to provide members for this study group, and the Studies, Analyses and Simulation (SAS) Panel agreed in May 2000 that the UK should provide the Director. The study group examined the requirements of the SAS Panel and prepared its report, Urban Operations in 2020 (UO2020). The results are intended to identify directions for further research and to contribute to the NATO Defence Planning Process, the Defence Capabilities Initiative, and the Concept Development Experimentation Process.

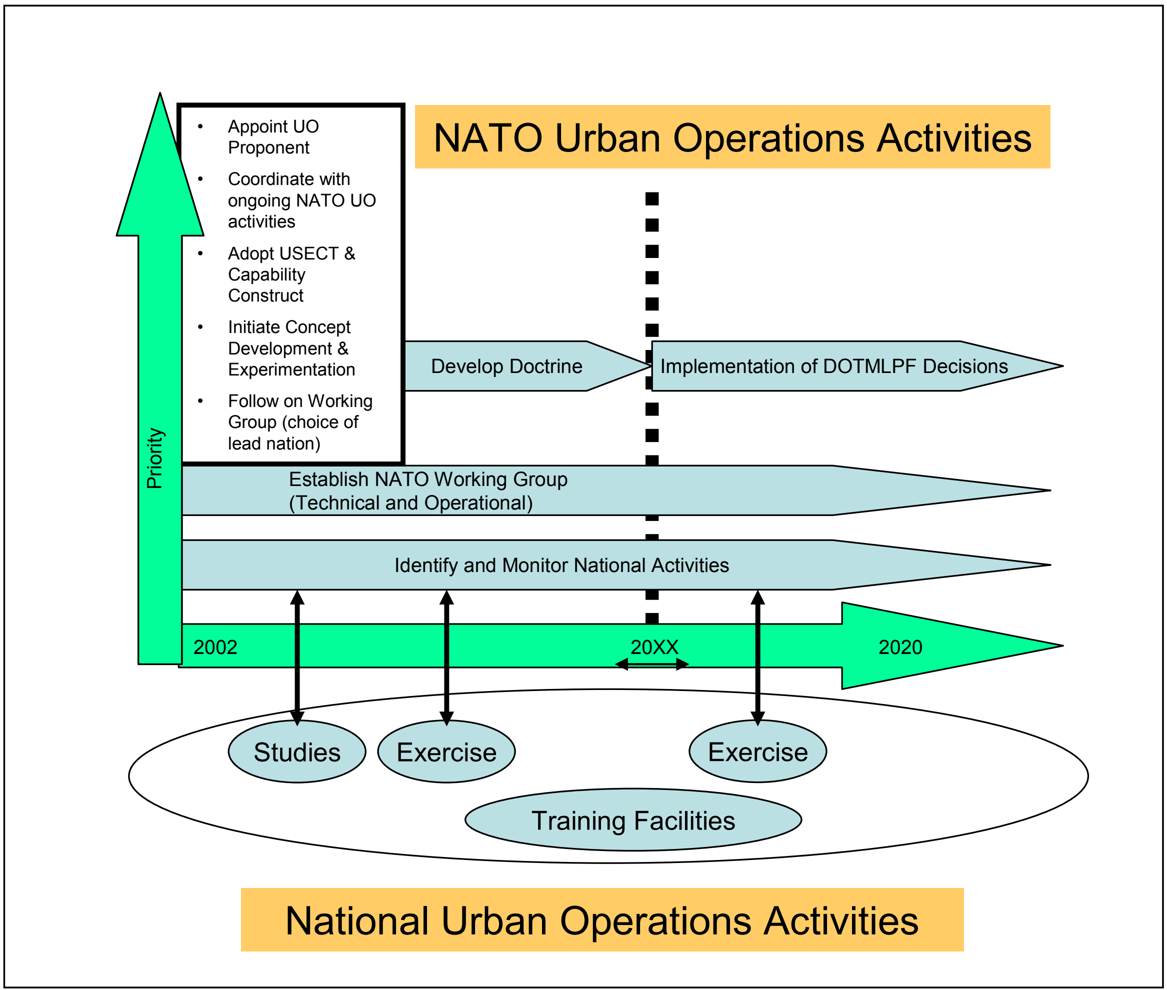


Figure 1-3: Roadmap for Improving Capability in Conducting Urban Operations.

1.4 NATO MILITARY OPERATIONS IN URBAN TERRAIN (MOUT) TEAM OF EXPERTS (TOE)

In a response to LO2020 and whilst a study group was examining UO2020, the NATO MOUT/TOE, under the direction of the National Army Armaments Group (NAAG) Land Group 8 (LG/8), conducted its own feasibility study which was presented to LG/8 in April 2002. The aim of the study was:

> *"To investigate and recommend a generic set of unclassified requirements to be made available for all NATO/PfP Nations to inform requirements and standards for development of instrumented MOUT capability. The generic requirement will specify and detail interface requirements".*

At the end of the feasibility study, the team reached the following key conclusions:

- There are sufficient areas of interest where standardisation would add value to recommend continuing the activities of the group;
- There is a requirement to formally identify and stimulate a representative user group to act as a focus for the work; and
- There are sufficient areas of potential interoperability for practical investigation by NATO bodies and agencies such as NATO Command, Control and Communications Agency (NC3A) and NMSG.

Its recommendation was that a NATO MOUT Simulation Working Group (WG) be formed to conduct an in-depth examination of identified issues.

1.5 UCATT-2 TASK GROUP

The UCATT-1 report was accepted by the MCO, and the Technical Activity Proposal (TAP) and Terms Of Reference (TOR) for the formal establishment of UCATT-2 where approved by the NMSG and the RTB.

1.5.1 Purpose

The purpose of the UCATT-2 TG was to provide recommendations for a generic set of unclassified requirements for the development of instrumented Fighting In Built-Up Areas (FIBUA)/MOUT sites, available to all NATO/PfP (Partnership for Peace) Nations in the timeframe 2020.

The UCATT-2 TG had a number of key objectives which evolved from the work carried out by the UCATT working group:

- Exchange and assess information on MOUT (live/constructive/virtual) installations and training/ simulation systems. Military feedback as to the effectiveness of current solutions will be obtained with a view toward establishing best practice.
- Identify a suitable architecture and a standard set of interfaces that enable interoperability of MOUT training components that does not inhibit future research and enhancements.
- Identify limitations and constraints on MOUT development with a view toward identifying areas for future research.
- Validate the applicability of JC3IEDM as the C4I standard for interfacing to the simulation environment.
- Provide a (SISO) standard for laser and data communication, audio and visual effects.
- Organize an interoperability demonstration to prove the standards.
- Define a generic set of data for lethality and vulnerability to enable unclassified interoperability of Nations' simulation systems.
- Establish a working relationship with industry partners and ensure that industrial participation was worthwhile.

1.5.2 Participation

The UCATT TG consisted of a combination of NATO and PfP Nations and representatives from industry. The decision to involve industry from the outset produced a win-win situation for both. This was because national defence organisations did not have all the knowledge, but were in a position to provide industry with context and direction. The UCATT-2 TG had a good balance of national Government (both military and civilian) and industrial representatives. The UCATT-2 TG initially consisted of representatives from the following:

- NATO and PfP Nations: CHE, DEU, ESP, FIN, GBR, NLD, SWE and USA; and
- Industrial participation from CUBIC Defence Systems (USA), SAAB Training Systems (SWE), RUAG (CHE), TENETEC (CHE), NSC (SWE) and RDE (DEU).

1.5.3 Conclusion of UCATT-1 Report

In conclusion, the work to date has provided NATO with a scalable functional architecture (Figure 1-4) based on USE CASES agreed by the military user community in NATO and Partner Nations. A web-based register of FIBUA/MOUT sites has been successfully developed and interoperability issues are being addressed. Work on identifying best practice however has been limited. Indications so far would suggest there is still more to be done particularly in developing the standards and more needs to be done to address the other two simulation domains of constructive and virtual simulation in support to urban training.

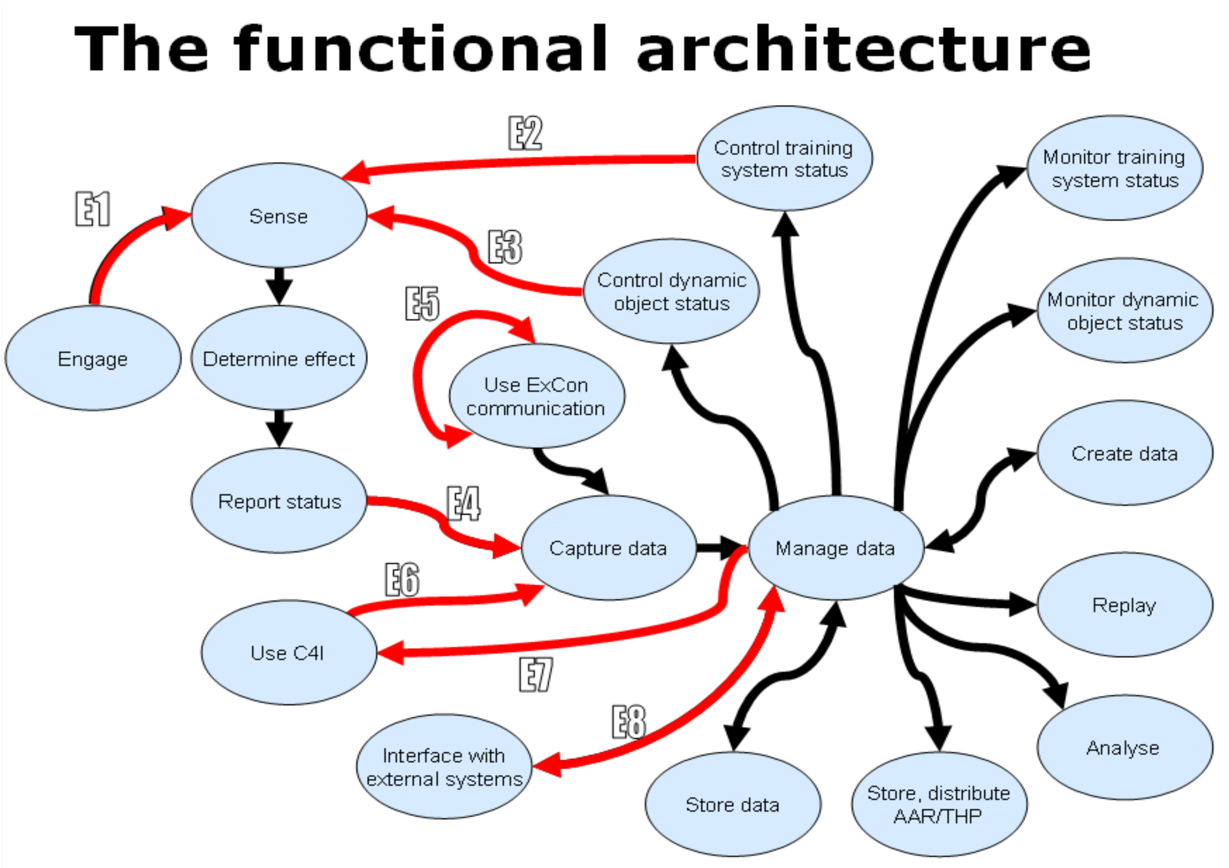


Figure 1-4: The Functional Architecture from UCATT-1 Report.

1.5.4 Recommendation of UCATT-1 Report

As a result of the work, the following key recommendations are made:

- To use the functional architecture defined in this report as the basis for developing an approved SISO standard to be used in the development and procuring of TES equipment for training for urban operations or instrumented FIBUA/MOUT sites;
- To work out in more detail: standardisation of laser codes, requirements for virtual and constructive MOUT training, Effects Representation (ER), data communication, the integration of LVC domains and further development of the functional architecture; and
- To establish a follow-on activity for UCATT-2.

1.5.5 Relationship with Other Groups

Communication with other NATO groups was established and there have been two groups that have been important in this respect: the FIBUA/MOUT Working Group (FIBUA/MOUT WG) and the Training Simulation Working Group (TSWG). Both groups belong to the NATO Army Training Group and represent the user community. All the work that is done by the UCATT TG has been communicated to, and where necessary verified by, the respective user community. In practice this meant that the UCATT TG has participated in the FIBUA/MOUT WG. It was, however, recognised that the interoperability requirements and standards advocated by the UCATT TG are equally applicable outside the urban training environment.

1.6 STUDY METHODOLOGY

The starting points for the UCATT-2 TG were the conclusions and the findings of the UCATT-1 report. This report was approved by MCO and the NMSG. Additionally, the conclusions from the LO2020 and UO2020 reports were used as a framework reference document to guide the UCATT TG.

1.6.1 Definition of Urban Operations

For the purposes of this study, operations in an urban area, or urban operations, are defined as those military and other activities in an area of operations where significant defining characteristics are man-made physical structures, associated urban infrastructures and non-combatant populations.

1.6.2 Staged Approach

The UCATT-2 TG adopted a staged approach which is illustrated in Figure 1-4. It began by:

- Maintaining the products that were produced by UCATT-1;
- Collecting information from external NATO groups; and
- Intensively studying and working in the areas like standardization bodies, studies and analysis and military user standards.

This was followed by:

- Best practices (Chapter 2):
  - Observer controller functions; and
  - Ammunition and weapon table.
- Minimum requirements for Exercise Control (EXCON) and After Action Review (AAR):
  - Template for safety and procedural briefings;
  - Effect representation on targets; and
  - How to create vulnerability models for buildings and vehicles.
- Studies and analysis (Chapter 3).
- Future challenges (Chapter 4).
- UCATT standardization and SISO (Chapter 5).
- Interoperability demonstration (Chapter 6).

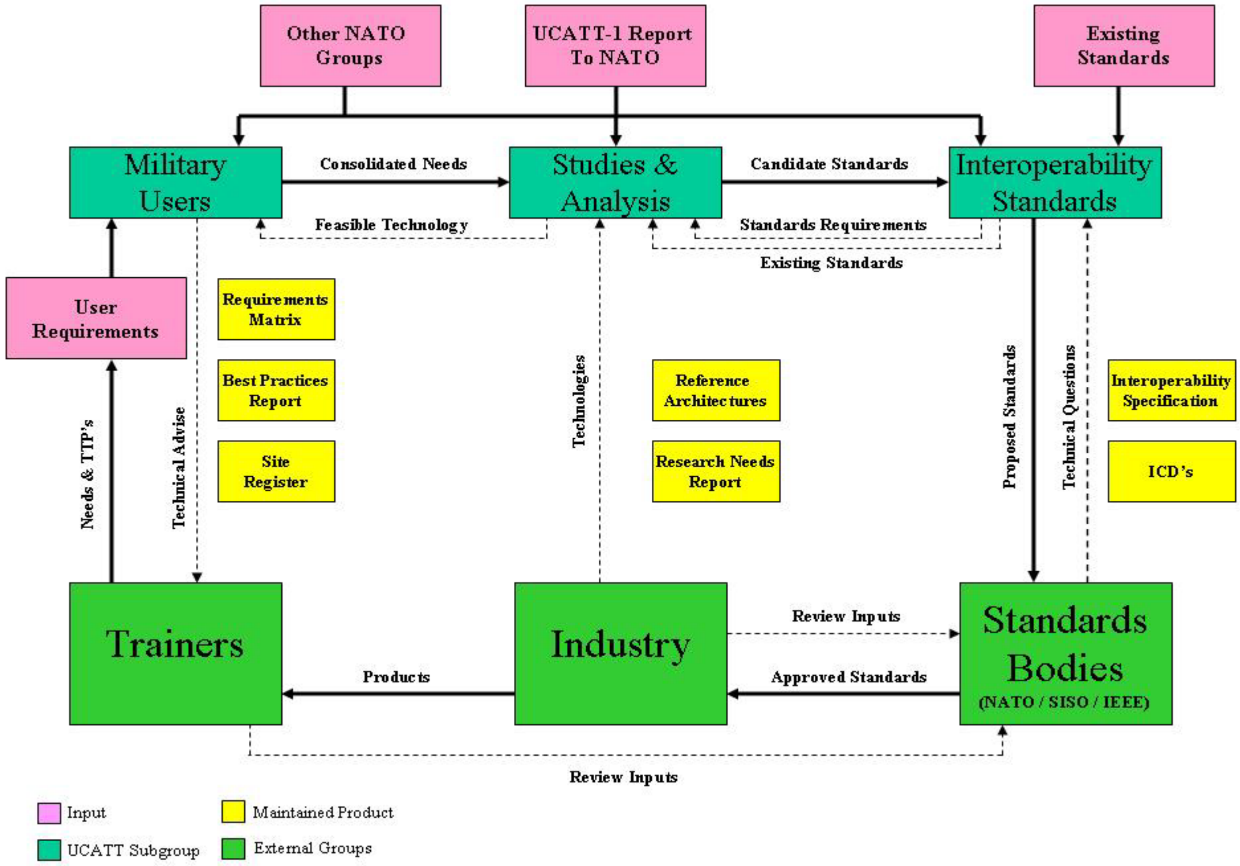


Figure 1-5: Study Approach.

1.7 OUTCOME OF THE UCATT-1

UCATT-1 has made the following recommendations in its report in order to improve overall approaches to training in an urban environment (as listed in the sub-sections below).

1.7.1 Maintenance of UCATT-1 Report

The work undertaken by the UCATT TG and encapsulated in their report is based on a vision of urban operations as laid out in UO2020 and the belief that:

- Nations will need to increasingly train for operations in an urban environment that will require the use of either national or other Nations FIBUA/MOUT facilities as described in the USE CASES;
- Training will need to be cooperative alliance amongst the Nations; and
- Nations will need to use technology that is currently or likely to be available in the 2020 timescale.

Although it is recognised that the context for military operations is changing and that what we expect today will be different tomorrow, it is clear that most operations will be conducted within an urban environment across the full spectrum of conflict and they will be joint. Therefore the work of the UCATT TG needs to be maintained and its report must be updated so that it will remain a valuable resource document and continue to guide national defence acquisition organisations and industry as they develop FIBUA/MOUT products and facilities to 2020 and beyond.

1.7.2 Related Working Groups

The UCATT-2 WG has been concentrating on the area of training with simulators in the urban environment; however there are a number of other working groups in this important area working under the NATO umbrella. The UCATT report has to be recognised and taken into account by TSWG, Urban Operations WG and other CSO and NMSG Task Groups. Both combat and the war against terrorism will increasingly take place within the urban environment and therefore the need to train in this environment will increase in importance in future military training and the work that has been done in this area will contribute to the actions of the others. It is expected that this report will carry more weight, since the document has been produced – unlike many other reports – in partnership with members of industry who will ultimately deliver the required capability that is interoperable between Nations.

1.7.3 Benefit and Continued Involvement of Industry

Industry partners were again invited to work within the UCATT-2 TG and the benefit which they gained while providing their expertise was that those members of industry were able to form a closer relationship with those Nations participating and their urban simulation experts. This has enabled industry to understand the user needs which should help to direct their own R&D work. This report will provide industry with further guidance on areas where they should invest and do more development, and by their participation, Nations will follow the guidelines in this report. It is recognised, at the time this report was completed, that there are technological development and solutions beyond the group's knowledge that will need to be considered when both industry and Nations invest in urban training facilities. To deliver interoperability standards, industries will be required to work together and provide support for the development of the proposed standards and continue to participate in the future with the UCATT TG work. It is also recognised that while looking to constructive and virtual simulation areas, there is a need for interoperability such that other industry participants may join future UCATT TG's work.

1.7.4 Continuation of the UCATT TG

The work of the UCATT TG's is not finalised yet – this report has been produced, but there are a number of other areas that need to be examined in more detail. These areas include:

- Laser standardisation;
- The use of virtual and constructive simulation in Urban Operation training;
- Effect representation (e.g. coloured smoke); and
- Data communication, etc.

A key area that will need more investigation in future urban military training is C4I systems and their connectivity with training systems. The TG is willing to continue the work with the same structural concept; working together with industry. A draft new TAP and TOR for UCATT Standards and UCATT Architecture is presented in Chapter 7. Figure 1-6 is an elaboration together with NATO UO WG and is describing how the work of a new UCATT TAP will potentially contribute in the future. With the overall goal for completion of the UCATT work being stated to be year 2020, Figure 1-6 also will cover the different milestones until then.

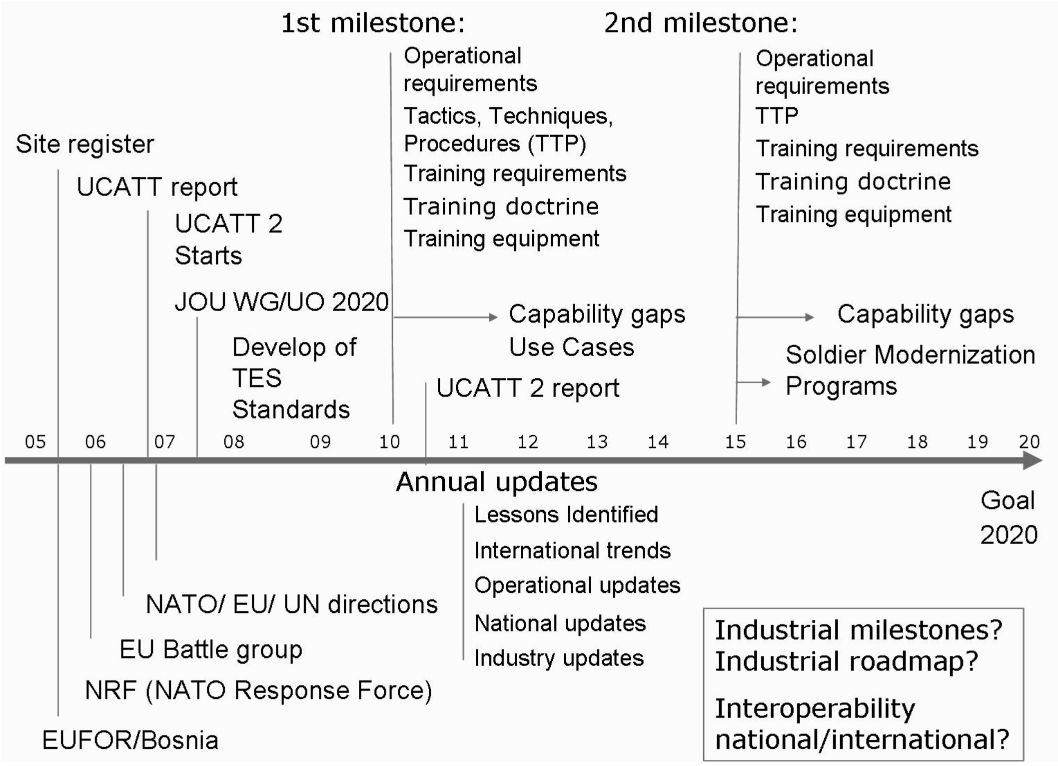


Figure 1-6: UCATT Continuation in the Context of Work by the Urban Operations WG.

Chapter 2 – BEST PRACTICE

2.1 BACKGROUND

For the Military Sub-Group it was obvious that multi-national exercises and joint and combined operations must be regulated and standardized. In the same way NATO has created regulations for PfP Nations with OCC E&F (Operational Capabilities Concept Evaluation and Feedback), we must have common rules for safety, colour codes and practices on how you conduct combat operation. The Military Sub-Group also has been working with a new ammunition table, discussing a common vulnerability and damage matrix, and has been a reference/user-group providing inputs and feedback to the studies/analysis and standards sub-groups.

During UCATT-2 the military sub-group used TSWG (Training & Simulation Working Group) and UOWG (Urban Operations Working Group), as reference groups that focussed on users' needs. UCATT-2 TG also received the work from UOWG "Urban Operations Handbook Vol. 1" delivered September 2008, and used it as a reference guide for the analysis of the overall urban operations requirements.

2.2 ANNEX A – BEST PRACTICE FOR O/C FUNCTION IN SUPPORT OF A BATTALION LEVEL EXERCISE

Annex A contains the three roles: Observer Controller (O/C); Training Analyst (TA); and Exercise Director (ExDir) outlined by the FIBUA/MOUT WG. The annex defines the main trainer roles that are not in all cases separate individuals.

Similarly, the availability of captured statistical supporting data during training exercises was determined by the technologies in use and the context of the activity.

2.3 ANNEX B – UCATT-2 TG AMMUNITION AND WEAPON TABLE

The intention of Annex B is to provide a comprehensive list of weapons and ammunitions types and it should be updated in the future if needed. The sources for this compilation have been open information on ammunition inventories such as Jane's Ammunition Handbook, etc.

The list has to be understood as a proposal of the weapon and ammunition types which have to be mapped with the UCATT-E1 engagement interface standard being developed via SISO.

2.4 ANNEX C – MINIMUM REQUIREMENTS FOR EXCON INFO AND AAR

The purpose of this annex is to provide the minimum desirable requirements for the EXCON and AAR documentation in order to make possible and more convenient the sharing of exercise data for multi-national training in Urban Operations Training Facilities.

2.5 ANNEX D – SAFETY AND ENVIRONMENTAL ISSUES

This document is intended to provide information to an incoming unit that will assist in the understanding of a new facility, its capabilities and constraints, in order that planning can include accurate and up-to-date detail on safety and procedural matters in the facilities.

2.6 ANNEX E – EFFECTS REPRESENTATION ON TARGETS

The purpose of Annex E is to encourage the different countries to adapt their facilities to a common framework that defines the representations of the effects on the side of the shooter and on the targets in a common way, so that the effect representations are realistic and clear.

2.7 ANNEX F – HOW TO CREATE VULNERABILITY MODELS FOR BUILDINGS AND VEHICLES

The intention of Annex F is to provide the different Nations with a guide to create vulnerability models for buildings and vehicles so that in the future all have common rules for the effects from different weapons and ammunition types on the buildings and vehicles of the training facilities.

2.8 ANNEX G – RELATED NATO STUDIES

The purpose of Annex G is to provide an overview of NATO STO active working groups with respect to the live urban or training environment.

2.9 ANNEX H – DEMONSTRATION SCENARIOS

This annex is intended to provide an overview of the scenarios that were used to show interoperability based on the UCATT functional architecture.

2.10 ANNEX I – DEMO TIMELINE

This annex gives the detailed timeline of the demo that was provided.

Chapter 3 – STUDIES AND ANALYSIS

3.1 INTRODUCTION TO SASG AND ITS WORK

The role of the Studies and Analysis Sub-Group (SASG) was to integrate requirements from the military into the Functional Architecture (FA) and identify candidates for future standards. Figure 3-1 shows the process applied to the SASG and how the group interacted with the military, demo and standards groups.

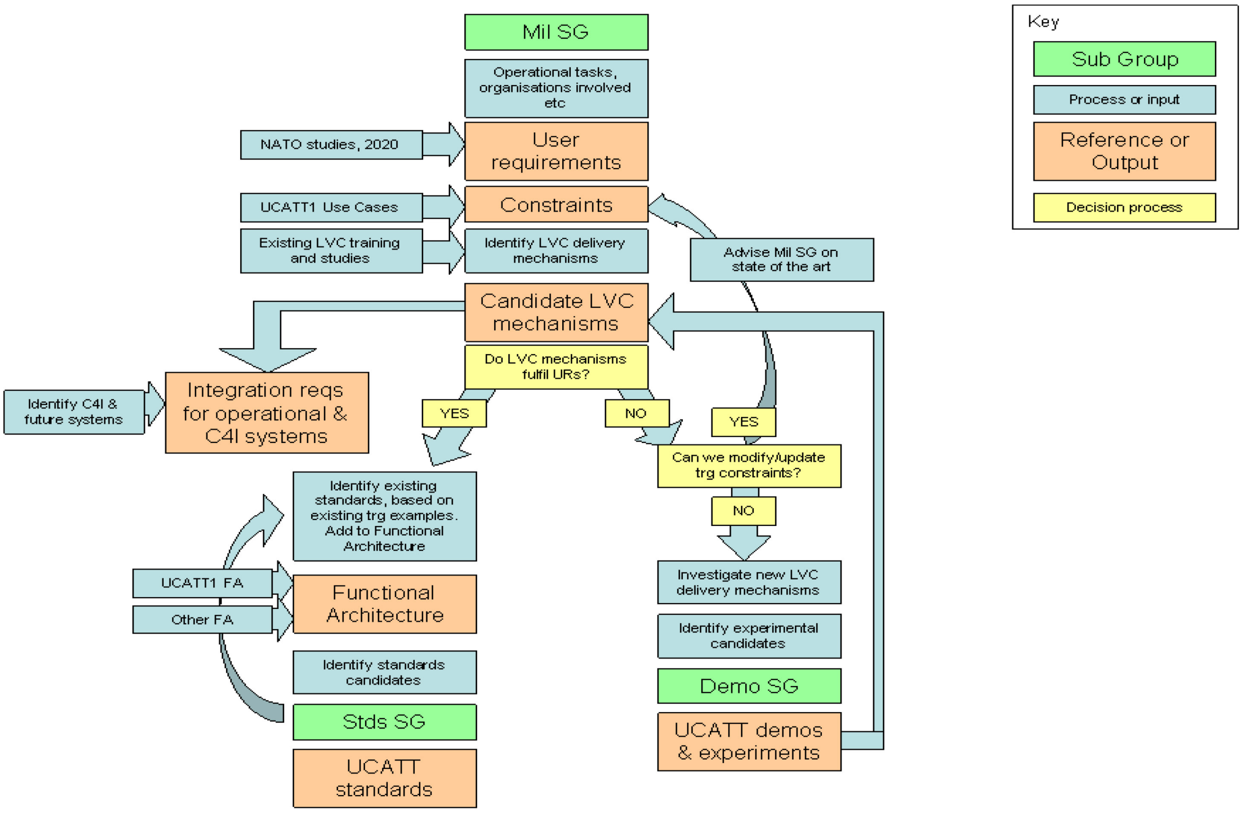


Figure 3-1: SASG Workflow and Relation with Demo and Military Sub-Groups.

The main principle of the workflow was that the user requirements were identified by the Military Sub-Group, either by themselves or by questions asked by the SASG. The requirements were then analyzed with the support of existing background information and the team's extensive knowledge about existing technology and training needs. Candidate LVC mechanisms were then sorted as integration requirements, potential standard requirements or candidates for demonstration and handed over to the Standards Sub-Group or the Demo Sub-Group respectively.

SASG developed the FA created in UCATT-1, mainly for the engagement interface to show how different engagement simulations could be made interoperable. SASG also re-examined the UCATT-1 use-cases to identify potential interfaces E9 and E10.

3.2 DEVELOPMENT OF UCATT FUNCTIONAL ARCHITECTURE

The SASG re-examined the UCATT-1 functional architecture to see if it would hold for various technical solutions. By taking examples from the various UCATT industry members, the group found that the UCATT architecture confuses data and physical architectures. This was particularly true for engagement simulation, where there are a variety of physical means to move data around and achieve the goal of simulating a fire event. Therefore, a new and more elaborate engagement information architecture is explored in Sections 3.2.1 and 3.2.2.

On reviewing the use-cases selected for the UCATT-2 demo, the SASG found that the architecture could be missing two interfaces that could enable interoperability. Section 3.2.3 examines the listed use-cases and Section 3.2.4 suggests two new interfaces, E9 and E10, for standardisation.

3.2.1 Mechanisms for Engagement Simulation

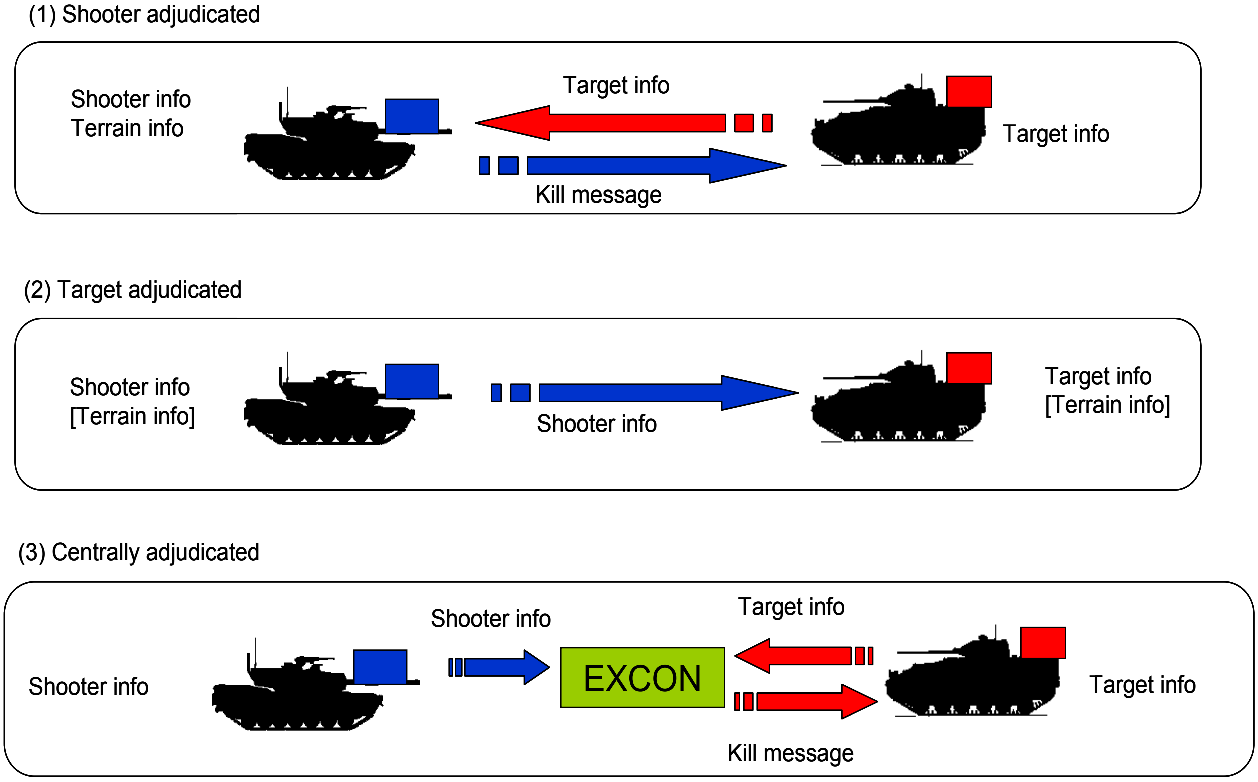


Figure 3-2: Mechanisms for Engagement Simulation.

These three example mechanisms show that there are many physical means to create an engagement simulation. The question for SASG was: How can we make standards for such differing ways of simulating engagements? The SASG developed a common information architecture for simulated engagement that is intended to be applicable to all physical systems.

3.2.2 Information Architecture for Engagement

The SASG iteratively developed an information and process flow that starts from a firing event and results in a status change on a target Dynamic Object (DO). This flowchart is depicted in Figure 3-3. The resulting information architecture was tested against the various engagement solutions available today, and some notional future engagement systems to check that all systems were representable in the architecture. The mechanisms for transferring information in a standardised way will be dependent on the actual physical implementation, but the generic architecture for engagements is very helpful in making the right decisions to implement interoperability.

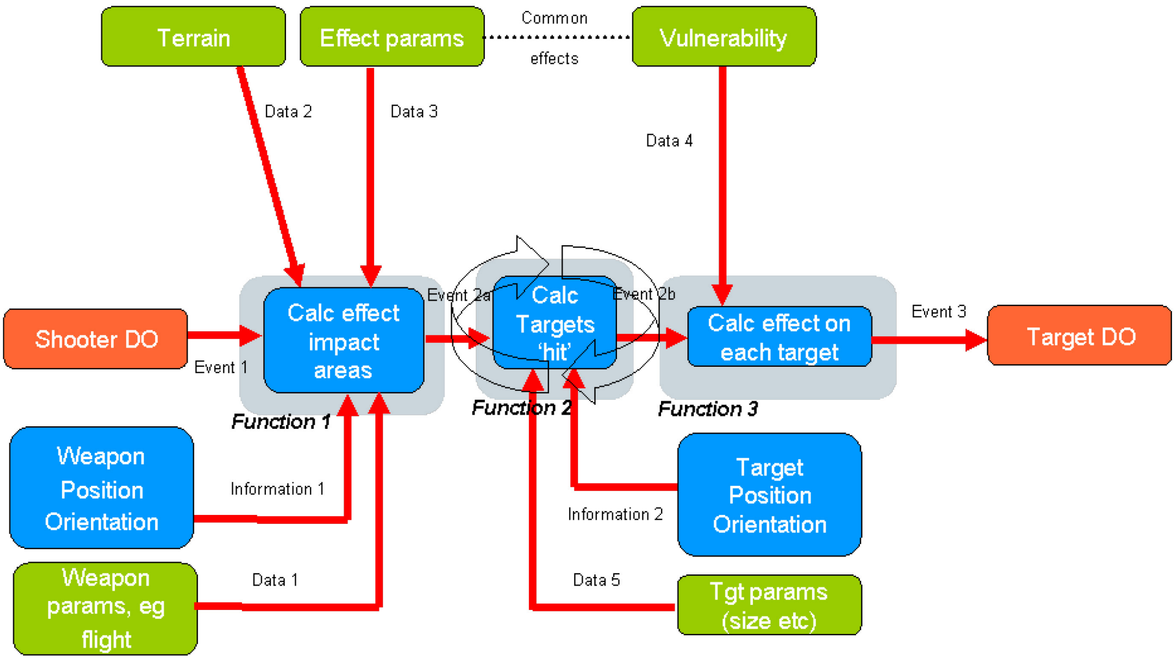


Figure 3-3: Generic Engagement Information Flow.

The main data flow is from left to right. Each of the 3 functions requires additional information in order to complete its calculation. This additional information might be dynamic, for example target position or target size.

It starts with a Dynamic Object (the shooter DO) that initiates an engagement (Event 1). This engagement initiation can be for example, the firing of a weapon, the throwing of a hand grenade, the triggering of an explosive device, etc. This event generates a weapon effect in the environment. The characteristics of this weapon effect are calculated by Function 1, this includes the exact time of the effect, its location and the impact area(s). In order to determine the weapon effect characteristics, Function 1 requires information of the shooter, such as the position, orientation and speed of the weapon at the moment of engagement initiation (Information 1). Furthermore, it requires information on the properties of the weapon and/or ammunition (Data 1: speed, ballistic properties, etc.), the physical environment (Data 2: the layout of the terrain, type of terrain, infrastructure, weather, etc.) and properties of the effect itself (Data 3: kinetic, blast, dispersion, etc.). Function 1 then publishes a weapon effect with its associated characteristics (Event 2a).

It is now up to Function 2 to calculate which dynamic objects are hit, or to put it more generally, are inside the influence sphere of the weapon effect and as a result can be influenced by this weapon effect. Depending on the type of effect, only one target will be affected (e.g. in case of a bullet) or many in case of area effects such as blasts, shrapnel or releases. So this function requires the current position and orientation of the relevant DOs (Information 2) and their properties (Data 5: size of the object, etc.). Function 2 identifies which dynamic objects are in which way affected by the weapon effect (Event 2b). Examples are that a DO is physically hit by a projectile or piece of shrapnel or is hit by the blast of an explosion (or both).

Subsequently, Function 3 calculates for each affected dynamic object if and how that weapon effect changes the status of that object, i.e. what kind of damage is inflicted. Of course this can also prove that the target is strong enough or sufficiently protected to withstand the weapon effect. So besides the characteristics of the weapon effect influence, as provided by Event 2b, this function requires vulnerability data (Data 4: armour at place of impact, level of protection against CBRN releases, etc.). As a result, Function 3 generates for each relevant dynamic object an event to change its status (Event 3).

A key concept to grasp is that the function steps do not need to take place in a computer model. As we are dealing with the live environment, we can make use of properties such as laser propagation, line-of-sight and other physical 'calculations' that would normally need a computer function to achieve in a synthetic environment. For example, the weapon volume and targets hit functions can be achieved with a laser beam simulating the weapon volume and the target's laser detectors physically receiving the beam.

Data flow between the functions can be considered as event based or 'push' interactions; one function acts on receiving data from the previous function. The additional information needed by each function will therefore likely be query based; as and when the function needs information it will be able to request it from the source. There may be polling or broadcast mechanisms that are more efficient in terms of network management, but the effect will be the same as each function will be accessing its own local database that is periodically updated with global information. This kind of dynamic data request is initially seen as necessary for dynamic variables such as entity position, weapon orientation, etc.

The other type of data is 'static' and is usually agreed and shared prior to training. However, there are arguments for dynamic distribution of data such as vulnerability and terrain modifiers that could in the future be shared at run-time. Such semantic information is usually agreed by Nations as part of the rules of fair play as vulnerability calculations are approximations. In the future, more analytical vulnerability calculations may enable more realistic, real-time simulation of damage in a wide variety of situations.

3.2.3 Interoperability Scenarios

Through the work of UCATT-2, the physical interpretation of the Functional Architecture made by UCATT-1 tended to be a reoccurring issue. In order to further investigate the implementation of the Functional Architecture the team returned to the UCATT use-cases.

Table 3-1: UCATT Use-Cases.

USE-CASE 0	National training on National site
USE-CASE 1	Live MOUT training multi-national force on national site (consolidated combined training)
USE-CASE 2	Use other Nations training facility and staff
USE-CASE 3a	Distributed combined training
USE-CASE 3b	Combined training in mission area
USE-CASE 4	Command and staff training for engagements in different mission areas

USE-CASE 1 was picked out and analyzed through particular physical implementations of the UCATT Functional Architecture in a real-world scenario. The assumption was that there would be both laser and geo-pairing technology involved.

From the scenario (Figure 3-4) we can see that the communication between EXCON and the dynamic objects is covered by the external interfaces E2, E3 and E4 from the Functional Architecture – in the same way the engagement between objects is covered by E1. However, there is a need for indoor tracking that is not obvious a part of a physical EXCON. One could argue that the indoor tracking is part of the EXCON capability and therefore part of the E4 of the Functional Architecture, in the same way as outdoor positioning is reported as a property of the object. On the other hand, the buildings, or part of buildings, represent dynamic objects themselves in the same way as combat vehicles.

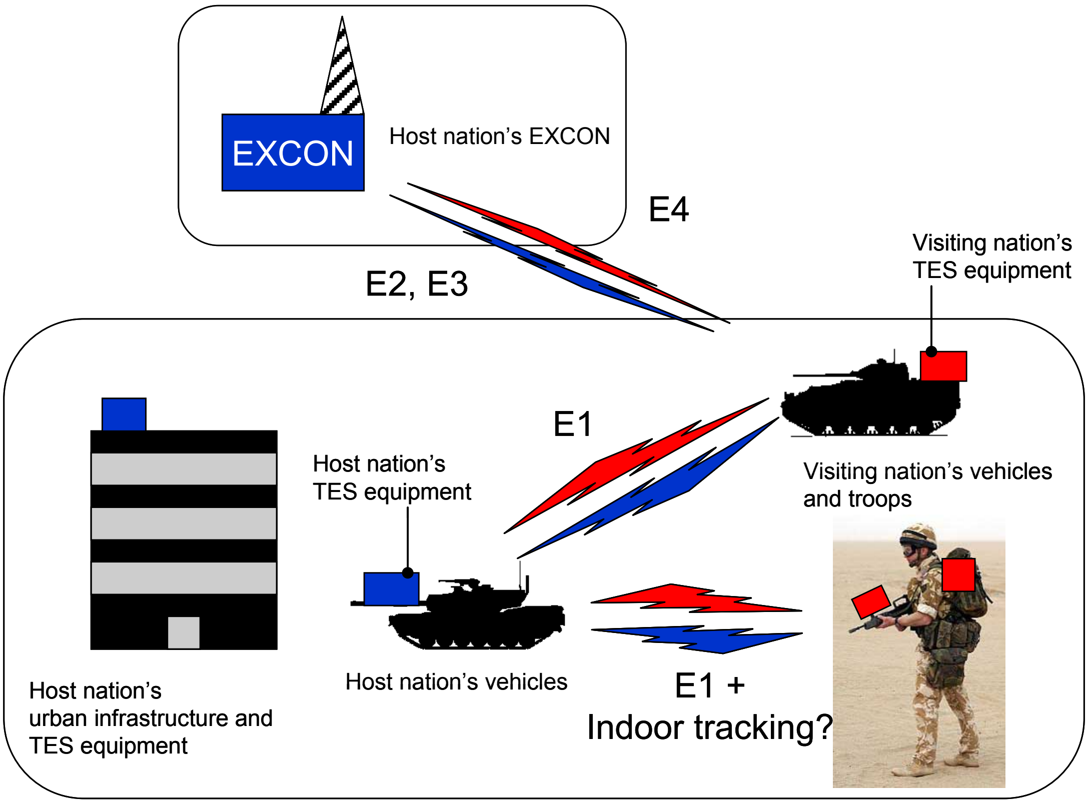


Figure 3-4: Diagram of USE-CASE 1.

