NORTH ATLANTIC TREATY ORGANISATION

RESEARCH AND TECHNOLOGY ORGANISATION

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RTO TECHNICAL REPORT **TR-MSG-032**

Urban Combat Advanced Training Technology

(Technologie avancée d'entraînement au combat urbain)

Final Report of Task Group 032.

Published April 2010

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The Research and Technology Organisation (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. 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 RTO 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.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also co-ordinates RTO's co-operation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of co-operation.

The total spectrum of R&T activities is covered by the following 7 bodies:

- 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 bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier co-operation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

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List of Acronyms

AAR	After Action Review
ACT	Allied Command Transformation
AGDUS	Ausbildungsgeräd Duelsimulator / Duel Simulator in German Language
C2IEDM	Command and Control Information Exchange Data Model
C4I	Command, Control, Communications, Computers and Intelligence
C-BML	Coalition Battle Management Language
CDT	Code Discriminator/Translator
CI	Central Interface
CJTF	Combined Joint Task Force
CTC	Combat Training Centre
CTIA	Cellular Telecommunications Industry Association
DIS	Distributed Interactive Simulation
DO	Dynamic Object
ER	Effects Representation
EHQ	European Headquarters
EU	European Union
EXCON	Exercise Control
FIBUA	Fighting In Built-Up Areas
H&S	Health and Safety
HLA	High Level Architecture
IPR	Intellectual Property Rights
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
LG/8	Land Group 8 (Group under NAAG)
LO2020	Land Operations in the Year 2020
M&S	Modelling and Simulation
MILSTD	Military Standard
MIP	Multinational Interoperability Programme
MOD	Ministry Of Defence
MODAF	Ministry of Defence Architectural Framework (UK term)
MOUT	Military Operations in Urban Terrain
MRE	Mission Rehearsal Exercise
MSMP	Modelling and Simulation Master Plan
NAAG	NATO Army Armaments Group
NATO	North Atlantic Treaty Organisation

NBC	Nuclear, Biological and Chemical
NC3A	NATO Command, Control & Communications Agency
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
PDG	Product Development Group
PfP	Partners for Peace
PI	Pulse Interval
PID	Player Identity
PSO	Peace Support Operation
R&D	Research and Development
RTO	Research and Technology Organisation
SAF	Semi-Automated Forces
SAS	System Analysis and Studies
SC	System Control
SE	Synthetic Environment
SHAPE	Supreme Headquarters Allied Powers Europe
SISO	Simulation Interoperability Standards Organization
TES	Tactical Engagement Simulation
TG	Task Group
TINA	Telecommunications Information Networking Architecture
TOE	Team Of Experts
TSWG	Training and Simulation Working Group
TTP	Tactics, Techniques and Procedures
UCATT	Urban Combat Advanced Training Technology
UN	United Nations
UO2020	Urban Operations in the Year 2020
WES	Weapon Effects System
WG	Working Group

Terms of Reference

I. ORIGIN

A. Background

The NATO Modeling and Simulation Action/ Master Plan (MSMP) 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. The NATO structure and objectives make it the most suitable organisation to harmonise training requirements and spearhead the effort toward common technical architecture and standards for the next generation of MOUT facilities.

B. Justification

The recent SAS-030 "Study on Urban Operations" and "Land Operations 2020" both clearly indicate that cities are the most likely battlefield in the 21st century. The urban environment confronts military forces with a large range of activities, from full-scale, high-intensity combat, to humanitarian assistance operations and police actions – often simultaneously. There are currently no standard interfaces or architectures that enable nations to share their MOUT training capability with other members of the Alliance. Execution of joint or combined multinational MOUT exercises would require considerable modification to host nation facilities.

Agreement on a generic set of requirements, technical architecture, and standards will make the next generation of MOUT systems more affordable and enable execution of multinational exercises.

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. 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. A Technical Report detailing best practices and proposed architecture and standards will be delivered.

B. Specific Activities to be Performed by the TG

Operational Concepts: The group will examine user requirements for the timeframe 2010, and develop a generic set of requirements.

Battlefield Effects: The group will conduct an investigation into techniques currently used and research required for representing aural cues and visual effects of all relevant munitions.

Exercise Control (EXCON) and After Action Review (AAR): The group will identify the major elements of the EXCON and AAR subsystems and identify the data to be captured during exercises, and the methods to be used for performance assessments.

System Architecture: The group will nominate an appropriate generic architecture for future systems and appropriate interfaces for communications and interactions with virtual and constructive simulations and C4I systems.

Standards: To achieve interoperability/compatibility the following areas will be addressed: agreement on a generic set of tables for vulnerability and lethality; agreement on a standard laser code; agreement on a single laser safety standard; recommendations for frequency spectrum required for training instrumentation.