A soldier may enter a combat vehicle as well as a building. The soldier may also be affected by collateral damage from a building or any type of dynamic object through E1, but the result of the engagement is dependent on if the soldier is inside or outside, close to or far away from, the other dynamic object. This shows that there may be a need for a function to relate the position of a dynamic object relative to another dynamic object. This function may or may not be part of EXCON capability or a dynamic object, depending on system design. Therefore the Functional Architecture has to be further investigated.

The example of USE-CASE 2 shows that there is a possibility of another UCATT interface standard that would allow simulation equipment to be appended to another Nation's simulation equipment and platforms.

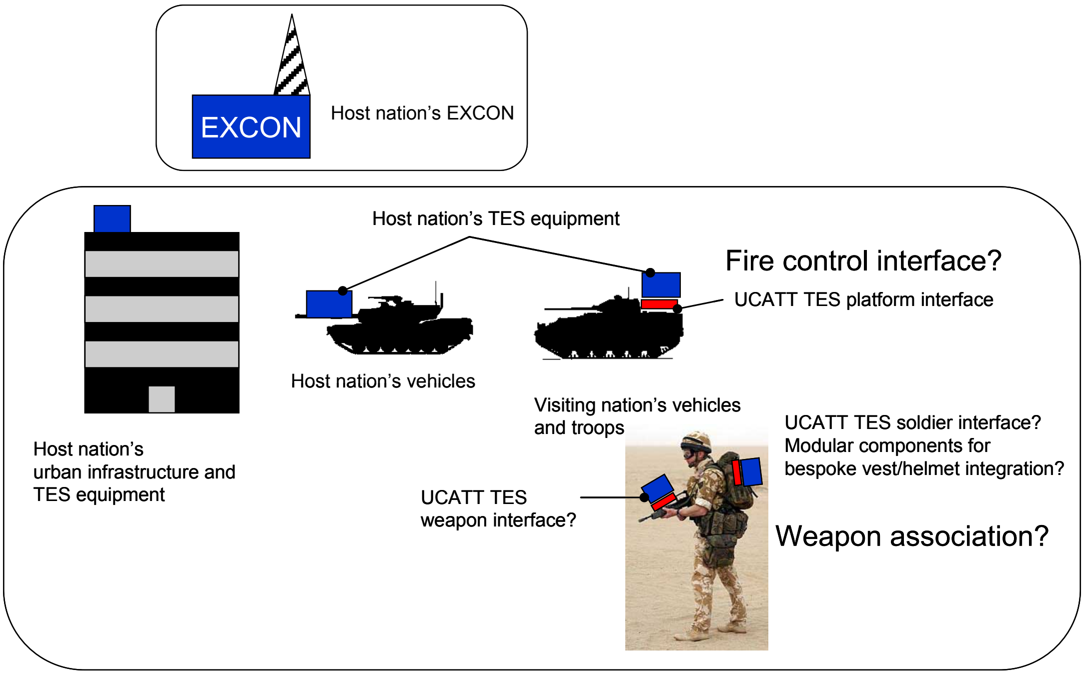


Figure 3-5: USE-CASE 2 Interfaces.

In the case that the Nation arrives at a training site with its operational equipment and needs to be fitted with training equipment, there has to be a mechanical, electrical and data interface standards to enable the visiting troops to fit host Nation training systems.

Another problem is that accurate simulations need access to data from the fire control systems. This is particularly needed for vehicle-mounted and long-range weapons. Fire control systems are complex and usually safety critical and often also have secrecy/classification aspects that add complication. A Nation that would like to be able to use another countries training facilities must therefore not only adapt to the standard, but it must also let the training providing Nation have access to needed data about its fire control systems. Whilst this might be technically possible, secrecy/classification is likely to outweigh the training benefit for vehicles that are equipped with fire control systems.

An obvious problem that arises is that most of the equipment are already in use and will be in use for many years. To do modifications to operational equipment for training needs may not be of priority, so it likely will take many years before a standard could be implemented.

This limits somehow the USE-CASE 2 to be feasible only to the soldier level and possibly lightly armed vehicles. However, some standards or recommendations might be suitable in this area for mechanical adhesion (i.e. picatinny rail) and power supply.

3.2.4 E9 and E10 – Impact on Functional Architecture

With further analysis there were other user requirements identified than the use-cases that indicate the need for new functional interfaces. In the training situation there may be situations where soldiers need to use different weapon systems and incorporate in the other Nation's weapon simulators. In a pure engagement situation, the need for association may not be necessary, but in a training and evaluation perspective it may be critical information who carried/operated/manned the weapon, as well as knowing that an available support weapon was not used by soldiers nearby. Also here we see a need for associating dynamic objects to each other.

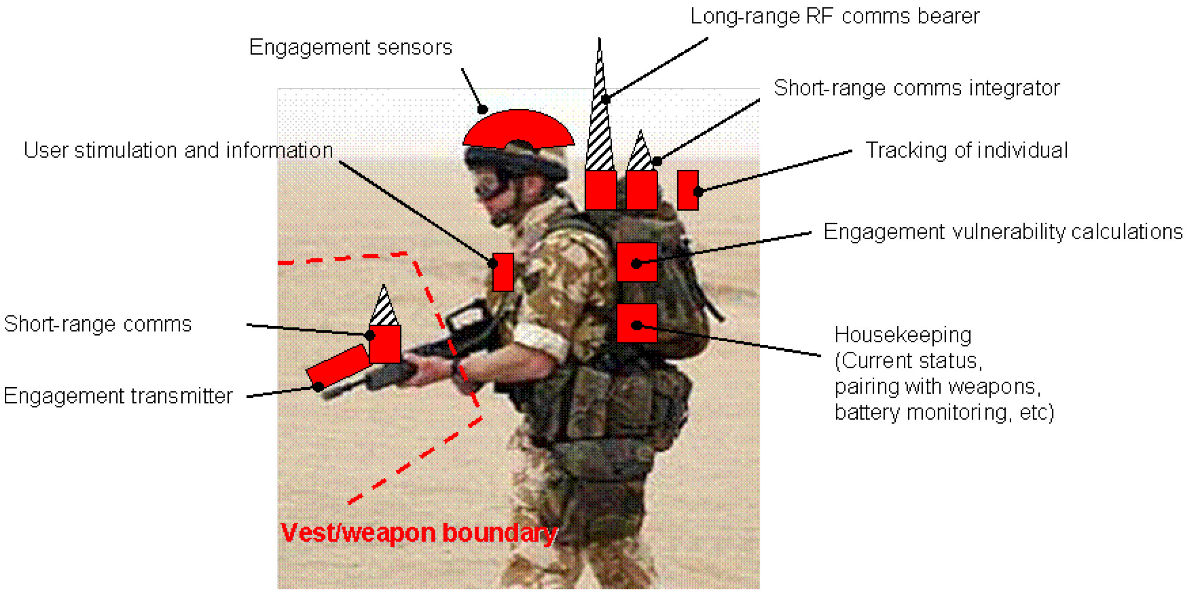


Figure 3-6: Possible Soldier Simulation Equipment Modules.

Other training-driven demands may be internal to the dynamic object itself. A soldier may, as we mentioned before, be part of a vehicle crew/passengers and must therefore be associated with the vehicle itself – and the status of the solider might therefore influence the status of the vehicle and also opposite might apply, e.g. if a vehicle is completely destroyed, the soldier will also be. A rifle or a crew served weapon may in the same way be interpreted as a part of the higher level dynamic object – the soldier – and the status of the weapon is must depending on the status of the soldier.

As noted, there are other functions for the dynamic object that are not fully captured in the Functional Architecture of UCATT-1. The main body of these functions is concluded to:

- Report position information;
- Capture events and state changes that are not engagement driven;
- Pairing dynamic objects (e.g. in cargo); and
- Interact with the real object.

Adapted to the Functional Architecture reporting of position can be inserted into E4, while the others are suggested to be added as new external interfaces E9 and E10 as stated below, and will be further studied during the next UCATT charter period.

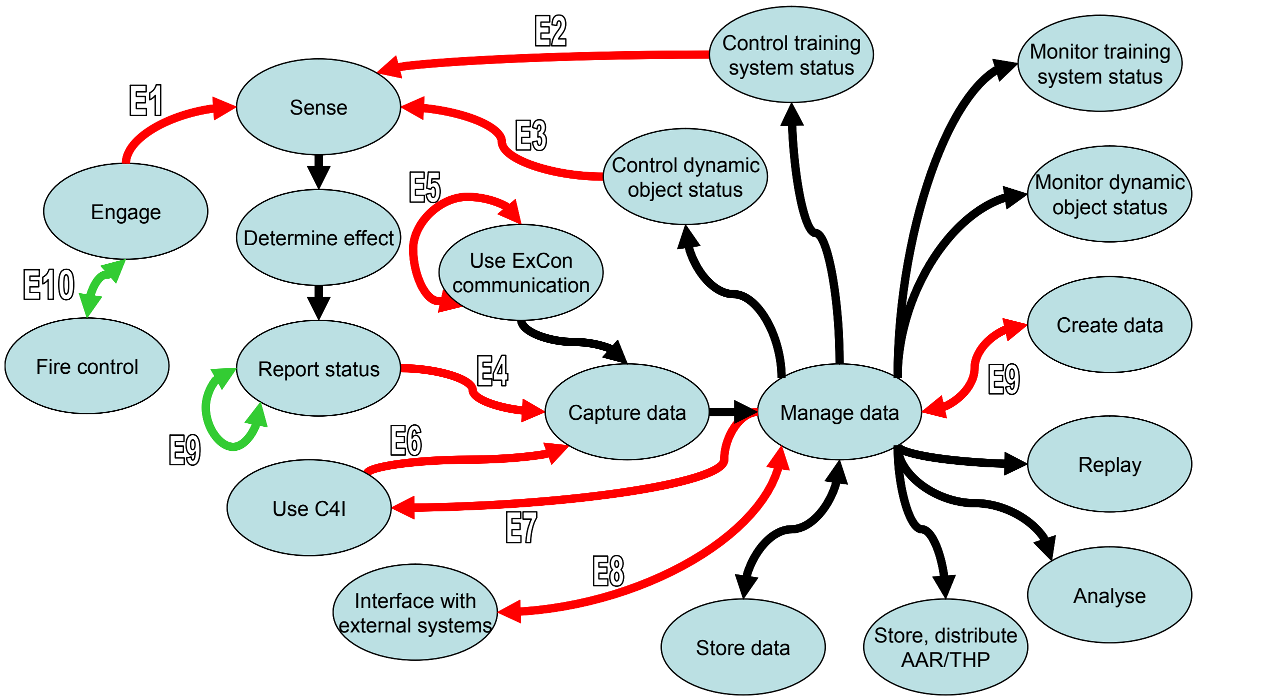


Figure 3-7: Suggested Elaboration of the Functional Architecture.

3.2.4.1 Report Status ⇔ Report Status (E9)

This interface enables the exchange of data between dynamic objects. Examples of data exchange are own status and pairing to other dynamic objects.

3.2.4.2 Fire Control ⇔ Engage (E10)

This interface enables the exchange of data between the training system and the fire control system in the real object. Examples of data exchange are trigger, ammunition type and ballistic tables.

3.3 LESSONS FROM THE UCATT DEMO

3.3.1 E8 Basic Principles

In the E8 part of UCATT-2, the main focus was to create interoperability between the six (6) EXCON systems participating in the final demo.

The six (6) systems came from six (6) different companies, which all had their own method of handling training data and distributing this data in an integrated network.

The basic interoperability that we wanted to achieve within E8 was based on the following actions:

- Full visibility of participating players in the demo; all EXCON systems should see both their own players as well as all players from the rest of the systems.
- For each player in the demo, the following attributes should be visible for the other systems:
  - Player ID, confined to a pre-defined list of IDs for each company in the demo;
  - Player designation;

  - Position including height above sea level; and
  - Basic health status; alive or killed.
- Exchange of player control commands for individual players:
  - Resurrect; and
  - Kill.
- Exchange of global player control commands:
  - Global resurrect; and
  - Global kill.
- Exchange of artillery simulation that on impact should wound or kill all players in each EXCON system.
- Exchange of hit/detonation information from each player when shot by the E1 laser engagement.

These interoperability functions in parallel with the E1 laser integration forms a closed loop where all systems can work and train together exchanging basic training information with each other.

3.3.2 Protocols and Information Models Used Within E8

For the E8 integration there was no single protocol used to enable communication between all EXCON systems. Due to each company policy regarding their integration capability, some were using High-Level Architecture (HLA), some Distributed Interactive Simulation (DIS) and some native protocols.

This is not an unusual integration situation, but requires some effort to solve, not only on the protocol level, but also on the information model level.

By having all these different protocols, especially with HLA as one of the standards with its multiple information model support, the total integration can contain several information models which do not naturally fit together.

Even if some models like the one used in DIS and the RPR FOM used in HLA are very similar, and although the base data in the integration is the same in all systems, the actual information models must be bridged to overcome the gaps.

3.3.3 Integration Issues

Issues with different protocols and information models are normal integration problems that can usually be resolved in a range of different ways.

The most traditional way is to make adjustments in one or more systems so that every system uses the same protocol and the same information model. In cases where many different systems are involved, this is often a cost ineffective and impractical solution due to companies having invested huge amounts of money in one technique.

Another way of solving the issue with multiple protocols is to use a middleware that can act as a bridge between all systems and their protocols. The issue with different information models still exist, but depending on the middleware used, this issue can be worked around by creating mappings between the information models.

3.3.4 Adaptations and Modifications of the Standard Information Models

Even though we can bridge the different protocols and create mappings for the different information models, there are still issues with the actual data needed for performing the integration.

Some of the information models used by the participating companies do not come from the live domain, but have roots in the virtual and constructive domains. Because of this, the models contain huge amount of data that are not used for typical live integrations, while some of the most necessary data is missing from the model.

As an example, the basic entity data that represents a live player does not have the needed resolution for representing a player orientation or the proper enumerations for depicting all those states that a player can get when shot upon, e.g. wounded.

In order to work around these problems the information models needs to be adapted to fit into the live integration.

The EXCON systems often contain all the needed data, the correct resolution and the proper enumerations, but due to the constraints of the protocols (and their either fixed or mostly used information models), this data can’t be fully used in integrations.

By having to adapt to fixed information models and in turn having to adapt and modify these models in order to get the integration working, we deviate from the standards thus making it harder to use the models for connecting to other systems.

3.3.5 Why the RPR FOM 2 Might Not be Suitable for All Types of Integration

For those systems using HLA for external communication, the most commonly used information model is the RPR FOM 2. This information model is a derivate from the information model in DIS with a few new extensions and constructions.

With the similarities between the RPR FOM and the DIS information model, the transition from DIS to the HLA standard was seen by many companies as key to future interoperability. That fact that the DIS information model was incomplete when it comes to connecting live training systems is often forgotten when changing to the RPR FOM. This in turn preserved the same integration problems as before when trying to use the RPR FOM to communicate live training specific data.

As long as the system using the RPR FOM only communicates within its own sub-systems, this approach might work since the RPR FOM then can be adapted to suit the needs of the system design.

Problems arise when this approach is used to communicate with systems from another company who depend on the RPR FOM being unaltered and that the integration follows the rules defined in the standard.

By having to continuously adapt and modify the RPR FOM to make it work for integrations in the live training domain, a reliable and reusable integration can never be achieved.

That the RPR FOM has become a defacto standard as an information model for all types of integration is an issue for the live domain, as instead of selecting a FOM that suits the needs of the information models in the systems targeted for integration, the default choice is the RPR FOM – and although when dealing with integrations within the virtual and/or constructive domains the RPR FOM suits the basic needs, when it comes to the live domain, RPR simply is inadequate.

3.4 IMPLEMENTATION OF UCATT ARCHITECTURE

In order to further implement the UCATT architecture, we recommend the following actions:

- SISO:
  - Collaborate with SISO to define UCATT standards, starting with the E1 interface and the physical interface of laser engagements.
- Advice to procurement:
  - Use the UCATT information architecture to help understand your interface requirements.
  - Where needed, look to use candidate standards – HLA, Test and Training Enabling Architecture (TENA), for E4, E8, etc.
  - Actively identify your requirements for *specific* open standards.
  - Consider training systems as a ‘system-of-systems’.
  - Consider longer term potential benefits of adopting instrumentation standards.
- Advice to industry:
  - UCATT defines open interfaces, not open designs. It will open up innovation in live training systems, whilst protecting ‘black-box’ intellectual property. Example – DIS standards, cell phone networks, etc.
  - UCATT physical standards will evolve over time to cope with new technologies, but architecture will endure.

Chapter 4 – FUTURE CHALLENGES

4.1 TECHNOLOGY TRENDS

4.1.1 Dynamic Object Instrumentation (DOI)

For the purposes of this report, the DOI will refer to the mobile measuring systems, radio communications, power source and processing systems needed to represent a dynamic object. The DO Unit (DOU) will refer more specifically to the data processing unit carried by the player.

The DOI must meet minimum requirements with respect to size, weight, robustness, processing power, communications bandwidth and operational battery life. However, all of these factors inter-relate and must be traded-off with one another for the best possible solution to be reached.

Figure 4-1 shows how the performance of processors, batteries and mobile communications technologies has increased over the past 30 years. The graph highlights that communications and processor performance have rapidly improved. However, battery performance increases have been comparatively slow, with energy density doubling roughly every 10 years. Battery performance can therefore be considered a design constraint. It is processing power and communications performance that are the primary technology drivers for the development of the next generation of TES services. The improvements are driven by the civilian mass-market for mobile internet.

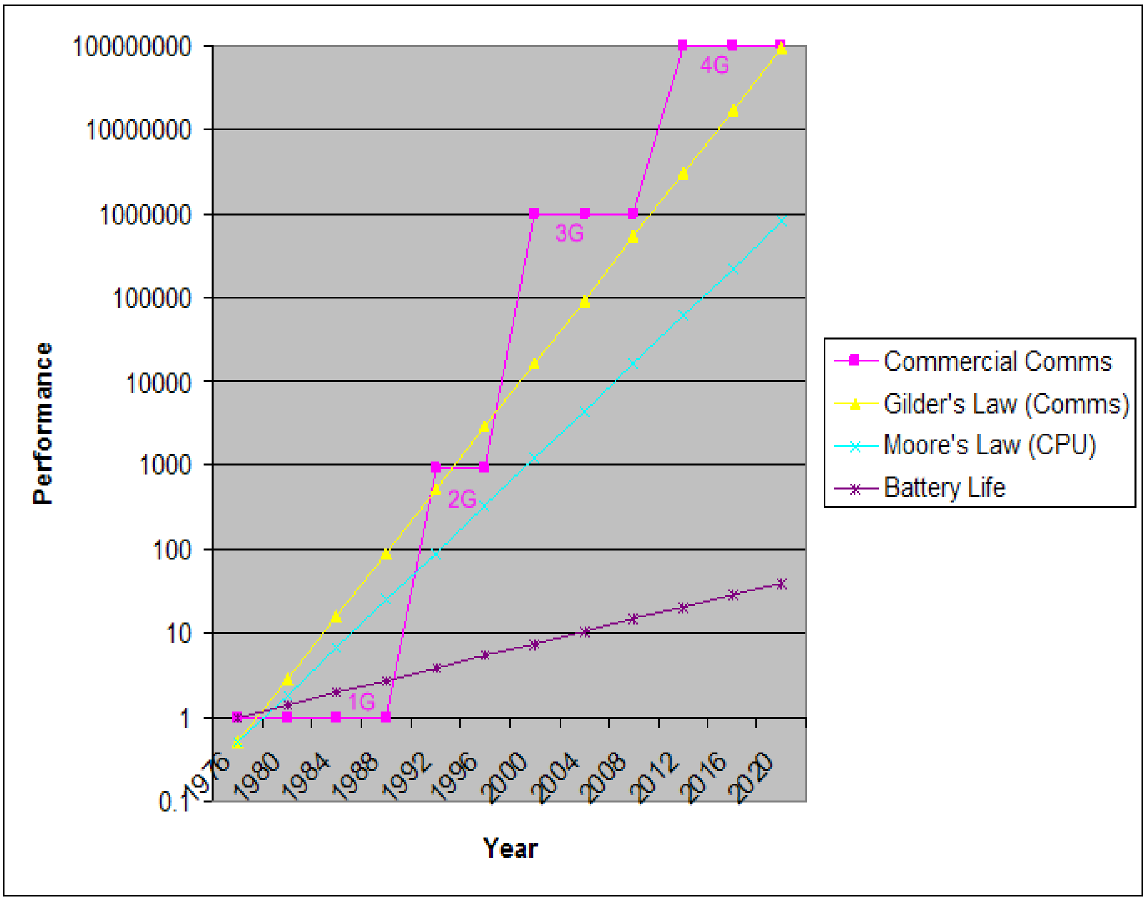


Figure 4-1: Performance of Commercial Mobile Computing Technologies Against Time.

4.1.2 Processing

Increasing the processing power on the DOU will enable the addition of new TES services, for example, video streaming. However, high-performance processors generally have high power consumption rates and a DOI that runs on battery power alone will be unlikely to be capable of operating for the duration of a multi-day training exercise. Increasing the DOI battery size may solve this problem for specific requirements, but the addition of too much bulk or weight to the individual soldier will not be satisfactory.

To allow the addition of processors and energy intensive services to existing TES systems, it will be critical to increase processor power without significantly reducing operational battery life. The processing speeds and energy efficiency of the DOU will need to keep pace with that of processors used in civilian mobile computing devices. Mobile internet devices constitute the fastest growing segment in consumer electronics and telecommunication end-user devices today. Market forces are driving rapid improvements in mobile computing technologies with low-power, high-speed processors being developed specifically for their use.

4.1.3 Battery

Increases in battery performance have been comparatively slow over the past 30 years when considered alongside other technology with energy density roughly doubling in capacity every 10 years (see Figure 4-1). However, there are technologies under development which have the potential to yield several times the capacity of the best currently available rechargeable batteries, for example nanowire anode and lithium-sulphur cathode technology.

New battery materials that can be moulded or have increased flexibility could also prove valuable; reducing the bulk associated with the TES player instrumentation and potentially replacing non-training equipment such as the chest plate in body armour.

4.1.4 System Infrastructure

TES infrastructure enables the provision of indirect fire, exercise control, monitoring, communications and data. This report focuses primarily on long- and short-range communications as well as architectures, standards and protocols. Figure 4-2 shows which parts of the communications infrastructure are considered long range and which are short range.

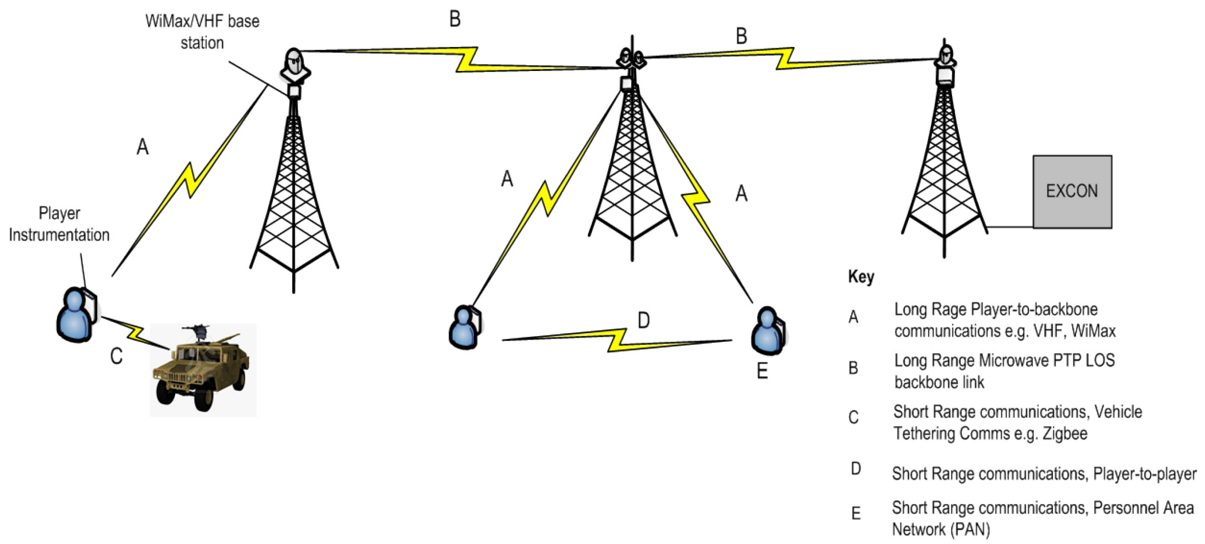


Figure 4-2: TES Infrastructure.

4.1.5 Long-Range Communications

Figure 4-1 shows the exponential rate at which cellular communications systems have increased in performance over the past 30 years. With 4th-Generation (4G) devices beginning to emerge and 5th-Generation (5G) already predicted for deployment circa 2020, there will continue to be large performance increases over the coming decades in the commercial communications sector.

Adoption of this technology into the TES infrastructure would give Player Instrumentation access to vast increases in bandwidth availability, which in turn would allow new services and capabilities to be run on the systems, for example live video streaming or transfer of database information to DOUs for geometric pairing calculations could be enabled through faster, more capable networks. WiMax, for example, provides up to 40 Mbps per channel which would provide far greater rates of data exchange between DOI, EXCON and other DOI than current TES radio modem links.

Another advantage of implementing 4G is that these networks are all-IP packet switched. This means that IP protocol is used from the backbone right down to the DOU. This approach could be used to enable IP-based services to operate across any wireless TES network. By adopting IP-based services and networks, interoperability at the data packet level can be ensured through the existing IPv4/6 protocols. This could enable DIS or HLA integration of live into synthetic environments.

4.1.6 Short-Range Communications

Wireless short-range communications are already used to provide connectivity between components on the DO such as DOU, laser receivers and weapon simulators. They can also provide DO-to-DO communications, such as tethering dismounted infantry to a vehicle.

There are a variety of protocols and standards that can be used each with their own strengths and weaknesses. Bluetooth provides high data rates, but is less energy efficient than Zigbee and Wibree. Zigbee provides the greater range (30 m) and also allows for wireless mesh networking. Wireless mesh networking further extends Zigbee's range by allowing data to hop from one node to the next, routing the data by the best available path. Zigbee is therefore a strong candidate for the implementation of vehicle tethering and player-to-player communications.

MiFi devices act as a wireless router, using WiMax/3G connectivity to create a WiFi hot-spot. This technology could provide the DOI with WiFi connectivity across the local wireless network and a WiMax/3G link into the wider network. However, the high power consumption rates of WiFi may negate its potential for use with man-worn DO. Power generation is less of an issue for vehicles; therefore such technologies could be employed in vehicle DOI to provide mobile connectivity for dismounted infantry.

4.1.7 System Architectures

The TES system is a complex 'system-of-systems' and in order to provide an overarching and coherent framework, it will be necessary to make use of technical standards, architectures and protocols. The benefits realised by this can be to:

- Promote interoperability;
- Promote scalability;
- Reduce integration times;
- Reduce programmatic costs;
- Maximise component re-use;

- Provide greater flexibility for development; and
- Promote increased commercial opportunities.

At present, the limited bandwidth long-range communications used by TES are a constraint on the standards and protocols that can be used across the network. The overhead on data transmitted to and from DOI must be kept to a minimum. However, the phasing-in of a high-bandwidth 4G network would open up the TES infrastructure to many IP-based architectures, standards and protocols, with associated benefits.

Enabling IP on the network down to the DOU would facilitate the bringing together of distributed TES technologies through a Service-Oriented Architecture (SOA). SOA promotes the loose coupling of the suite of services with the operating systems, and other technologies that underlie the applications. SOA is based on principles and criteria, which address characteristics such as modularity, encapsulation, and re-use. Adopting a service-oriented approach would increase the interoperability of the TES simulation services implemented on the system, regardless of the programming language, location, platform or model.

The bandwidths provided by 4G connectivity could also enable the adoption of a 'cloud computing' model (cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand). Implementing a cloud-computing architecture would minimise the computation carried out by the DOI and push it out onto the 'cloud'. Cloud computing takes a Software as a Service (SaaS) approach, in a similar vein to SOAs and implementation of a sound SOA framework can leverage cloud computing. Cloud-computing applications are easier to maintain since they don't have to be installed on each user's computer. They are easier to support, scale and upgrade since applied changes reach the clients instantly. This could be of importance to international interoperability, where the ability to instantly change a service from a national classification to an unclassified one would remove some of the barriers to managing interoperability.

4.2 OPERATIONAL TRENDS

The operational environment for military forces is changing rapidly, both the physical environment (more becoming urban) and the adversary (more towards irregular forces). Also the nature of operations is changing, it is not only focussed on physically neutralising the opposing forces, but nowadays all different kinds of effects have to be achieved (in the fields of defence, diplomacy and development). More specifically this means:

- A shift from large-scale high-intensity battles with large (armoured) forces to small combined arms units operating across the spectrum of violence. The level of violence can change rapidly and locally (Three Block War).
- A move from open fields to the confined spaces of the urban environment.
- An increased role of many other parties, such as the local population and its leadership, IO/NGOs, the international media – the distinction between combatants and non-combatants is not always clear.
- A greater use of situational awareness, ISTAR, etc.
- The combination of kinetic and non-kinetic capabilities, such as information operations, civil-military co-operation within the military, and also co-operation of military forces and other agencies to achieve the desired end-state.
- Operating in many different and even ad-hoc joint and combined force structures.
- The rise of irregular forces, employing non-conventional or improvised means (weapons, such as Improvised Explosive Devices (IEDs)) and methods (techniques, tactics, procedures, including terrorism) – the most fanatic among them being motivated by ethnic or religious reasons.

- In many cases, winning and sustaining the support of the local population has become the centre of gravity of operations, as opposed to physically defeating an opposing force. Because of the increase of the impact of perception of the military actions and inactions, also on the home front, rules of engagement have changed, such as the importance to avoid collateral damage.
- The introduction of new technologies and systems on the battle field, such as remotely operated and autonomous vehicles.
- Lack of national training site; in general, specific training equipment is scarce.
- The requirement to train during missions.

4.3 UO2020 REVIEW

A review of UO2020 eight years after completion of the final draft shows that the premises upon which the document is based are still valid, but the changes expected in doctrine and materiel have not emerged as quickly or with the priority that was envisaged in 2002. The document stresses the importance of understanding the urban environment, and of obtaining a quick, clear situational awareness using technologies that should be developed by 2015. These include a centralized battle field data fusion system that would be able to collect, parse and distribute all relevant sensor data, micro air vehicles for outdoor surveillance, the same for indoor surveillance, and even a field of very low cost, unattended Micro Electro-Mechanical System (MEMS)-based sensors able to communicate covertly, and detect enemy vehicles and soldiers using seismic, acoustic, thermal and visual sensors.

It is possible that work is still ongoing with these technologies, but they have not reached the field and thus have not changed the way in which NATO forces conduct their operations, and consequently, the way in which they train.

UO2020 concludes that "specific training in urban areas is considered the best short-term enhancement available to NATO". The report also indicates a need for more urban-specific training facilities featuring simulation systems that accurately portrait the complexity of the urban battle space. These points are still valid, and it seems that most NATO and Partner Nations are taking the recommendations seriously. Procurement plans for urban combat training centres are being announced, and for the most part these procurements are encouraging industry to overcome the technical challenges inherent in live urban-specific simulations (indoor tracking, shoot-through-the-wall capabilities and minimum operating range of tactical engagement simulators 10 meters, for example). UO2020 also indicates that more joint, international training is desirable, and it is particularly in support of this objective that the UCATT architecture was developed.

The UCATT interoperability demonstration held in the Netherlands in September 2010 highlighted industry's willingness and ability to accommodate this international training requirement. The joint training recommendations identified in the UO2020 are broadly described and are as such not specific to current operational requirements. We need something that is specific and is linked to current operational requirements for multi-national training if industry is to take direction from these conclusions. As the need for multi-national training is not specific to urban operations, it might be useful to investigate if NATO has specific multi-national training requirements that have an urban element.

4.4 DISCUSSIONS

4.4.1 Changing Military Requirements – Impact on the UCATT Architecture

The operational trends have a major impact on all military levels of conducting operations. However, it is not a simple matter of doing different things or doing things differently. In addition to having to be able to execute their traditional tasks, the military will have to execute more tasks, in a more complex physical and social environment – and they will have to be more adaptable, with more responsibility being allocated at the lower command levels.

From these observations it can therefore be concluded that existing requirements on urban operations training equipment are still valid, and in fact are even more demanding. Military users still have to be able to practise offensive, defensive and stabilising activities in an urban environment. However, the training environment and training possibilities should be enhanced by populating the environment with more civilians and other actors. New technologies and systems should be incorporated and new Tactics, Techniques and Procedures (TTPs) should be supported. Also, the use cases that have driven the requirements for UCATT are still valid; and it could even be argued that the need to integrate live, virtual and constructive simulation has increased. Thus it is clear that the UCATT standard must have provisions for enabling live, virtual and constructive simulation (see Section 4.4.2).

This will not change the philosophy and the design of the UCATT archtecture. Identified external interfaces are still required and the standardisation efforts are well on track. New requirements could require changes to existing interfaces or even new external interfaces. During its existence, the UCATT-2 working group has looked into capability gaps resulting from user requirements and existing training systems. So far, it has identified two possible candidates for new external interfaces. These issues are discussed in Section 3.2.4.

4.4.2 Live, Virtual and Constructive (LVC) Simulation

Simulation systems are commonly classified into three categories: live, virtual and constructive. In 'Live' simulations, human operators use real equipment in a real environment to perform their tasks. Examples of live simulations are field exercises in instrumented ranges. 'Virtual' simulations are characterised by human operators that use simulated equipment in a simulated environment, for example a pilot in a flight simulator. In 'Constructive' simulations, we find simulated players (artificial intelligence, often at an aggregated level) that control simulated equipment in a simulated environment. An example is a wargame that represents units at brigade level.

The characteristics of these types of simulation in terms of operators and environments are depicted in Figure 4-3. This gives rise to a fourth type of simulation, the use of simulated players in a real environment. This is augmented reality and is often seen as a special case of live simulation.

		Environment	
		Simulated	Real
Actors	Real	Virtual	Live
	Simulated	Constructive	Augmented reality

Figure 4-3: Types of Simulation.

Simulation applications can be used for several different types of purposes, such as training and instruction, doctrine development, simulation based acquisition, concept development and experimentation. Which simulation type is best suited, depends on the objectives of the project – however each simulation (type) has its own characteristics, advantages and drawbacks.

The strength of live training is that it is the best known way to consolidate practical knowledge and also has the highest level of fidelity and friction. For example, skills and drills (techniques) in an urban environment can be best trained or evaluated in a live environment, because other simulations lack the required level of detail and interaction with the physical infrastructure. Weaknesses are that changes in the physical environment as a result of weapon effects, can only be simulated very poorly (e.g. the destruction or breaching of a wall), and that the live environment requires the full sets of soldiers and equipment and consumes a lot of time. Moreover, many Nations face the challenge to populate these environments sufficiently with own forces, opposing forces and non-combatants. Additional (role) players and equipment (e.g. UAVs) are rarely available due to operational needs, costs or other limitations.

Strengths of virtual simulation are that they can represent any physical environment and also any realistic changes to that environment (e.g. holes in walls, collapsing buildings). Individual soldiers or a small team of soldiers can train procedures and decision-making with a reasonable fidelity without the full set of equipment and generally it is less time consuming than live training. Weaknesses are that virtual simulation never can provide the same fidelity of all senses as the live training. For example, interaction is done through keyboards or virtual reality helmets and/or suits. Therefore, virtual simulations are very suited for training and evaluating tactical procedures in a multi-player mode. Artificial intelligence can be used to simulate other players, but realistic communication and more complex behaviour is still very marginal.

The strength of constructive simulation is that (the behaviour of) units and other large numbers of personnel, can be represented at aggregated level. Commanders can train to perceive situations and make plans and decisions without using a full set of soldiers and equipment and in a time effective way. A weakness is that with the limited level of detail presented by constructive simulations, the operational environment can look less complex than in reality and can influence the training value.

Interconnecting different (types of) simulations can be a solution to combine the advantages of the individual simulations and mitigate the disadvantages. Examples are:

- **Constructive Wrapping:** A live simulation is placed in a broader constructive context. This way, the live part can focus on a detailed part of a much larger operation.
- **Virtual Enhancement:** A live simulation is extended with (large numbers of) virtual players and weapon systems.
- **Virtual Replacement:** Real sensors or systems of a live platform are replaced or extended with simulated input.
- **Virtual Replay:** Live exercises are logged and can be replayed in a virtual or constructive simulation.

Of course, many other combinations are possible as well.

One question that often arises is how to balance the use of live, virtual and constructive simulations for training purposes. The question is tricky because it is like choosing between a teacher, a book or just ‘trial and error’ when to learn a trade. It is obvious that you will need all three, but depending on the trade and where the students are on the learning curve, the different types of simulation will be of varying importance. Occasionally the mix of LVC is listed as a good idea, but one should be aware that sometimes the mix of LVC simulation in the same exercise could look as a half-track vehicle – you get the limitations of both wheels and tracks. For example, when the level of fidelity is not managed well, a mix of virtual units in a live exercise has the risk that live players cannot see or engage virtual players, while those live payers may be covered and concealed in reality, but still be engaged by virtual players.

The lessons to be learned is that when considering interconnecting simulations and/or adding realism to a simulation, one continuously has to question the necessity of these issues with respect to the objectives of the project. Just because it is technically possible, while not contributing to a more effective or efficient process, is therefore never a good reason.

4.4.3 C4I

The operational environment is becoming more digitised. At all military levels, from the highest headquarters to individual soldiers on the ground, equipment and functionality are added to improve the effectiveness and efficiency of the conduct of operations. C4I systems (Command, Control, Communications, Computers and (military) Intelligence) are a category of systems that support military Commanders to direct forces, by providing insight in the actual status of actors and (weapon) systems in the operational environment, assisting in decision-making and enabling fast distribution of orders.

As C4I systems are introduced into operations, they must also be incorporated into training and training systems as well. When C4I systems are used by the training audience, the training staff should be able to monitor the information that is displayed by the C4I systems of each trainee, to monitor the interactions of the trainees with the C4I systems and even to inject input into the C4I systems, e.g. to issues orders from a higher control headquarters. UCATT-1 already expressed the assumption that many of these requirements can be fulfilled when (embedded of emulated) C4I systems are issued to members of the training staff. However, for training purposes extra functionality for the C4I systems could be required and it could even be required that information has to be exchanged between C4I systems and training systems. Exactly for the latter purpose, the UCATT functional architecture has identified two interfaces that accommodate the interoperability of C4I systems and (urban operations) training systems:

- **E6**: The interface from C4I systems to the “capture data” function of a training system; and
- **E7**: The interface from the “manage data” function of a training system and C4I systems.

Of course it is also possible to use different C4I systems in the operational and training environment. However, interoperability among C4I systems themselves is considered to be outside the scope of the UCATT mandate.

Other NATO RTO NMSG working groups are addressing the standardisation concerning Command and Control (C2)-simulation interoperability. In particular, they are investigating a Coalition Battle Management Language (C-BML). This is an unambiguous language for digitised representation of a Commander’s intent, orders, plans, reports and information requests. It should be used for live forces, for simulated troops and for future robotic forces, both in real-world operations and in simulated situations. C-BML provides the capability to exchange the required context through digitized messages and returns for situational awareness and a shared common operational picture. C-BML is particularly relevant in a network-centric environment for enabling mutual understanding and collaboration.

MSG-048, titled “Coalition Battle Management Language (C-BML)”, has conducted a series of experimentations from 2006 to 2009 that has led to the conclusion that C-BML holds promise for enabling C2-simulation interoperability. The Simulation Interoperability Standards Organisation (SISO) C-BML Product Development Group (PDG) was chartered to elaborate C-BML specifications and MSG-048 has provided inputs to improve and extend the existing draft specifications based on a reference implementation and coalition experimentation.

Currently, another NATO RTO NMSG Task Group, MSG-085 (the successor of MSG-048), addresses the C-BML scope and requirements. The main and central focus will be interoperability between C2 and simulation systems, but possibly other applications should be explored (C2-ISR systems, C2-CIMIC, etc.). The topics to be covered include, among other things, the operational use of C-BML to enable interoperation of C2 systems and simulations within a coalition. The overarching concept is to seamlessly control the simulation from the C2 systems without interfering with operational databases, while preserving legacy C2 system interfaces. The Task Group will also investigate specific technical issues such as C2 and simulation systems initialization (e.g. through the use of SISO Military Scenario Definition Language), exercise control and time management.

Also the outcome of MSG-091, titled “Identification of Command and Control, M&S Gaps”, running from 2010 to 2011, is of particular interest.

From the UCATT perspective it is recommended to investigate whether C-BML can serve as E6 and E7 standard, and if so, what additional requirements UCATT might impose on C-BML and how those can be addressed.

A final comment to make is that when C4I systems and simulation systems are integrated for training purposes, additional requirements for the C4I systems arise. One such requirement is that C4I systems must be able to simulate damages or destruction as a result of activities in the training environment. Another example is a biometric system that monitors the health of a soldier. When that soldier is killed in the training environment, the biometric system is still registering the normal physical functions such as their heartbeat. However, in communication with other systems in the training context, it should reflect the simulated status of the soldier instead of the actual status. This is technically possible, as long as such requirements are taken into account in the design phase of C4I systems.

4.4.4 Laser

We can see some development in laser in longer wavelengths (> 1200 nm). The reason for this is that the safety limits are less restrictive in some frequencies and offer superior performance in smoke and fog environments. For a one-way system, the relaxation in laser safety requirements would allow for a theoretical range increase, but the component cost will increase significantly. For two-way systems, that transmit more data the relaxation in laser safety limits is quite modest and the range performance would decrease with a significant increase in cost of components. With evolution of new detector materials, it might be possible to obtain a range increase in the future. The conclusion has to be that, at this point, it is not cost efficient to take advantage of the marginal improvements provided by longer wavelengths. Therefore, for training purposes using 905 nm wavelength is expected to be continued into the foreseeable future – but as with all statements regarding technology, this conclusion must be re-evaluated within ten years.

4.4.5 Levels of Fidelity

In discussing the requirement for interoperability, it has become increasingly clear that Nations will specify a training facility that meets their internal training objectives. Requirements that accommodate multi-national training at best take a second seat to homeland needs. This means that the capabilities of national training facilities will vary greatly, depending on missions, doctrine, budgets and even culture.

To support the interoperability of these variously capable national simulators, the UCATT group expects that the standards we are working – and the training facilities that are eventually procured with these standards in mind – need to have the ability to go to the lowest common denominator. This in turn suggests that a “minimum UCATT standard” should be identified and that levels of interoperability – and fidelity – might need to be defined for the tactical engagements simulators, for EXCON-EXCON communications, and even for positioning.

4.4.5.1 Position and Orientation Accuracy

For industry, the users' endless discussions of the level of necessary accuracy tend to be of no guidance at all. This makes it hard to make the right investments in technology and actually to some extent puts a wet blanket on technology development. The question cannot be seen as simple, since it is an outcome of different countries' training doctrines. It can also be divided into the purpose of the accuracy and the situation to be simulated. This gives a (at least) three-dimensional matrix of accuracy. One purpose of accuracy is of course the engagement that may or may not need high accuracy, and on the other hand we have the evaluation that may or may not need high accuracy. If we look into these two purposes we can see different situations. In the engagement situation we have for example a supporting fighting vehicle at 1000 m that must put suppressing fire to one part of the building, while own troops assault the other part of the building. This simulation must be quite accurate. An indoor situation that needs high accuracy is when an enemy is hiding behind the doorpost. The soldier that engages this kind of target will probably try to aim at the suspected location of the target and needs of course a simulation that rewards him for the right behaviour. On the other hand, when soldiers 'spray and pray' through a wall or two and the location of the target is not known, the accuracy of the simulation might be as good as any based on statistics. For evaluation purposes the picture shows the same patterns. For platoon exercises and above, the positioning accuracy might be good enough if it is possible to keep track of 'red or blue' terrain, but for soldier to squad level training it might be that not only the position of the soldier and the weapon, but also the orientation of these need to be reported.

The drive for accuracy to replicate is the nature of all simulation. To provide this higher accuracy needs better measurement, which means that there is more data to collect transmit and process. Even though it is possible to collect very accurate data, we are still limited to the available bandwidth, and when training over extensive areas, we are still relying on radio solutions with the pros and cons connected to that.

It is evident that the fidelity of the training is very dependent on the accuracy and timeliness of positioning data, and it also seems evident that a single technology will not satisfy all requirements. Nevertheless, here some minimum standard that bears some relationship with the urban environment should be defined: it is hard to believe that a training facility can adequately train soldiers for urban combat using tactical engagement simulators that have a minimum range of 10 meters, or that a realistic after action review of a squad level exercise can be satisfied with a positioning system that locates troops to the house only.

The situation now appears to be that procurement agencies are unable or unwilling to specify an adequate positioning accuracy because they assume that they cannot afford it, and hence industry has no incentive to work on a solution that would be adequate since no one is really asking for it. A change here would be welcome by industry.

4.4.5.2 Ammunition and Vulnerability Assessment

To make Nations able to train together it is not only necessary to standardise the E1 interface, but Nations also have to agree upon a common open ammo and vulnerability assessment model to achieve 'fair fight' in the training. Some countries have very simplified models (i.e. box targets) and others have complex target modelling with different protection levels on each surface and several different outcomes of a hit (i.e. mobility kill, weapon kill). As the calculation capacity in the simulators continues to increase, the ability to make even better simulations improves. A future standard will have much better modelling of vulnerability, but if the standard is to be kept unclassified, some adjustments must be made to the data. On the other hand, a future standard should make it possible to keep 'national vulnerability data' with better data than the open one to use in any country.

This is yet another reason why a minimum standard or "lowest common denominator" would prove useful. Unclassified vulnerability models, centrally modified and updatable via software, would go a long way to ensuring interoperability. Although it is important that the vulnerability model supports the E1 interface, the UCATT standard should investigate a new physics-based approach to vulnerability calculations that does not require a complex matrix of ammunition/target combinations that are difficult and costly to modify.

Even though we might recommend a minimum UCATT standard of fidelity, and Nations might actually purchase simulators based on this recommendation, these Nations will likely continue to push for maximum fidelity in their vulnerability models since this will also support the tactical evaluation of methods and equipment to enhance the military capacity. Although this secondary ability is not usually a stated requirement in simulation procurement programmes, it is nevertheless desirable. For this reason, if for no other, the users will continue to push the fidelity and accuracy of the simulation forward with the end result that the work for better evaluation data will introduce deviations from a set international standard and most likely this data will be considered as Nation classified. This can be supported if it is possible to have a national vulnerability model that can be easily swapped with a less accurate international standard. If this route is taken, one of the most difficult problems will be to have an agreed upon process to keep the international standard updated.

4.4.6 AAR

Currently each simulation system will have its own database in which to record an exercise. UCATT has addressed sharing of live 'ground truth' information through E8 but has not examined the requirement to deliver AAR from a single, combined data source.

There are two possible ways to achieve this:

- Pool information into a single database; and
- Provide a standard for database access such that any system can query another for exercise information.

The information that is stored in such a database should include:

- Ground truth – positions, events, status changes, etc.;
- C4I data – perceived ground truth, commands, radio comms, etc.;
- Order of battle – the organisational structure of the exercise and the capabilities of each entity (e.g. tank, soldier, weapons carried); and
- Video or other instrumentation sources of 'ground truth'.

To keep data access consistent, there are some common requirements such as accurate and consistent timestamps on events and a single entity ID database for all players. A common stamp is desirable.

Further work is needed to define the data structure of such a database to provide a common exercise data store that can be accessed by all training systems. This role could be fulfilled by UCATT-3.

4.4.7 Integration of Indoor and Outdoor Tracking

Today there is a stable market for outdoor training systems. The market for effective indoor systems is growing and the outdoor systems try to adapt to the new requirements of urban operation training. However, urban training needs to integrate both indoor and outdoor training to be satisfactory. Suppressive fire, breaching of walls, advance to objective, as well as assault must mainly be done outdoors and in support of the clearing of a building, and defending units have to be able put effective fire in the streets to be able to measure their training objectives. There may be special drill houses to train indoor fighting techniques, but the need for cooperative training between assaulting and supporting troops is likely to immerse in the future. Thus training systems of tomorrow will have to integrate indoor and outdoor training, and today there are no obvious single suitable systems available.

4.4.8 The Hole, Pole and Wall – Instrumentation for the Urban Environment

In the urban environment, the wall is often addressed as the main issue that restrains tactical training. That is all true as the wall may or may not protect from incoming fire, but always blocks the laser beam from our common training equipment. There are also other situations that have the similar negative effect to training. In generic terms they have been identified as the hole and the pole. The hole is the situation were the soldier takes cover in a foxhole, sewer entrance or cellar beneath ground where they can be reached by some but not all weapon systems – and never by laser. The pole represents the object of a telegraph pole, electric pole or a tree. These objects are frequently occurring in built-up areas and will in reality influence projectiles in different ways, but in the simulated training with laser there will be no effect. Some of the poles will also have secondary effects in reality, i.e. cutting of electricity for the whole neighbourhood.

For small training facilities there may be the possibility to instrument walls, floors and ceilings both indoor as outdoor, but it will never be possible to instrument all of the ground and tree growth from all directions. This makes it clear that these three generic objects form special Dynamic Objects (DO, see the UCATT-1 report) that have to be dealt with, but instrumentation is at this point not an acceptable solution in economic and practical terms.

On the other hand, the geometric pairing is making its advance on the technology market. As far as we can see today, geometric pairing will not have the same or better accuracy as laser with extensive instrumentation in the coming years. Even with extensive instrumentation the sum of errors in positioning and direction tend to be decisive at all ranges. Another drawback of geometric pairing is that there have to be a highly detailed virtual replica of the live environment to be able to simulate singular weapon systems. Up to today, the geometric pairing technology is best used for weapons with powerful warheads or statistical calculation for area fire, but as technology advances, these drawbacks will be reduced.

As we see it, the laser needs to be complimented by other engagement services, such as geometric pairing solutions – either as appliqué or embedded into the laser system.

4.4.9 Adding Non-Line-of-Sight Engagements to Training

The need of simulating non-line-of-sight weapon engagements is not new. In combat training centres of today, artillery fires can often be simulated by the EXCON even though the artillery shell itself is not simulated. In the battle field of today and tomorrow, and especially in the urban environment, the cooperation of direct fire, indirect fire and even air support is the normal way to do it. This makes the cooperation between forces and to share space between fires and forces an essential task to avoid fratricide. In the urban environment this picture also includes the closest vicinity of the soldier as they try to fire a rifle grenade into a window, but the granite bounces on the wall and lands by the feet of their comrades entering the building. The coordination has to be trained and one way to do it is to instrument all units and let them be responsible for their actions. Therefore, the recommendation is that training systems should handle non-line-of-sight events from artillery, air and naval engagements down to the path of the single shell because it may affect dynamic objects on its way to the intended target.

Chapter 5 – UCATT STANDARDIZATION AND SISO

One of the main tasks of UCATT-2 was to initiate standardization of identified external interfaces through SISO. The idea of using SISO as a standardization vehicle was raised during UCATT-1. In 2007 there was an agreement between NATO and SISO where NATO acknowledged SISO for development of standards within training and simulation. This agreement was also a justification for UCATT to continue the proposed route.

SISO has its background mainly in the virtual and constructive simulation domains. These domains are characterized by a large number of stakeholders both in industry and academia. The relatively small number of companies active in the live domain has raised a number of questions. Is there really a need? Is there an interest in the area? Are there enough resources to put in? Over time an understanding between UCATT and SISO has however evolved. UCATT is today a study group under SISO. A lot of progress has been made, but outside the three official and annual SISO meetings. This has been brought to SISO's attention and it is expected that UCATT soon will become a SISO Product Development Group. This is the point when the formal development of a standard is started.

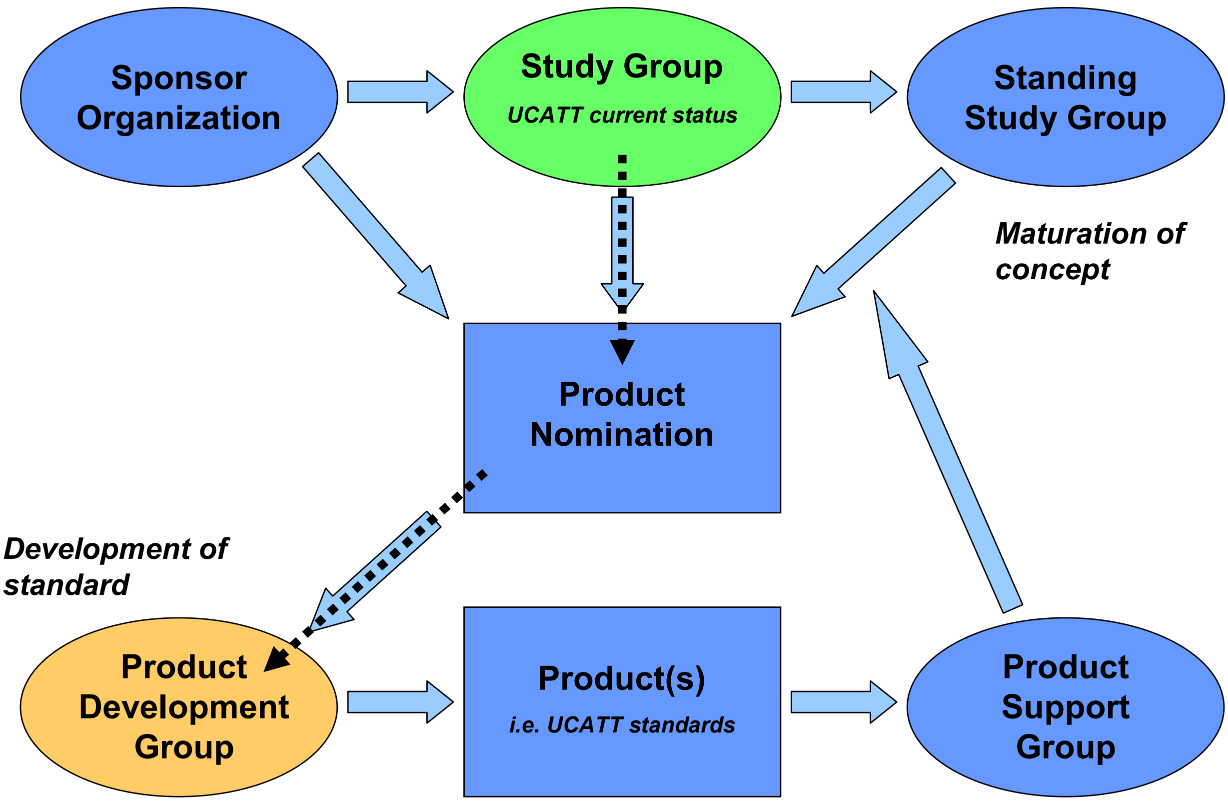


Figure 5-1: UCATT Path in SISO Balloted Product Development and Support Process.

Even if the progress has been slow, so far it is still the opinion within UCATT-2 that the decision to develop standards under the SISO umbrella using an established process is correct and that the group should continue this route. Standardization work shall however be done during the UCATT meetings. One of the UCATT members shall continue to take part in SISO meeting as a liaison officer reporting progress. The SISO process shall be followed in order to finally reach a consensus around the proposed standards developed by UCATT.

Chapter 6 – INTEROPERABILITY DEMONSTRATION

According to the TAP and TOR, one of the major tasks of UCATT-2 was to organize and conduct an interoperability demonstration to prove some of the concepts of the functional architecture.

This demo was held in September 2010 at the urban training facility at Marnehuizen in the Netherlands. It was organized as a presentation for the members of NMSG and to international decision-makers in the live domain.

The following sub-sections describe how this demonstration was planned, organized and conducted.

6.1 CONCEPT AND MANAGEMENT/ORGANIZATION

6.1.1 Technical Concept

Concept of the demo was to bring all six systems of the UCATT-involved industry partners together. The focus was set to demonstrate feasible standardisation of the two most important external interfaces:

1) E1 for the engagements; and

2) E8 for the system to system information exchange.

For E8-representation, a proprietary data gateway system from SAAB was used (WISE) to connect three of the systems. It provided connectivity with various interfaces and standards e.g. HLA, DIS and also proprietary interfaces. A common set of telegrams was defined to exchange all information necessary for the demo. The remaining three systems were integrated directly utilizing native HLA and/or TENA with an HLA translator.

For E1, Germany provided the OSAG-2 Basic code set to be commonly used amongst all laser simulators. OSAG-2 Basic is an open protocol distributed by the German BWB with some limitations in functionality and data handling, and therefore is not the proposed final UCATT laser code set.

The intent of the demonstration was to link the six EXCON systems of CUBIC, NSC, SAAB, RDE, RUAG and TENETEC together and to have results from laser and geo-pairing engagements propagate through all the systems.

The results should be presented in one big EXCON on 6 different screens in parallel. In addition to this, video coverage of the live actions should be presented on a seventh screen.

6.1.2 Demo / Management Organization

At an early stage of the demo preparation (September 2008), it was decided to hand over the responsibility for the demo organization to a demo manager. The demo manager was also the lead of the newly formed demo sub-group and thus became a member of the UCATT steering group.

As demo manager, the UCATT group elected Mr. Armin Thinnes from Germany.

Responsibilities of the demo manager were the creation of a demo plan including all action items necessary, coordination of all participating companies and the host Nation, survey of workshops and onsite monitoring and coordination of the integration and the demo execution itself.

The demo manager was supported by a military and a civilian POC – Capt. Dennis de Weert, Dutch armoured infantry school, and Mr. Rudi Gouweleeuw, TNO, both provided courtesy of the Dutch armed forces.

6.2 LOCATION AND ONSITE SURVEY

As location for the demo, the Netherlands offered their MOUT training facility "Marnehuizen", about 30 km northwest of the city of Groningen.

During the 9th UCATT-2 meeting, a UCATT delegation went to Marnehuizen for a site survey to check the facilities and decide which part of the training village could be used. In a second survey mid-2009, the final decision on buildings was made. The confirmation of exact location and facilities to be used was vital for the development of the scenarios to be presented during the demo. During a third survey arranged for industry, all facilities to be used for the demo were taped on video. The video was provided to all participating partners.

6.3 DEMO/SCENARIOS

Based on the use cases and the possibilities and limitations given by the location chosen, a set of generic scenarios was created (see Annex H).

From these scenarios, the military sub-group, together with the demo-manager, created a step-by-step storybook with timeline for each and every day of the 14 demo-days. The scenarios covered all interoperability aspects that could be addressed with the two interfaces chosen.

On site, the scenarios were conducted by an exercise squad formed of soldiers provided by Germany, the Netherlands, Sweden and Switzerland. The soldiers were divided into 6 different groups. Each group was assigned to and equipped by one of the participating industries. The military Commander of the squad was the Dutch military POC. He communicated directly with the demo moderator (Dutch civil POC) and transferred the orders to the troops according to the respective scenario.

6.4 PREPARATIONS AND ORGANIZATIONAL ASPECTS

A lot of preparation had to be done beforehand to ensure a successful demo, e.g.:

- Provision of soldiers by the different countries up to 9 months in advance;
- Organization of transportation and storage of weapons and ammunition;
- Preparation of NATO-order;
- Invitation of spectators and press;
- Coordination of lodging, travelling and catering of the soldiers as well as the guests;
- Design and order of hand-outs and team uniforms; and
- Local arrangements with the barracks to provide meeting rooms.

All these preparations had to be finished before the actual integration phase could start.

6.5 DEMO/SET-UP

The general set-up is depicted in Figure 6-1.

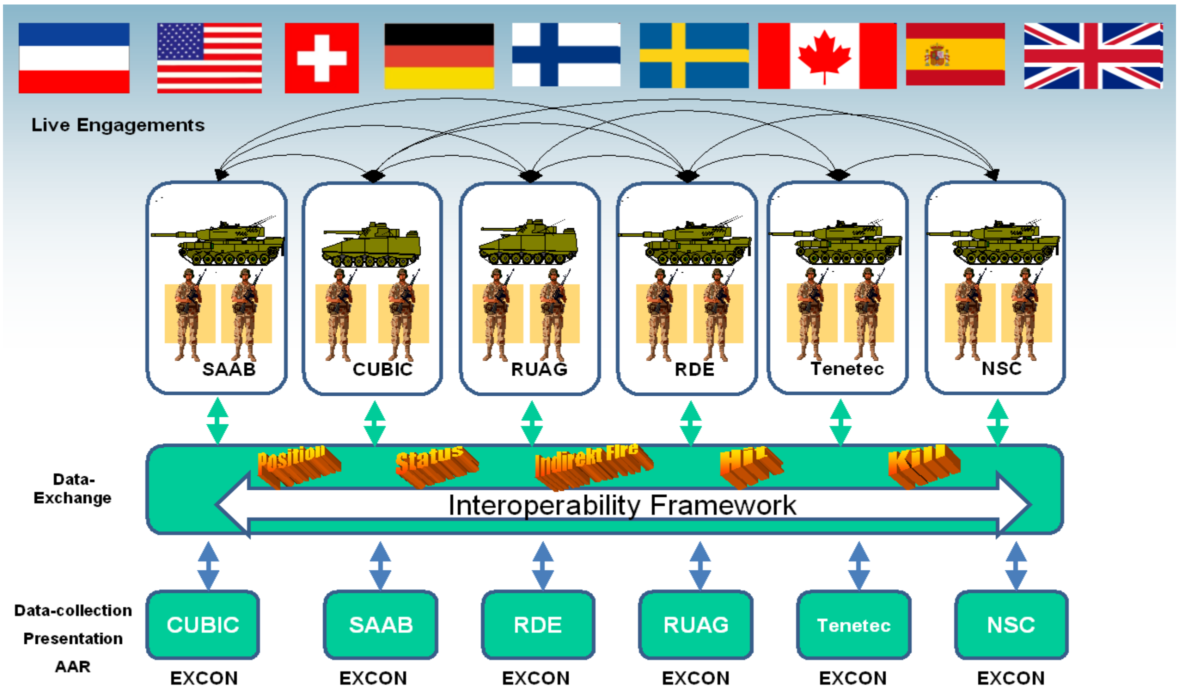


Figure 6-1: General Set-Up.

In the field, three buildings were used, as shown in Figure 6-2.

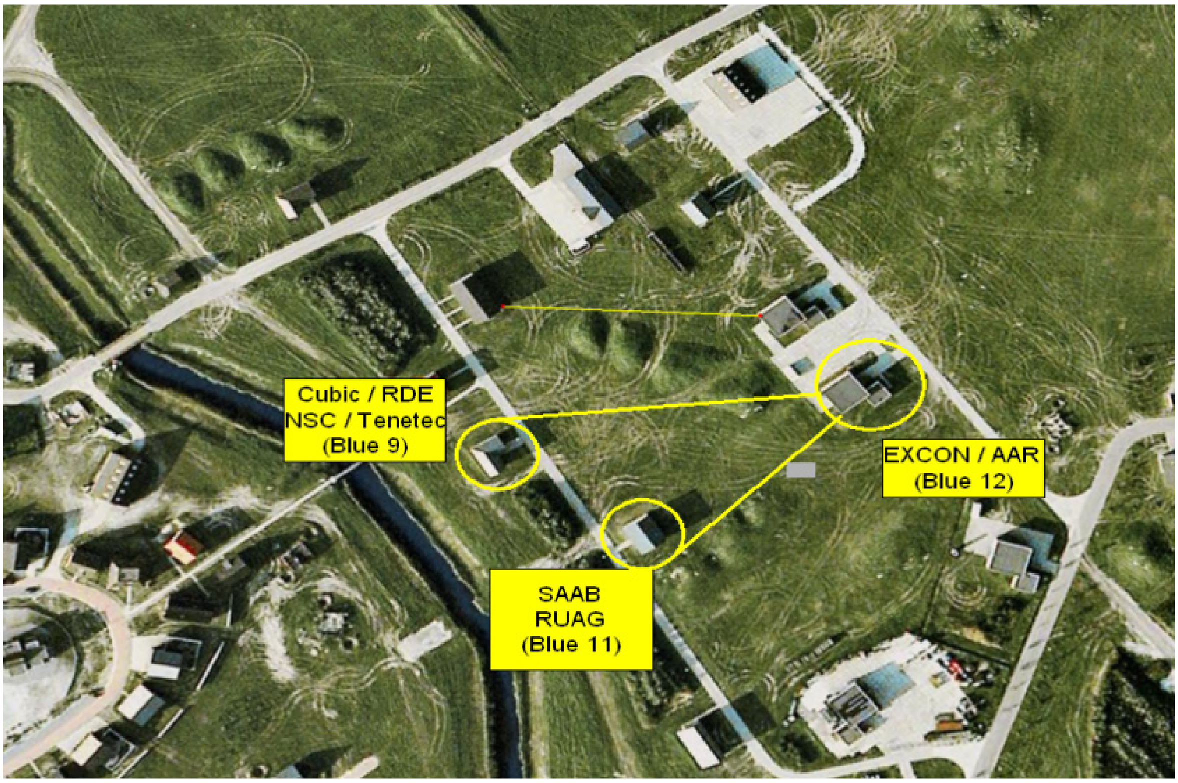


Figure 6-2: Building Overview.

6.6 PREPARATION

Due to the good preparation using early pre-integration workshops, only 2 weeks would be required to deal with onsite integration: the first week to connect all systems together; the second week to make the proper rehearsals.

It was an optimistic decision as during the testing, interconnection problems with the EXCON-to-EXCON interface emerged. It took a little bit longer to sort this out, but because of the excellent cooperation between all participating companies, the group managed to stay on schedule. The result of this interconnection task was an HLA federation agreement that could be used as a basis of an E8 standard for this kind of interface.

Parallel to the technical preparation, the rehearsals with the soldiers was due to commence. It took two days of practice to ensure a smooth performance. Despite all the problems, through the dedicated efforts of all, the group was able to have a running system and well prepared actors for the first presentation, just in time.

Since all of the laser engagement products to be utilized for the demonstration had the capability of being programmed to transmit and receive OSAG-based codes, it was decided to utilize an open version of the OSAG II (basic) as the common basis for all laser engagements. Each company had to verify their implementation of the code set against the other company products prior to the demonstration. This required several operational test events prior to the demonstration to verify the equipment performance. By the demonstration date, all systems were correctly using a minimal subset of the codes to support the demonstration. Although OSAG II (basic) was used for this demonstration to simplify the integration effort, the ultimate UCATT laser code set will consist of a more robust and capable set with no proprietary content, standardized via SISO and open to all future industry developers.

To ensure final total interoperability, the laser-based systems must not only implement the UCATT code set, but also the physical compatibility guidelines for laser power, transmission wavelength, modulation timing, beam profile and propagation dynamics.

6.6.1 Individual Company Set-Ups

6.6.1.1 CUBIC

6.6.1.1.1 CUBIC Set-Up

CUBIC used the following hardware to perform the demo:

Player equipment:

- 4 player harnesses
- 4 SAT (AK5 / KSP 58 weapons)

Figure 6-3: CUBIC SAT and Player Harness.

MOUT equipment / building instrumentation:

- 1 shoot-through-the-wall simulator
- 12 room level IR tracking modules

EXCON:

- 1 desktop computer with three screens running PC-range instrumentation system plus a TENA / HLA gateway enabling interconnection with the other EXCON programs
- 1 portable radio base station

Figure 6-4: CUBIC Shoot-Through-the-Wall Detector Belt.

The player equipment was based on the combination of engagement modules from the Australian/Canadian combat training centres plus player unit modules from the US Army Homestation training system. From the Swedish soldier point of view, the system was perfectly transparent to their tactical operations. The small arms transmitters implemented one-way codes according to the OSAG-II (Basic) specification chosen for this demonstration. The harnesses were instrumented, providing real-time tracking of positions utilizing GPS and indoor IR-based tracking along with events from EXCON.

6.6.1.2 NSC TS

6.6.1.2.1 NSC Set-Up

NSC used the following hardware to perform the demo:

Player equipment:

- 2 weapon sensor direction/fire unit
- 3 soldier tag kit (RFID TAG)
- 1 RPG 7 with sensor/fire unit
- 3 Personal Audio System (PAS)

Figure 6-5: NSC Soldier Equipment.

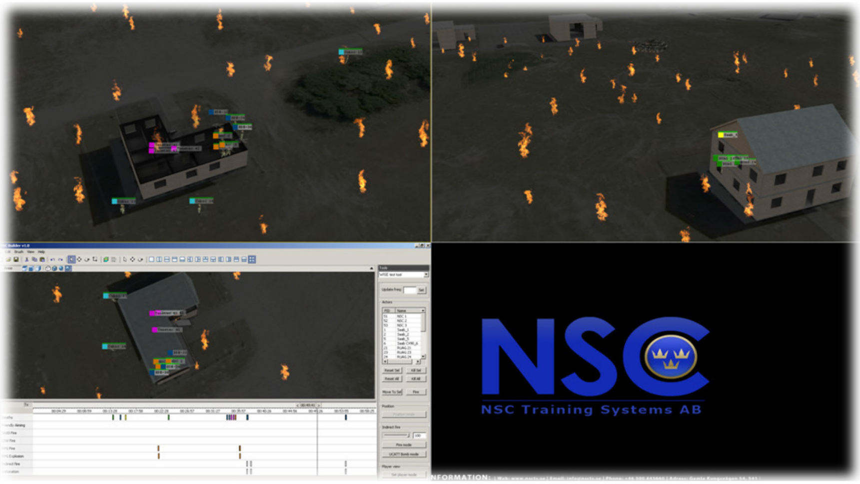


Figure 6-6: NSC EXCON 4 Split Screen.

Figure 6-7: NSC Mobile Wireless Positioning Matt.

6.6.1.2.2 MOUT Equipment / Building Instrumentation

3 positioning wireless mats integrated in two rooms covering an area of 30 m² plus 10 m² (0.3 accuracy).

6.6.1.2.3 EXCON

One desktop computer, with a four-way split screen, running EXCON for total real-time information and exchange between the different EXCONs.

6.6.1.2.4 Fighting a Tank/Target in the Field

In order to fight and eliminate the CV 90 in the terrain, NSC fired a RPG7 from inside the building through a window. This was performed by using NSC's non-laser-based technique. This was technically possible because of the knowledge of the CV 90's positioning (GPS – Global Positioning System) in the terrain and the positioning of the RPG shooter in the house.

6.6.1.3 RDE

The legacy system approach of Rheinmetall Defence Electronics (RDE) has basically similar interfaces as the UCATT architecture. So Rheinmetall was prepared to support the demonstration in order to validate the suggested interfaces E1 and E8.

6.6.1.3.1 Rheinmetall Set-Up

The Rheinmetall set-up for the demo was based on two LAN circuits, one was responsible for the data exchange between Rheinmetall computers and video equipment in the building, the other LAN implemented the E8 interface. The interconnection with the participating companies was arranged with the external LAN connected to the HLA Interface on the EXCON workstation.

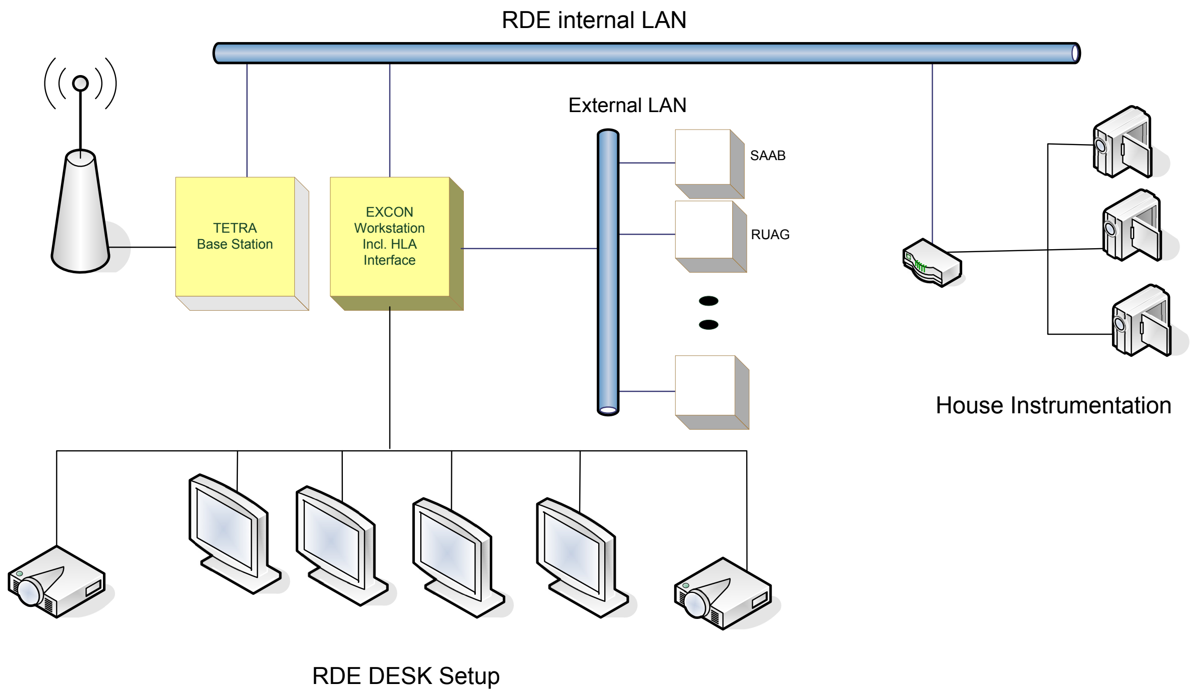


Figure 6-8: RDE Diagram Communication Infrastructure.

The Rheinmetall EXCON was represented by one workstation including all functions, like the audio/video functionality, the data unit with tactical display and player status, the AAR review capability and exercise preparation functions. To support the presentation for additional spectators, two large screen projectors were installed.

The projector view could be selected from the available screens on user demand.

Figure 6-9: RDE Screen Arrangement.

In order to prepare, control and monitor the exercise, Rheinmetall used up to four screens with different views. All screens were equal in their capability and could be switched from one function/view to the other.

The top left screen showed the 3D viewer in order to visualize the urban operation training details. The top right one was foreseen to display all possible video streams in a proper way and displayed the control functions for tactical radio and observer/trainer radio as well. The bottom left one showed the tactical map (satellite images as well as military type 2D maps in different scales were available), the last one bottom right showed as well the tactical map and was used for additional control function.

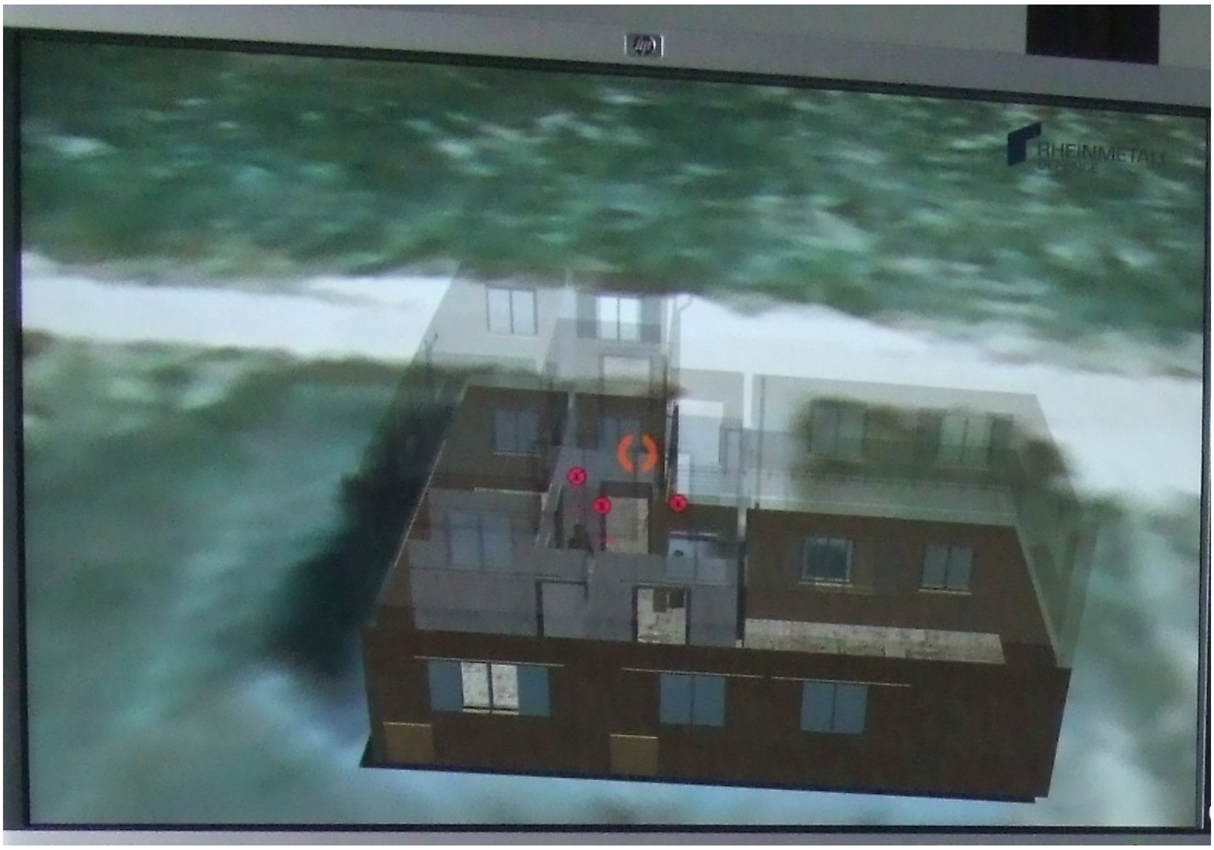


Figure 6-10: RDE Urban Operation Image.

In order to display urban operation details, Rheinmetall had realized a transparency view of the buildings. The grade of transparency could be adjusted to the viewer needs in order to work out the details of their attention.

A workstation provided the functionality and communication infrastructure. The TETRA radio base station provided the wireless data network. The situation in Marnehuizen required one radio base station for one TETRA radio cell only. This basic configuration of the TETRA radio base station was capable to handle data as well as voice communication. In this configuration, up to 200 players could be handled.

Figure 6-11: TETRA Radio Base Station and EXCON Workstation.

The task in the field was to provide 5 individual player instrumentation sets including small arms laser transmitters and building instrumentation to simulate urban operation capabilities like indoor-position-tracking, shoot-through-the-wall simulation and in-room indirect fire effect simulation.

The indoor position tracking task was fulfilled with the help of infrared beacons. The coded infrared beam of the beacon leads to the room associated player position within the building.

Figure 6-12: Indoor Beacon.

In order to allow differentiated building vulnerability models, the building was equipped with angle selective, wireless connected laser sensor modules. These Laser sensor modules are able to detect different directions of incoming laser beams.

Type of ammunition as well as the direction of the attack is considered. An evaluation module receives data from each sensor module via a wireless link. The decoded attack information is evaluated based on a building vulnerability model. The result is in accordance with the structural composition of the building, e.g. a fatal impact can lead to a “virtual” collapse of the building. This effect is transmitted via TETRA to the soldiers occupying the building. If they are within the damage zone, their vulnerability status will be changed accordingly. The sensor module has a flashlight to indicate that an impact has occurred. A pyrotechnic hit effect unit dedicated to the evaluation module shows the effect on the building for all players.

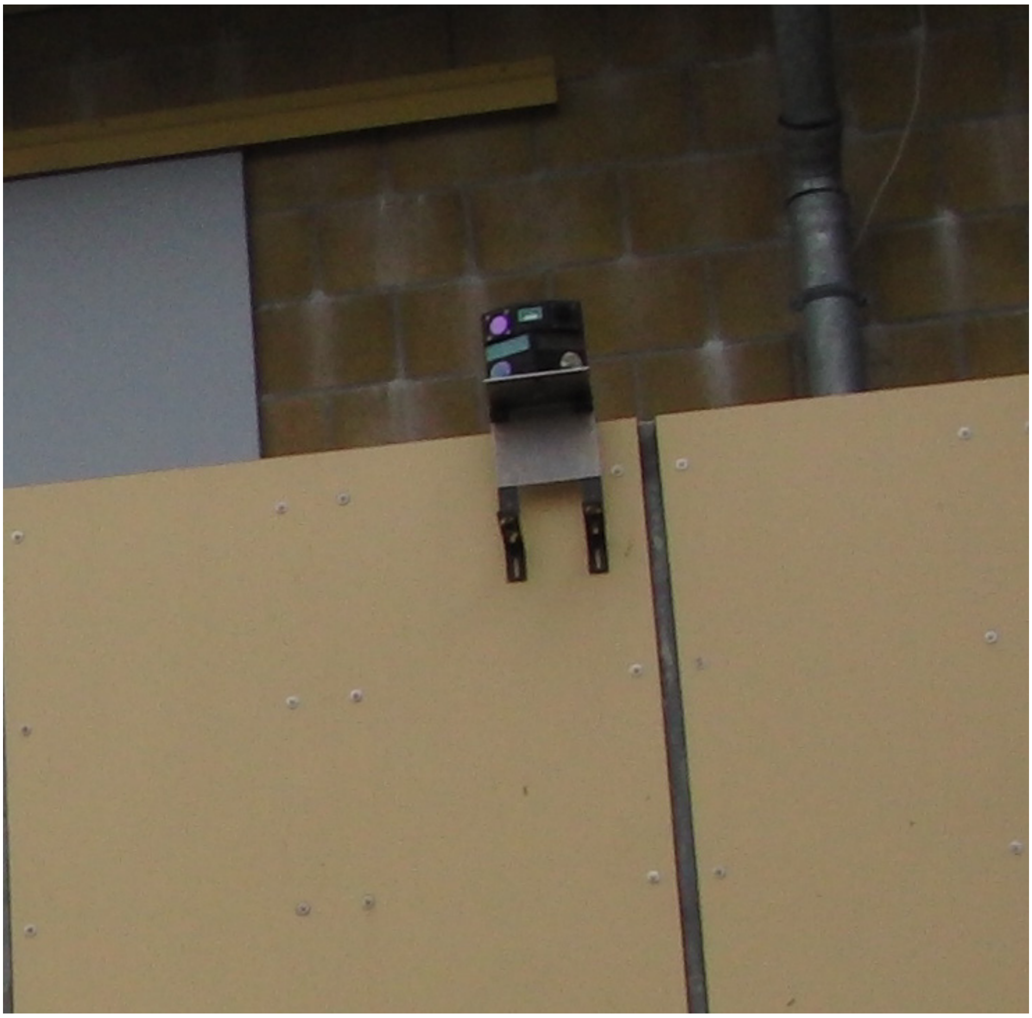


Figure 6-13: Wireless Sensor Module.

For the demonstration exercise 5 players were equipped with small arms laser transmitters for their G36 rifles and a soldier target system, both systems based on the OSAG 2.0 Basic laser code standard. The soldier target system included an integrated TETRA radio module, integrated data antenna, GPS receiver and wireless laser detectors. A bracelet with a display indicated the actual status to the soldier. A sound device informed the soldier about a simulation event status change. All components interfaced via a personal area network.

Figure 6-14: Soldier Target System.

6.6.1.4 RUAG

6.6.1.4.1 RUAG Set-Up

RUAG served all parts of the UCATT demo for the external interfaces E1 and E8. Therefore the following material was used:

Player material:

- 5 Integrated Harness Units (IHU)
- 5 Universal Helmet Units (UHU)
- 5 Integrated Laser Units (ILU) for Swiss Sturmgewehr 90 (Stgw 90)
- 1 simulator for Antitank Panzerfaust 3

Building material:

- 12 Precise Tracking Sensors (PTS)
- 1 PTS receiver
- 1 PTS controller
- 1 universal building receiver
- 1 POE switch
- 1 generator for flash, sound and smoke
- 2 laptops for technical control
- 1 field transponder
- 1 building transponder

EXCON:

- 1 laptop computer
- 1 beamer
- 1 video-screen
- 1 switch

Field instrumentation:

- 2 field transponders

6.6.1.4.2 Functional Description

The RUAG player material was worn by Swiss soldiers that have been instructed in the use of the material. The ILUs adapted to the Stgw 90 were programmed to send the OSAG 2 Basic One Way Code to interoperate with the other equipment. The simulator for the anti-tank weapon Panzerfaust 3 was provided by the Swiss Armed Forces and was programmed to send the OSAG 2 Basic Two Way Code to take effect on the CV9035. The player material was also capable for indoor tracking (PTS) and outdoor tracking (GPS). Also the control of the players via EXCON was possible.

Figure 6-15: RUAG Player Material IHU and UHU.

The 2 rooms were instrumented with the PTS to allow precise tracking inside. The system is based on ultra-sonic and radio. For the attack on the building a combined universal building receiver was used, to allow measurement and data transmission by laser simulators. For both systems, POE was used to connect the units to the building control system. A rack-based generator for flash, sound and smoke and a pyrotechnic-based COPAS 24 were used to show the ammunition impact on the walls. The connection between building and EXCON was done by LAN. The players were connected to the system via radio link to a field transponder for outside and a building transponder for inside the building.

Figure 6-16: RUAG Generator for Flash Sound and Smoke.