Produce the 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.

D. Overall Duration

The duration of the task group will be three years, starting as an approved activity in Spring 2003 with the final report submitted in Spring 2006.

III. RESOURCES

A. Membership

Participating nations are initially Canada, France, Germany, Finland, the Netherlands, Switzerland, the United Kingdom, and the United States. Ing. Jan Vermeulen, Directorate of Materiel RNLA, C3I, 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 Task Group (TG). The TG is expected to communicate on the specific topics highlighted above via email and in 2 – 3 day meetings 3 – 4 times a year.

C. RTA Resources Needed

Report Publication.

IV. SECURITY CLASSIFICATION LEVELS

NATO UNCLASSIFIED.

V. PARTICIPATION BY PARTNER NATIONS

Partner nations will be invited to participate.

VI. LIAISON

The group is to liaise with:

- SHAPE (User).

- Army Training Group, Training and Simulation Working Group (ATG-TSWG) (Training Requirements).
- Army Training Group, Fighting in Built Up Areas/Military Operations in Urban Terrain (ATG- FIBUA/ MOUT) Working Group (Training Requirements).
- Land Group 3/Working Group 2 on Military Operations in Urban Terrain and Non-Lethal Capabilities.
- 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 TG. In particular he extends his thanks to Mr. Gary Washam (Cubic) who has ensured that the group has remained focussed on its outputs from its first meeting.

Task Group Participants

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

Finland	FIN
France	FRA
Germany	DEU
Greece	GRC
New Zealand	NZL
Sweden	SWE
Switzerland	CHE
Netherlands	NLD
Turkey	TUR
United Kingdom	GBR
United States of America	USA

Steering Group Members:

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

Secretary: Mr. Osmo Forstén, National Defence College, FIN (10)

Other Steering Group Member: Mr. Gary Washam, Cubic International, USA (11)

Other Participants:

Nation	Rank/ Title	Name	Department/Company	Timeframe*
CHE	Col.	Fenner, Max	Swiss Army	2003 – 2006 (12)
CHE	Mr.	Herren, Hugo	Swiss MoD	2003 – 2006 (11)
CHE	Mr.	Luethi, Roland	RUAG	2003 – 2006 (9)
CHE	Ms.	Buchanan, Nancy	Tenetec Innovations Inc.	2003 – 2006 (9)
DEU	Maj.	Muller-Marquardt, Stefan	German Armed Forces	2003 (1)
DEU	Mr.	Lieberich, Helmut	BWB, German MOD	2003 – 2004 (1)
DEU	Mr.	Thinnes, Armin	BWB, German MOD	2005 – 2006 (6)
DEU	Mr.	Wichmann, Eckhard	EADS/TSF	2003 – 2006 (7)
DEU	Mr.	Int-Veen, Rainer	EADS/TSF	2003 – 2006 (6)
DEU	Mr.	Böttcher, Holger	COEL	2003 – 2006 (7)
DEU	Mr.	Dietrich, Juergen	COMET/Diehl	2003 – 2005 (4)
FIN	Maj.	Kortelainen, Pekka	Finnish Defence Forces	2003 (1)

* Number of meetings attended shown in brackets.

Nation	Rank/ Title	Name	Department/Company	Timeframe*
FRA	Mr.	Queval, Remy	Thales Training & Simulation	2003 – 2005 (4)
FRA	Mr.	Hervé, Rochard	Thales Training & Simulation	2006 (2)
FRA	Mr.	Anglade, Claude	EADS	2003 (1)
FRA	Mr.	Gallo, Laurent	EADS	2003 (1)
GRC	LtCol.	Kallinis, George	Hellenic Armed Forces	2003 (1)
GBR	Maj.	Galvin, Kevin	Directorate Equipment Capability (Ground Manoeuvre), UK MOD	2004 – 2005 (8)
GBR	Mr.	Wong, Kwok	QinetiQ	2005 – 2006 (2)
GBR	Mr.	Wright, Mathew	QinetiQ	2005 – 2006 (4)
NLD	LtCol.	Uilenbroek, George	Dutch Army MTC	2003 – 2004 (1)
NLD	Mr.	Gouweleeuw, Rudi	TNO	2003 – 2005 (7)
NLD	Mr.	Bloem, Micha	TNO	2006 (3)
NZL	Mr.	Fairweather, Keith	OSCMAR	2003 (1)
SWE	Maj.	Gullstrand, Johnny	Swedish Armed Forces	2003 – 2006 (10)
SWE	Mr.	Brandin, Joakim	C-ITS/BAE	2004 – 2005 (4)
SWE	Mr.	Olander, Johan	SAAB Training Systems	2003 (1)
SWE	Mr.	Manley, Håkan	SAAB Training Systems	2003 – 2006 (9)
SWE	Mr.	Holmquist, Anders	SAAB Training Systems	2006 (2)
SWE	Mr.	Nyfelt, Leif	NSC	2004 – 2006 (4)
SWE	Mr.	Larsson, Göran	C-ITS	2003 (1)
SWE	Mr.	Karlsson, Magnus	C-ITS	2004 (1)
TUR	LtCol.	Yavas, Altan	Turkish Army	2004 (1)
USA	Col.	Reyenga, Robert	PEO STRI, U.S. Army	2003 (3)
USA	Ms.	Kahl, Randi	PEO STRI, U.S. Army	2003 – 2006 (6)
USA	Mr.	Coltman, Dick	Anteon Corporation	2003 (2)
USA	Mr.	North, Steve	Anteon Corporation	2004 – 2005 (4)
USA	Mr.	Alonso, A.	Anteon Corporation	2003 (1)