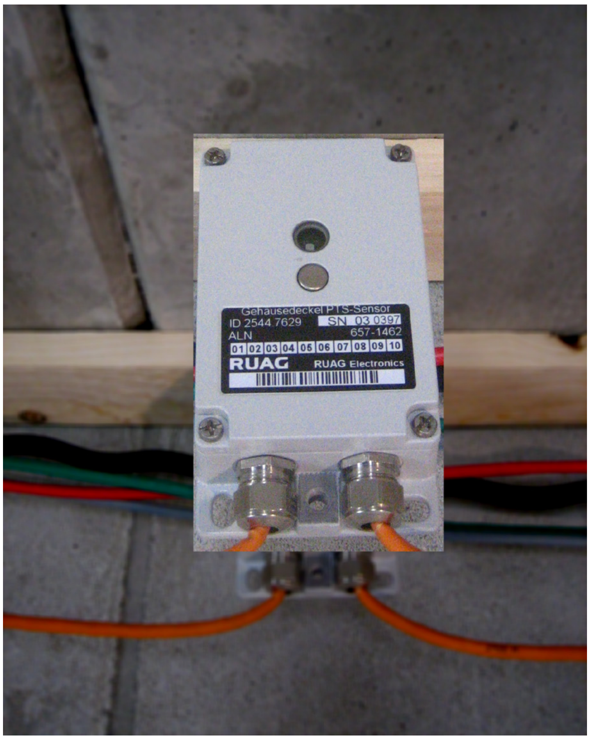


Figure 6-17: Precise Tracking Receiver.

Figure 6-18: Universal Building Receiver.

In the EXCON building, one EXCON Laptop managed the communication to the instrumented player and building material. The laptop also had connections to the SAAB WISE System and a video projector to display the area with all participants.

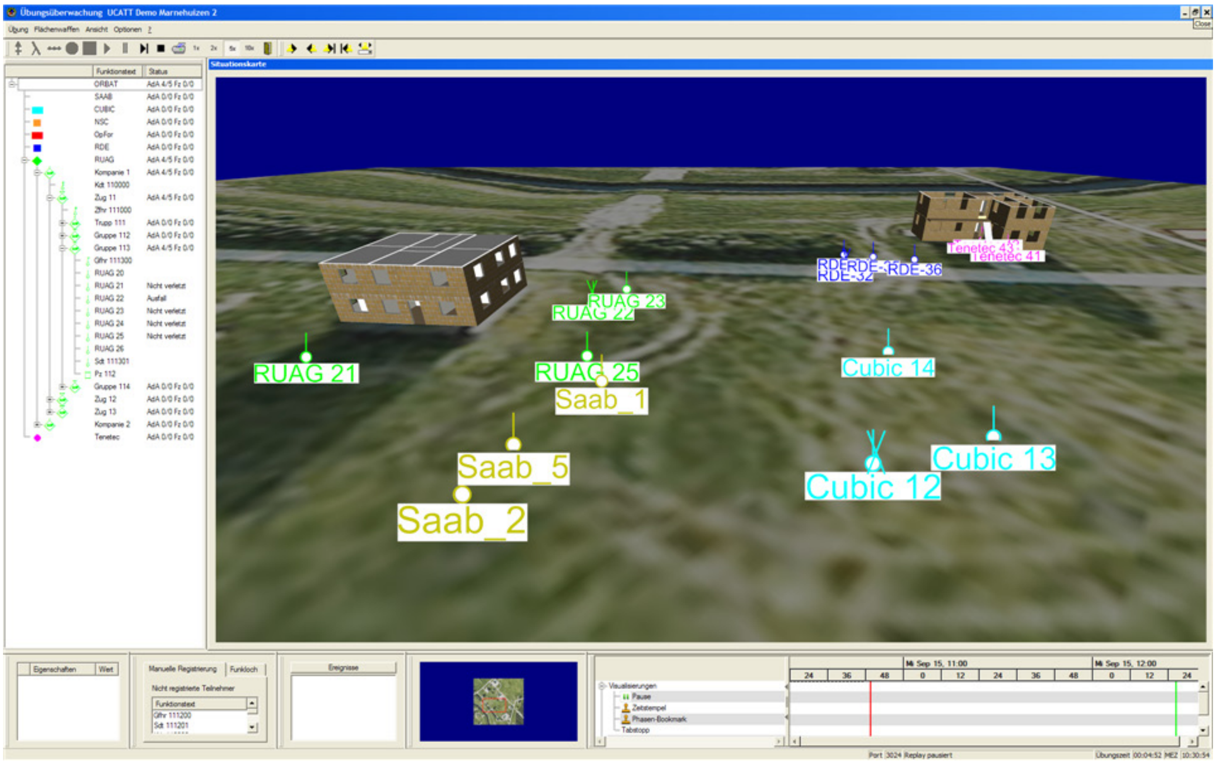


Figure 6-19: EXCON View.

6.6.1.5 SAAB

6.6.1.5.1 SAAB Set-Up

SAAB used the following hardware to perform the demo:

Player equipment:

- 5 player harnesses
- 5 SAT Diemaco C7/C8
- 1 SAT Minimi
- 1 ATW Panzerfaust
- 1 CV90 BT46 vehicle system NL

Figure 6-20: Player Harness.

MOUT equipment / building instrumentation:

- 1 Structure Effects Simulator (SES)
- 1 Structure Information Device (SID)
- 25 Room Association Device (RAD)

EXCON:

- 1 desktop computer with double screens running WinEXCON and WISE, the latter supporting the information exchange between the different EXCONs
- 1 portable radio base station

Figure 6-21: Portable Radio.

6.6.1.5.2 Functional Description

The player equipment was provided by the RNLA, thus the Dutch soldiers who were participating in the exercise were already familiar with the equipment. From their point of view, the software modification was perfectly transparent. The Small Arms Transmitters (SAT) implemented one-way codes whereas the Panzerfaust and the CV90 implemented two-way codes and the one-way scanning according to the OSAG Basic specification. The CV90 was, during the demonstration, used for firing both coax and main gun. Both the vehicle and the harnesses were instrumented, providing real-time tracking of positions and events from EXCON.

Figure 6-22: RAD, SES with Target Belt and SID.

In order to instrument the back entrance, the staircase and the first floor of the Blue 11 building, SAAB used its deployable and battery powered MOUT products. The Velcro-mounted RADs provided room level tracking and the SES with retro reflectors for both one-way and two-way interoperability was mounted by one of the windows. The SES also provided the secondary effects to the soldiers occupying the building, as applicable to their respective positions.

6.6.1.6 TENETEC

6.6.1.6.1 TENETEC Set-Up

Player equipment:

- 3 soldier tags (VTAGs)
- 4 weapon kits (VTAG/fire unit)
- 3 soldier alarm systems
- 1 power over Ethernet switch
- 1 RF transmission module for soldier alarm systems

Figure 6-23: Soldier Equipped with VTAG and Weapon Kit.

6.6.1.6.2 MOUT Equipment / Building Instrumentation

18 data capture modules for positioning and engagements.

Two rooms covering an area of 30 m² plus 10 m² outdoors (> 0.05 meter accuracy).

Figure 6-24: TENETEC Participants are Represented by Cones Showing the Direction of the Head.

6.6.1.6.3 EXCON

One laptop computer running EXCON for total real-time information and exchange between the different EXCONs. A projector and a screen for viewing.

6.6.1.6.4 Fighting a Tank/Target in the Field

In order to fight and eliminate the CV 90 in the terrain, TENETEC fired an RPG, equipped with a weapon kit from inside the building through a window. This was performed by using TENETEC's non-laser-based technique (geopairing). This was technically possible because of the knowledge of the CV90's positioning (GPS) in the terrain and the positioning of the RPG shooter in the house.

6.7 LIVE/VIRTUAL INTEROPERABILITY

E8 is the interface to exchange information between different systems. In order to demonstrate the interoperability with other systems than the EXCON applications of the participating live urban operations training systems, the demonstration also incorporated a virtual simulation of an Unmanned Aerial Vehicle (UAV) provided by TNO.

During the demonstration the simulated UAV was located above the Marnehuizen training area, where it flew user-defined tracks. Its onboard sensors, both daylight and infrared cameras, focused on the live players around the buildings. The UAV control application and the camera images were displayed in the EXCON building.

The information of the entities, such as their status and their activities, were distributed on E8, using HLA. The UAV simulation captured this data to feed its displays.

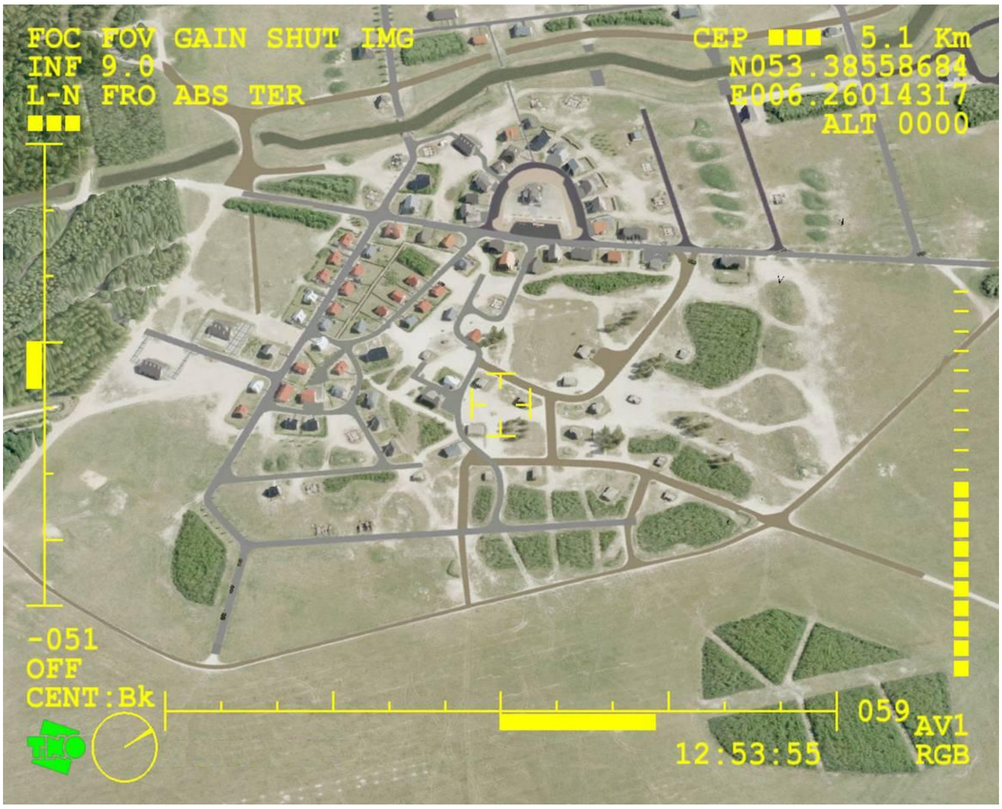


Figure 6-25: Screenshot of the Virtual UAV Display.

6.8 DEMO EXECUTION

After the arrival of the respective audience, an in-brief was held informing about the location the Dutch infantry armoured school, the history of and the concept behind UCATT and the demo itself.

After a lunch break the audience was transported to the training village. The Dutch moderator took over and guided the 20 minutes of live demonstration according to the timeline provided in Annex I. After all scenarios of Annex H were presented, the audience had the opportunity to walk around, look at the different instrumentations and ask questions. Following a coffee break, a souvenir (mug) was handed out to the guests and a final summary was given by the Chairman.

6.9 DEMO CONCLUSIONS

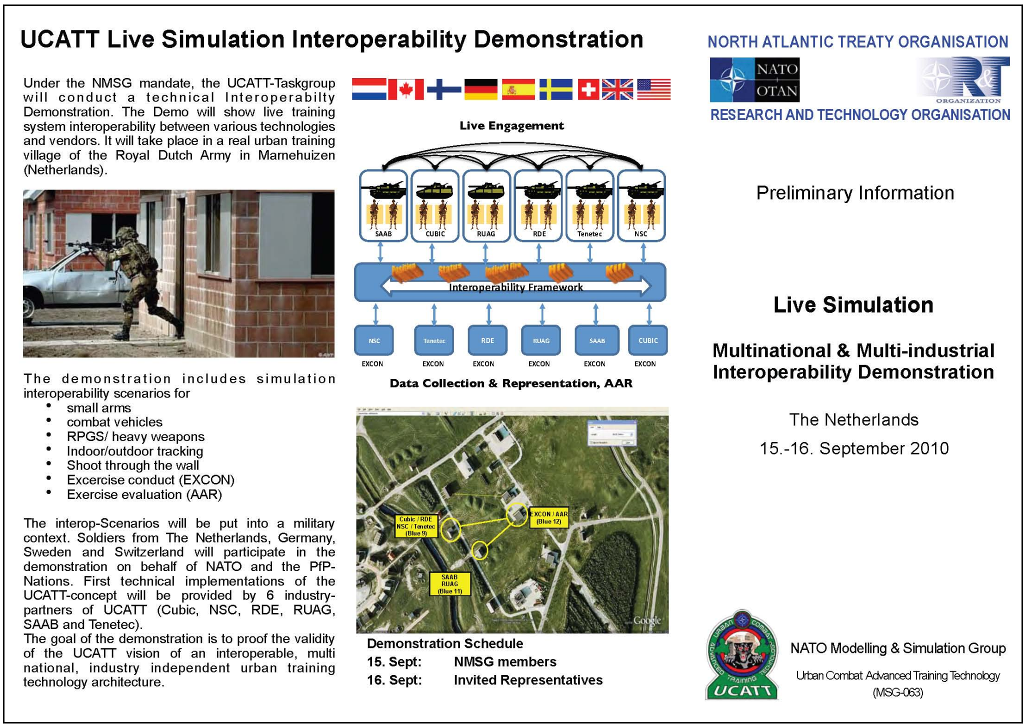
The system architecture described in the earlier UCATT report is an outcome of industrial experience and competence of all included parties in this group. This system architecture shows how the parts of a live-simulation approach interact and work together.

All planned parts of the demo were operational. Some of the functions took some time to implement and some compromises had to be made – but in the end, the demo was very successful. The audience got a good impression of systems-to-systems interoperability possibilities based on the UCATT architecture.

The feedback received after the demo clearly indicated that people were very impressed what UCATT has achieved during the last years and that fulfilling the user requirement of international interoperable systems is reachable by following the roadmap depicted and by implementing the standards created by UCATT. First feedback of the international press was very positive.

6.10 PR MATERIAL AND MEDIA FEEDBACK

6.10.1 Demo Flyer



UCATT Live Simulation Interoperability Demonstration

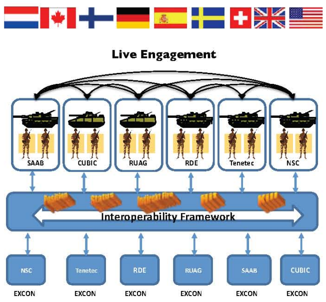
Under the NMSG mandate, the UCATT-Taskgroup will conduct a technical Interoperabilty Demonstration. The Demo will show live training system interoperability between various technologies and vendors. It will take place in a real urban training village of the Royal Dutch Army in Marnehuizen (Netherlands).

The demonstration includes simulation interoperability scenarios for

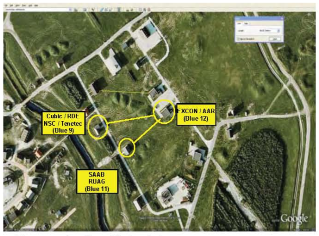
- small arms
- combat vehicles
- RPGS/ heavy weapons
- Indoor/outdoor tracking
- Shoot through the wall
- Excercise conduct (EXCON)
- Exercise evaluation (AAR)

The interop-Scenarios will be put into a military context. Soldiers from The Netherlands, Germany, Sweden and Switzerland will participate in the demonstration on behalf of NATO and the PfP-Nations. First technical implementations of the UCATT-concept will be provided by 6 industry-partners of UCATT (Cubic, NSC, RDE, RUAG, SAAB and Tenetec).

The goal of the demonstration is to proof the validity of the UCATT vision of an interoperable, multi national, industry independent urban training technology architecture.



Data Collection & Representation, AAR



Demonstration Schedule

15. Sept: NMSG members

16. Sept: Invited Representatives

NORTH ATLANTIC TREATY ORGANISATION

RESEARCH AND TECHNOLOGY ORGANISATION

Preliminary Information

Live Simulation

Multinational & Multi-industrial Interoperability Demonstration

The Netherlands

15.-16. September 2010

NATO Modelling & Simulation Group

Urban Combat Advanced Training Technology (MSG-063)

UCATT (Urban Combat Advanced Training Technologies)

The NATO Modeling and Simulation Group identified the need for common open standards and technical frameworks to promote the interoperability and reuse of models and simulations across the Alliance. Included in this requirement is the need for a common technical framework for "Live" training among members of the Alliance. Urban warfare is arguably the most deadly type of warfare and tends to neutralise the technical superiority of modern militaries. Nation's investments in the first generation of MOUT training facilities began in the early 1990s. Much has been learned over the past decade but there is minimal effort in the area of formal standardisation and interoperability.

RTO mandates UCATT task group to define solutions to harmonise training requirements and spearhead the effort toward common technical architecture and standards for the next generation of MOUT facilities.

UCATT approach was initiated to accelerate the process of defining training requirements, systems functional capabilities and technology specifications leading towards an interoperable set of product solutions to be developed and delivered by industry in order to meet the complex training needs in a very challenging urban environment.

UCATT, through its unique mix of government, military, scientific and industry partners has continued the accelerated development of the future interoperability model for all NATO urban training instrumentation.

Based on a military requirement for future urban operations, a generic functional architecture has been developed, functions and interfaces have been identified and prioritized.

UCATT will provide a set of military recommendations to achieve interoperability in live simulation as well as a set of candidates (functions and interfaces) to be standardized. The most important interfaces will be standardized in cooperation with SISO.

In September 2010 UCATT will show in a practical interoperability demonstration the first results of the future standards.

UCATT Demo Composition

Marnehuizen Training Village, in the northern part of the Netherlands, consisting of 120 objects designed for military training in an urban

NATO and Partner countries: appropriate government representatives (military, planning & procurement agencies, homeland security, etc) are invited to express their interest in participating.

Please contact MSCO staff for details
ganzi@rta.nato.int

6.10.2 Article Military Training and Simulation News

UCATT

A Paradigm Shift?

UCATT Live Simulation Interoperability Demonstration

Trevor Nash reports from the Royal Netherlands Army's Marnehuizen combat training centre on the recent UCATT interoperability demonstration.

During 15-16 September 2010 at the Royal Netherlands Army's Marnehuizen Combat Training Centre, the NATO Urban Combat Advanced Training Technology (UCATT) task group undertook a live interoperability demonstration. The results of this event have the potential to create a paradigm shift in the way nations undertake live training. The demonstration proved the validity of the UCATT vision of deploying an interoperable, multinational and industry independent urban training technology architecture for live training.

The UCATT working group operates under the mandate of the NATO Modelling and Simulation Group (NMSG) and has its roots in two key documents: NATO Land Operations 2020 (LO2020) and NATO Urban Operations 2020 (UO2020). The latter study was published in 2000 and concluded that, "...urban areas will continue to increase in number and size and are likely to become focal points for unrest and conflict. The physical and human complexity of this environment presents unique challenges for a commander which are not adequately addressed by those military capabilities designed for open environments."

Many of the UO2020 report recommendations concentrated on training and amongst others, called for more urban training facilities, to make greater use of simulators and the need for greater complexity in training. Clearly, post the publication of UO2020, events in Iraq and Afghanistan have only added to the validity of the report.

An urban Team of Experts (TOE) was created in 2001 to specifically address the issue of developing interoperability standards for urban instrumentation. The initial feasibility study that was published in April 2002 had the stated aim, "to investigate and recommend a generic set of unclassified requirements to be made available for all NATO/Partnership for Peace (PfP) nations to inform requirements and standards for development of instrumented MOUT capability. The generic requirement will specify and detail interface requirements."

Following this initial work, UCATT officially came into being in late 2002 and held its first meeting in the Hague, Netherlands in June 2003. UCATT has worked closely with NATO's Urban Operations and Training Simulation working groups ever since.

Participants in UCATT include members of the training industry, military end users, defence organisations and government technical advisors. Together, these players represent Finland, Sweden, Germany, UK, Switzerland, Netherlands, Spain and the USA.

Although a significant weight of 'serious' MOUT training players, there are of course some notable exceptions; France being the key omission.

Over recent years, UCATT has been working on a number of issues facing interoperability and has identified nine priority areas where interfaces need to be common. For the Marnehuizen demonstration, two key interfaces were developed: the so-called E1 interface for laser engagement interoperability and the E8 interface for the EXCON data interchange format interoperability. These are considered as the most important and relevant to the immediate needs of demonstrating an interoperable capability.

The draft specification for E1 was submitted to the Simulation Interoperability Standards Organization (SISO) in mid-2009 and prior to the demonstration in Marnehuizen, laser wavelengths were standardised to 904 nm and three and then four different Tactical Engagement Systems (TES) tested at IITSEC 2009 and ITEC 2010 respectively.

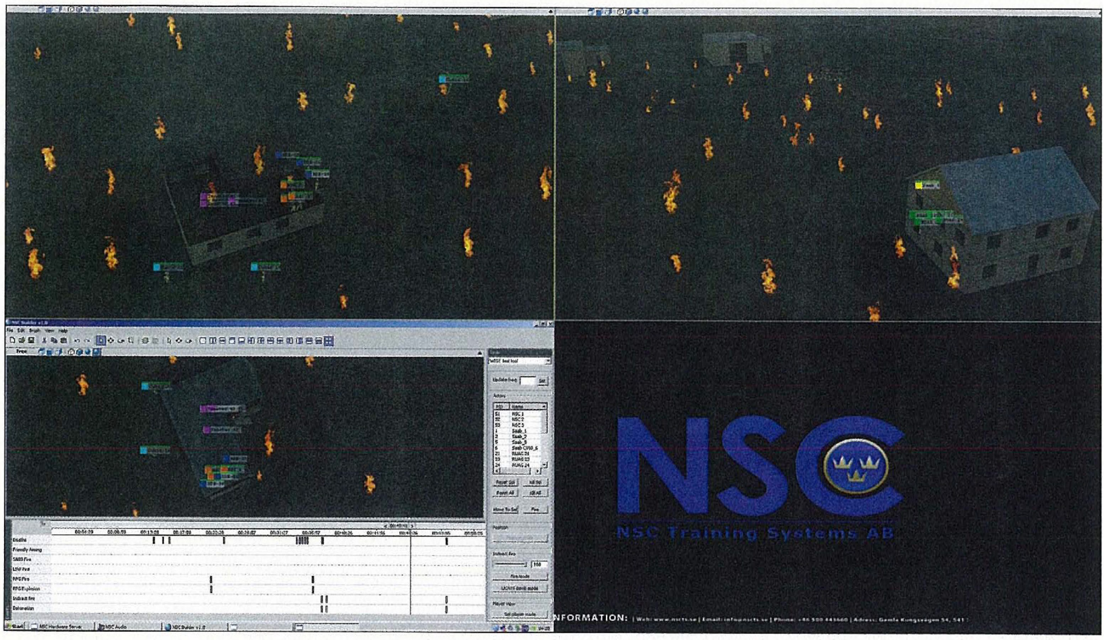
As far as the E8 protocol is concerned, DIS, HLA and TENA standards were considered but UCATT found DIS was too limiting and TENA was too computing power intensive for the job. The six industry partners in the trial (Cubic, New Swede Construction, Rheinmetall Defence Electronics, RUAG, Saab and Tennetec) verified interoperability through a Virtual Private Network (VPN) based on Cubic Simulation Systems Division's Orlando server prior to the demonstration in March of this year. With all systems go, thoughts then moved on to planning the Marnehuizen event.

A Swiss soldier, equipped with RUAG's laser-based tactical engagement system, prepares to engage enemy forces within a building using a Panzerfaust.

(Source: T. Nash)

Despite the whines and whinges often directed at the training and simulation industry *(often in MT&SN)* about their lack of initiatives in generating common standards, UCATT has been a real lesson in what can be achieved. Although a small amount of funding has come from NATO, UCATT has mainly been funded by the industry partners; a fact that is perhaps surprising

MT&SN Vol. 12 Issue 4 2010 Page 21.



A screen capture showing New Swede Construction Training Systems' EXCON. Individual industry EXCONs were able to communicate with each other and regiser all events during the demonstration.

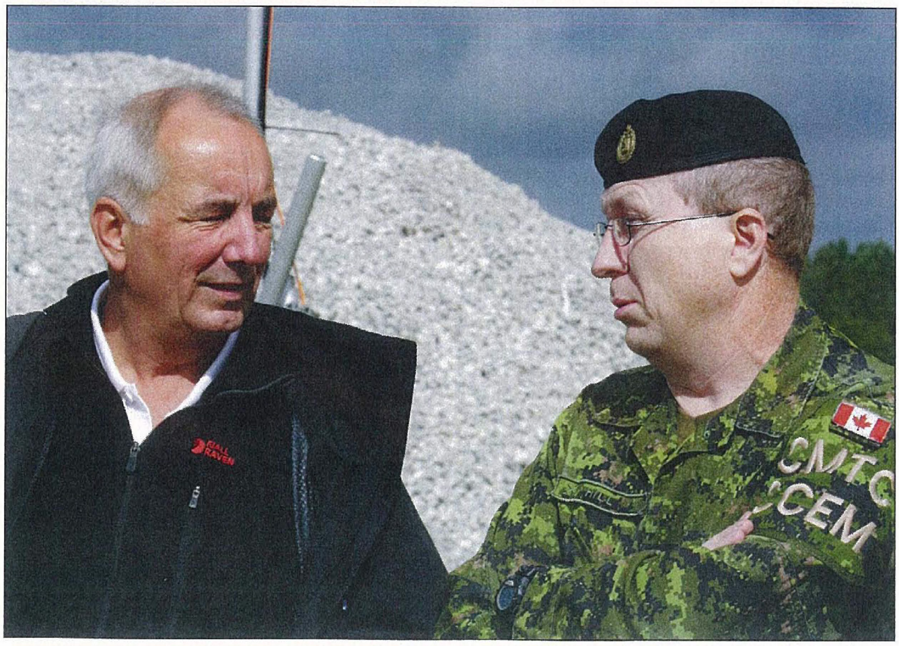
(Source: NSC)

considering the operational benefits that the system can bring to the user community.

"The real benefits of interoperable live training are the flexibility and cost-effective approach that it brings to the users," says Jan Vermeulen, the Chairman of the UCATT task group. "If implemented across the board it will mean that nations can undertake multinational training at home, at allied facilities or in actual combat theatres."

Another view of UCATT's potential is provided by one of its training system industry players, Cubic Defense Applications. The company's Director of Advanced Programmes at its Advanced Systems Division, Gary Washam, tells *MT&SN* that, "we have now proved the concept that interoperability works in the live training environment and to take this further, we really need industry to step up to the plate and invest, to speed up the process."

But UCATT is not all about the technical aspects of interoperability. Recommendations from the task group also cover areas such how best to integrate engineer assets and indirect fire into MOUT, developing a common After Action Review (AAR)



The UCATT Chairman, Jan Vermeulen, talks to a Canadian officer during the recent UCATT interoperability demonstration at Marnehuizen in the Netherlands.

(Source: T. Nash)

system, using common vulnerability codes to ensure a fair-fight between different systems and standardising battlefield effects.

Demonstration Day

Marnehuizen is located in northern Holland, some 25 km from the city of Groningen. The urban combat training centre at Marnehuizen has 120 buildings, of which around 25% are instrumented, and undertakes reinforced platoon and company-level (Level III/IV) urban training for Holland's mechanised and air assault infantry. Level I training is conducted in barracks whilst Level II training is undertaken at Harskamp – Oostdorp, again in northern Holland.

The demonstration used two instrumented buildings, the area around the buildings and a CV9035 Mk III Armoured Infantry Fighting Vehicle (AIFV). The EXCON building had EXCONs from RDE, Saab, NSCTS, Tenetec, Cubic and Ruag whilst soldiers on the exercises, all using their national equipment, came from Germany, Netherlands, Sweden and Switzerland.

The interoperability demonstration drew together a number of senior military officers and executives from the live training and simulation industry.

(Source: T Nash)

A Royal Netherlands Army CV9035 also took part in the interoperability demonstration.

(Source: T. Nash)

"It has been amazing to see industry working together so closely in this project," comments Nancy Buchanan from Swiss company Tennetec. "I'm sure that I can speak for everyone here when I say that we have all learned so much from each other. This can only benefit the end user in the long run."

The short exercise demonstration started with soldiers attempting to take a reinforced building that was defended by enemy forces. As the first attackers were killed, the engagement was highlighted on the six company EXCON workstations showing the interoperability between the systems. After each engagement, companies took it in turns to 'resurrect' casualties on other companies EXCON systems.

Once in the buildings, soldiers moving between rooms were again visible on all six EXCON displays. Swedish forces, using Saab tactical engagement systems, were 'shooting' German, Swiss and Dutch troops, whose respective systems were generating killed or wounded outputs due to common laser codes. These troops then engaged each other with the same interoperable results.

Following the demonstration, UCATT Chairman Jan Vermeulen, summarised the event as a "major milestone in the development of live training systems" and thanked industry for its commitment to the project.

This demonstration was also a swan-song for Jan Vermeulen who is standing down as the chairman of UCATT at the end of the year. He is to be replaced by Armin Thinnes who is charged with taking the project forward to look at other areas of interoperability. With the current funding problems impacting NATO as well as individual nations, this is going to be a major challenge but with what has been achieved so far, this project needs to continue to fulfil the UCATT dream and help achieve common live training throughout NATO and PfP countries.

The Rheinmetall Defence Electronics' EXCON showing live video streams and a 2D map overlay.

(Source: T. Nash)

Page 24.

MT&SN Vol. 12 Issue 4 2010

6.10.3 Article in MS&T

WORLD NEWS & ANALYSIS

Live Training Systems Interoperability Demonstrated

On 15 September 2010, an important intermediate step towards interoperability in live training was achieved. On that day the UCATT TG provided evidence to the members of the NATO MSG and other guests that interoperability between different systems is technically possible. Soldiers from the Netherlands, Germany, Sweden and Switzerland brought their small arms to Marnehuizen, the instrumented training site of the Dutch Army, and as part of a joint exercise demonstrated weapon effects across different technologies and between systems from different providers. The demonstration included a combat vehicle, anti-tank weapons, indoor and outdoor tracking, shoot-through walls, exercise conduct and evaluation.

While the message itself was exciting, the actual presentation came across as rather unspectacular – more of a sort of acceptance test than a field exercise. Everyone shot at everyone. Weapon effects were registered by the person fired at, while the participating companies' EXCONs monitored the engagements, determined the results and updated the objects' status accordingly. The original status was then restored and the candidate waited for the next round in the script. This was successfully demonstrated for all players, regardless of whether they were the subject of a line-of-sight engagement or a non-line-of-sight engagement. The spectators were able to track that either indoors from one of the various exercise control stations or outside in the field. But wherever they were, they only got a brief snapshot of the overall picture. From that point of view it is no wonder that some of the experts attending the demonstration simply could not believe what they had learned; interoperability of training in urban terrain between different systems and manufacturers, and across different technologies or software and hardware releases, and between different nations is possible!

The participating system providers – Cubic, NSC, RDE, RUAG, SAAB and Tenetec – put a great deal of effort into conducting this technical interoperability demonstration. The costs of preparing and conducting the event totalled approximately 1 million euros. It is only amazing at first glance those fierce competitors are now acting in concert. It was the pressure from user nations that finally brought the companies round the table, users who had just had enough of seemingly unbridgeable interfaces. UCATT's concept of interoperability – not excluding existing technologies a priori but rather trying to define interoperability among any set of systems – made it easier for industry to take the decision to join in.

The vision of an unclassified, interoperable, multi-national, industry-independent urban training technology architecture where armies from different countries can train together is not only attractive for the military. Without obstacles set by proprietary hardware and interfaces, industry can compete on a much larger scale. And more competition has never been a drawback.

Military users have for some time been aware of the technical limitations to perform joint exercises. For more than a decade NATO working groups (e.g. FIBUA/MOUT WG, TSWG) have been discussing the subject. The steadily increasing number of multi-national missions has, however, brought the lack of adequate joint live training possibilities for soldiers from different nations to the fore. The UCATT (Urban Combat Advanced Training Technology) Task Group (TG) was established within the NATO Modelling and Simulation Group in 2003.

According to Jan Vermeulen (NL), UCATT Chairman the demonstration was a successful experiment. "The UCATT architecture is alive and kicking. Six companies that normally compete with one another, all UCATT members, are now working side by side, helping each other with great trust and respect in the pursuit of one goal: To show that the UCATT architecture makes interoperability between live simulation systems from different vendors possible." He noted UCATT will continue its work in order to produce standards for nations to use in their future RFQs and standards will be published through SISO channels. – *Walter F. Ullrich*

56 MS&T MAGAZINE ▪ ISSUE 6/2010

Chapter 7 – NEW TAP AND TOR FOR THE UCATT-2 SUCCESSOR

A new TAP and TOR were created to initiate the formation of the UCATT-2 successor.

7.1 UCATT ARCHITECTURE

<table>
<tr><td>ACTIVITY</td><td>MSG-098</td><td colspan="11" rowspan="2">Urban Combat Advanced Training Technology – (UCATT) Architecture</td><td colspan="3">TBA</td></tr>
<tr><td>Activity REF. Number</td><td>RTG-xxx</td><td colspan="3"></td></tr>
<tr><td colspan="2">Principal Military Requirements</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td></td><td></td><td colspan="3">NU</td><td colspan="3"></td></tr>
<tr><td colspan="2">Military Functions</td><td>1</td><td></td><td></td><td>4</td><td></td><td>6</td><td></td><td></td><td></td><td></td><td>11</td><td>12</td><td></td><td></td></tr>
<tr><td colspan="2">Panel and Coordination</td><td colspan="8">MSG</td><td colspan="6">TSWG / UO</td></tr>
<tr><td colspan="2">Location and Dates</td><td colspan="11">2011 ITEC meeting Germany
2011 Fall meeting, Europe
2011 I-ITSEC meeting USA, Orlando

2012 ITEC meeting
2012 Fall meeting
2012 I-ITSEC meeting

2013 ITEC meeting
2013 Fall meeting
2013 I-ITSEC meeting</td><td colspan="3">P-I</td></tr>
<tr><td colspan="2">Publication Data</td><td colspan="6">TR</td><td colspan="3">2014</td><td colspan="2">100</td><td colspan="3">NU</td></tr>
<tr><td colspan="2">Keywords</td><td colspan="4">MOUT</td><td colspan="5">FIBUA</td><td colspan="5">Urban</td></tr>
<tr><td colspan="2"></td><td colspan="4">Interoperability</td><td colspan="5">Training</td><td colspan="5">Standard</td></tr>
</table>

I. BACKGROUND AND JUSTIFICATION

NATO studies SAS-030, Study on Urban Operations 2020 and Land Operations 2020 clearly indicate that urban areas are the most likely battle field in the 21st century.

The problems and limitations associated with developing the first generation of Military Operations on Urban Terrain (MOUT) training facilities are only just beginning to be understood.

A team of experts from NATO NAAG completed a feasibility study in 2002. The conclusion was that a number of potential interoperability areas were identified and assessed to be worthy of further investigation.

TG-032 of NMSG started to identify and investigate some areas and reported them in their final report for the live domain. A number of areas were not completely covered or needed more investigation; also a number of areas are new. The UCATT report became more or less the guideline for URBAN COMBAT TRAINING facilities design. Also, the first steps in order to bring the defined interface specification to a standard (through the SISO) process have been started. The result of UCATT work approach was displayed in a life (technical) demonstration of interoperability between (modified) existing systems. A spin-off of the UCATT work is a new laser standard (OSAG2) that is already in use with a number of European countries. After further development refinement and SISO approval this standard will be replaced by the universal UCATT SISO Tactical Engagement Standard.

The virtual and constructive domain needs more exploration and other standards as a result of the UCATT architecture needs to be more developed to be SISO standard candidates.

NATO's FIBUA/MOUT Working Group recognizes the work done by the UCATT and endorses UCATT's continuation to maintain and complete its work.

UCATT deliverables to date:

- Site register;
- Research needs;
- Interoperability specification;
- Functional architecture;
- Documented live interoperability demonstration;
- Draft standard on visual effect; and
- Best practices.

In the last couple of years UCATT has become NATO's focal point for MOUT training technology and exchanging information with the military community and is also well regarded among industry as the driving force within the live domain.

II. OBJECTIVE(S)

Exchange and assess information on MOUT (live/constructive/virtual) installations and training/simulation systems. Military feedback as to the effectiveness of current solutions will be obtained with a view toward establishing best practice. Maintain and identify a suitable architecture and a standard set of interfaces that enable interoperability of MOUT Training components that does not inhibit future research and enhancements.

Identify limitations and constraints on MOUT development with a view toward identifying areas for future research. Validate the applicability of JC3IEDM as the C4I standard for interfacing to the simulation environment. Prepare information for the SISO standard process for engagement and data communication, audio and visual effects and future interfaces.

III. TOPIC TO BE COVERED

Operational Concepts – A comprehensive list of developed generic user requirements will be maintained in conjunction with NATO training groups and military users on the live, virtual and constructive domain.

Standardization of potential UCATT defined interfaces (for example, frequency spectrum allocation and management, laser compatibility, battle field effects simulations, firing through walls, indirect fires, tracking and position/location in built-up areas). Extension of (live) UCATT functional architecture for MOUT training and incorporate the virtual and constructive domains.

IV. DELIVERABLE

Technical Report.

V. TECHNICAL TEAM LEADER AND LEAD NATION

Chair: Armin THINNES, Germany (GOV).

Deputy Chair: Jan VERMEULEN, Netherlands (GOV).

Lead Nation: Germany.

VI. NATIONS WILLING/INVITED TO PARTICIPATE (MIL, GOV AND IND)

Canada, Finland, Germany, Netherlands, Norway, Sweden, Spain, Switzerland, United Kingdom and United States.

VII. NATIONAL AND/OR NATO RESOURCES NEEDED

Travel funding for national participation in meetings.

VIII. RTA RESOURCES NEEDED

MSCO support to TG.

Publication.

IX. ADDITIONAL INFORMATION

Limited Participation Technical Team: No.

TERMS OF REFERENCE

RTG on
Urban Combat Advanced Training Technology (UCATT) Architecture
MSG-xxx, RTG-xxx

I. ORIGIN

A. Background

NATO studies SAS-030, Study on Urban Operations 2020 and Land Operations 2020 clearly indicate that urban areas are the most likely battle field in the 21st century.

The problems and limitations associated with developing the first generation of Military Operations on Urban Terrain (MOUT) training facilities are only just beginning to be understood.

A team of experts from NATO NAAG completed a feasibility study in 2002. The conclusion was that a number of potential interoperability areas were identified and assessed to be worthy of further investigation.

TG-032 of NMSG started to identify and investigate some areas and reported them in their final report for the live domain. A number of areas were not completely covered or needed more investigation also a number of areas are new. The UCATT report became more or less the guideline for urban combat training facilities design. Also the first steps in order to bring the defined interface specification to a standard (through the SISO) process have been started. The result of UCATT work approach was displayed in a live (technical) demonstration of interoperability between (modified) existing systems. A spin-off of the UCATT work is a new laser standard (OSAG2) that is already in use with a number of European countries. After further development refinement and SISO approval this standard will be replaced by the universal UCATT SISO Tactical Engagement standard.

Virtual and constructive domain needs more exploration and other standards as a result of the UCATT architecture needs to be more developed to be SISO standard candidates.

NATO's FIBUA/MOUT Working Group recognizes the work done by the UCATT and endorses UCATT's continuation to maintain and complete its work.

UCATT deliverables to date:

- Site register;
- Research needs;
- Interoperability specification;
- Functional architecture;
- Documented live interoperability demonstration;
- Draft standard on visual effect; and
- Best practices.

In the last couple of years UCATT has become NATO's focal point for MOUT training technology and exchanging information with the military community and is also well regarded among industry as the driving force within the live domain.

B. Military Benefit

Operational Concepts – A comprehensive list of Generic Harmonized (between Nations) User Requirements will be maintained in conjunction with NATO Training Groups and Military Users on the live, virtual and constructive domain.

Standardization in SISO of frequency spectrum allocation and management, laser compatibility, battle field effects simulations, firing through walls, indirect fires, tracking and position/location in built-up areas. Extension of the live functional architecture for MOUT training to incorporate the virtual and constructive domains.

II. OBJECTIVES

Exchange and assess information on MOUT (live/constructive/virtual) installations and training/simulation systems. Military feedback as to the effectiveness of current solutions will be obtained with a view toward establishing best practice. Identify a suitable architecture and a standard set of interfaces that enable interoperability of MOUT Training components that does not inhibit future research and enhancements.

Identify limitations and constraints on MOUT development with a view toward identifying areas for future research. Validate the applicability of JC3IEDM as the C4I standard for interfacing to the simulation environment. Provide a standard for laser and data communication, audio and visual effects.

Organize an interoperability demonstration to prove the standards. Define a generic set of data for lethality and vulnerability to enable interoperability of nations' simulation systems.

III. RESOURCES

A. Membership

Chair: Armin THINNES, Germany (GOV).

Deputy Chair: Jan VERMEULEN, Netherlands (GOV).

B. Nations Willing/Invited to Participate (MIL, GOV and IND)

Finland, Germany, Netherlands, Norway, Sweden, Spain, Switzerland, United Kingdom and United States.

IV. SECURITY LEVEL

The security level will be Public Release.

V. PARTICIPATION BY PARTNER NATIONS AND OTHER NATIONS

This activity is fully open to PfP.

VI. LIAISON

None required.

VII. REFERENCE

None required.

7.2 UCATT STANDARDIZATION

<table>
<tr><td>ACTIVITY</td><td>MSG-xxx</td><td colspan="11" rowspan="2">Urban Combat Advanced Training Technology – (UCATT) Standards</td><td colspan="3">TBA</td></tr>
<tr><td>Activity REF. Number</td><td>RTG-xxx</td><td colspan="3"></td></tr>
<tr><td colspan="2">Principal Military Requirements</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td></td><td></td><td colspan="3">NU</td><td colspan="3"></td></tr>
<tr><td colspan="2">Military Functions</td><td>1</td><td></td><td></td><td>4</td><td></td><td>6</td><td></td><td></td><td></td><td></td><td>11</td><td>12</td><td></td><td></td></tr>
<tr><td colspan="2">Panel and Coordination</td><td colspan="8">MSG</td><td colspan="6"></td></tr>
<tr><td colspan="2">Location and Dates</td><td colspan="11">• 2011 ITEC meeting Germany in conjunction with UCATT Architecture
• 2011 SISO Fall meeting Orlando, FL, USA
• 2011 I-ITSEC meeting Orlando, FL, USA, in conjunction with UCATT Architecture
• 2012 ITEC meeting in conjunction with UCATT Architecture
• 2012 SISO Fall meeting Orlando, FL, USA
• 2012 I-ITSEC meeting in conjunction with UCATT Architecture
• 2013 ITEC meeting in conjunction with UCATT Architecture
• 2013 SISO Fall meeting
• 2013 I-ITSEC meeting in conjunction with UCATT Architecture</td><td colspan="3">P-I</td></tr>
<tr><td colspan="2">Publication Data</td><td colspan="6">TR</td><td colspan="3">2014</td><td colspan="2">100</td><td colspan="3">NU</td></tr>
<tr><td colspan="2">Keywords</td><td colspan="4">MOUT</td><td colspan="5">FIBUA</td><td colspan="5">Urban</td></tr>
<tr><td colspan="2"></td><td colspan="4">Interoperability</td><td colspan="5">Training</td><td colspan="5">Standard</td></tr>
</table>

I. BACKGROUND AND JUSTIFICATION

NATO studies SAS-030, Study on Urban Operations 2020 and Land Operations 2020 clearly indicate that urban areas are the most likely battle field in the 21st century.

The problems and limitations associated with developing the first generation of Military Operations on Urban Terrain (MOUT) training facilities are only just beginning to be understood.

A team of experts from NATO NAAG completed a feasibility study in 2002. The conclusion was that a number of potential interoperability areas were identified and assessed to be worthy of further investigation.

TG-032 of NMSG started to identify and investigate some areas and reported them in their final report for the live domain. A number of areas were not completely covered or needed more investigation also a number of areas are new. The UCATT report became more or less the guideline for URBAN COMBAT TRAINING facilities design. Also the first steps in order to bring the defined interface specification to a standard (through the SISO) process have been started. The result of UCATT work approach was displayed in a life (technical) demonstration of interoperability between (modified) existing systems. A spin-off of the UCATT work is a new laser standard (OSAG2) that is already in use with a number of European countries. After further development refinement and SISO approval this standard will be replaced by the universal UCATT SISO Tactical Engagement standard.

The SISO process needs to be followed and work on standards needs to be done during SISO meetings but also coordination needs to be done with the UCATT architecture working group.

NATO's FIBUA/MOUT Working Group recognizes the work done by the UCATT and endorses UCATT's continuation to maintain and complete its work.

In the last couple of years UCATT has become NATO's focal point for MOUT training technology and exchanging information with the military community and is well regarded among industry as the driving force within the live domain. Also UCATT is bringing the live domain in the SISO focus.

II. OBJECTIVE(S)

Guide and follow the SISO process and work toward SISO approved standards for UCATT architecture defined interfaces. Exchange and assess information on MOUT (live/constructive/virtual) installations and training/simulation systems to be used to define the standards. Military feedback as to the effectiveness of current solutions will be obtained with a view toward establishing best practice. Maintain and identify a suitable architecture and a standard set of interfaces that enable interoperability of MOUT Training components that does not inhibit future research and enhancements.

III. TOPIC TO BE COVERED

Interoperability standards defined by the UCATT Architecture needs to be worked in SISO accepted standards that will make interoperability between MOUT training systems possible. Standardization of potential UCATT defined interfaces (for example, frequency spectrum allocation and management, laser compatibility, battle field effects simulations, firing through walls, indirect fires, tracking and position/ location in built-up areas).

IV. DELIVERABLE

Technical Report.

V. TECHNICAL TEAM LEADER AND LEAD NATION

Chair: Ingo WITTWER, Germany (RUAG COEL GmbH).

Deputy Chair: Armin THINNES, Germany (GOV).

Lead Nation: Germany.

VI. NATIONS WILLING/INVITED TO PARTICIPATE (GOV, IND)

Canada, Finland, Germany, Netherlands, Norway, Sweden, Spain, Switzerland, United Kingdom and United States.

VII. NATIONAL AND/OR NATO RESOURCES NEEDED

Travel funding for national participation in meetings.

VIII. RTA RESOURCES NEEDED

MSCO support to TG.

Publication.

IX. ADDITIONAL INFORMATION

Limited Participation Technical Team: No.

TERMS OF REFERENCE

RTG on
Urban Combat Advanced Training Technology – (UCATT) Standards
MSG-xxx, RTG-xxx

I. ORIGIN

A. Background

NATO studies SAS-030, Study on Urban Operations 2020 and Land Operations 2020 clearly indicate that urban areas are the most likely battle field in the 21st century.

The problems and limitations associated with developing the first generation of Military Operations on Urban Terrain (MOUT) training facilities are only just beginning to be understood.

A team of experts from NATO NAAG completed a feasibility study in 2002. The conclusion was that a number of potential interoperability areas were identified and assessed to be worthy of further investigation.

TG-032 of NMSG started to identify and investigate some areas and reported them in their final report for the live domain. A number of areas were not completely covered or needed more investigation also a number of areas are new. The UCATT report became more or less the guideline for urban combat training facilities design. Also the first steps in order to bring the defined interface specification to a standard (through the SISO) process have been started. The result of UCATT work approach was displayed in a life (technical) demonstration of interoperability between (modified) existing systems. A spin-off of the UCATT work is a new laser standard (OSAG2) that is already in use with a number of European countries. After further development refinement and SISO approval this standard will be replaced by the universal UCATT SISO Tactical Engagement standard.

The SISO process needs to be followed and work on standards needs to be done during SISO meetings but also coordination needs to be done with the UCATT architecture working group.

NATO’s FIBUA/MOUT Working Group recognizes the work done by the UCATT and endorses UCATT’s continuation to maintain and complete its work.

In the last couple of years UCATT has become NATO’s focal point for MOUT training technology and exchanging information with the military community and is well regarded among industry as the driving force within the live domain. Also UCATT is bringing the live domain in the SISO focus.

B. Military Benefit

Standards from SISO for the following areas:

- Frequency spectrum allocation and management;
- Laser compatibility;
- Battlefield effects simulations;
- Firing through walls, indirect fires; and
- Tracking and position/location in built-up areas.

Extension of the live functional architecture for MOUT training to incorporate the virtual and constructive domains will grow international training possibilities in Urban MOUT training facilities. This will result in better trained coalition forces.

II. OBJECTIVES

Guide and follow the SISO process and work toward SISO approved standards for UCATT architecture defined interfaces. Exchange and assess information on MOUT (live/constructive/virtual) installations and training/simulation systems to be used to define the standards. Military feedback as to the effectiveness of current solutions will be obtained with a view toward establishing best practice. Maintain and identify a suitable architecture and a standard set of interfaces that enable interoperability of MOUT Training components that does not inhibit future research and enhancements.

III. RESOURCES

A. Membership

Chair: Ingo WITTWER, (RUAG COEL Gmbh).

Deputy Chair: Armin THINNES, Germany (GOV).

B. Nations Willing/Invited to Participate (GOV, IND)

Finland, Germany, Netherlands, Norway, Sweden, Spain, Switzerland, United Kingdom and United States.

IV. SECURITY LEVEL

The security level will be Public Release.

V. PARTICIPATION BY PARTNER NATIONS AND OTHER NATIONS

This activity is fully open to PfP.

VI. LIAISON

None required.

VII. REFERENCE

None required.

Annex A – BEST PRACTICE FOR O/C FUNCTION IN SUPPORT OF A BATTALION LEVEL EXERCISE

A.1 INTRODUCTION

As a result of a syndicate discussion at a meeting of the FIBUA/MOUT WG (today UOWG – Urban Operations Work Group), they made the following suggestions regarding the functions of an Observer Controller (O/C) and Training Analyst (TA) and Exercise Director (ExDir).

They defined the role of the O/C as follows:

- **Observer** – Observing activity, capturing lessons and cueing the TA to collect evidence.
- **Controller –** Should/can influence the conduct of the exercise and support the conduct of the After Action Review (AAR) and present it independently if required.
- **Safety Supervisor** (when applicable).

For the role of the O/C, there is a requirement for Training Analysis to support the O/C function.

The role of the Training Analyst (TA) is:

- **Training Analyst** – Compile evidence to support lessons to be presented by the O/C in the AAR.

In order to properly understand the role of O/C and to ensure structured use of O/Cs and associated resources, the role of ExDir must also be understood.

The role of the ExDir is:

- **ExDir** – To identify both the training audience (individual/team/sub-unit/unit) and the intended training benefits in order to plan the capture of lessons which can be reinforced by objective evidence.

The three roles outlined above are not in all cases separate individuals. The level of activity (individual through to large-scale collective), the desired training output and the facilities at hand will determine the division of effort and responsibility.

Similarly, the availability of evidential support will be determined by the technologies in use and the context of the activity. This would ideally be pre-determined by the ExDir in some form of Information Collection Plan, and executed during the activity by the O/C who would be empowered to use their best judgement and tools to achieve the ExDir’s intent.

A.2 O/C REQUIREMENTS IN SUPPORT OF A BATTALION LEVEL EXERCISE

O/C Capabilities – The O/C will require the capability, expertise and qualifications to:

- Understand the contextual situation and the exercising unit’s mission within the context.
- Evaluate the exercising unit’s approach to the task, their plan, and the contextual implications of their intended approach.
- Evaluate the effectiveness of the unit’s activity and capture those evidential elements that will assist in the provision of training benefit.

- Influence the dynamic evolution of the training activity where appropriate.
- Ensure that the best balance is struck between physical co-location and technological observation so that the O/C activity does not intrude on the exercise.
- Draw lessons from the activity and present evidence as an AAR, and have the required skills to conduct an effective AAR.

Some key O/C tasks are listed below. The precise tasks will be dependent upon the exercise construct, size, etc.:

- Focus on unit/Commander's leadership and Command and Control (C2);
- Focus on use of support weapons and vehicles;
- Monitor every soldier/support weapon in squad/section (using where available "on-line" portable display type equipment such as Personnel Digital Assistant (PDA) to provide dynamic information (e.g. location, status, images and overlays));
- Control OPFOR and other entity groupings;
- Control and monitor targets/effects; and
- Provide safety overwatch.

The roles of the O/C, TA and ExDir are shown in Figure A-1 below.

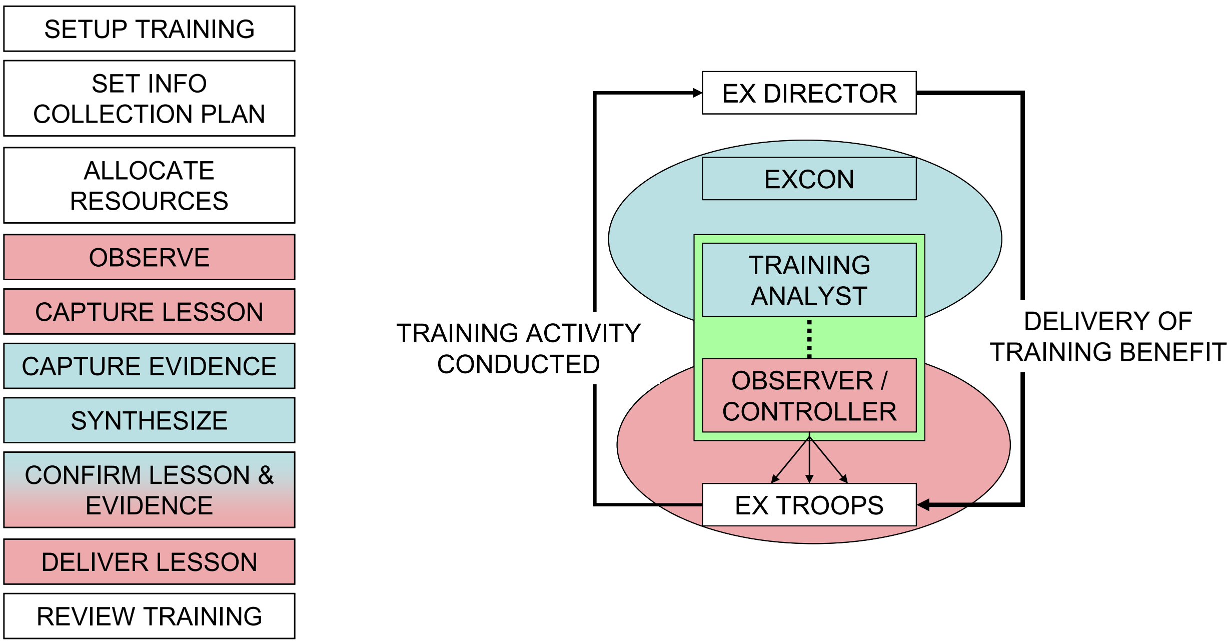


Figure A-1: Exercise Supporting Staff Structure.

Annex B – UCATT-2 TG AMMUNITION AND WEAPON TABLE

B.1 INTRODUCTION

The information has been compiled from several open sources – some are noted below:

- Jane's Ammunition Handbook, 2007-09-25;
- Jane's Infantry Weapons, 2004 – 2005;
- fas.org;
- www.globalsecurity.org;
- www.atk.com;
- www.rheinmetall-defence.com; and
- wikipedia.org.

B.2 BACKGROUND

The ammunition table is based on the munitions currently used by different countries, as well as open information on ammunition inventories such as Jane's Ammunition Handbook, etc. The intent is of course to have a comprehensive list that covers all used ammunitions. Finally, of course, the ammunition table must also have growth potential and thus the ability to accommodate not yet fielded weapon systems in order to be truly future-proof.

B.3 TOPICS FOR CONSIDERATION

While examining and proofreading the ammunition table, the reader is kindly asked to consider as for example the following:

- Is the list comprehensive in that it covers all current and soon to be fielded ammunitions (consider the national arsenal primarily)?
- Is there any redundancy – ammunitions that are similar enough for merging into one?
- Are there ammunitions in the list that seem to be irrelevant?
- Are there any other elements, adding to the addressed IFFs – laser warning systems, etc., that are identified as affecting simulation requirements and thus should be addressed in this baseline?

B.4 ACRONYMS

Table B-1: Ammunition-Related Acronyms.

Acronym	Description	Note
APAM	Anti-Personnel/Anti-Material	
APCR	Armour-Piercing, Composite Rigid	As HVAP
APDS	Armour-Piercing, Discarding-Sabot	
APFSDS	Armour-Piercing, Fin-Stabilized, Discarding-Sabot	
APERS	Anti-Personnel	
API	Armour-Piercing Incendiary	
APTOP	Armour-Piercing, Top Attack	OSAG acronym only
BB	Bunker Buster	OSAG acronym only
DPICM	Dual-Purpose Improved Conventional Munitions	
HE	High Explosive	
HEAB	High Explosive Air Bursting	Exploding using for example time fuse
HEAT	High Explosive Anti-Tank	
HEDP	High Explosive Dual Purpose	
HE-FRAG	High Explosive Fragmentation	Can be considered as APERS
HEI	High Explosive Incendiary	
HEMP	High Explosive Multi-Purpose	
HEORT	High Explosive Obstacle Reduction Tank	
HEP	High-Explosive Plastic	See Note HESH; US acronym for HESH
HESH	High Explosive Squash Head	See Note HESH
HVAP	High Velocity Armour Piercing	As APCR
HVAPDS	High or Hyper Velocity APDS	
LAHAT	Laser Homing Attack or Laser Homing Anti-Tank	
MPI	Multi-Purpose Incendiary	See Note MPI
MRM-CE	Mid-Range Munition, Chemical Energy	www.defense-update.com MRM
MRM-KE	Mid-Range Munition, Kinetic Energy	www.defense-update.com MRM
NLETH	Non-Lethal	
PPHE	Programmable Pre-fragmented HE	
RRLP	Reduced Ricochet Limited Penetration	The RRLP is intended for use against personnel without collateral damage
SABOT	A carrier designed to center a smaller caliber projectile in a larger gun barrel.	When the SABOT round is fired, it is normally discarded after leaving the muzzle

Acronym	Description	Note
SLAP	Saboted Light Armour Penetrator	Small Arms APDS
STAFF	Smart Target Activated Fire and Forget	
TERM	Tank Extended Range Munition	Beyond Line-of-Sight
THBAR	Thermobaric	See Note Thermobaric
TPDS	Training-Practice, Discarding-Sabot	
WP	White Phosphorus	See Note WP

Note HESH – HESH rounds are thin metal shells filled with plastic explosive and a delayed-action base fuse. On impact, the plastic explosive is "squashed" against the surface of the target, and spreads out to form a disc or "pat" of explosive. A tiny fraction of a second later, the base fuse detonates the explosive, creating a shock wave that, owing to its large surface area and direct contact with the target, conducts very effectively through the material. In the case of the metal armour of a tank, the compression shock wave conducts through the armour to the point where is reaches the metal/air interface (the hollow crew compartment), where some of the energy is reflected as a tension wave. At the point where the compression and tension waves intersect, a high stress zone is created in the metal, causing pieces of steel to be projected off the interior wall.

Note MPI – This cartridge is effective against airborne and light surface threats at 2,000 meters range. The multi-purpose concept projectile with delayed reaction carries the effectiveness inside the threat with large fragments and incendiary effects.

Note Thermobaric – The lethality effect results from a thermobaric overpressure blast rather than fragmentation. As a result of the thermobaric reaction, all enemy personnel within the effective radius will suffer lethal effects as opposed to the conventional fragmentation round.

Note WP – WP is a flare/smoke producing incendiary weapon, or smoke-screening agent, made from a common allotrope of the chemical element phosphorus. White Phosphorus bombs and shells are incendiary devices, but can also be used as an offensive anti-personnel flame compound capable of causing serious burns or death.

B.5 ADDITIONAL ACRONYMS

Acronym	Description	Note
APC	Armoured Personnel Carrier	
ERA	Explosive Reactive Armour	
GL	Grenade Launcher	
IFV	Infantry Fighting Vehicle	
IUC	International User Community	
NMISS	Near MISS	
RCL	Recoilless Rifle	
RHA	Rolled Homogeneous Armour	

Acronym	Description	Note
RPG	Rocket-Propelled Grenade **R**eaktivnyy/**R**uchnoy **P**rotivotankovyy **G**ranatomyot	Hand-Held Anti-Tank Grenade Launcher
TNT Equivalent	Trinitrotoluene Equivalent	The explosive yield of TNT is considered a standard measure of strength of bombs and other explosives

B.6 AMMUNITION TABLE

Table B-2: Ammunition Table.

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
≤ 9 mm Hand Gun	Ball		5.7, 7.62, 7.65, 9 Cal. 0.22, 0.32
9 x 19 mm Cal. 0.38	Ball		Glock 17 wikipedia.org Glock 17, 18, 19, 26, 34
> 9 mm Hand Gun	Ball		10, 12.3, 12.5, Cal. 0.357, 0.38, 0.40, 0.44, 0.45, 0.454, 0.48
11.4 mm Pistol Cal. 0.45	Ball		M1911 wikipedia.org Glock 37 wikipedia.org Glock 37, 38, 39
Sub-Machine Gun			
< 9 mm Sub-Machine Gun	Ball		
4.6 x 30 mm	Ball		MP7
5.7 x 28 mm	Ball		P90
≥ 9 mm Sub-Machine Gun	Ball		
5.45 – 6.5 mm Assault Rifle			5.56 mm, Cal. 0.223
5.45 x 39 mm	AP		
5.56 x 45 mm	AP		M995 AP
5.8 x 42 mm	AP		China
5.45 x 39 mm	Ball		5.45 mm M74 (USSR/Russia)
5.56 x 45 mm Assault Rifle	Ball		Small Arms M16
	Ball		AK74
	Ball		.223 Remington / 5.56 NATO (USA) M855 NATO Ball, M193 Ball
5.8 x 42 mm	Ball		China
5.45 – 6.5 mm Light Machine Gun			5.56 mm, Cal. 0.223
5.45 x 39 mm	AP		
5.56 x 45 mm	AP		

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
5.45 x 39 mm	Ball		
5.56 x 45 mm Light Machine Gun	Ball		
5.45 – 6.5 mm Sniper			5.56 mm, Cal. 0.223
	AP		
5.56 x 45 mm	Ball		Mk 262 Sniper
6.8 – 8.6 mm Assault Rifle			6.8 mm, Cal. 0.27 7.62 mm, Cal. 0.30
7.62 x 39 mm	AP		
7.62 x 51 mm	AP		
6.8 x 43 mm	Ball		6.8 x 43 mm SPC (Spec. Purpose Cartridge)
7.62 x 39 mm	Ball		
7.62 x 51 mm	Ball		
	Ball		M59, M61, M64, M80 Ball
6.8 – 8.6 mm Light Machine Gun			7.62 mm, Cal. 0.30
7.62 x 39 mm	AP	AP/SLAP	
7.62 x 51 mm	AP	AP/SLAP	
7.62 x 54R mm	AP	AP/SLAP	
7.62 x 39 mm	Ball		
7.62 x 51 mm	Ball		
7.62 x 54R mm	Ball		
6.8 – 8.6 mm Machine Gun			7.62 mm, Cal. 0.30
7.62 x 51 mm	AP	AP/SLAP	M993 AP
7.62 x 54R mm	AP	AP/SLAP	
7.62 x 51 mm Machine Gun	Ball		M60
7.62 x 54R mm	Ball		
6.8 – 8.6 mm Sniper			7.62 mm, Cal. 0.30
7.62 x 51 mm	AP	AP/SLAP	
7.62 x 54R mm	AP	AP/SLAP	
8.6 x 70 mm	AP		
7.62 x 51 mm	Ball		M118 Long Range
7.62 x 54R mm	Ball		
8.6 x 70 mm	Ball		
12.7 – 14.5 mm Heavy Mach. Gun Anti-Materiel Rifle			12.7 mm, Cal.0.5
12.7 x 99 mm	AP		

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
12.7 x 99 mm (cont'd)	AP		M2 Armour-Piercing, M8, M20
	AP	SLAP	M903 SLAP, M962 SLAPT
12.7 x 107 mm	AP		
14.5 x 114 mm	AP		
12.7 x 99 mm	Ball		
12.7 x 107 mm	Ball		
	Ball		XM1022
14.5 x 114 mm	Ball		
12.7 x 99 mm	HE/MP	MP	
12.7 x 107 mm	HE/MP		
14.5 x 114 mm	HE/MP		
Shotgun, Grenade Rifle			
40 mm GL	HE/MP		20, 25, 30, 35, 40, 43 mm M203 wikipedia.org
			MK19 wikipedia.org, XM320 wikipedia.org
5.45 – 6.5 mm Assault Rifle	Ball		
5.45 x 39 mm	Ball		5.45 mm M74 (USSR/Russia)
5.56 x 45 mm Assault Rifle	Ball		Small Arms M16
	Ball		AK74
	Ball		.223 Remington / 5.56 NATO (USA) M855 NATO Ball, M193 Ball
5.8 x 42 mm	Ball		China
< 6.8 mm Near Miss Small Arms	NMISS		5.45 mm, 5.56 mm
5.56 mm	NMISS		
6.8 – 8.6 mm Machine Gun			
6.8 x 43 mm	Ball		6.8 x 43 mm SPC (Spec. Purpose Cartridge)
7.62 x 39 mm	Ball		
7.62 x 51 mm	Ball		M60
	Ball		M59, M61, M64, M80 Ball
6.8 – 12 mm Near Miss Small Arms	NMISS		7.62 mm, Cal. 0.30
7.62 mm	NMISS		
Mine			Horizontal Weapon Effects
PzAbw Richtmine Kill	AT-Mine	HEW Kill	Mine, HEW HEW: Horizontal Effects Weapon
PzAbw Richtmine Hit	AP-Mine	HEW Hit	Mine, HEW M18 wikipedia.org

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
Additional			
Indirekter Ausfall Transport			
Indirekter Ausfall Rückstrahl			Backfire from a recoilless weapon GE: Indirekter Ausfall Rückstrahl
12.7 – 14.5 mm Sniper Rifle			12.7 mm, Cal. 0.50
12.7 x 99 mm	AP		
12.7 x 107 mm	AP		
14.5 x 114 mm	AP		
12.7 x 99 mm	Ball		
12.7 x 107 mm	Ball		
14.5 x 114 mm	Ball		
12.7 mm	HE/MP		
12.7 x 99 mm	HE/MP	MP	
12.7 x 107 mm	HE/MP	MP	
14.5 x 114 mm	HE/MP		
≥ 12.7 mm Near Miss Small Arms	NMISS		12.7 mm, 14.5 mm
12.7 mm	NMISS		Heavy Weapon Miss
Non-Lethal Less-Lethal Small Arms			For example, Tear Gas Shells, Bean Bags, Stun Rounds and Rubber Projectiles
5.45 mm 5.56 mm, Cal.0.223	NLETH		Blank, Rifle-Launched Non-Lethal Ammo
	NLETH		M200
7.62 mm, Cal.0.30	NLETH		Non-Lethal Ammunition
12.7 mm, Cal. 0.50	NLETH		
Shotgun	NLETH		M1012, M1013
40 mm Grenade	NLETH		M385, M918, M918, M203, Mk19, XM320 M385 M918 fas.org
Shotgun, Grenade Rifle			
Shotgun	HE/MP		Gauge wikipedia.org 10-, 12-, 16-, 20-, 28-, 67-Gauge
Near Miss Shotgun, Grenade Rifle			
Shotgun, Grenade Rifle	NMISS		
Additional			
			Universal Kill
	HEAT	HEAT	FI: 125 mm OKR
	NMISS	NMISS	FI: 125 mm Near Miss (Heavy Calibre)
Mine, Anti-Personnel	AP-Mine		List of landmines wikipedia.org

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
M-16			M16 Mine wikipedia.org
M-19 – Effect on Personnel			Anti-Personnel **Note:** Although M19 is an anti-tank mine, for simulation purposes a specific anti-personnel code is required to give the possibility of adjusting the laser effect radius and vulnerability. Used on its own, it simulates a smaller type of anti-personnel mine.
M-100 – Effect on Personnel			**Note:** Although M100 is an anti-tank mine, for simulation purposes a specific anti-personnel code is required to give the possibility of adjusting the laser effect radius and vulnerability. Used on its own, it simulates a larger type of anti-personnel mine.
Mine, Anti-Tank Mine	AT Mine		AT-Mine fas.org
M-7			M7 wikipedia.org
M-15			M15 wikipedia.org
M-19			Anti-Tank Mine M19 Mine wikipedia.org
M-21			M21 wikipedia.org
M-100			
Free to Use			Free to use ammunition codes for national training
			Free to use
Free to Use			
Lethality as 33 – 79			
5.45 – 6.5 mm Assault Rifle			5.56 mm, Cal. 0..223
5.45 x 39 mm	AP Single		
5.56 x 45 mm			M995 AP
5.45 x 39 mm	AP Burst		
5.56 x 45 mm			M995 AP
5.45 x 39 mm	Ball Single		5.45 mm M74 (USSR/Russia)
5.56 x 45 mm			
			.223 Remington / 5.56 NATO (USA) M855 NATO Ball, M193 Ball
5.45 x 39 mm	Ball Burst		5.45 mm M74 (USSR/Russia)
5.56 x 45 mm			Similar as OSAG 1.0 ammo.no 56
			.223 Remington / 5.56 NATO (USA) M855 NATO Ball, M193 Ball
6.8 – 8.6 mm Assault Rifle			6.8 mm, Cal. 0.27 7.62 mm, Cal. 0.30
7.62 x 39 mm	AP Single	AP	
7.62 x 51 mm			
7.62 x 39 mm	AP Burst		
7.62 x 51 mm			

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
6.8 x 43 mm	Ball Single	Ball	Similar as OSAG 1.0 ammo.no 58 6.8 x 43 mm SPC (Spec. Purpose Cartridge)
7.62 x 39 mm			
7.62 x 51 mm			
			M59, M61, M64, M80 Ball
6.8 x 43 mm	Ball Burst		Similar as OSAG 1.0 ammo.no 58 6.8 x 43 mm SPC (Spec. Purpose Cartridge)
7.62 x 39 mm			
7.62 x 51 mm			
			M59, M61, M64, M80 Ball
6.8 – 8.6 mm Sniper			7.62 mm, Cal. 0.30
7.62 x 51 mm	AP	AP/SLAP	
7.62 x 54R mm			
8.6 x 70 mm			
7.62 x 51 mm	Ball		M118 Long Range
7.62 x 54R mm			
8.6 x 70 mm			
6.8 – 8.6 mm Vehicle			7.62 mm, Cal. 0.30 1. Tank, IFV, and APC Coaxial Gun 2. IFV and APC Main Gun
	AP Single		
	AP Burst		
	Ball Single		
	Ball Burst		Small Arms (M16, M60, Coax), Vehicle Mounted
Vehicle COAX 7.62	Ball Burst		
12.7 – 14.5 mm Heavy Mach. Gun Anti-Materiel Rifle			12.7 mm, Cal.0.5
12.7 x 99 mm	AP Single	AP	
			M2 Armour-Piercing, M8, M20
		SLAP	M903 SLAP, M962 SLAPT
12.7 x 107 mm		AP	
14.5 x 114 mm	AP Single	AP	
12.7 x 99 mm	AP Burst	AP	
			M2 Armour-Piercing, M8, M20
		SLAP	M903 SLAP, M962 SLAPT
12.7 x 107 mm		AP	
14.5 x 114 mm	AP Burst	AP	
12.7 x 99 mm	Ball Single	Ball	M82 M95 Barrett
12.7 x 107 mm			XM1022

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
14.5 x 114 mm			
12.7 x 99 mm	Ball Burst	Ball	Heavy MG (M2, M85) M82 M95 Barrett
12.7 x 107 mm			
			XM1022
14.5 x 114 mm			
12.7 x 99 mm	HE/MP single	MP	Mk 211 MP
12.7 x 107 mm			
14.5 x 114 mm			
12.7 x 99 mm	HE/MP burst	MP	Mk 211 MP
12.7 x 107 mm			
14.5 x 114 mm			
14.5 x 114 mm			
12.7 – 14.5 mm Sniper Rifle			12.7 mm, Cal. 0.50
12.7 x 99 mm	AP		
12.7 x 107 mm			
14.5 x 114 mm	AP		
12.7 x 99 mm	Ball		
12.7 x 107 mm			
14.5 x 114 mm			
12.7 x 99 mm	HE/MP	MP	
12.7 x 107 mm			
14.5 x 114 mm			
12.7 mm Vehicle Cal. 0.50			1.Tank, IFV, and APC Coaxial Gun 2.IFV and APC Main Gun
	AP Single		
	AP Burst		
	Ball Single		
	Ball Burst		
Vehicle COAX 12.7	Ball Burst		
	HE/MP Single		
	HE/MP Burst		
14.5 mm Vehicle			1.Tank, IFV, and APC Coaxial Gun 2.IFV and APC Main Gun
	AP Single		
	AP Burst		
	Ball Single		
	Ball Burst		

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
14.5 mm Vehicle (cont'd)	HE/MP Single		
	HE/MP Burst		
20 – 50 mm Grenade Rifle			20, 25, 30, 35, 40, 43 mm
40 x 46	APERS		M576 wikipedia.org M576 globalsecurity.org
	HE/MP	HEDP	M203 wikipedia.org M203:M433
		HEDP	http://www.globalsecurity.org/military/systems/munitions/m430.htm 40x46 MEI Hellhound
			M79
Shotgun			10-, 12-, 16-, 20-, 28-, 67-Gauge
	APERS		
	HE/MP		
AGL ≤ 35 mm			AGL: Automatic Grenade Launcher 20, 30 mm
	HE		
	HEAB		
20, 25 mm	HEAB		XM1018, XM1019
	HE/MP		
	HEAT		
AGL > 35 mm			AGL: Automatic Grenade Launcher 40, 43 mm
40 x 51	HE	HE	40 mm grenade wikipedia.org
40 x 51	HEAB		
40 mm	HE/MP	HEDP	MK19 wikipedia.org MK19:M430
		APERS	MK19:M1001 Canister
		HEDP	XM320 wikipedia.org
		HEI HEDP	
		HEDP	Extended Range Low Pressure (ERLP) 40 × 51 mm
	HEAT	HEAT	
≤ 35 mm Cannon			Low Velocity, Fast-Firing, Automatic Guns
	AP Single		
	AP Burst		
	HEAB Single		
	HEAB Burst		
	HE/MP Single		
	HE/MP Burst		

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
> 35 mm Cannon			Low Velocity, Fast-Firing, Automatic Guns
	AP Single		
	AP Burst		
	HEAB Single		
	HEAB Burst		
	HE/MP Single		
	HE/MP Burst		
< 30 mm Cannon			High Velocity, Fast-Firing, Automatic Guns
20 mm	AP Single	APDS	
		APDS	Mk 149 CIWS, Mk 244 CIWS
		APHE	PGU-2/B SAPHE
		APHEI	PGU-28A/B SAPHEI
		API	M53 API, M601 API-T, M775 API-T
25 mm	AP Single	AP	ZSU 23-4 fas.org ZSU 23-4 wikipedia.org NL: YPR, 25 mm AP, Single
		AP	XM1049
		APDS	M791 APDS-T, M919 APDS-T
		APHEI	PGU-20/U API
20 mm	AP Burst	APDS	
25 mm	AP Burst	AP	
4 x 23 mm		SABOT	ZSU 23-4, SABOT
25 mm	HEAB Single	HEAB	
	HEAB Burst	HEAB	
20 mm	HE/MP Single	HE/MP	
		HEI	M56 HEI, M56A3 HE/I
		HEI	M210 HEI, M242 HEI-T
		HEI	M246 HEIT-SD, M246 HEI-T
		MPI	M940 MPT-SD
23 mm	HE/MP Single	HE/MP	
		HEI	M792 HEI-T, MK210 HEI-T
		HEI	PGU-22 HE-I, PGU-25 HE-I
		HEI	PGU-32/U, SAPHEI, PGU-38/U HE-I
20 mm	HE/MP Burst	HE/MP	
25 mm	HE/MP Burst	HE/MP Burst	
4 x 23 mm		HEAT	ZSU 23-4, HEAT
30 mm Cannon			High Velocity, Fast-Firing, Automatic Guns

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
30 mm	AP Single	APDS APFSDS APEP API	
		API	PGU-14/B API
	AP Burst	APDS APFSDS API	30 mm, GAU-8 30 mm, (NTC HIND-D), Vulcan 30 mm, AAA-2 GAU-8 wikipedia.org Mi-24 HIND wikipedia.org NO: CV9030, 30 mm APFSDS-T, Burst
	HEAB Single	HEAB	
	HEAB Burst	HEAB	
	HE/MP Single	HE MP MPLD	
		HEI	PGU-13/B HEI
	HE/MP Burst	HE MPLD	NO: CV9030, 30 mm MPLD-T, Burst
35 – 37 mm Cannon			High Velocity, Fast-Firing, Automatic Guns
35 mm	AP Single		
	AP Burst		
	HEAB Single		
	HEAB Burst		
	HE/MP Single	MP HEI	
	HE/MP Burst		
40 mm Cannon			High Velocity, Fast-Firing, Automatic Guns
40 mm	AP Single		
	AP Burst		
40 mm	HEAT Single	HEAT	
	HEAT Burst		
40 mm	HE/MP Single	HE	
40 x 46 mm			M406HE, M381HE, M386HE, M441HE
40 x 53 mm			M383 HE, M384 HE
40 mm	HE/MP Burst	HEDP	
40 mm	HEAB Single		
			M397 Airburst , M397A1 Airburst
		PPHE	MK285
40 mm	HEAB Burst		
40 mm		THBAR	XM1060 Thermobaric Round
< 76 mm AT Gun RPG, RCL			RPG: Rocket-Propelled Grenade RCL: Recoilless Rifle

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
40 mm	HE	HE	RPG-7 wikipedia.org RPG-7: OG-7V
73 mm	HE		
75 mm	HEAB	HEAB	Type 69
	HEAT		M72 LAW wikipedia.org
64 mm	HEAT	HEAT	RPG-18 wikipedia.org
73 mm	HEAT	HEAT	RPG-22 wikipedia.org RPG-26 wikipedia.org
77 – 94 mm AT Gun RPG, RCL			RPG: Rocket-Propelled Grenade RCL: Recoilless Rifle
84 mm RPG, RCL	HE		84 mm Carl Gustaf 84 mm, HE 441DRS
	HE		
90 mm RPG, RCL	HE		90 mm, M590E1 Canister
84 mm RPG, RCL	HE	HEDP	AT4 wikipedia.org 84 mm, M136 AT4 HEDP 84 mm, HEDP 502RS
83 mm	HE	HEDP	83 mm, SMAW HEDP Rockeye, SMAW
92 mm	HE	HE-FRAG	Type 69
	HE	HE-FRAG	
84 mm	HEAB		
	HEAT	HEAT	84 mm Carl Gustaf
			84 mm, HEAT 5511M, HEAT 551CRS
83 mm			83 mm, SMAW HEAA Rockeye, SMAW
84 mm			AT4 fas.org AT4 wikipedia.org 84 mm, M136 AT4 HEAT
			84 mm, M136 AT4CS, M136 AT4CSHP
85 mm			RPG-7 en.wikipedia.org RPG-7: PG7V
85 mm	HEAT	HEAT	Type 69-1
90 mm RPG, RCL			90 mm, M371E1 HEAT
93 mm			RPG-7: PG7VL
94 mm	HEAT		Type 69-II, Type 69-III
94 mm RPG, RCL			LAW80 www.armedforces.co.uk 94 mm, LAW80
95 – 109 mm AT Gun RPG, RCL			RPG: Rocket-Propelled Grenade RCL: Recoilless Rifle
107 mm	HE	HE-FRAG	OF-883A
107 mm	HEAB		Cargo Round

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
105 mm	HEAT	HEAT	RPG-7 en.wikipedia.org RPG-29 wikipedia.org RPG-7: PG-7VR RPG-29: PG-29V
			RPG-27 wikipedia.org
107 mm	HEAT		BK-883
105 mm	THBAR	THBAR	RPG-7: TBG-7V RPG-29: TBG-29V
			RPG-27: RShG-1
≥ 110 mm AT Gun RPG, RCL			RPG: Rocket-Propelled Grenade RCL: Recoilless Rifle
110 mm	HE	HEI HE	PzF3 wikipedia.org PzF3 (110 mm)
110 mm	HEAB		
110 – 112 mm	HEAT		
110 mm	THBAR	BB	PzF3 110 mm Bunkerfaust
≤ 76 mm Gun Tank, IFV and APC			57, 73, 76 mm IFV: Infantry Fighting Vehicle APC: Armored Personnel Carrier
	AP	AP APC APFSDS	
	HE		
	HEAT		
77 – 94 mm Gun Tank, IFV and APC			82, 84, 85, 90 mm
90 mm	AP	AP	90mm fas.org M77 AP-T, M318 AP-T, M318A1 AP-T
	AP	AP	M332A1 HVAP-T
	AP	APC	M82 APC-T
	AP	APFSDS	M690 APFSDS
90 mm	HE	HE	M71 HE, M71A1 HE-T
90 mm	HEAT	HEAT	M348A1 HEAT, M431 HEAT-T
90 mm	HESH	HESH	M691 HESH-T, M692 HESH-TP
95 – 103 mm Gun Tank, IFV and APC			100 mm
100 mm	AP	APFSDS	3UBM10
	AP	APHE	BR-412B, JPSV, PSV
	AP	APFSDS	UBM-2, UBM-8
	AP	HVAPDS	UBM-6
	AP	APHE	UBR-412B
100 mm	HE	HE	UK: Opfor APC2, 100 mm HE
	HE	HE-FRAG	3UOF10, 3UOF11

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
100 mm (cont'd)	HE	HE-FRAG	UOF-3, UOF-412, UO-415
100 mm	HEAB		
100 mm	HEAT	HEAT	3BK-5M, 3UBK9, 3BK16M, 3BK17M
	HEAT	HEAT	BK3, BK5, JPRSV, M69
	HEAT	HEAT-T	Type 73, UBK-412R
	HEAT	HEAT	UBK-2, UBK-4, UBK-4M, UBK-9M
104 – 109 mm Gun Tank, IFV and APC			105, 106
105 mm	AP	APFSDS	
	AP	APFSDS	M735 APFSDS-T, M774 APFSDS-T
	AP	APFSDS	M833 APFSDS-T, M900 APFSDS-T
	AP	APFSDS	FP105, Olin 105
	AP	MRM-KE	www.defense-update.com MRM
	APDS	TPDS	M724A1
	APDS	APDS	M392 APDS-T, M728 APDS-T
	APDS	APDS	NO: APDS-T 105 mm
105 mm	HE	HE	AT:105 – 120 mm HE
	HE	HE	M494 APERS-T
	HE	HE	M1040 Canister
	HE	HE	M393A3
	HE	HE	M546
105 mm	HEAB	HEAB	APAM
105 mm	HEAT	HEAT	
	HEAT	HEAT	M456 HEAT-T, M662 HEAT-T
	HEAT	HEAT-MP	XM815 HEAT-MP
	HEAT	MRM-CE	www.defense-update.com MRM
	HESH	HEP	M393A2
105 mm	HESH	HEP-T	
110 – 116 mm Tank, IFV and APC			115 mm
115 mm	AP	APDS	
	AP	APFSDS-T	UBM-3, UBM-9
	AP	HV APFSDS-T	UBM-5
115 mm	HE	HE	
	HE	HE-FRAG	3UOF-37, UOF-37, UOF-6
115 mm	HEAB		
115 mm	HEAT	HEAT	
	HEAT	HEAT-T	UBK-3, UBK-3M

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
117 – 122 mm Tank, IFV and APC			120, 122 mm
120 mm	AP	APFSDS	M829A1 APFSDS-T
	AP	APFSDS	M829E3, M338
	AP	APFSDS	DM63A1KE, DM53A1KE
	AP	APFSDS	DM43A1KE, DM33A1KE
	AP	APFSDS	Advanced Tungsten KE Cartridge
	AP	MRM-KE	www.defense-update.com MRM
	AP	TERM	XM1007 ERM/TERM
	AP	AP	X-ROD
120 mm	APTOP	STAFF	XM943 STAFF, Top Attack
120 mm	HE	HE	M1028
	HE	HE	AMOS wikipedia.org
	HE	HE	
	HE	HEORT	M908
	HE	HEMO	M933, M934
	HE	HEMP	DM12A2MP, M337
120 mm	HEAB		
	HEAT	HEAT	M830A1 HEAT
	HEAT		
	HEAT	MRM-CE	www.defense-update.com MRM
120 mm	HESH	HESH	UK: Bluefor Challenger, 120 mm HESH
≥ 125 mm Tank, IFV and APC			125 mm
125 mm	AP	APDS	
	AP	APHE	BR-471B
	AP	APC-T	VBR-472
125 mm	APTOP		
125 mm	HE	HE	
	HE	DPICM	Type 83
	HE	HE	OF-1, M76, Type 54
	HE	HE-FRAG	OF-56, OF-56-1, Type 462
	HE	HE-FRAG	OF-462, OF-471N, OF-472
125 mm	HEAB		
125 mm	HEAT	HEAT	
	HEAT	HEAT	BK-9, BP-463
	HEAT	HEAT-FS	BK-6M, BK-13, BK463UM, 3UBK-9