* Number of meetings attended shown in brackets.

Urban Combat Advanced Training Technology

(RTO-TR-MSG-032)

Executive Summary

INTRODUCTION

The Urban Combat Advanced Training Technology (UCATT) Task Group (TG) was established within the NATO Modelling and Simulation Group (NMSG) in 2003 as MSG-032 TG-023. The UCATT TG was tasked 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 identify interoperability requirements and a suitable architecture and a standard set of interfaces that would enable interoperability of MOUT training components. Uniquely the UCATT TG from the outset drew its members from both government and industry.

BACKGROUND

Two NATO studies have been fundamental to taking the work of the UCATT TG forward; RTO 1999 Technical Report, Land Operations in the Year 2020 (LO2020) [1] and their 2003 Urban Operations in the Year 2020 (UO2020) report [4]. LO2020 concluded that NATO forces would potentially have to conduct future operations in urban areas and furthermore it made a series of recommendations and training was highlighted as an area that needed to be improved.

THE UCATT TASK GROUP

Over a three year period the UCATT TG has held 12 meetings and although in its ToR it was required to liaise with a number of groups both within SHAPE and outside of NATO, who included the Training and Simulation Working Group (TSWG), the FIBUA/MOUT Working Group (WG), Topical Group 3 from the NAAG and the Simulation Interoperability Standards Organization (SISO), it found that the major contact group was the FIBUA/MOUT WG. They received briefs on the work of the UCATT TG at each of their meetings. They assisted by validating requirements from nations represented in their group. More recently there has however been active liaison with TSWG who have been examining Tactical Engagement Simulation (TES) interoperability and they have recognised that the architecture being recommended in this report is equally applicable in meeting their purpose. In addition papers have been given to SISO and at ITEC.

Initial work centred on developing a set of USE CASES, a capability requirements matrix and creation of a web based portal for disseminating information on FIBUA/MOUT facilities and best practice.

Based on the USE CASES and a capability requirements matrix developed by the UCATT TG, both of which were validated by the FIBUA/MOUT WG, the UCATT TG defined a functional architecture, which provides the context to define requirements for interoperability.

CONCLUSION AND RECOMMENDATIONS

In conclusion the work to date has provided NATO with a scaleable functional architecture based on USE CASES agreed by the military user community in NATO and partner nations. 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 of urban training.

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

1) To use the functional architecture defined in this report as the basis for developing and procuring TES equipment for training for urban operations or instrumented MOUT sites.

2) To work out in more detail; standardisation of laser codes, requirements for virtual and constructive MOUT training, Effects Representation (ER), data communication including the exchange of data with C4I systems, the integration of LVC domains and further development of the UCATT functional architecture as required.

Technologie avancée d'entraînement au combat urbain

(RTO-TR-MSG-032)

Synthèse

INTRODUCTION

Le groupe de travail (TG) sur la Technologie avancée d'entraînement au combat urbain (UCATT) a été constitué au sein du groupe de modélisation et de simulation de l'OTAN (NMSG) en 2003 sous la référence MSG-032 TG-023. L'UCATT TG a reçu pour tâche d'échanger et d'évaluer les informations sur les installations et systèmes d'entraînement/simulation concernant les opérations militaires en zone urbaine (MOUT) en vue de définir les meilleures pratiques. Il lui a en outre été demandé d'identifier les besoins en interopérabilité ainsi qu'une architecture adaptée et un ensemble standard d'interfaces qui pourraient permettre l'interopérabilité des composantes de l'entraînement MOUT. De manière unique l'UCATT TG a, dès le début, été constitué de membres en provenance à la fois du gouvernement et de l'industrie.