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
≤ 94 mm Mortar, Field Gun and Art. Rockets			50, 51, 52, 70, 76, 60, 81, 82, 88 mm
	HE		Type 71
70 mm	HE	HE-FRAG	Artillery Rocket FZ LAU-97: FZ-71
	HE	PFHE	Artillery Rocket FZ LAU-97: FZ-85
	HE	HE	Artillery Rocket Hydra 70: M151
80 mm	HE		
105 mm	HE	DPICM	M915, 105 mm
	HE	DPICM	M916, 105 mm
	HEAB		
70 mm	HEAB	Cargo	Artillery Rocket FZ LAU-97: FZ-100
70 mm	HEAB	HE	Hydra70 www.fas.org Artillery Rocket Hydra 70: M151: Time Fuzed
70 mm	HEAB	MPSM HE	Art. Rocket Hydra70: M261: Remote Fuzed
70 mm	HEAB	HE	Art. Rocket Hydra 70: M255: Remote Fuzed
	HEAT		
70 mm	HEAT	AP	Artillery Rocket FZ LAU-97: FZ-49
70 mm	HEAT	HEAP	Artillery Rocket FZ LAU-97: FZ-58
73 mm	HEAT	HEAT	73 mm 2.75-inch Rocket
95 – 109 mm Artillery Mortar, Field Gun			98, 100, 105, 107 mm
100 mm	HE		Type 71
105 mm	HE	DPICM	M915, M916
107 mm	HE	HE	Type 63 Rocket
	HEAB		
95 – 149 mm Artillery, Mortar, Field Gun, Artillery Rocket			100, 105, 107, 120, 122, 130 mm
100 mm	HE		Type 71
105 mm	HE	DPICM	M915, M916
107 mm	HE	HE	Type 63 Rocket
122 mm	HE		122 mm ARTY DF
120 mm	HE	HE	AMOS wikipedia.org
120 mm	HE	DPICM	OGR 120 PR
122 mm	HE	HE	Firos 25/30 Rocket
130 mm	HE	APHE	M46
130 mm	HE	APHE-T	BR-482B
130 mm	HE	HE	Type 59, M79, OF33
130 mm	HE	HE-FRAG	OF-482M
130 mm	HE	HE	HE-482M

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
122 mm	HEAB	APAMB	Firos 25/30 Rocket
120 mm	HEAT	HEAT	
122 mm	HEAT	ATM	Firos 25/30 Rocket
130 mm	THBAR	HE-BB	M79BB
≥ 150 mm Artillery, Mortar, Field Gun			152, 155, 160, 165, 175, 180, 203, 240, 305 mm
152, 155 mm	HE	HE	152 mm 155 mm
155 mm	HE	DPICM	M483A1, M864, Type 66
	HE	HE	M107, M549A1, M795, M795E1, M864
	HE	HE	
160 mm	HE	HE	F-853A, F-853U
180 mm	HE	HE	G-572
203 mm	HE		G-620
240 mm	HE		F864
280 mm	HE		675
305 mm	HE		724
155 mm	HEAB	HEAB	
	THBAR		
Anti-Tank Missile Russia	Russia		AT-Missiles wikipedia.org
AT-1 3M6	HEAT	Snapper "Shmel"	AT1 wikipedia.org Truck Mounted; Reserve Use and 3rd World
AT-2 3M11	HEAT	Swatter "Falanga"	AT2 wikipedia.org Wide Export and Use
AT-3 9M14	HEAT	Sagger "Maljutka"	BMP, BMD, BRDM, HELO, Man-Pack Models; Very Wide Use and Export; Chinese Copy is HJ-73 Red Arrow
RAAD	HEAT Iran		AT-3 Based
AT-4 9M111	HEAT	Spigot "Fagot"	BMP, BMD, BRDM, Man-Pack Mounts; Can be fired from AT-5 launchers
AT-5 9M113	HEAT	Spandrel "Konkurs"	9M113, BMP, BMD, BRDM, Man-Pack Mounts; Can be fired from AT-4 launchers
AT-6 9M114	HEAT	Spiral "Shturm"	Shturm Army-technology.com MT-LB Launchers in Non-Divisional AT Units
AT-7 9M115	HEAT	Saxhorn "Metis"	Airborne and BTR Units; Man-Pack Mounts
AT-7b	HEAT	Saxhorn "Metis"	Improved Missile Using Existing Saxhorn Launchers
AT-6 9M114	THBAR	Spiral "Shturm"	
AT-9 9M120	THBAR	Spiral-2 "Ataka"	

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
AT-8 9M112	HEAT	Songster “Kobra”	125 mm Gun Launched; T-64B and Early T-80
AT-9 9M120	HEAT	Spiral-2 “Ataka”	Ataka Army-technology.com HAVOC, HOKUM, HIND E/F Launchers
AT-10 9M117	HEAT	Stabber “Bastion”	100 and 115 mm Gun Launched; T-55, T-62, MT-12, and BMP-3
AT-10 9M117M	HEAT	Stabber “Kan”	100 and 115 mm Gun Launched; T-55, T-62, MT-12, and BMP-3
AT-10 9M117M1	HEAT	Stabber “Arkan”	100 and 115 mm Gun Launched; T-55, T-62, MT-12, and BMP-3
AT-11 9M119 9M119M	HEAT	Sniper “Svir” “Refleks”	125 mm Gun Launched; T-72, T-80, T-84, T-90 UK: OPFOR MBT2, ATGW 2
AT-12 9M117	HEAT	Swinger “Sheksna”	Uses the same missile as the AT-10 115 mm Gun Launched; T-62
AT-12 9M117M	HEAT	Swinger “Sheksna”	Uses the same missile as the AT-10 115 mm Gun Launched; T-62
AT-12 9M917M1	HEAT	Swinger “Sheksna”	Uses the same missile as the AT-10 115 mm Gun Launched; T-62
AT-13 9M131	HEAT	Saxhorn-2 “Metis-M”	
AT-14 9M133	HEAT	Spriggan “Kornet”	Kornet Army-technology.com 152 mm. Tripod or Vehicle-Mounted; Thermal Viewer Effective to 3500 m
AT-15 9M123	HEAT	Springer “Kriz-antema”	150 mm
AT-13 9M131F	THBAR	Saxhorn-2 “Metis-M”	
AT-14 9M133F	THBAR	Spriggan “Kornet”	
AT-15 9M123F	THBAR	Springer “Kriz-antema”	
AT-16	THBAR		
AT-16	HEAT	Scallion “Vikhr”	Air-to-Ground System
AT-16	HEAB		Time Fuzed
SA-14 9M36	HE	Gremlin “Strela-3”	SA-14 wikipedia.org
SA-16 9M313	HE	Gimlet “Igla-1”	SA-16 wikipedia.org
SA-18 9M39	HE	Grouse “Igla-M”	SA-18 wikipedia.org
SA-24 9M342	HE	Grinch “Igla-S”	SA-14-16-18-24 globalsecurity.org
Anti-Tank Missile	US		
AGM-65	HE	HE	Maverick wikipedia.org Maverick, 57 kg Hollow Charge with Contact Fuse
	HE	HEAT	135 kg High Explosive

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
AGM-114K	HEAT	HEAT Hellfire II	Hellfire wikipedia.org US, Swedish, NATO, and Israeli Use
AGM-114N	HEAT	MAC	Metal Augmented Charge
AGM-114KII	HE	HE/MP	External Blast Frag Sleeve
AGM-114M	HE	HE-FRAG	Blast Fragmentation
AGM-114L	HE	Longbow Hellfire	
AGM-BGM-XYZ	HEAT	JAGM	JAGM wikipedia.org Joint Air-to-Ground Missile
	HE	HE-FRAG	
	HEAT	TOW	
Anti-Tank Weapon	HEAT	HE	
BGM-71A	HEAT	TOW	Basic TOW; TOW Army-technology.com
BGM-71C	HEAT	TOW	
BGM-71D	HEAT	TOW 2	
M220/ BGM-71E	HEAT	TOW 2A	
	HEAT	Predator	Direct Attack
Troophan 2	Iran		Copy of TOW
HJ-8E	HEAT China	Red Arrow 8	HJ-8 answers.com Copy of TOW
Baktar-Shikan	Pakistan		License Production of HJ-8
KAM9/ TYPE 79	HEAT JPN		Similar to TOW
M220/ BGM-71H	THBAR	TOW 2A BB	Bunker Buster
	THBAR	Predator BB	Multi-Purpose Variant (MPV) Blast Fragmentation Warhead, (which will convert the system into a direct attack urban assault weapon, effective against buildings and bunkers)
M220/ BGM-71F	HEAT	TOW 2B	Top Attack
FGM-172 SRAW	HEAT	Predator	Predator army-technology Top Attack; UK Kestrel
TOW 2B Air Launched	HEAT	TOW 2B Areo	
	HEAT	TOW 2B RF	
	HEAT	TOW FF	TOW Fire and Forget; Top Attack
	HEAT	TOW FF	TOW F&F Alternate Mode Fire and Forget; Direct Attack
YMGM-157B	HEAT	EFOGM	EFOGM army-technology.com TOW Based
	HEAT	LOSAT	Fire and Forget Weapon System Line-of-Sight Anti-Tank Weapon Using Kinetic Energy Missile (KEM) LOSAT Army-technology.com
M47	HEAT	Dragon	Saudi, Yugoslav, Swiss, Moroccan, Jordanian and Other Users
	HEAT	Javelin	Fire and Forget Weapon System Javelin Army-technology.com Top Attack; Imaging Infrared (I2R)

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
M47 (cont'd)	HEAT	Javelin	Direct Attack
Stinger (Fire and Forget) Ground-to-Air	HE		Also as OSAG 1.0 ammo.no. 25 Stinger fas.org; Direct Attack
Type 87	JPN		Stinger Copy
MIM-72	HEAT	Chaparral	SAM wikipedia.org Chaparral, SAM
Anti-Tank Missile	Europe		
HOT 1	HEAT		HOT Army-technology.com HOT wikipedia.org Several Missile Versions; Anti-Reactive Armor Capability
HOT 2	HEAT		
HOT 3	HEAT		
HOT Air Launched	HEAT		
MILAN 2	HEAT		Milan Army-technology.com Ground and Vehicle Mounts
MILAN 2T	HEAT		
MILAN 3	HEAT		
TRIGAT MR	HEAT		TRIGAT Army-technology.com
TRIGAT LR	HEAB		Also as OSAG 1.0 ammo.no.30 Top Attack
TRIGAT LR	HEAT		Direct Attack
MBT LAW	HEAB	NLAW, RB57	Fire and Forget Weapon System NLAW Army-technology.com Top Attack
MBT LAW	HEAT	NLAW, RB57	Direct Attack
ERYX	HEAT FR		ERYX Army-technology.com HE Calibre 137 mm
SWINGFIRE	HEAT UK	Swingfire	Adaptable to almost all vehicles; Belgian and Egyptian use
Brimstone	HEAT UK		Brimstone Army-technology.com Single Launch
Brimstone	HEAT UK		Multiple Launch
RBS-56	HEAB SWD	BILL1 Top	Proximity and Top Attack Modes; Thermal Sights; Export Offered
RBS-56	HEAT SWD	BILL1 Direct	AT: Bill 1 Direct Attack
RBS-56	HEAB SWD	BILL2 Top	AT: Bill 2 Top Attack
RBS-56	HEAT SWD	BILL2 Direct	AT: Bill 2 Direct Attack
RBS-56	HEAT SWD	BILL Soft	AT: Bill Soft Target
RBS-70	HEAT SWD	MK0	RBS-70 wikipedia.org

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
RBS-70	HEAT SWD	MK1	RB70ÖS
RBS-70	HEAT SWD	MK2	
RBS-70	HEAT SWD	BOLIDE	
RBS-70	HEAB SWD	BOLIDE	
Anti-Tank Missile	International		
SPIKE-SR	HEAT		
SPIKE-MR	HEAT	Gill	
SPIKE-MR	HEAB	Gill	
SPIKE-ER	HEAT	NTD Dandy	
LAHAT	HEAT		LAHAT wikipedia.org 105 and 120 mm Launched; Also a 105 mm RCL may be available
Nimrod	HEAT		Nimrod wikipedia.org Laser Designation Possible
Nimrod	HE	HE-FRAG	
Nimrod	THBAR		
MAPATS	HEAT	Toger	MAPATS janes.com Similar to TOW-2
HJ-9	HEAT China	Red Arrow 9	HJ-9 answers.com Similar to MAPATS and TOW-2
ZT3	South Africa	Swift	ZT3 Swift janes.com
KAM3D/ TYPE 64	HEAT JPN		Obsolete
Mokopa	HEAT South Africa		Not Simulated Laser Designator Required
Ingwe	HEAT South Africa		Not simulated Ingwe answers.com
Nabukhadnazar	HEAT Iraq		Limited Info
Non-Lethal Less Lethal			For example, Tear Gas Shells, Bean Bags, Stun Rounds and Rubber Projectiles
Ammo with no effect	NLETH		
≤ 76 mm	NLETH		
40 mm Grenade	NLETH		M385 M918 fas.org M385, M918, M203, Mk19, XM320
40 mm	NLETH		M1006 Sponge Round (Point), M651 CS
40 mm	NLETH		M1029 Crowd Dispersal Cartridge
77 – 109 mm	NLETH		
105 mm	NLETH		Stun Cartridge
≥ 110 mm	NLETH		

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
120 mm	NLETH		Stun Cartridge
Improvised Explosive Device, IED			IED wikipedia.org TNT equivalent wikipedia.org
Small 2 kg TNT equivalent			For example, Improvised shrapnel packed together with a number of dynamite cartridges
Booby-trap			Booby-trap wikipedia.org
Suicide Bomber			Suicide bombing wikipedia.org
Medium 20 kg TNT equivalent			Can be carried by a car; for example, some 120 mm HE shells armed as an IED
Large 200 kg TNT equivalent			Can be carried by a lorry
Mine			Horizontal Effects Weapon, HEW
HEW	AT Mine	HEW Kill	
HEW	AP Mine	HEW Hit	
Mine, Anti-Personnel	AP Mine		List of landmines wikipedia.org
M-16			M16 Mine wikipedia.org
M-19			Anti-Personnel
M-100			
Mine, Anti-Tank Mine	AT Mine		AT-Mine fas.org
M-7			M7 wikipedia.org
M-15			M15 wikipedia.org
M-19			Anti-Tank Mine M19 Mine wikipedia.org
M-21			M21 wikipedia.org
M-100			
Mine	AT Mine		Horizontal Effects Weapon (HEW)
Off-Route Mine, M24	AT Mine		wikipedia.org M24 mine
Hand Grenade			Handgrenade wikipedia.org
100 g TNT Equivalent		FRAG	Fragmentation Grenade
M67	US		M67 wikipedia.org
F1	USSR	Limonka	F1 wikipedia.org
250 g TNT Equivalent			Concussion Grenade
MK3A2	US		
Engagement Alert			To inform the target about an engagement
Laser Range Fire			A LRF is made against the target
Laser Designator			A laser designation is done against the target
Laser Beam Rider			A laser beam riding missile is engaging the target
IFF by a Friend			Identification Friend or Foe; IFF is done against the target by a friend
IFF by a Foe			IFF is done against the target by a foe

Calibre or Weapon	Ammo Type or Origin	Real Ammo Type or Nick-Name	Description
IFF answer			Answer to a friendly IFF; Not Simulated
Munition Flame			A weapon is fired against the target
Additional			Additional Simulated Functions
RF SAM			RF SAM
Secondary Effects Kill			As for example splitter from a tank hit
Flame Thrower			
Universal Kill			Universal Kill Possible Scanning Diamond Universal Kill
Helmet Off Kill			Possible scanning diamond killing soldiers with helmet taken off
Traffic Kill or Other Indirect Kill			OSAG 1.0 Ammo. No. 62
Backblast			OSAG 1.0 Ammo. No. 63 Backfire from a Recoilless Weapon
Free to use			
Free to use			
Free to use			

Annex C – MINIMUM REQUIREMENTS FOR EXCON INFO AND AAR

This annex provides the minimum functional requirements of the EXCON and AAR are described.

The main aim of Exercise Control (EXCON) is to provide the capability to define (planning and preparation), monitor, control and analyse the results of an exercise. This leads to the preparation and provision of an interactive After Action Review (AAR), which is the most important output.

These requirements could be grouped by categories as is shown below:

Events triggered by Dynamic Objects (UCATT-1 report) involved in the exercise:

WHO (Identification):

- Persons (Unique and Gp);
- Vehicles (Unique and Gp);
- Buildings (Unique);
- Weapon systems (Unique and Gp);
- Belonging the objects to the involved exercise party;
- Every object is definitive identified with a graphical symbol; and
- Order of battle.

WHERE (Localisation):

- Static positions of every object in the buildings and around them;
- Movement tracking of the objects; and
- Localisation of the impact point.

WHEN (GPS Time):

- Time stamping for all defined 'what' and 'where' events.

WHAT HAPPENED (Event Description):

- EXCON must record and provide, as a minimum, information about the following events for the AAR.

TARGET:

- Impact analysis:
  - Direct engagement (firing/hit/miss);
  - Indirect engagement (hit/miss); and
  - Weapon type: (SA/ rocket/ IED/ heavy/ tank/ arty and blast).
- Identification and status of objects: alive/degraded – intervention/dead.

ATACKER:

- Who was the shooter;

- Weapon and ammunition type used by the shooter; and
- Status of the shooter: alive/degraded – intervention/dead.

Requirements from the side of ExDir and EXCON:

- All information defined in the requirements above must be available for the ExDir and EXCON.
- Command staff must have the possibility to act as a dynamic object on the battle field especially by:
    - Definition of virtual attacks (e.g. area weapons, Nuclear, Biological and Chemical (NBC) attack, IEDs);
    - Changing the status of the objects; and
    - Control and capture of the exercise scenarios.

The aim of the EXCON should be to give a possibility to configure the training system (e.g. EXCON, dynamic objects) to national and international requirements.

After Action Review

The provision of AAR is the final output. AAR should be tailored to meet the exercising troop's needs and will be based on the captured and recorded data of the exercise, e.g. engagement events or video sequences. EXCON should provide the Commander with the tools to analyse and present the exercise. Delivery of the AAR material can be delayed or provided immediately depending upon training need.

Annex D – SAFETY AND ENVIRONMENTAL ISSUES

D.1 GENERAL INFORMATION

This document is intended to provide very basic information and awareness on safety and environmental issues to exercising units that will assist in the understanding of a new facility, its capabilities and constraints. Each country/organisation will have its own safety and environmental policies and procedures and they must take priority. However, the listed items below are things of note and can/should form a part of any briefing material.

Safety and Environmental Issues

- For international training facilities and sites;
- For the conduct of training and exercises; and
- For exercises in an urban environment.

Description of Location

- Aim (give an overview for the first contact);
- General description of training level, instrumentation and evaluation;
- Map; and
- Address.

Infrastructure

- Overview/pictures of main buildings (ground – general / ground – detail);
- Sub-training areas as map; and
- Detailed information of single buildings.

Aim:

- Show possibilities of usage, including specific facilities.
- Give impression of e.g. electricity, stairs.

Available Training Equipment

Detail of available stores, e.g. ladders, barrels, obstacles, fences, sand sacks, ropes, improvised "Helpers", breaching material.

Demo-Buildings and Showcases

Detail of cut-away buildings, set-piece demonstrations and prepared rooms.

Training Site Locations and Buildings

- Briefing rooms for training – including classroom facilities;
- Briefing rooms for exercise – including orders and central lecture facilities;
- Headquarters locations;
- EXCON building and AAR facilities; and
- Stores and admin areas.

Site Standing Instructions

Do’s and Don’ts:

- Usage of instrumentation;
- Usage of furniture;
- Usage of roofs;
- Rappelling;
- Usage of ruins;
- Usage of tunnels and underground systems;
- Bivouac and vehicle parking areas (tactical and real/live);
- Usage of various types of weapons, training explosives, vehicles and open fire, e.g. handling (driver, stabilisation of weapon); and
- Restricted areas.

Restrictions on signs (signs which have a real/live effect to another environment).

Signs During the Training and Exercise

- Participants and neutral persons or vehicles.

Usage of Weapons, Training Explosives and Positions

- Inside/outside buildings and infrastructure (distances, etc.);
- Changes of infrastructure to build up positions for weapons; and
- Digging.

Usage of Radios and C2I Systems

- Frequencies (training and safety-organisation).

Usage of Helicopters

- Landing sites and local procedures (air traffic controls).

Responsibilities

Aim:

- Define relationship between training facility / training site / military training unit.
- Also for example sign and signals (see above).

Safety Equipment

For example, eye protection.

Live-Fire Regulations

- Request;
- Permission;
- Markers/borders;
- Limitations on the environment;
- Cases of fire an emergency; and
- Qualification and coverage of medical personal on the range.

SimMunition-Fire Regulations

- See Live-Fire directions above; and
- Protection.

Restrictions to Protect the Environment

- Restricted areas – animals, plants and pollution;
- Signs for borders and limits; and
- Fines and consequences.

Handling of Equipment

Describe the takeover-handling-handover, especially in cases of damage.

Notification of Changes

For example, notice times for changes and cancellations, site POC and contact details and forms and templates.

Cooperation with Civil or Industrial Personnel

For example, competences, times of opening and closing.

Legal Regulations

- Right to enter, carry weapons and to stay in the foreign country; and
- Memorandum of Understanding (MoU), incl. the regulation concerning the costs.

Annex E – EFFECTS REPRESENTATION ON TARGETS

E.1 EFFECTS REPRESENTATION (ER)-RELEVANT EVENTS ON THE SIDE OF THE SHOOTER

Table E-1 shows examples of possible engagement events on a shooter, the kind of representation, a means of representing the effect.

Table E-1: Examples of Engagement Events.

Engagement Event Shooter	Kind of Representation	Means of Representing Effect	ER Example
Small arms shot	Acoustical, optical	Pyrotechnics	Blank ammo bang and flash
Anti-tank fire	Optical	Pyrotechnics	White flash, bang and smoke
Battle-tank, anti-aircraft or howitzer fire and mortars	Acoustical, optical	Pyrotechnics	White flash, loud bang and smoke
Anti-tank helicopter fire and CAS	Optical	Pyrotechnics (safety?), flashing lights	White flash, smoke/flare (?)

E.1.1 ER-Relevant Events on Targets

Table E-2 shows examples of possible engagement events and their respective representation on the targets. The list has been approved by STWG and UOWG. UCATT TG have taken in to consideration that we can’t show more information to the soldiers than what the soldier can expect in real-life experiences.

Table E-2: Examples of Effects on Targets.

Target	Engagement Event	Engagement Result	Kind of Representation	Means of Representing Effect	ER Example	Remarks
Personnel	Near miss (from small arms)	No change	Acoustical	Electroacoustic	Short beep	
Personnel	Direct/indirect weapon hit	Degree of wounds	Acoustical	Electroacoustic	–	
Personnel	Direct/indirect weapon hit	Kill	Acoustical	Electroacoustic	Long, loud beep	
Vehicle	Near miss	No change	Acoustic or visible	Headphones, display		
Vehicle	Hit no damage	No change	Acoustic or visible	Single flash (target)	–	People inside the vehicle hear the sound of the shots on their earphone/ loudspeakers of the vehicle communication
Vehicle	Direct fire	Degree of damage	Optical outside and acoustic/ visible inside	Flashing lights	Temporary (5 s) flashing light	Damage to weapons, radios, mobility, optics, etc.
Vehicle	Direct weapon hit	Total kill	Acoustical, optical	Pyrotechnic, flashing lights	Agreed color of smoke, permanent flashing light	
Vehicle	Indirect weapon hit (artillery, aircraft bombing)	Degree of damage	Optical outside and acoustic/ visible inside	Flashing lights	Temporary (5 s) flashing light	

Target	Engagement Event	Engagement Result	Kind of Representation	Means of Representing Effect	ER Example	Remarks
Vehicle	Indirect weapon hit (artillery, aircraft bombing)	Total kill	Optical, acoustical	Pyrotechnics, flashing lights	Permanent flashing light	
Vehicle	Mine hit	Degree of damage	Optical, outside and acoustic/ visible inside	Flashing lights	Temporary flashing light	
Vehicle	Mine hit (incl. IED)	Total kill	Optical, acoustical	Pyrotechnics, flashing lights	Permanent flashlight	
Building	Direct or indirect hit	Hit with no damage on sheltering capability	Optical, acoustical	Flashing lights, electro acoustics, signs	No sign	
Building	Direct or indirect hit	Partial destruction	Optical, acoustical	Flashlights, electro acoustics, signs, smoke generators	Temporarily flashing light, smoke	
Building	Direct or indirect hit	Total destruction	Optical, acoustical	Flashing lights, electro acoustic, signs, smoke generators	Permanent flashlight indicating "infrastructure destroyed"	
Bridges and obstacles	Direct or indirect hit	Hit with no damage	Optical, acoustical	Flashing lights, electro acoustics, signs, smoke	Hazard light, smoke	No simulation, only showed by fire markers smoke

Target	Engagement Event	Engagement Result	Kind of Representation	Means of Representing Effect	ER Example	Remarks
Bridges and obstacles	Direct or indirect hit	Partial destruction	Optical, acoustical	Flashing lights, electro acoustic, signs, smoke	Hazard light, smoke, sign to indicate totally destroyed, yellow flag for non-instrumented sites	Sound and smoke simulated by fire markers and/or pyrotechnics A visual sign (for example yellow tape or yellow flag)
Bridges and obstacles	Direct or indirect hit	Total destruction	Optical, acoustical	Flashing lights, electro acoustic, signs, smoke generators	Hazard light, smoke, sign to indicate totally destroyed, red flag for non-instrumented sites	Sound and smoke simulated by fire markers and/or pyrotechnics A visual sign (for example red tape or red flag)
Suicide-borne improvised explosive device	Direct hit on personnel	Kill and wounded personnel	Optical and acoustic	Chalk, sim explosion as well as a spoken signal by the PDD		There should be a bubble created around the PDD of the device; for example within a range of 20 meters everybody will be killed; within a range of 50 meters everybody will be wounded and within a range of 200 meters everybody got a sign on their PDD

Target	Engagement Event	Engagement Result	Kind of Representation	Means of Representing Effect	ER Example	Remarks
Vehicle-borne improvised explosive device; Suicide-controlled vehicle-borne improvised explosive device; Radio-controlled improvised explosive device	Direct hit on soft vehicle	Total destruction	Optical and acoustic	Optical acoustic (by the PDD?) as well as by a sim explosive	(Chalk?), and permanent flashing light	Within the vehicle a percentage or all personnel should be killed, the rest of the personnel should be wounded; within a range of 50 meters some personnel will be wounded and within a range of 200 meters everybody got a sign on their PDD
Vehicle-borne improvised explosive device; Suicide-controlled vehicle-borne improvised explosive device; Radio-controlled improvised explosive device	Direct hit on armored vehicles	Partial destruction	Optical and acoustic	Optical acoustic (by the PDD?) as well as by a sim explosive	Optical acoustic (by the PDD?) as well as by a sim explosive	Within the vehicle a percentage should be have light injuries; within a range of 50 meters some personnel will be wounded and within a range of 200 meters everybody got a sign on their PDD
Vehicle-borne improvised explosive device; Suicide-controlled vehicle-borne improvised explosive device; Radio-controlled improvised explosive device; Pressure plate improvised explosive device; Command wire improvised explosive device; Explosive formed projectile	Direct hit on vehicle	Damage < kill	Optical and acoustic	Optical acoustic (by the PDD?) as well as by a sim explosive	(Chalk?), and flashing light for 5 seconds	Within the vehicle a percentage can be wounded; within a range of 200 meters everybody got a sign on their PDD

Annex F – HOW TO CREATE VULNERABILITY MODELS FOR BUILDINGS AND VEHICLES

F.1 BACKGROUND

Every Nation has its own method to create vulnerability models for buildings and vehicles. In multi-national exercises it is important to have common rules for the effects from different weapons and ammunition types. The accuracy doesn't need to be perfect, but good enough for the players involved to feel that the effect is near the reality. When we collect this information from the Nations today, it differs a lot and so much so that it will lose focus from TTPs to a discussion between partners if it was the right effect. Some Nations already use programs to assist when they create new vulnerability models. UCATT-2 suggestion is to give the base for such a program which can be available for all Nations using the UCATT code (SISO).

F.2 SEVEN STEPS TO CREATE A VULNERABILITY MODEL

This idea has been successfully used for more than ten years in Sweden, and now further developed in the International User Community (IUC).

F.2.1 Step One (The Model)

Create a 2D or 3D picture or model of the target (building with all rooms or the vehicle in all needed aspect/ angles).

Figure F-1: Picture of an Urban Structure.

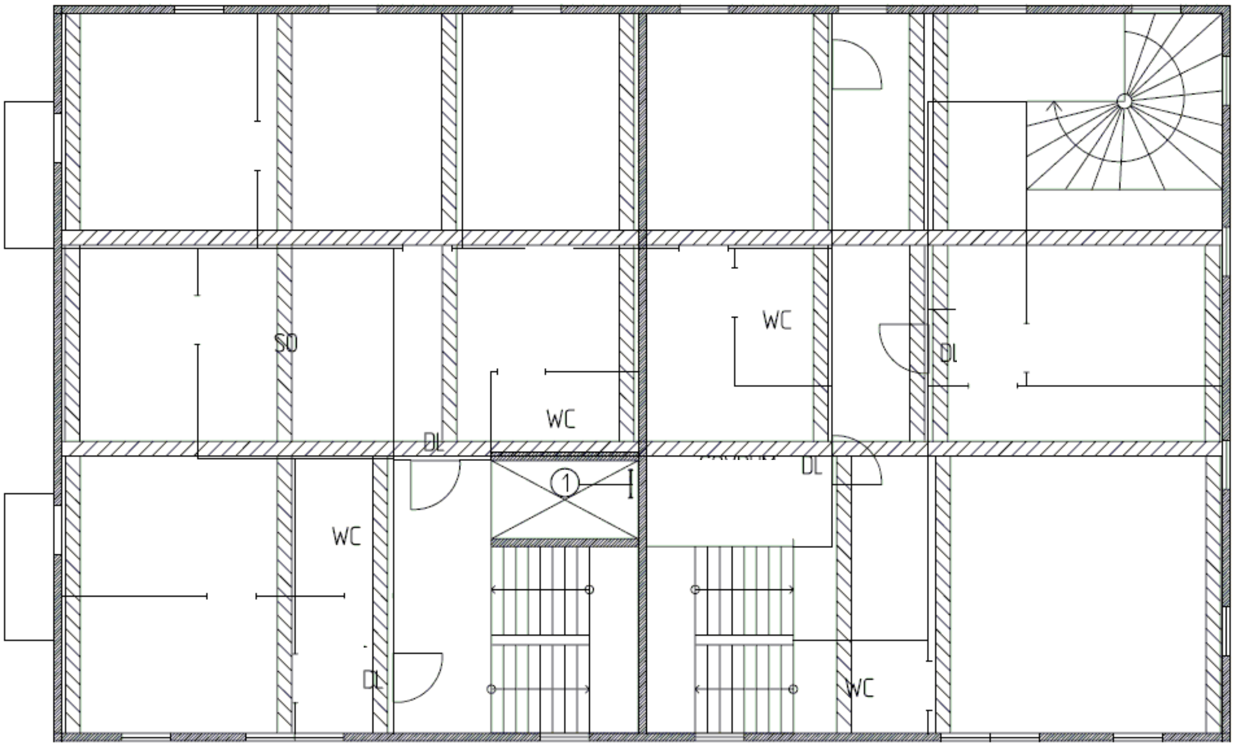


Figure F-2: 2D Model.

Figure F-3: 3D Model.

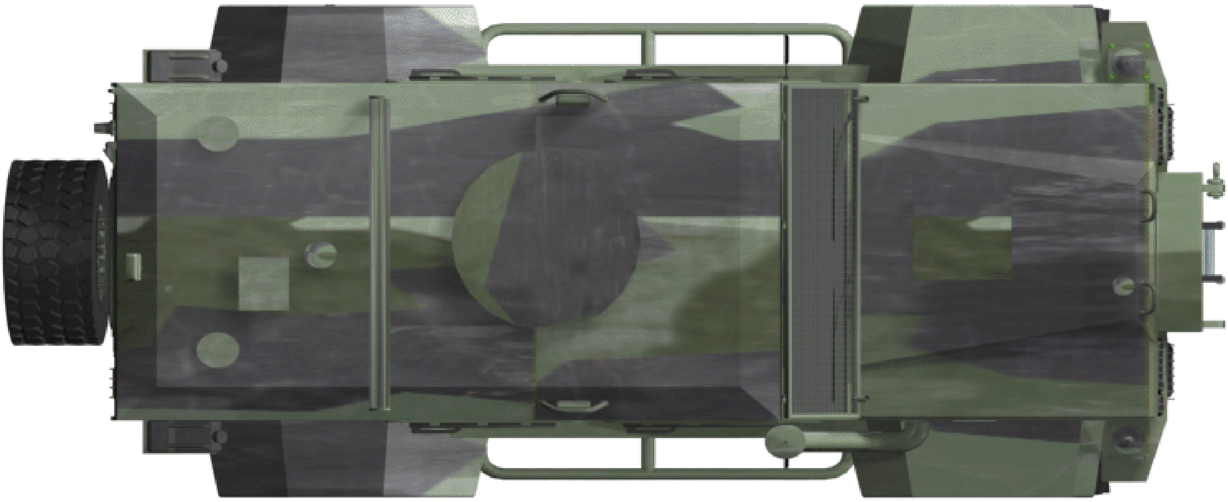


Figure F-4: 3D Model from Above.

F.2.2 Step Two (Vulnerability Zones)

Create the different vulnerability zones for all needed aspects.

It means that you have to classify the different parts of the vehicle or building. If it is a vehicle it must be divided into areas for drive line/ engine/ trucks, turret/ weapon/ sight, driver/crew area, etc.

For buildings and rooms it must be divided into areas for windows/doors, walls with different materials and thicknesses, stairs and other construction-details.

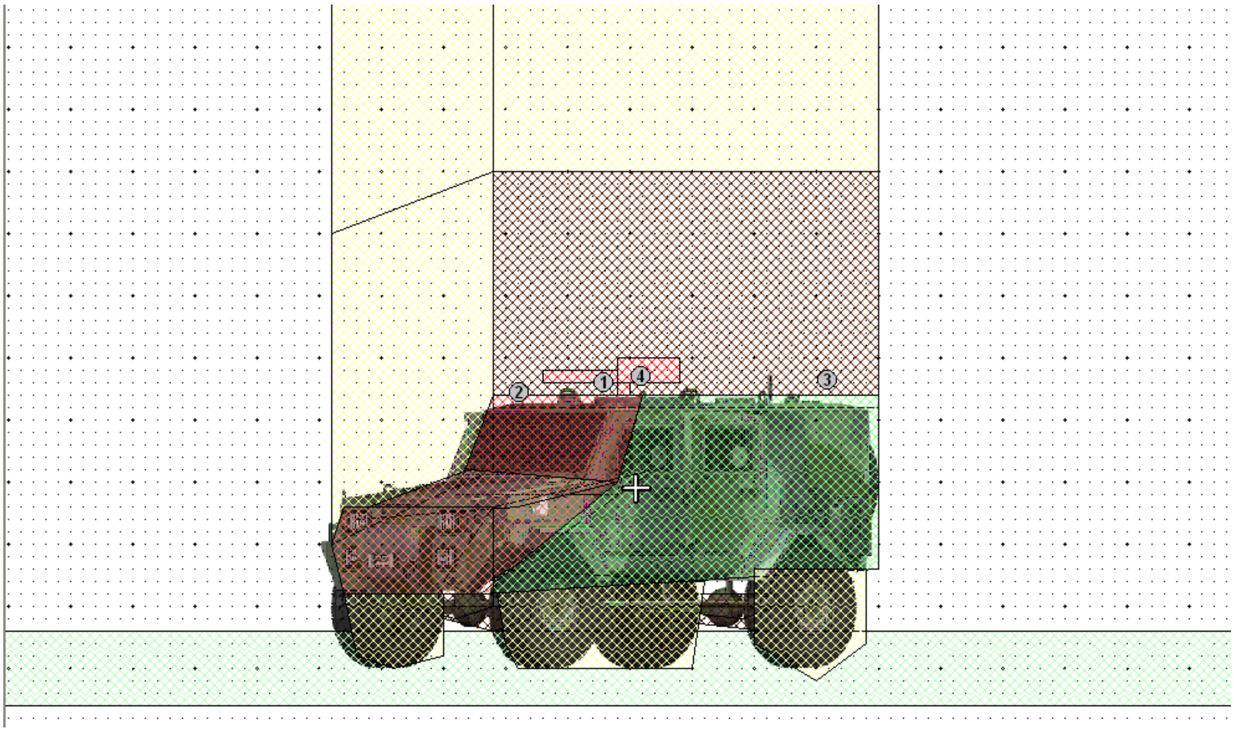


Figure F-5: Different Zones on a Vehicle.

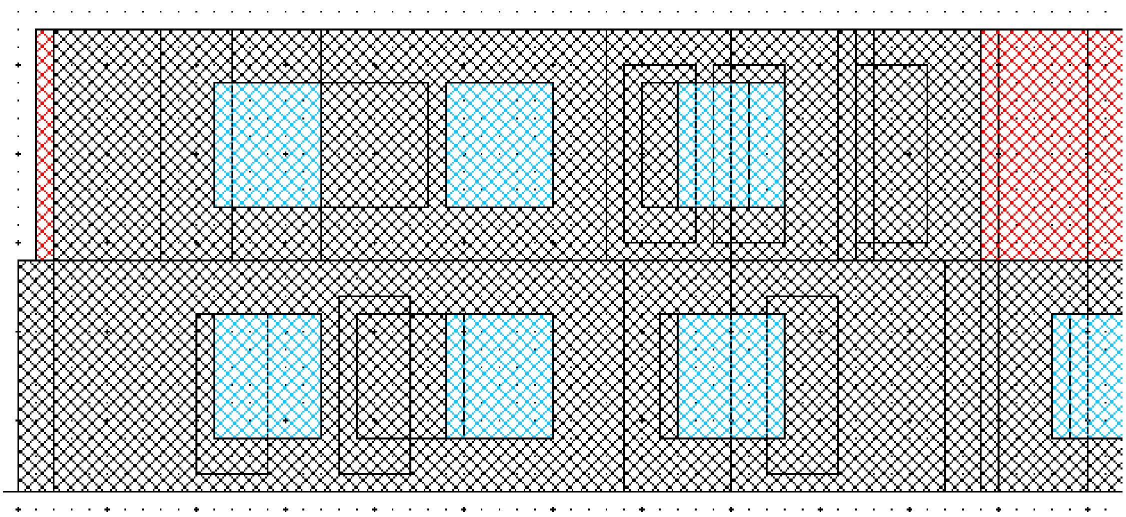


Figure F-6: Different Zones Outside on a Building.

F.2.3 Step Three (Material Thickness and Vertical Angle)

Add data to the areas you created in Step Two – data includes type of material, thickness and if the material has a vertical angle other than 90 degrees.

For vehicles you must refer to thickness in equivalent armour, and add the vertical angle.

For buildings and rooms you have to define material type (concrete, reinforced concrete, wood, glass, etc.) and if combinations of different materials are present.

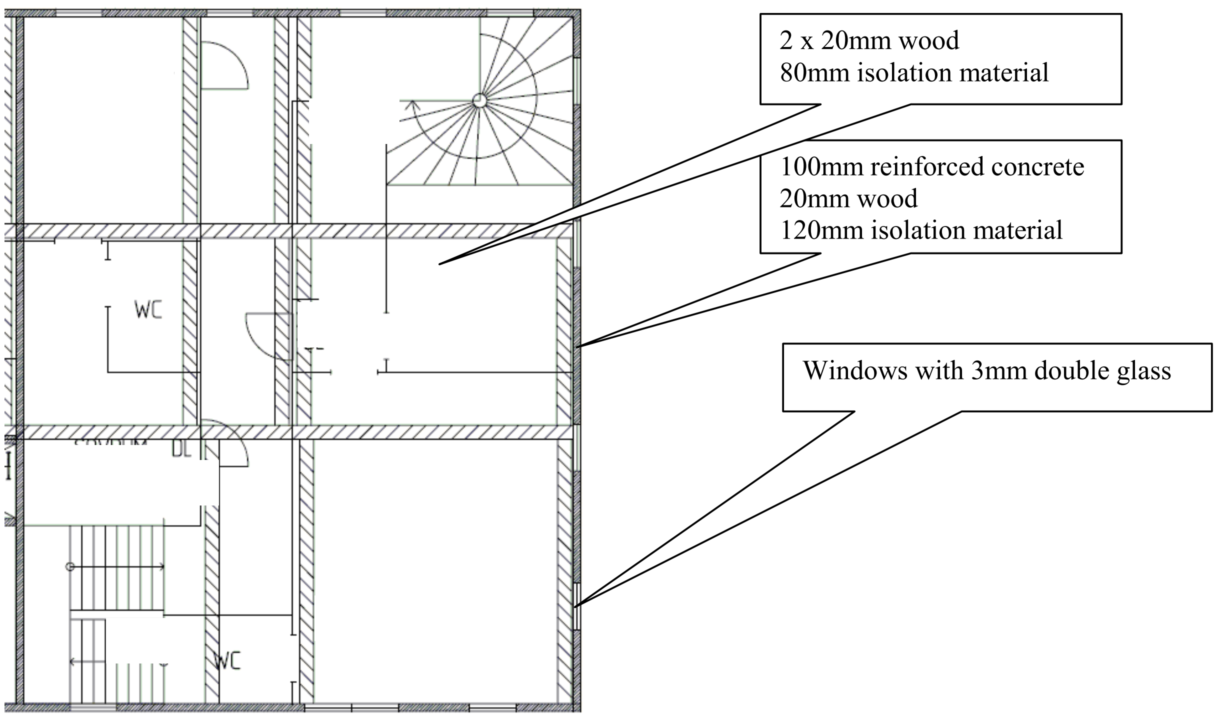


Figure F-7: Thickness and Different Materials.

F.2.4 Step Four (Ammunition Definitions)

Create all ammunition definitions (name, calibre, penetration in armour or different materials "millimetre", and if they have secondary effects and/or they have stand-off, etc. (you only need to do this once for every new ammunition type)). It could be wise to separate kinetic ammunition types, also by different distances.

F.2.5 Step Five (Let the Program Run)

At this state you have all the information you need – with a suitable computer program to calculate you can now create the vulnerability model. A suitable program is maintained and is available from the SAAB Training System UIC.

The program automatically calculates the vulnerability when the horizontal angle is more or less than 90 degrees. The different degrees are related to the specific simulator and its accuracy.

F.2.6 Step Six (Test Phase of the Model)

The program must have a test function to show the result, and also in a pedagogical way, show the result from a single shot on a specific point on the building or vehicle.

Usually there is a need for some adjustments for effects you don't want to happen.

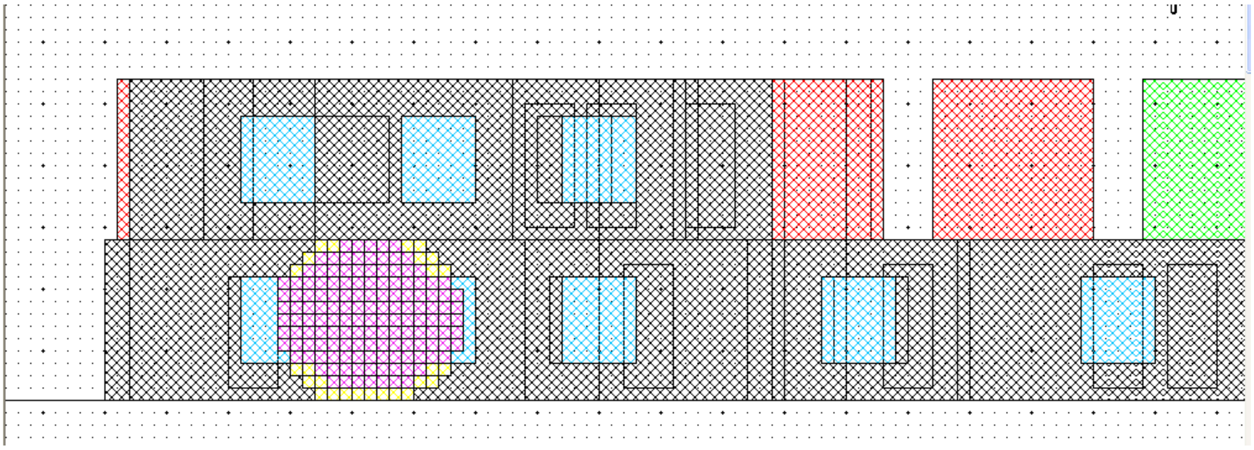


Figure F-8: Vertical Hit Position from 155 mm Artillery Grenade and Outside Effect.

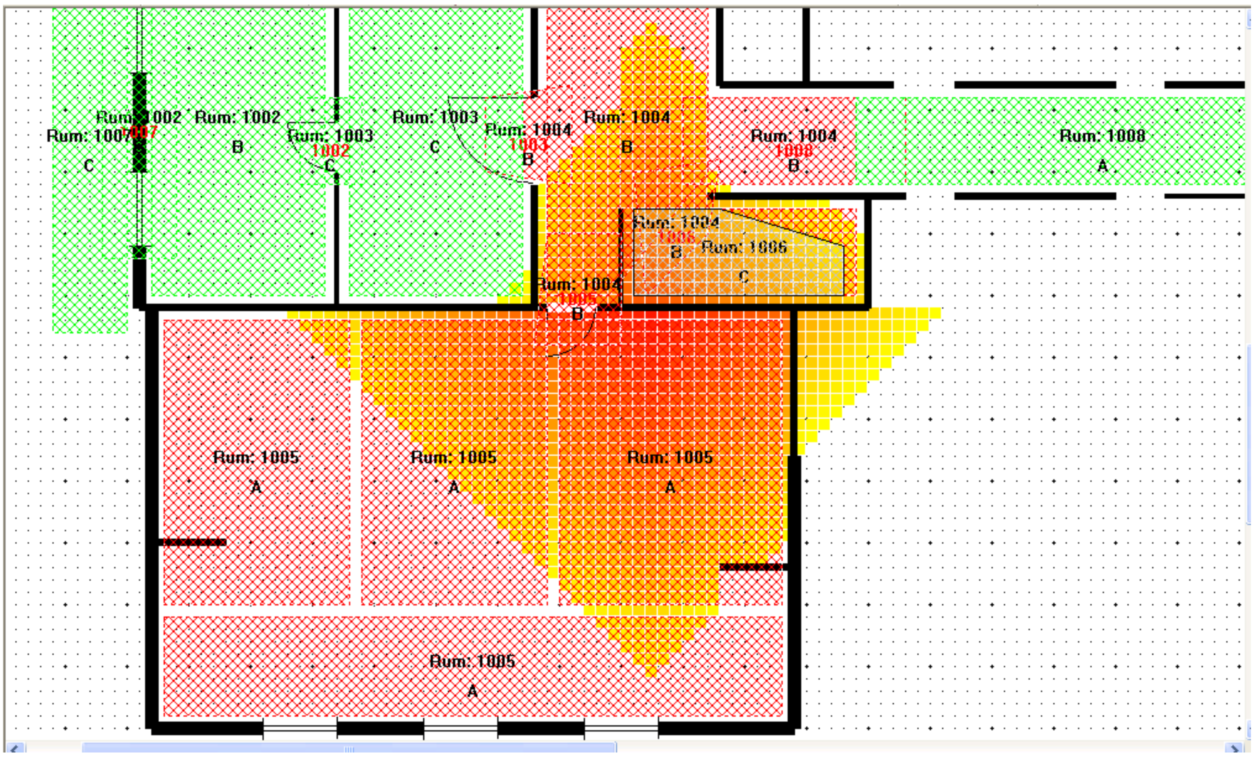


Figure F-9: Indoor Effect from 155 mm Artillery Grenade; Areas where Soldiers are Killed or Injured.

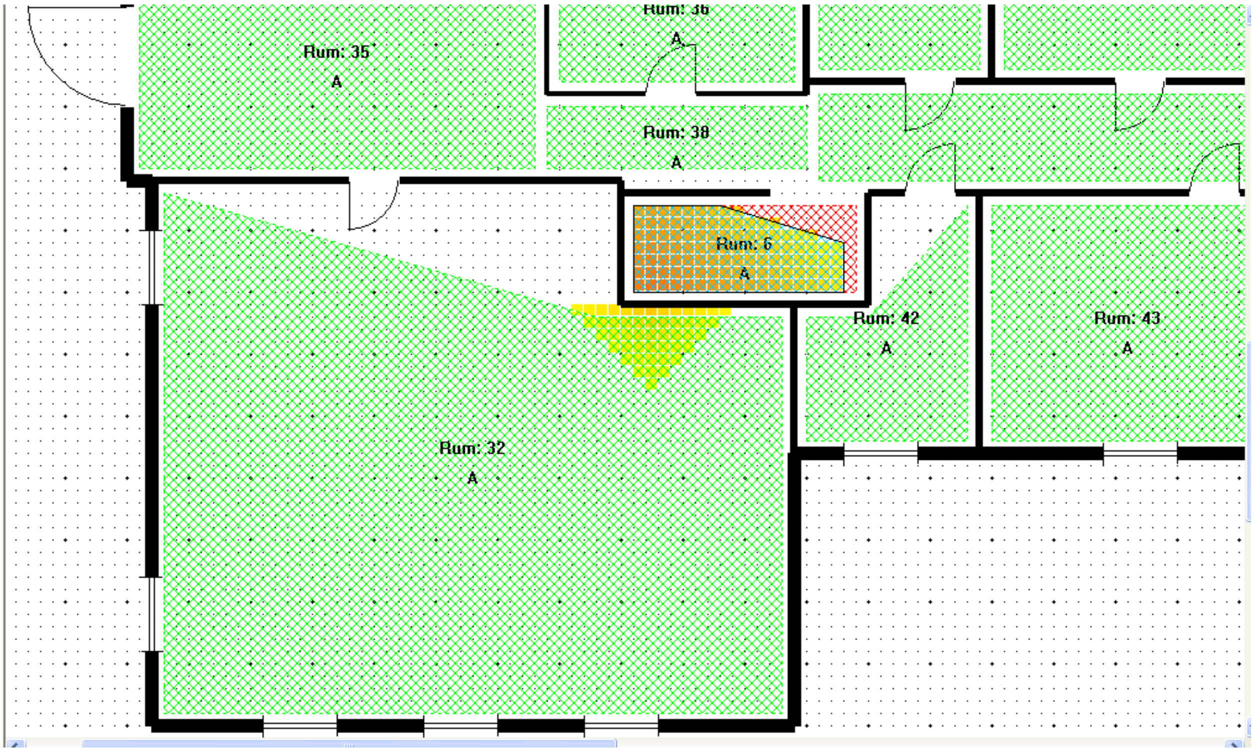


Figure F-10: Indoor Effect (Second Floor) from 155 mm Artillery Grenade; Areas where Soldiers are Killed or Injured.

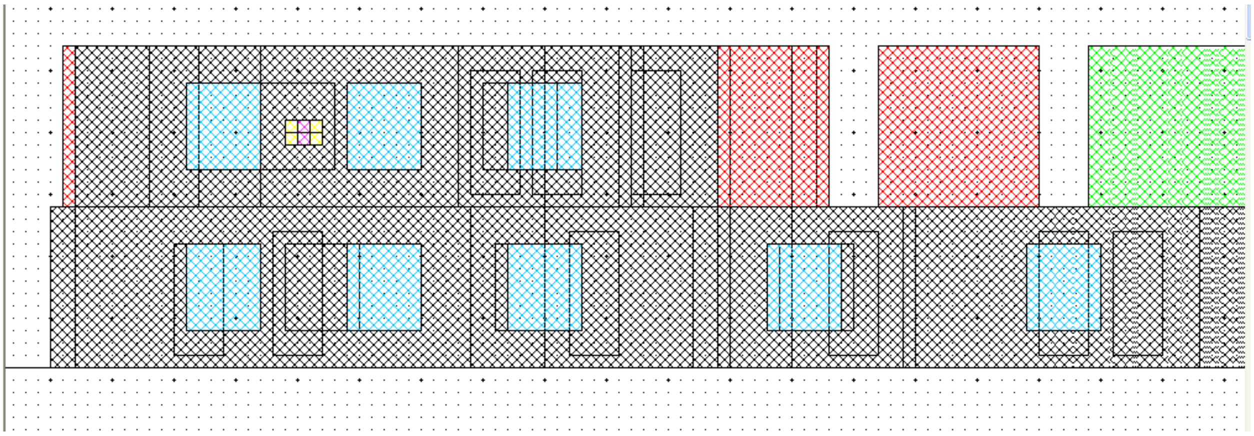


Figure F-11: Vertical Hit Position from AT4 (84 mm Anti-Tank Weapon) and Outside Effect.

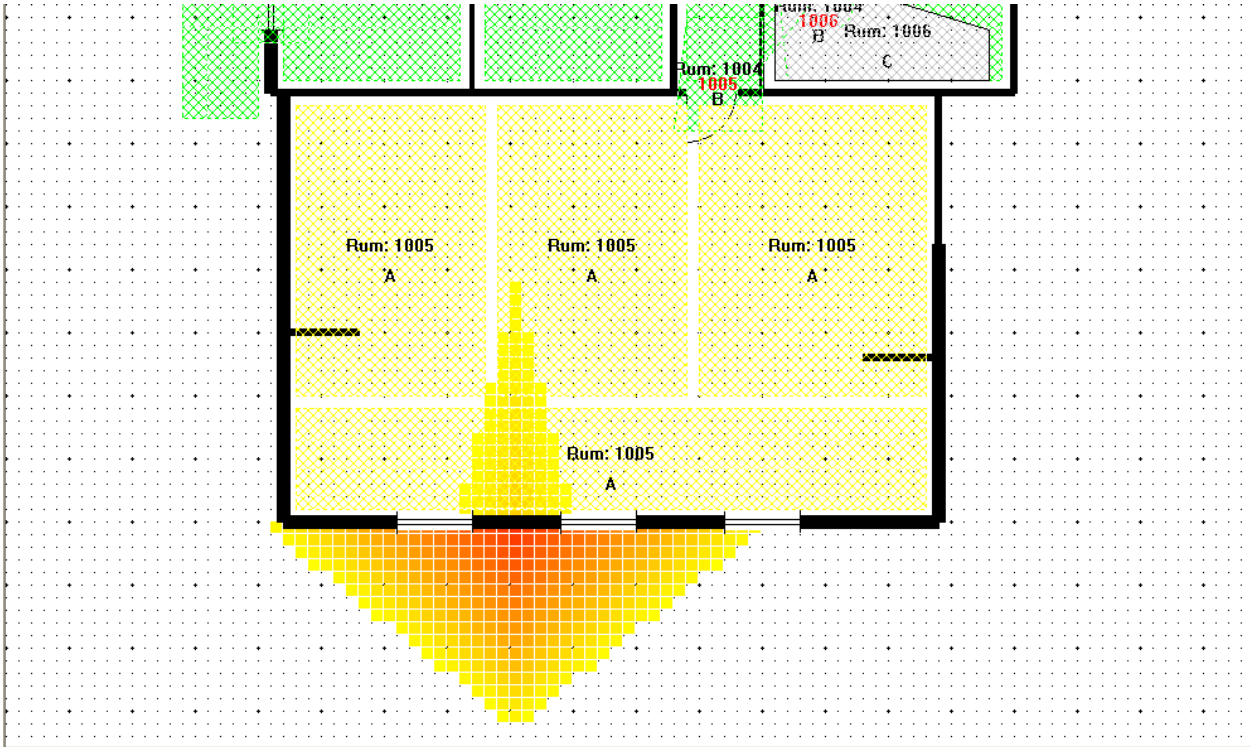


Figure F-12: Indoor and Outdoor Effect from Position from AT4 (84 mm Anti-Tank Weapon); Areas where Soldiers are Killed or Injured.

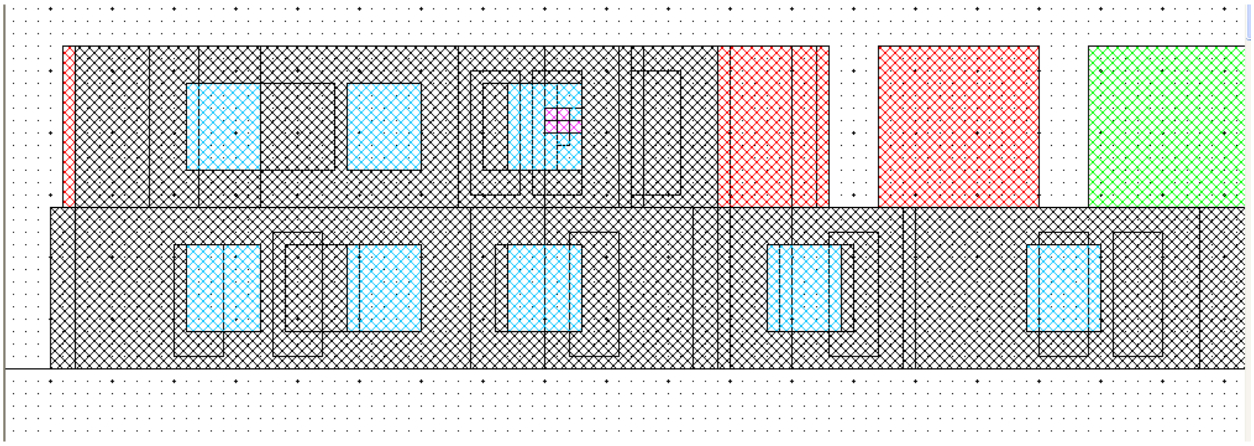


Figure F-13: Vertical Hit Position from AT4 (84 mm Anti-Tank Weapon) and Outside Effect.

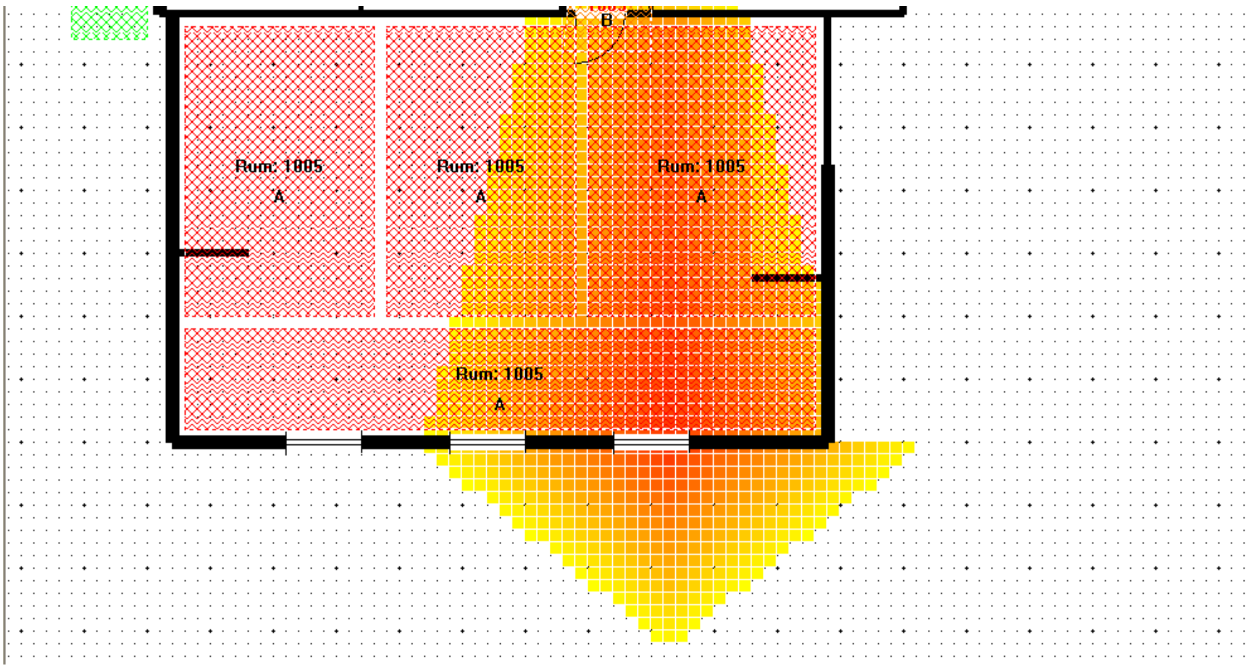


Figure F-14: Indoor and Outdoor Effect from Position from AT4 (84 mm Anti-Tank Weapon); Areas where Soldiers are Killed or Injured.

F.2.7 Step Seven (Export and Import)

Now the vulnerability model is ready to be exported from the program and to be imported into the simulator systems.

Annex G – RELATED NATO ACTIVITIES

This section provides an overview of NATO STO task groups active in the area of Urban Operations. Some task groups are already concluded, others still exist. The UCATT Working Group was aware of their existence and in many cases used their results or actively co-operated with them.

G.1 STO

The Science and Technology Organisation STO) is the single focus in NATO for Defence Research and Technology activities (see Figure G-1). Its mission is to conduct and promote co-operative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision-makers. The STO performs its mission with the support of an extensive network of national experts. It also ensures effective co-ordination with other NATO bodies involved in R&T activities.

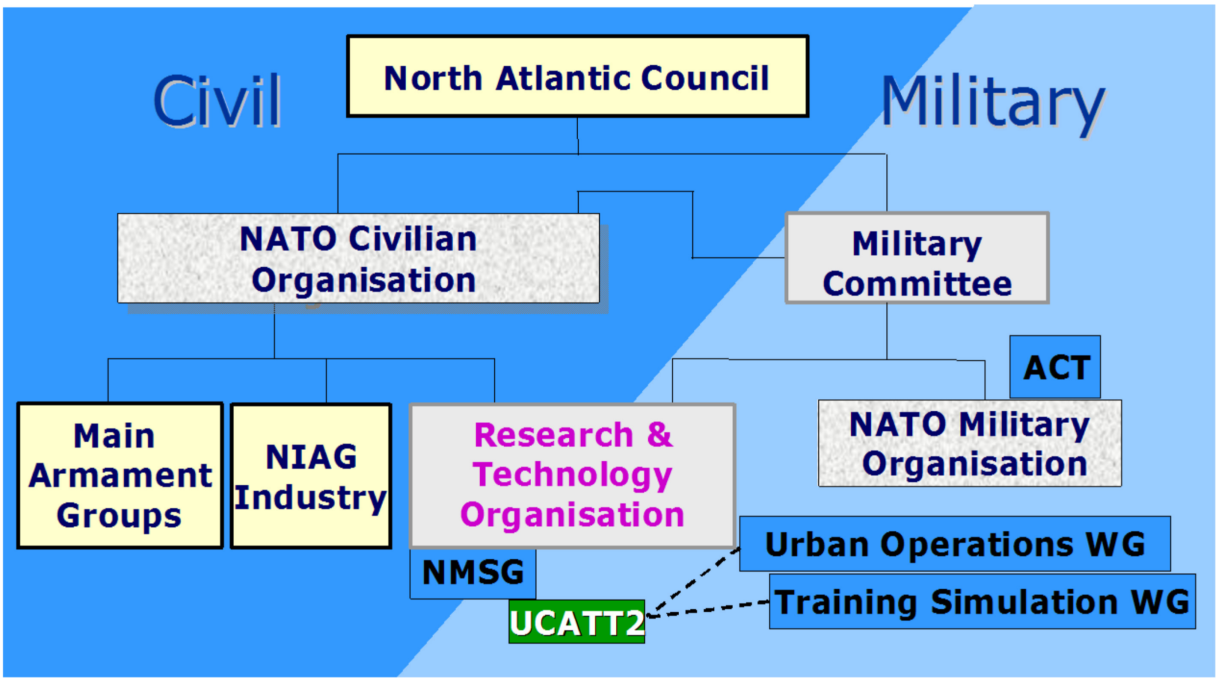


Figure G-1: The NATO R&T/D Community.

The STO reports both to the Military Committee of NATO and to the NATO Civilian Organisation (the Conference of National Armament Directors). STO consists of the Research and Technology Board (RTB) as the highest level of national representation and the Collaboration Support Office (CSO).

The total spectrum of R&T activities is covered by the following 7 bodies (see Figure G-2):

- System Analysis and Studies (SAS) Panel;
- Systems Concepts and Integration (SCI) Panel;
- Sensors and Electronics Technology (SET) Panel;
- Information Systems Technology (IST) Panel;

- Applied Vehicle Technology (AVT) Panel;
- Human Factors and Medicine (HFM) Panel; and
- NATO Modelling and Simulation Group (NMSG).

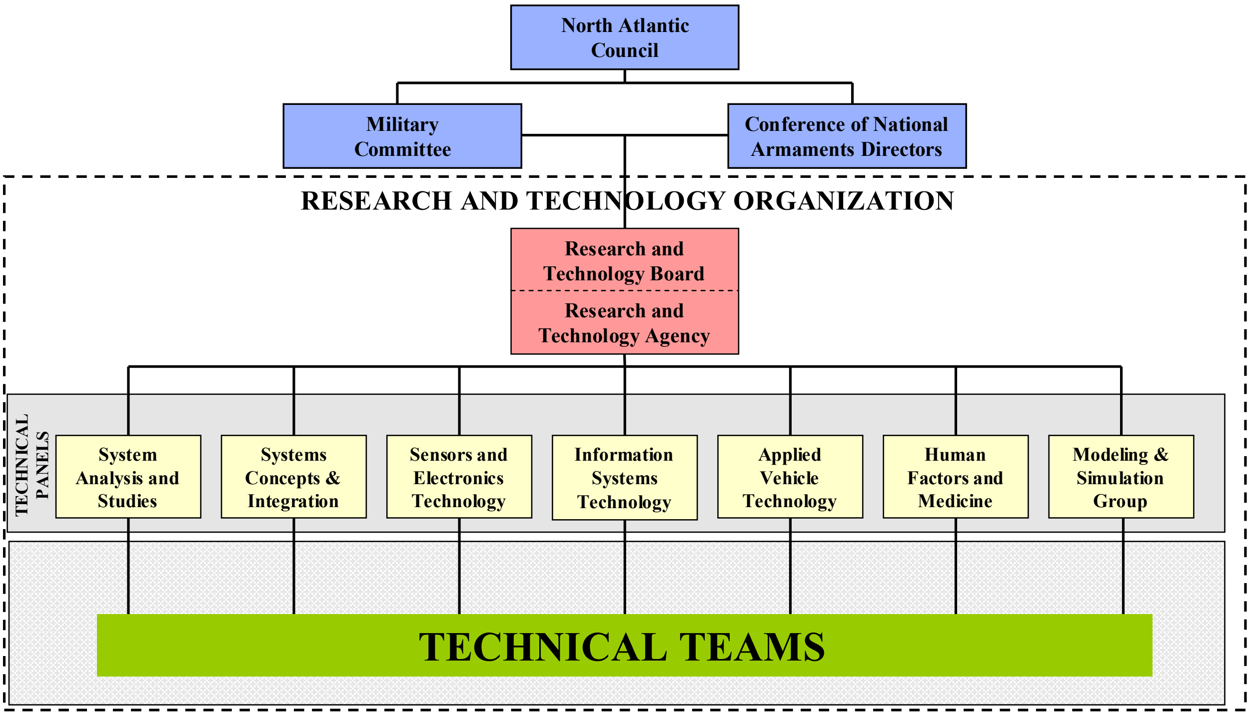


Figure G-2: NATO STO Structure.

G.1.1 Task Group SAS-030 Urban Operations in the Year 2020

G.1.1.1 Task Group Data

Begin: 01-06-2000

End: 01-12-2001

G.1.1.2 Objectives

The purpose of the Task Group RTO Technical Report Land Operations in the Year 2020 has been to develop a conceptual framework for operations in an urban area to address operational level needs and that will support the operational Commander in future NATO urban operations in 2020.

G.1.1.3 Results

The conceptual framework for planning and conducting urban operations is constructed from the interrelated Understand, Shape, Engage, Consolidate and Transition (USECT) activities. Although not all elements of USECT necessarily need to occur in an urban operation, the (final) objective for a military Commander is to transfer control of the urban area to the local authorities or an international organisation, which is the transition from an unstable situation to a self-sustainable stable situation. Therefore the planning and execution of urban operations should always be based with the Transition activity in mind.

USECT moves the focus from the traditionally predominant Engagement element to the Understand element. Understanding the urban battle space will lead to effective and precise targeting and influencing the situation and achievement of the desired end-state.

The interrelated military and non-military activities described in the USECT framework form the basis to achieve objectives with fewer casualties, less collateral damage to urban systems, and reduced harm to the non-combatant population. This general approach will enable forces to function more effectively in the uncertain operations of an urban area.

G.1.1.4 Reference

NATO report RTO-TR-071, *Urban Operations in the Year 2020*, ISBN 92-837-1100-9, April 2003.

G.1.2 Task Group IST-046 (RTG-018) Command and Control Challenges for Urban Operations

G.1.2.1 Task Group Data

Begin: 01-01-2004

End: 31-12-2006

G.1.2.2 Objectives

This activity was initiated after the SAS-030 Urban Seminar War Game indicated that the availability of information and knowledge through a fully integrated C2 system is an essential resource, and a key asset toward an Understand capability. The aim of this activity was to examine how C2 processes in urban operations can be improved by emerging Information Technologies (IT).

The specific objectives of this study were the following:

- Establish all information requirements for battalion-level and below;
- Identify which information requirements cannot be supported with the current doctrine, organisation, equipment, personnel and training;
- Make an inventory of the technologies that might be relevant for the shortcomings;
- Develop conceptual solutions as a result of the preceding activities;
- Organise a Workshop/Specialists' Meeting to discuss the subject of C2 in urban operations; and
- Develop a concept demonstrator considering one relevant shortcoming and one potential IT solution.

G.1.2.3 Results

The Task Group members first identified all information requirements during the planning and conducting of an operation in urban terrain, at the battalion, company and platoon level. More specifically, they created a common list of information requirements based on a scenario in which the participating Nations have defined the basic assumptions for several topics related to the doctrine, tasks and C2 processes. Three vignettes were designed and exploited to illustrate the range and complexity of urban operations: a crisis response operation, a defensive operation and an offensive operation. Fifteen information requirements were considered as critical. In particular, the critical information requirement 'Blue Force Tracking' was detailed and considered for the development of a concept solution. The critical information requirements, in a priority order, were:

Most critical:

1) Blue Force tracking;
2) Mapping of the city;
3) Red Force tracking;
4) Dynamic route planning (vehicles, soldiers);
5) Real-time surveillance of objectives, of routes of approach;
6) Communications (coverage map, testing);
7) Culture and social visualisation (symbolic non-physical information);
8) Buildings layouts for objectives;
9) Foe discrimination; and
10) Prediction of adversary actions.

Less critical:

11) Identification of sites which may be centres of gravity;
12) Request for support;
13) Performance analysis of capability (sight, weapon systems, etc.);
14) Identification of people and equipment in real time; and
15) Graphic and verbal situation reports.

The Task Group made an inventory of the current and future C2 information technology developments that might be relevant for the identified shortcomings. The survey included existing systems, prototypes, as well as studies or ideas on more prospective solutions. To illustrate the results of this IST activity, a movie clip was produced in conjunction with the written report.

G.1.2.4 Reference

NATO report RTO-TR-IST-046, *Command and Control Challenges in Urban Operations*, February 2009.

G.1.3 Task Group IST-067 (RTG-030) Tactical Communications in Urban Operations

G.1.3.1 Task Group Data

Begin: 01-01-2006

End: 01-12-2008

G.1.3.2 Objectives

- To determine urban military communications operational requirements, utilising NATO subject-matter experts and studies such as Land Operations 2020, Urban Operations 2020 (SAS-030), and various national studies.
- To define technical challenges in meeting these urban operations communications requirements.
- Determine ability to meet these challenges with current communications systems and identify likely shortcomings.

- To identify, assess, and report on collaborative trials and/or assessment activities that will lead to a greater understanding of the true communication capabilities, complementarities and limitations associated with military operations in urban environments.

- Determine communication technology development requirements for current, near-term (2010), and far-term (2020) solutions.

G.1.3.3 Reference

NATO report RTO-TR-IST-067, *Tactical Communications in Urban Operations*, September 2010.

G.1.4 Task Group MSG-032 Urban Combat Advanced Training Technology (UCATT)

G.1.4.1 Task Group Data

Begin: 01-06-2003

End: 31-12-2007

G.1.4.2 Objectives

- Exchange and assess information on MOUT facilities and training/simulation systems. Military feedback as to the effectiveness of current solutions will be obtained with a view toward establishing best practice.

- Identify a suitable architecture and a standard set of interfaces that enable interoperability of MOUT training components that does not inhibit future research and enhancements.

- Identify limitations and constraints on MOUT development with a view toward identifying areas for future research.

- Provide a report detailing best practices for MOUT training facilities.

G.1.4.3 Results

A NATO report was drafted, providing NATO with a scalable functional architecture (Figure 1-4) based on use cases agreed by the military user community in NATO and Partner Nations. A web-based register of FIBUA/MOUT sites was successfully developed and interoperability issues are being addressed. Work on identifying best practice, however, was limited. Indications suggest there is still more to be done particularly in developing the standards and more needs to be done to address the other two simulation domains of constructive and virtual simulation in support to urban training. All three domains, Live, Virtual and Constructive (LVC), will potentially need to be integrated.

G.1.4.4 Reference

NATO report RTO-TR-MSG-032, *Urban Combat Advanced Training Technology*, September 2008.

G.1.5 Task Group MSG-048 Coalition Battle Management Language (C-BML)

G.1.5.1 Task Group Data

The Task Group started in the year 2006 and ended in the year 2010.

G.1.5.2 Objectives

Enable interoperability between C2 systems and simulation systems. Key for this standardisation is a Coalition Battle Management Language (C-BML). This is an unambiguous protocol for digitised representation of a Commander's intent to be used for live forces, for simulated troops and for future robotic forces, both in real-world operations and in simulated situations. C-BML is particularly relevant in a network centric environment for enabling mutual understanding and collaboration.

The MSG-048 Technical Activity (TA) conducted a series of experimentations from 2006 to 2009 that led to the conclusion that Coalition BML (C-BML) holds promise for enabling C2-simulation interoperability. The Simulation Interoperability Standardization Organisation (SISO) C-BML Product Development Group (PDG) chartered to elaborate C-BML specifications and MSG-048 provided inputs to improve and extend the existing draft specifications based on a reference implementation and coalition experimentation.

G.1.6 Task Group MSG-085 Standardization for C2-Simulation Interoperability

G.1.6.1 Task Group Data

Begin: 01-04-2010

End: 01-04-2013

G.1.6.2 Objectives

The primary objective was to clarify the C-BML scope and requirements. The scope of the C-BML was defined and prioritized in the form of a set of operational and technical use-cases that illustrate how C-BML is intended to act as an interoperability enabler between systems. The main and central focus will be interoperability between C2 and simulation systems, but possibly other applications should be explored (C2-ISR systems, C2-CIMIC, etc.). A use-case specification should form the basis for a C2-Simulation Statement Of Requirements (SOR) document. The C2-Sim SOR should be drafted by the TA and made available for public consultation and review. The revised C2-Sim SOR will be communicated to the SISO C-BML PDG as an input for the C-BML specifications and standardization.

The second objective was to reach a consensus regarding the way to produce a digitized order. For example, the SISO requirement to capture the Commander's intent in an unambiguous language using an operational vocabulary and that is human-readable should be reviewed. The NATO set of orders (e.g. OPORD, FRAGO, ACO, ATO) was used as a common reference set. SISO C-BML specifications will be assessed regarding its capability to represent all the mandatory information that it convey. In addition, the possibility to include Measures Of Effectiveness (MOE) and Measures Of Performance (MOP) as part of the digitized orders was considered in order for the simulation to automatically produce relevant desired metrics for further assessment. This objective implies coordination with the Multi-lateral Interoperability Programme (MIP) concerning JC3IEDM Change Proposals (CP) based on the group's findings.

The third objective was to assess and leverage available C-BML open-source reference implementations. The assessment considered a range of criteria consistent with given coalition application domains. This was done during experimentations involving NATO and Member Nations' military personnel.

The fourth objective of this TA was to address C2 and simulation system initialization requirements, including the complementary use of SISO MSDL with C-BML.

The fifth objective deals with the operational aspects related to the utilization of C-BML during military operations, such as decision support, pre-mission planning, mission rehearsal, mission planning, and C2 system training, after-action review, etc. In this context, C2-C2 interoperation is based on the operational use of MIP protocols. Therefore, the TA was required to clearly demonstrate how C-BML complements the MIP standards and improves the military efficiency. This included revisiting and establishing relevant procedures for each application domain in order to assist the military community in adopting C-BML and MSDL. This objective entails demonstrating the operational benefits to the C2 and simulation communities through several experiments leading up to a final operational exercise with end-users in the loop.

Each of these objectives produced findings that will be made available for general dissemination to the public for educational purposes.

The overall aim was to evaluate C-BML and recommend a C-BML standard to be adopted by NATO.

Also the outcome of MSG-091, titled "Identification of Command and Control, M&S Gaps", running from 2010 to 2011, is of particular interest in this respect.

G.1.7 Task Group SET-076 (RTG-044) Sensor Requirements for Urban Operations

G.1.7.1 Task Group Data

Begin: 01-06-2003

End: 31-12-2007

G.1.7.2 Objectives

This activity was initiated to investigate sensors requirements in urban operations. Based on previous studies, which looked at identifying the requirements in terms of information, capabilities and technologies and at current shortcomings in meeting these requirements when dealing with urban operations, SET-076 addressed more specifically sensor requirements and the shortcomings and limitations of existing sensor technologies.

SET-076 aimed to identify the fundamental limitations associated with various sensor types when deployed in urban areas and to propose future research topics and collaborative assessment or demonstration activities. The specific objectives of this study were the following:

- Define the sensing problems posed by operations in urban environments;
- Identify likely shortcomings in current sensing capability, and predict likely sensor technology developments in the near future;
- Recommend research areas to address the sensing requirements identified by studies such as Land Operations 2020, Urban Operations 2020 (SAS-030), and various other national studies;
- Provide guidance on overcoming the limitations of sensors that have a potential to be used in urban/ complex terrain; and
- Propose collaborative trials and/or assessment activities that will lead to a greater understanding of the true sensing capabilities, complementarities and limitations in urban operations.

G.1.7.3 Results

From IST-046 results, various critical information requirements were consolidated into categories that better reflect the sensors requirements. Then the Task Group examined technologies potentially able to provide the needed capabilities. A worksheet was prepared to be filled in for each potential technology concept. The worksheet included the list of information requirements that are addressed by the technology, a drawing picture, a short description, performance, size, cost, maturity, concept of operation and limitations. Finally, the sensors technologies were evaluated and ranked.

G.1.7.4 Reference

NATO report RTO-TR-SET-076, *Sensors for Urban Operations*, June 2009.

G.1.8 Task Group SET-114 (RTG-065) Urban, Indoor and Subterranean Navigation Sensors and Systems

G.1.8.1 Task Group Data

Begin: 15-04-2006

End: 01-12-2009

G.1.8.2 Objectives

The group assessed advances in the field of navigation sensors (e.g. position, velocity, orientation, and time sensors) applied to operations in urban, indoor, subterranean, and other Global Navigation Satellite System (GNSS) degraded environments for the NATO community. Advances in low cost, very small micro-electromechanical sensors are expected to continue in the foreseeable future. In addition, improvements in GNSS receivers and space systems, and new and innovative positioning systems such as networked navigation, ultra-wideband, map making/matching systems and various distance and velocity measurement devices, etc., continue to evolve. The group identified recent advances as well as new applications and potential benefits to military operations and operational concepts.

G.1.8.3 Reference

NATO report RTO-TR-SET-114, *Basic Guide to Advanced Navigation*, February 2010.

G.2 NATO ARMY SUB-GROUPS

G.2.1 NATO Army Sub-Group Training and Simulation Working Group (NTG ASG TSWG)

G.2.1.1 Working Group Data

This WG meets twice a year and is composed of military of NATO and Partnership for Peach (PfP) Nations.

G.2.1.2 Objectives

The TSWG will provide a venue for Member Nations to discuss concepts for simulation in Army training at all three levels, with a view to conducting the following:

- Identify common concepts that may have general application to Member Nations, NATO, or other international organizations;
- Provide co-ordination where necessary amongst Nations using simulation in Army training;
- Recommend guidance to the ASG for the development of policy and standards with respect to the use of simulation in Army training; and
- Provide co-ordination where necessary with other NATO working groups (e.g. FIBUA/MOUT WG, NATO Modelling and Simulation Group (NMSG)).

The TSWG will be responsible for the following:

- Providing an annual review that identifies organizations that are interested in simulation in Army training;
- Providing an annual review of all simulation systems used in Army training that are in service or in development by Member Nations;
- Monitoring the development of training devices and correlating identified Army training needs with the development of simulation technology;
- Identifying common national requirements for training simulation systems and exploring opportunities amongst Member Nations for common approaches to the use of simulation in training;
- Recommending user requirements for interoperability and standardization of simulation protocols with a view to providing these recommendations to the NMSG, which in turn will develop the appropriate technical Standardisation Agreements (STANAGs); and
- Encouraging and promoting the use of simulation in Army training.

G.2.2 NATO Training Group Army Sub-Group Urban Operations Working Group (NTG ASG UO WG) (Formerly: FIBUA/MOUT Working Group)

G.2.2.1 Working Group Data

This WG meets twice a year and is composed of military of NATO and PfP Nations.

G.2.2.2 Objectives

The UO WG will:

- Receive from Nations represented at the Working Group offers of training assistance, papers and other items related to urban operations training.
- Review emerging training aids, equipment and techniques in order to provide a common and integrated approach to all aspects of urban operations training.
- Ensure that the urban operation's training remains current and relevant in line with current operations and developing threats.
- Organise and conduct an urban operations training Symposium as required.

The Urban Operations (UO) WG is responsible for the regularly update of the volumes of NATO UO Tactical handbook.

G.2.2.3 Results

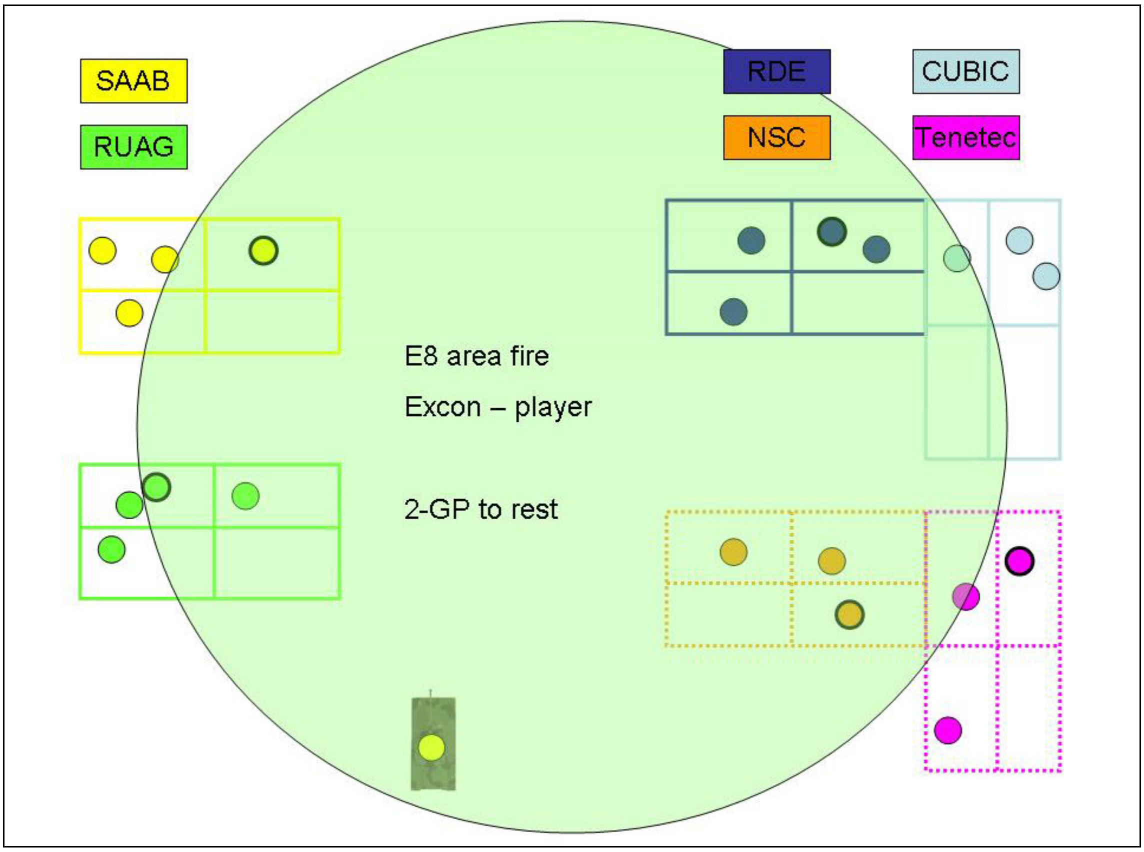
Information is exchanged among the participating Nations, documented in meeting minutes and presentations, accessible via a password at the website www.fibuamoutsite.info.

This website is a product of both the Urban Combat Advanced Training Technology Working Group (UCATT) and the NATO Urban Operations Working Group.

In addition to an overview of different FIBUA/MOUT training sites all over the world, the site provides the user with information about tactics and training in the participating Nations and information about new technology for training in urban areas. The provided information is NATO UNCLASSIFIED.

NATO UO Tactical Handbook, version October 2009.

Annex H – DEMONSTRATION SCENARIOS



SLD distribution

- NSC: 3xSWE
- SAAB: 4xNLD
- RUAG: 4xSUI
- TENETEC: 1xSUI, 1xDEU, 1xSWE
- CUBIC: 2xNLD, 1xSWE
- RDe: 4xDEU

Figure H-1: Start-Up Set-Up and Soldier Distribution.

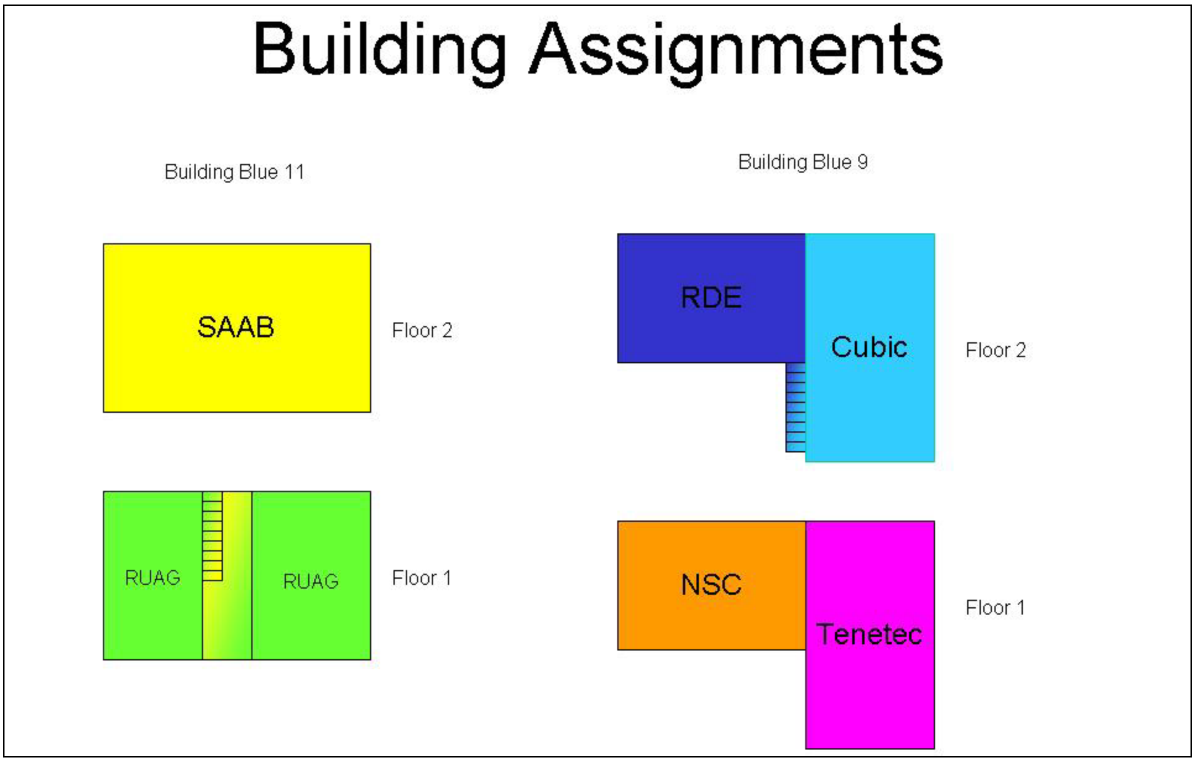


Figure H-2: Building Assignments.

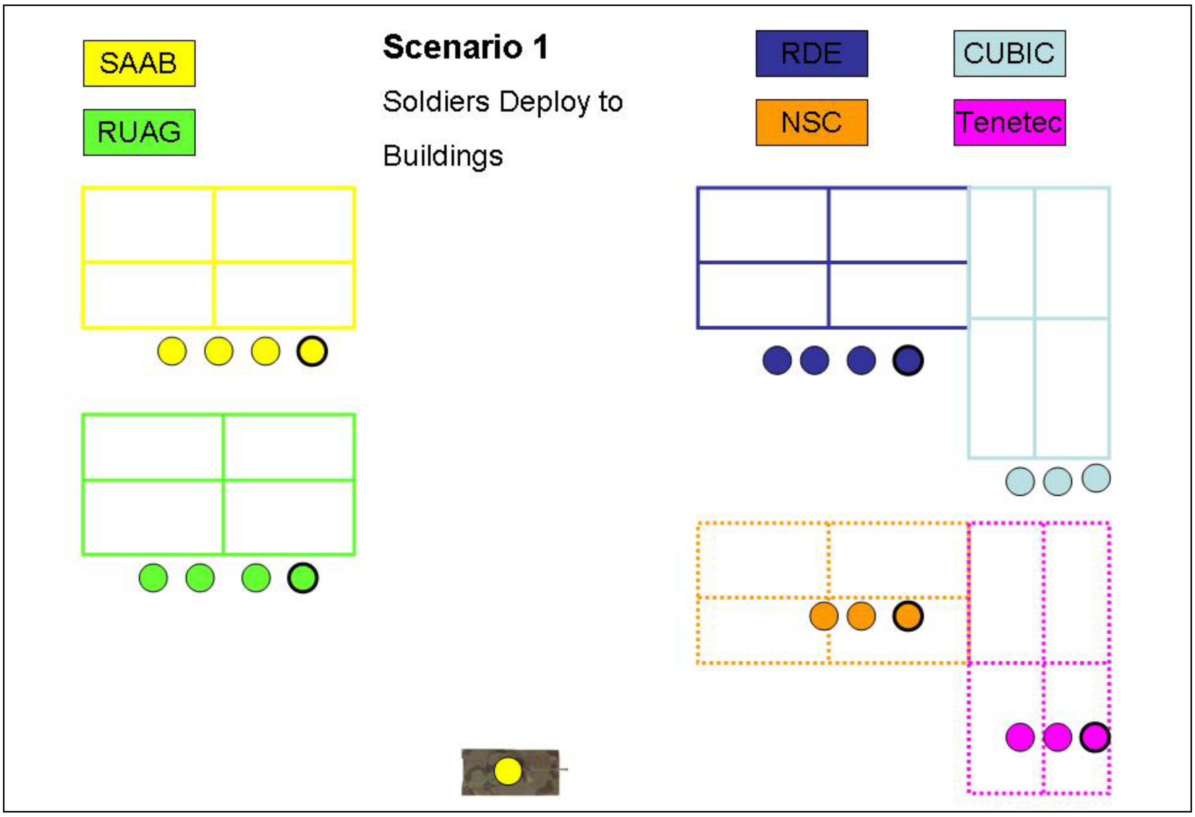


Figure H-3: Scenario 1.

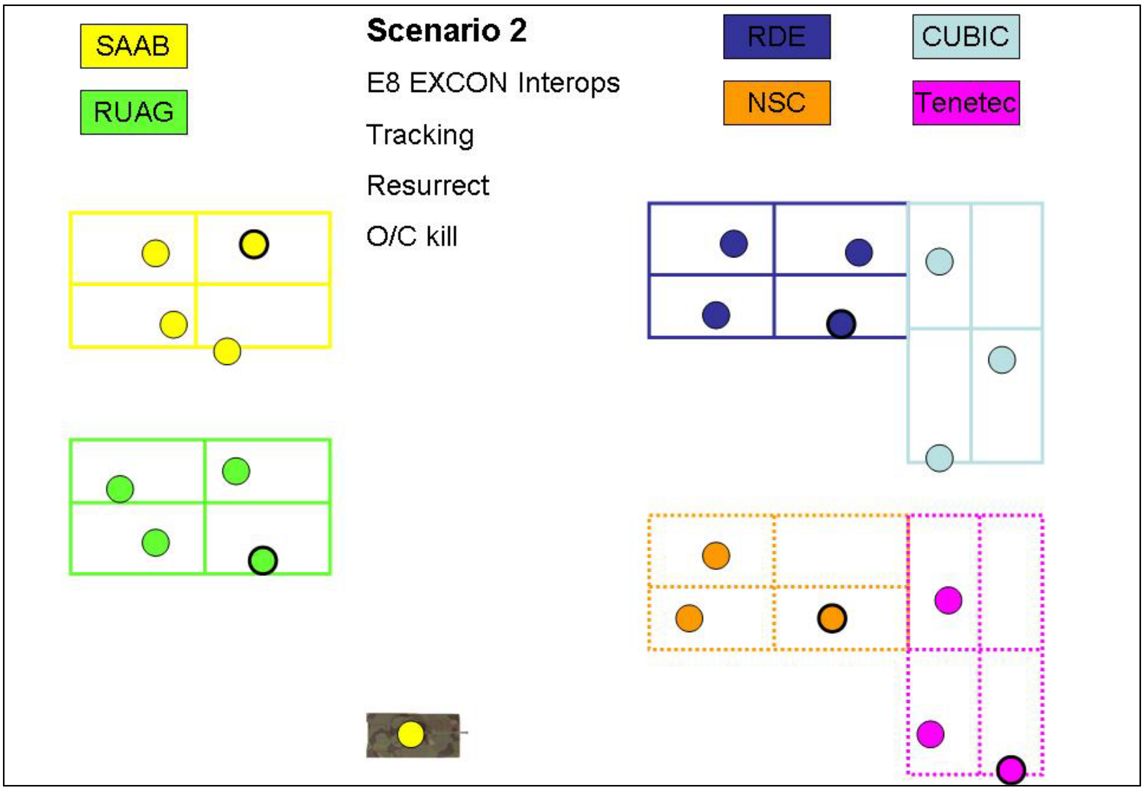


Figure H-4: Scenario 2.

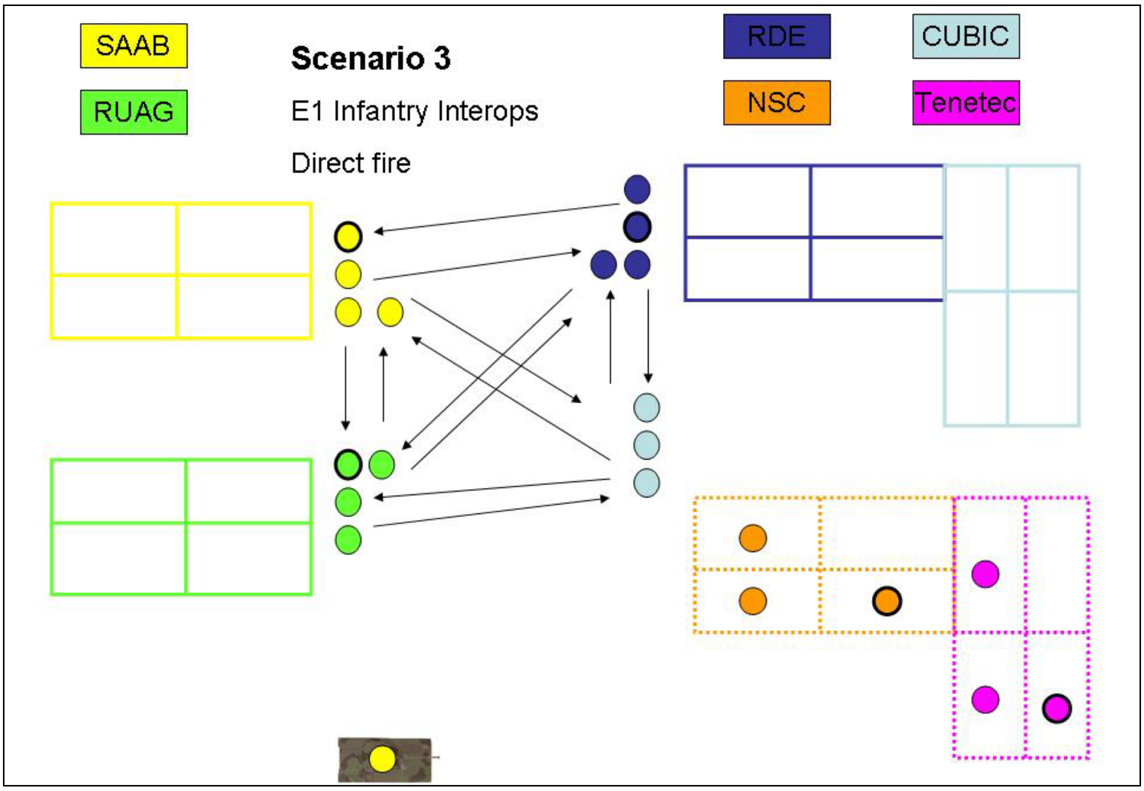


Figure H-5: Scenario 3.

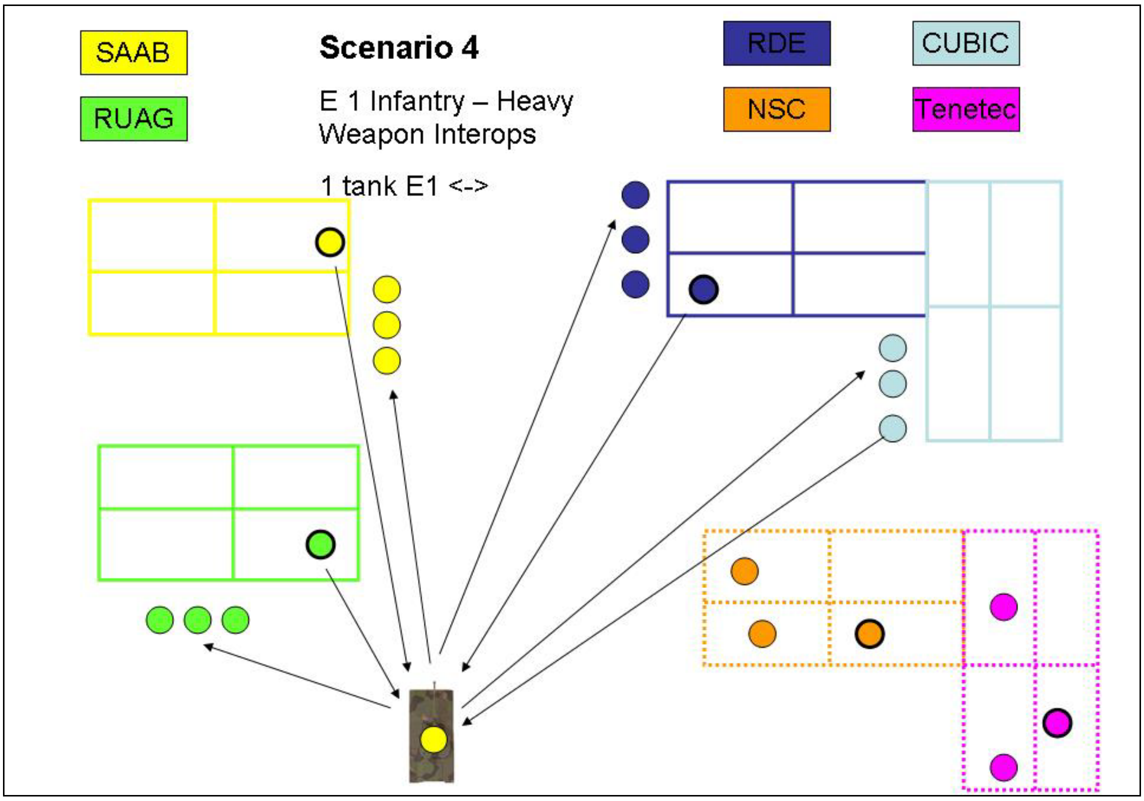


Figure H-6: Scenario 4.

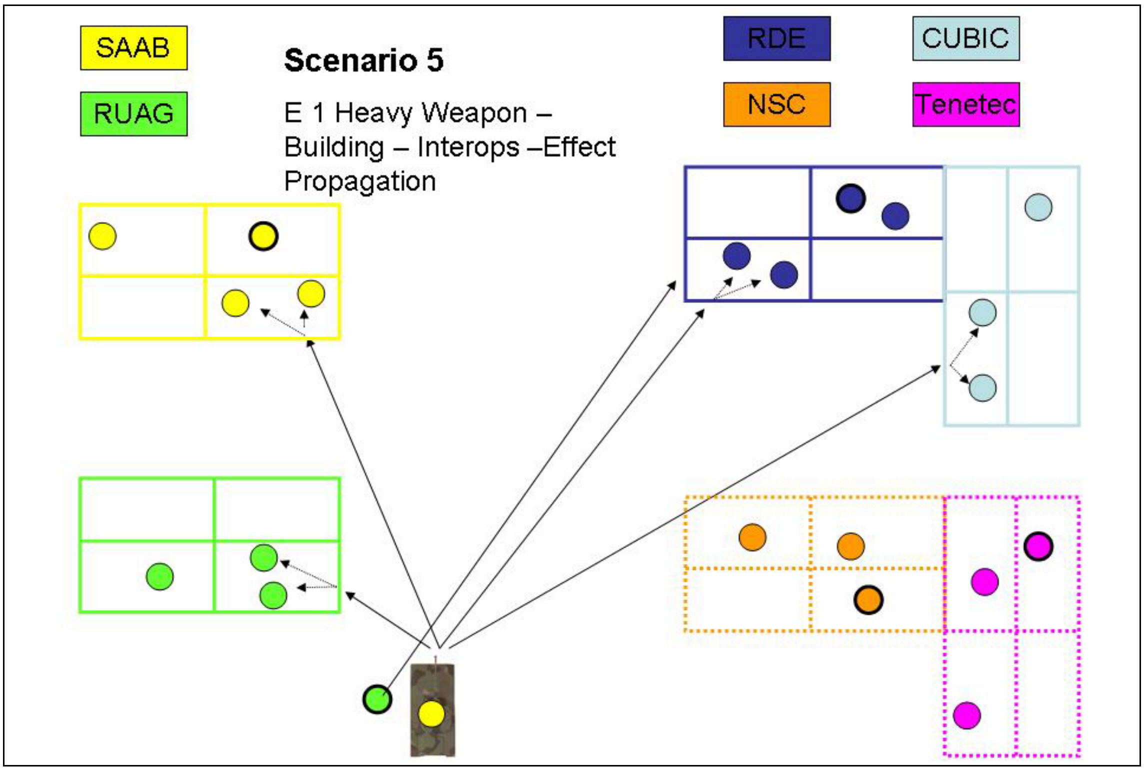


Figure H-7: Scenario 5.

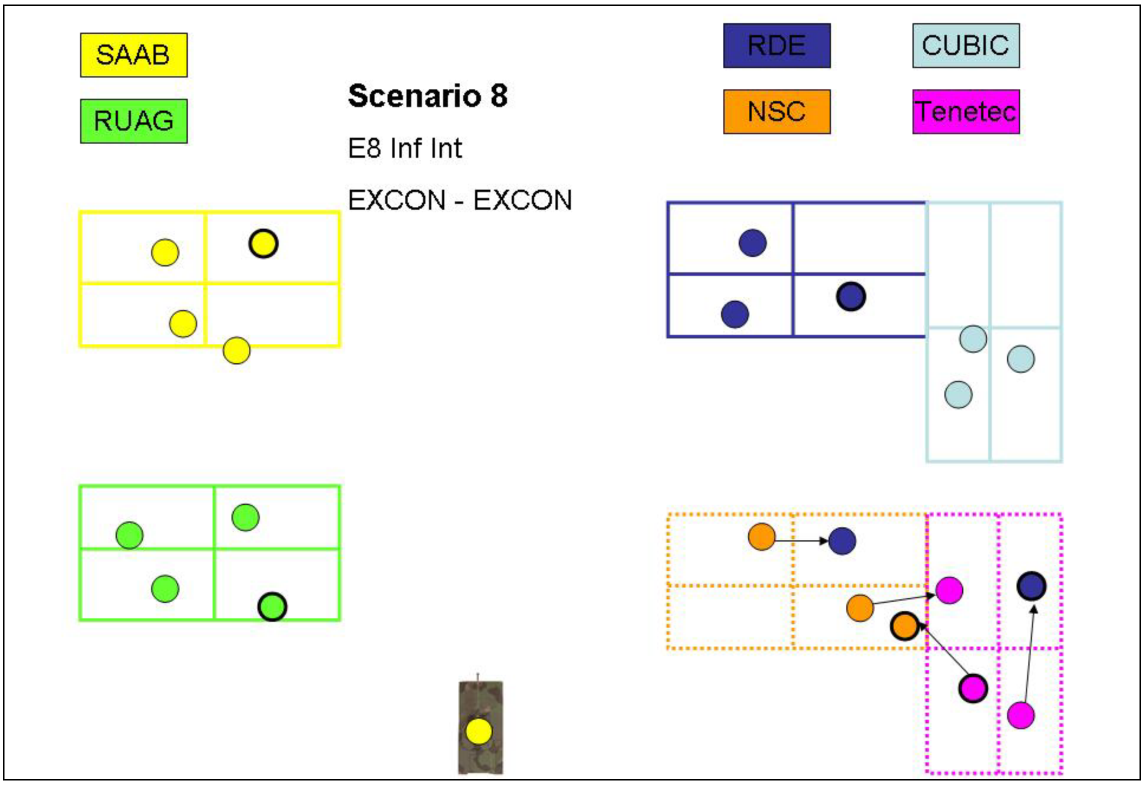


Figure H-8: Scenario 8 (6 and 7 Intentionally Left Out).

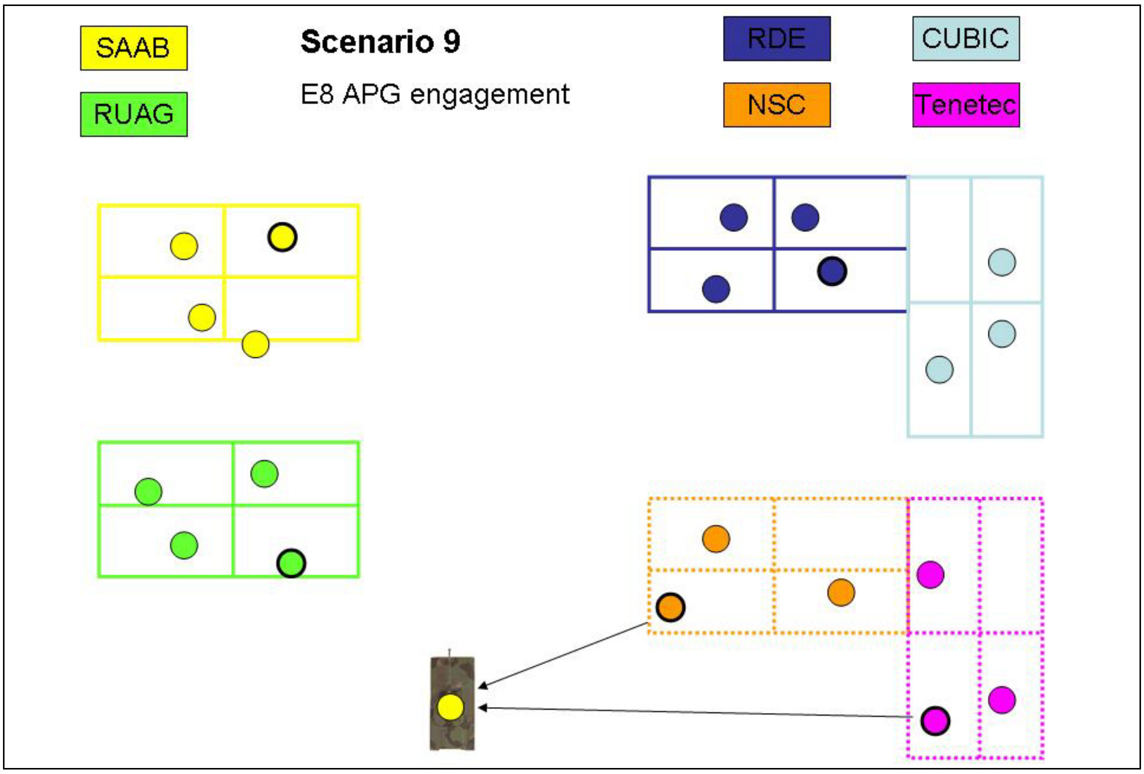


Figure H-9: Scenario 9.

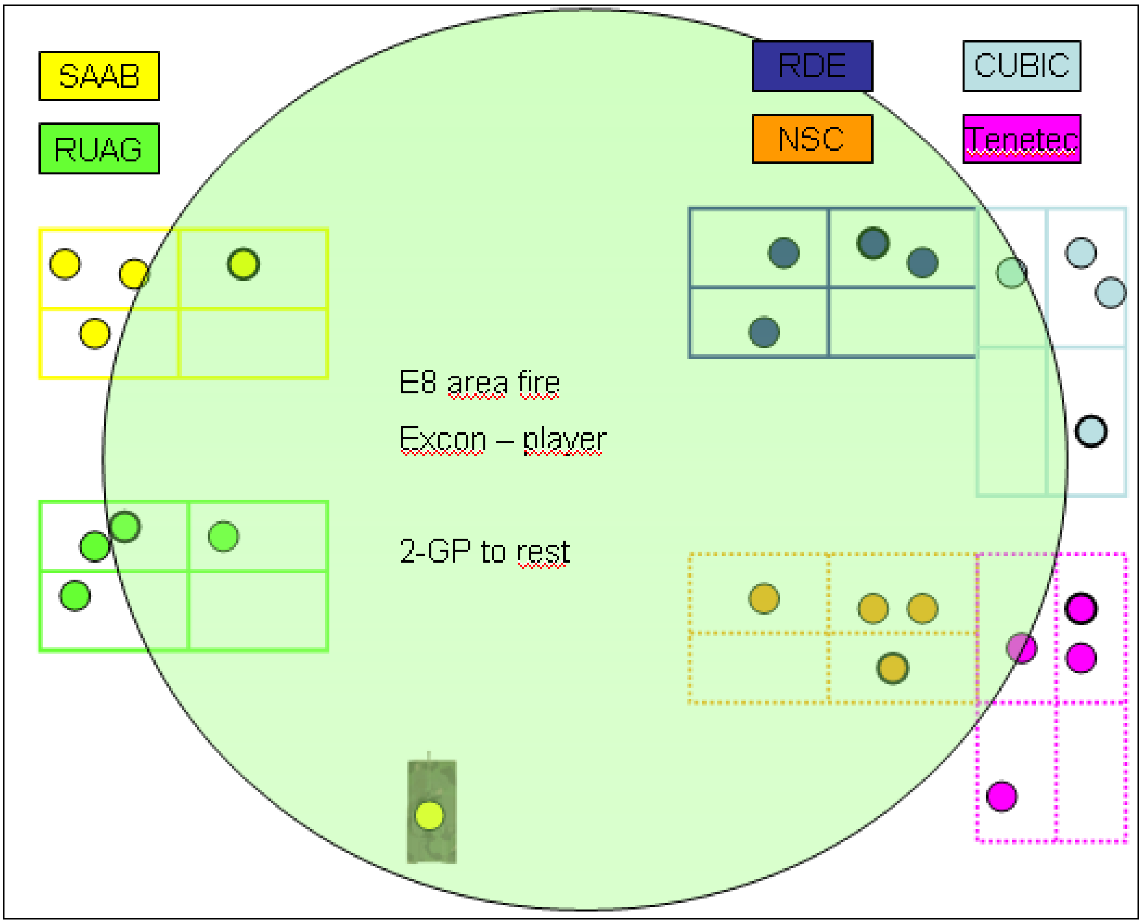


Figure H-10: Scenario 10.

Annex I – DEMO TIMELINE

Table I-1: Demo Timeline.

Time	Step	Action	Reference
	Startpicture	Go in the Start position defined by Picture 1 (EXCON has 6 screens, one each for the company)	
		CV90 stands behind last container	
		1 squad is dedicated to SAAB, with SAAB equipment (4 NLD)	
		1 squad is dedicated to RUAG, with RUAG equipment (4 CHE)	
		1 squad is dedicated to CUBIC, with CUBIC equipment (2 NLD, 1 SWE)	
		1 squad is dedicated to RDE, with RDE equipment and one soldier with NSC tag and one soldier with TENE tag (4 DEU)	
		1 squad is dedicated to NSC, with NSC equipment (3 SWE)	
		1 squad is dedicated to TENETEC, with TENETEC equipment (1 CHE, 1 DEU, 1 SWE)	
		Building 9 and 11 are equipped with indoor tracking devices according to Picture 3	
		SAAB communication is placed nearby EXCON	
		RDE communication is placed nearby EXCON	
		RUAG communication is placed nearby EXCON and close to Building 11	
		CUBIC communication is placed nearby EXCON	
		TENETEC communication is placed in Building 9 in the designated rooms	
		NSC communication is placed in Building 9 and nearby EXCON	
		Building 9 and 11 are connected by wire to Building 12	
		Line-up/presentation of soldiers and 6 industry-reps in front of Blue 12	
		SAAB-Squad 1 is moving to Building 11, RUAG-Squad 2 to Building 11, CUBIC-Squad to Building 9, RDE-Squad to Building 9, NSC-Squad into Building 9,TENETEC-Squad into Building 9	
		CV90-Crew moves to vehicle	
		Every company provides video pictures from the designated buildings	
	1	Audience is in the EXCON building (Building 12)	Scenario 1
5	2	The Start situation is explained to the audience, 6 EXCON are showing identical situations	
		(Introduce EXCON positions of each company, introduce UCATT 6 members, terrain orientation, player orientation (incl. CV90))	
		Explain first scenario (“movement”), will be visible on all EXCONs	
		Players move around, inside and outside	
5	3	SAAB-Squad moves into Building 11	
	4	RUAG-Squad moves into Building 11	
	5	CUBIC-Squad moves into Building 9	

Time	Step	Action	Reference
	6	TENE-Squad moves into Building 9	
	7	NSC-Squad moves into Building 9	
	8	RDE-Squad moves into Building 9	
1	9	This scenario is explained to the audience / soldiers stay at their position in the buildings	Scenario 2
3	10	SAAB EXCON OC kills RUAG player, player drops down	
	11	TENE EXCON resurrect RUAG player, stands up again	
	12	~~CUBIC EXCON kills to RDE Player~~	Not possible
	13	NSC EXCON resurrect RDE Player	
	14	RDE EXCON kills SAAB Player	
	15	RUAG EXCON resurrect SAAB Player	
2	16	This scenario is explained to the audience	Scenario 3
	17	SAAB, CUBIC, RUAG, RDE soldiers go outside, in front of the building (simultaneously with explanation)	
2	19	SAAB player kills RUAG player	
	20	SAAB player kills CUBIC player	
	21	SAAB player kills RDE player	
	22	RUAG player kills SAAB player	
	23	RUAG player kills CUBIC player	
	24	RUAG player kills RDE player	
	25	CUBIC player kills SAAB player	
	26	CUBIC player kills RUAG player	
	27	CUBIC player kills RDE player	
	28	RDE player kills SAAB player	
	29	RDE player kills RUAG player	
	30	RDE player kills CUBIC player	
1	31	Explanation for next step	
	32	TENE resurrect all players, CUBIC resets own player	
1	33	Explanation of next scenario	Scenario 4
1	34	CV90 moves in position near Building 12	
1	35	Soldiers equipped with anti-tank weapons enter the building in their designated areas	

Time	Step	Action	Reference
1	36	CV90 fires with the coax gun on the remaining soldiers outside the buildings (The CV90 does that with several bursts, CV90 is in gunnery mode, do not fire at the building itself!!)	
1	37	Explanation for next step	
2	38	SAAB player equipped with “Panzerfaust” is firing on the CV90 CV90 is reset after each shot by SAAB O/C gun	
	39	CUBIC player equipped with gun fires at CV90 (no effect, but fire lines visible on EXCON)	
	40	RUAG player equipped with “Panzerfaust” is firing on the CV90 CV90 is reset after each shot by SAAB O/C gun	
	41	RDE player equipped with “Panzerfaust” is firing on the CV90 CV90 is reset after each shot by SAAB O/C gun	
1	42	Explanation for next step	
	43	NSC resurrect all players, CUBIC resets own players	
3	44	Explanation for next step	Scenario 5
	45	The RUAG AT gunner moves towards the CV90, all outside remaining soldier enter the building in their designated area	
4	46	CV90 fires on Building 11 (1st Floor)	
	47	CV90 fires on Building 11 (2nd Floor)	
	48	CV90 fires on Building 9 left (2nd Floor)	
	49	CV90 fires on Building 9 top right (2nd Floor)	
	50	RUAG fires Panzerfaust at RDE building Players within engaged rooms are killed	
1	51	SAAB resurrect all players, CUBIC resets own players	
2	52	Explanation for next step	Scenario 8
2	53	RDE soldier enter TENE Area (different rooms) (RDE soldiers are tagged at the helmet)	
0	54	TENE soldiers are firing on RDE soldier	
1	55	RDE soldier enter NSC area (different rooms) (RDE soldier are tagged on shoe)	
1	56	NSC soldiers are firing on RDE soldier	
1	57	Explanation for next step	

Time	Step	Action	Reference
1	58	NSC is firing on TENE thru the wall!	
1	59	TENE is firing on NSC	
1	60	Explanation for next step	
	61	RUAG resurrect all players, CUBIC resets own players	
1	62	Explanation for next step	Scenario 9
1	63	NSC player is firing with an anti-tank weapon on CV90	
1	64	TENE player is firing on the CV90	
1	65	Explanation for next step	
	66	RDE resurrect CV90 after every kill	
2	67	Explanation for next step	Scenario 10
1	68	NSC is engaging the big bomb	
	69	Explanation for next step	
	70	Time for questions, visit of the buildings, time to ask the soldiers, AAR on demand	
		Soldiers stay in the buildings	
52	Total Time		

REPORT DOCUMENTATION PAGE

1. Recipient's Reference	2. Originator's References	3. Further Reference	4. Security Classification of Document
	STO-TR-MSG-063 AC/323(MSG-063)TP/591	ISBN 978-92-837-2011-9	PUBLIC RELEASE

5. Originator	Science and Technology Organization North Atlantic Treaty Organization BP 25, F-92201 Neuilly-sur-Seine Cedex, France
6. Title	Urban Combat Advanced Training Technology
7. Presented at/Sponsored by	Final Report of Task Group 063.

8. Author(s)/Editor(s)	9. Date
Multiple	July 2015
10. Author's/Editor's Address	**11. Pages**
Multiple	176

12. Distribution Statement	There are no restrictions on the distribution of this document. Information about the availability of this and other STO unclassified publications is given on the back cover.

13. Keywords/Descriptors

Combat Training Centre (CTC)	Interoperability
Demonstration	Laser
Direct Fire Weapon Effects System (DFWES)	Simulation
Functional Architecture	Simulation Interoperability Standards Organisation (SISO)
Geo-pairing	

14. Abstract

The Urban Combat Advanced Training Technology (UCATT) Task Group was established within the NATO Modelling and Simulation Group (NMSG) in 2007 as MSG-063 TG-040. The UCATT TG was tasked to exchange and assess information on Military Operations in Urban Terrain (MOUT) or urban operation facilities and training/simulation systems with a view toward establishing best practice. In the UCATT-1 report, the suitable architecture and a standard set of interfaces was defined. The UCATT-2 report is based on the directions of the UCATT-1 report. The architecture is verified, discussed and refined. Preparations for a proof-of-concept demonstration were discussed and finally the demonstration was held showing basic interoperability between six different current industry solutions. Also the discussion and work towards formalizing the UCATT standards via the SISO community was continued. A number of standards were defined regarding battlefield effect. The end product of this Task Group is this comprehensive report detailing the details of the demonstration and future research requirements for MOUT training facilities.

NORTH ATLANTIC TREATY ORGANIZATION

NATO OTAN

BP 25
F-92201 NEUILLY-SUR-SEINE CEDEX • FRANCE
Télécopie 0(1)55.61.22.99 • E-mail mailbox@cso.nato.int

SCIENCE AND TECHNOLOGY ORGANIZATION

DIFFUSION DES PUBLICATIONS
STO NON CLASSIFIEES

Les publications de l'AGARD, de la RTO et de la STO peuvent parfois être obtenues auprès des centres nationaux de distribution indiqués ci-dessous. Si vous souhaitez recevoir toutes les publications de la STO, ou simplement celles qui concernent certains Panels, vous pouvez demander d'être inclus soit à titre personnel, soit au nom de votre organisation, sur la liste d'envoi.

Les publications de la STO, de la RTO et de l'AGARD sont également en vente auprès des agences de vente indiquées ci-dessous.

Les demandes de documents STO, RTO ou AGARD doivent comporter la dénomination « STO », « RTO » ou « AGARD » selon le cas, suivi du numéro de série. Des informations analogues, telles que le titre est la date de publication sont souhaitables.

Si vous souhaitez recevoir une notification électronique de la disponibilité des rapports de la STO au fur et à mesure de leur publication, vous pouvez consulter notre site Web (http://www.sto.nato.int/) et vous abonner à ce service.

CENTRES DE DIFFUSION NATIONAUX

ALLEMAGNE
Streitkräfteamt / Abteilung III
Fachinformationszentrum der Bundeswehr (FIZBw)
Gorch-Fock-Straße 7, D-53229 Bonn

BELGIQUE
Royal High Institute for Defence – KHID/IRSD/RHID
Management of Scientific & Technological Research for Defence, National STO Coordinator
Royal Military Academy – Campus Renaissance
Renaissancelaan 30, 1000 Bruxelles

BULGARIE
Ministry of Defence
Defence Institute "Prof. Zvetan Lazarov"
Blvd "Totleben" 34
1606 Sofia

CANADA
DGSIST
Recherche et développement pour la défense Canada
101 Colonel By Drive, 6 CBS
Ottawa, Ontario K1A 0K2

DANEMARK
Danish Acquisition and Logistics Organization (DALO)
Lautrupbjerg 1-5
2750 Ballerup

ESPAGNE
SDGTECIN (DGAM)
C/ Arturo Soria 289
Madrid 28033

ESTONIE
Estonian National Defence College
Centre for Applied Research
Riia str 12
Tartu 51013

ETATS-UNIS
Defense Technical Information Center
8725 John J. Kingman Road
Fort Belvoir, VA 22060-6218

FRANCE
O.N.E.R.A. (ISP)
29, Avenue de la Division Leclerc
BP 72
92322 Châtillon Cedex

GRECE (Correspondant)
Defence Industry & Research General Directorate, Research Directorate
Fakinos Base Camp, S.T.G. 1020
Holargos, Athens

HONGRIE
Hungarian Ministry of Defence
Development and Logistics Agency
P.O.B. 25
H-1885 Budapest

ITALIE
Centro Gestione Conoscenza
Secretariat General of Defence
National Armaments Directorate
Via XX Settembre 123/A
00187 Roma

LUXEMBOURG
Voir Belgique

NORVEGE
Norwegian Defence Research Establishment
Attn: Biblioteket
P.O. Box 25
NO-2007 Kjeller

PAYS-BAS
Royal Netherlands Military Academy Library
P.O. Box 90.002
4800 PA Breda

POLOGNE
Centralna Biblioteka Wojskowa
ul. Ostrobramska 109
04-041 Warszawa

PORTUGAL
Estado Maior da Força Aérea
SDFA – Centro de Documentação
Alfragide
P-2720 Amadora

REPUBLIQUE TCHEQUE
Vojenský technický ústav s.p.
CZ Distribution Information Centre
Mladoboleslavská 944
PO Box 18
197 06 Praha 9

ROUMANIE
Romanian National Distribution Centre
Armaments Department
9-11, Drumul Taberei Street
Sector 6
061353 Bucharest

ROYAUME-UNI
Dstl Knowledge and Information Services
Building 247
Porton Down, Salisbury SP4 0JQ

SLOVAQUIE
Akadémia ozbrojených síl gen. M.R. Štefánika, Distribučné a informačné stredisko STO
Demänová 393
031 06 Liptovský Mikuláš 6

SLOVENIE
Ministry of Defence
Central Registry for EU & NATO
Vojkova 55
1000 Ljubljana

TURQUIE
Milli Savunma Bakanlığı (MSB)
ARGE ve Teknoloji Dairesi Başkanlığı
06650 Bakanliklar – Ankara

AGENCES DE VENTE

The British Library Document Supply Centre
Boston Spa, Wetherby
West Yorkshire LS23 7BQ
ROYAUME-UNI

Canada Institute for Scientific and Technical Information (CISTI)
National Research Council Acquisitions
Montreal Road, Building M-55
Ottawa, Ontario K1A 0S2
CANADA

Les demandes de documents STO, RTO ou AGARD doivent comporter la dénomination « STO », « RTO » ou « AGARD » selon le cas, suivie du numéro de série (par exemple AGARD-AG-315). Des informations analogues, telles que le titre et la date de publication sont souhaitables. Des références bibliographiques complètes ainsi que des résumés des publications STO, RTO et AGARD figurent dans le « NTIS Publications Database » (http://www.ntis.gov).

NORTH ATLANTIC TREATY ORGANIZATION

NATO OTAN

BP 25
F-92201 NEUILLY-SUR-SEINE CEDEX • FRANCE
Télécopie 0(1)55.61.22.99 • E-mail mailbox@cso.nato.int

SCIENCE AND TECHNOLOGY ORGANIZATION

DISTRIBUTION OF UNCLASSIFIED STO PUBLICATIONS

AGARD, RTO & STO publications are sometimes available from the National Distribution Centres listed below. If you wish to receive all STO reports, or just those relating to one or more specific STO Panels, they may be willing to include you (or your Organisation) in their distribution.

STO, RTO and AGARD reports may also be purchased from the Sales Agencies listed below.

Requests for STO, RTO or AGARD documents should include the word 'STO', 'RTO' or 'AGARD', as appropriate, followed by the serial number. Collateral information such as title and publication date is desirable.

If you wish to receive electronic notification of STO reports as they are published, please visit our website (http://www.sto.nato.int/) from where you can register for this service.

NATIONAL DISTRIBUTION CENTRES

BELGIUM
Royal High Institute for Defence – KHID/IRSD/RHID
Management of Scientific & Technological Research for Defence, National STO Coordinator
Royal Military Academy – Campus Renaissance
Renaissancelaan 30
1000 Brussels

BULGARIA
Ministry of Defence
Defence Institute "Prof. Zvetan Lazarov"
Blvd "Totleben" 34
1606 Sofia

CANADA
DSTKIM
Defence Research and Development Canada
101 Colonel By Drive, 6 CBS
Ottawa, Ontario K1A 0K2

CZECH REPUBLIC
Vojenský technický ústav s.p.
CZ Distribution Information Centre
Mladoboleslavská 944
PO Box 18
197 06 Praha 9

DENMARK
Danish Acquisition and Logistics Organization (DALO)
Lautrupbjerg 1-5
2750 Ballerup

ESTONIA
Estonian National Defence College
Centre for Applied Research
Riia str 12
Tartu 51013

FRANCE
O.N.E.R.A. (ISP)
29, Avenue de la Division Leclerc – BP 72
92322 Châtillon Cedex

GERMANY
Streitkräfteamt / Abteilung III
Fachinformationszentrum der Bundeswehr (FIZBw)
Gorch-Fock-Straße 7
D-53229 Bonn

GREECE (Point of Contact)
Defence Industry & Research General Directorate, Research Directorate
Fakinos Base Camp, S.T.G. 1020
Holargos, Athens

HUNGARY
Hungarian Ministry of Defence
Development and Logistics Agency
P.O.B. 25
H-1885 Budapest

ITALY
Centro Gestione Conoscenza
Secretariat General of Defence
National Armaments Directorate
Via XX Settembre 123/A
00187 Roma

LUXEMBOURG
See Belgium

NETHERLANDS
Royal Netherlands Military Academy Library
P.O. Box 90.002
4800 PA Breda

NORWAY
Norwegian Defence Research Establishment, Attn: Biblioteket
P.O. Box 25
NO-2007 Kjeller

POLAND
Centralna Biblioteka Wojskowa
ul. Ostrobramska 109
04-041 Warszawa

PORTUGAL
Estado Maior da Força Aérea
SDFA – Centro de Documentação
Alfragide
P-2720 Amadora

ROMANIA
Romanian National Distribution Centre
Armaments Department
9-11, Drumul Taberei Street
Sector 6
061353 Bucharest

SLOVAKIA
Akadémia ozbrojených síl gen M.R. Štefánika, Distribučné a informačné stredisko STO
Demänová 393
031 06 Liptovský Mikuláš 6

SLOVENIA
Ministry of Defence
Central Registry for EU & NATO
Vojkova 55
1000 Ljubljana

SPAIN
SDGTECIN (DGAM)
C/ Arturo Soria 289
Madrid 28033

TURKEY
Milli Savunma Bakanlığı (MSB)
ARGE ve Teknoloji Dairesi Başkanlığı
06650 Bakanliklar – Ankara

UNITED KINGDOM
Dstl Knowledge and Information Services
Building 247
Porton Down, Salisbury SP4 0JQ

UNITED STATES
Defense Technical Information Center
8725 John J. Kingman Road
Fort Belvoir, VA 22060-6218

SALES AGENCIES

The British Library Document Supply Centre
Boston Spa, Wetherby
West Yorkshire LS23 7BQ
UNITED KINGDOM

Canada Institute for Scientific and Technical Information (CISTI)
National Research Council Acquisitions
Montreal Road, Building M-55
Ottawa, Ontario K1A 0S2
CANADA

Requests for STO, RTO or AGARD documents should include the word 'STO', 'RTO' or 'AGARD', as appropriate, followed by the serial number (for example AGARD-AG-315). Collateral information such as title and publication date is desirable. Full bibliographical references and abstracts of STO, RTO and AGARD publications are given in "NTIS Publications Database" (http://www.ntis.gov).

ISBN 978-92-837-2011-9