ARRIERE-PLAN

Deux études de l'OTAN ont été fondamentales dans la progression du travail de l'UCATT TG ; le rapport technique RTO 1999 : Opérations terrestres en 2020 (LO2020) [1] et son rapport de 2003 Opérations urbaines en 2020 (UO2020) [4]. LO2020 concluait que les forces de l'OTAN auraient potentiellement à conduire leurs opérations futures en zone urbaine ; il émettait en outre une série de recommandations et mettait l'accent sur la nécessité d'améliorer l'entraînement.

LE GROUPE DE TRAVAIL UCATT

Sur une période de trois ans l'UCATT TG a tenu 12 réunions. Bien que dans son ToR il était demandé de se mettre en liaison avec un certain nombre de groupes appartenant au SHAPE et extérieurs à l'OTAN, groupes qui comprenaient le groupe de travail sur la simulation et l'entraînement (TSWG), le groupe de travail FIBUA/MOUT (GT), le groupe thématique 3 du NAAG et l'Organisation de normalisation de l'interopérabilité en matière de simulation (SISO), il est apparu que le groupe de contact principal était le GT de FIBUA/MOUT. Des notes sur le travail de l' UCATT TG lui furent envoyées à chacune de ses réunions ; il apporta son aide en validant les exigences des nations représentées dans son groupe. Il y eut cependant plus récemment une liaison active avec le TSWG qui étudiait l'interopérabilité en matière de simulation d'engagement tactique (TES) et il fut reconnu que l'architecture recommandée dans ce rapport s'appliquait également à la satisfaction de son objectif. De plus des documents ont été donnés au SISO et à l'ITEC.

Le travail initial a porté sur le développement d'un jeu de SITUATIONS d'UTILISATION, d'une matrice d'exigences capacitaires et sur la création d'un portail internet pour diffuser l'information sur les installations FIBUA/MOUT et sur les meilleures pratiques.

A partir des SITUATIONS d'UTILISATION et de la matrice capacitaire développés par l'UCATT TG, qui ont été tous les deux validés par le FIBUA/MOUT WG, l'UCATT TG a défini une architecture fonctionnelle, qui fournit le contexte nécessaire à la définition des conditions d'interopérabilité.

CONCLUSION ET RECOMMANDATIONS

En conclusion : les travaux, à ce jour, ont fourni à l'OTAN une architecture fonctionnelle d'une dimension modulable basée sur les SITUATIONS d'UTILISATION, agréée par la communauté des utilisateurs militaires de l'OTAN et des nations partenaires. Le travail sur l'identification des meilleures pratiques a cependant été limité. Les indications fournies jusqu'ici suggéreraient qu'il y a encore davantage à faire en particulier dans le développement des normes et qu'il doit en être fait plus pour aborder les deux autres domaines de la simulation, de la simulation constructrice et virtuelle en soutien de l'entraînement urbain.

En conclusion des travaux, les recommandations principales suivantes sont faites :

1) Employer l'architecture fonctionnelle définie dans ce rapport comme base pour développer et acquérir l'équipement TES pour l'entraînement aux opérations urbaines ou pour les sites équipés MOUT.
2) Et, plus en détail : standardisation des codes laser, exigences d'entraînement virtuel et constructif MOUT, représentation des effets (ER), communication des données comprenant l'échange des données avec des systèmes de C4I, intégration des domaines de LVC et développement ultérieur de l'architecture fonctionnelle UCATT selon besoin.

Chapter 1 – INTRODUCTION

"The rule is, not to besiege walled cities if it can possibly be avoided."
Sun-Tzu, The Art of War

1.1 INTRODUCTION

This is the final 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. It was established in order to examine key interoperability issues that had been identified in a feasibility study that was conducted between 2001 and 2002 by a NATO Military Operations in Urban Terrain (MOUT) Team of Experts (TOE).

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) [1] 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. The battle for An Najaf by the U.S. Army in March 2003 and Fallujah predominantly by the U.S. Marine Corps in October 2004, both in Iraq, and continuing operations in that country and Afghanistan have provided more evidence that future military operations are more likely to take place in the urban environment. This is perhaps particularly true with asymmetric warfare waged by terrorists and others who see that the technical advantages of NATO forces can be negated in urban areas. 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' [2][3].

1.2.1 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 the Alliance.

Figure 1-1: Typical Urban Area (Photograph K. Galvin).

Figure 1-2: Patrolling in Kabul (UK Defence Image Library).

The study group that produced the LO2020 report stated that present capabilities for operating in urban areas were essentially those of World War II, which are characterised by massive mechanised confrontations in fairly open terrain, with high levels of casualties and extensive collateral damage. It argued that NATO commanders had very few military options which would avoid serious damage and casualties when dealing with an enemy in urban areas. Such effects were considered unacceptable, particularly at the lower levels of conflict, where NATO forces are more likely to become involved. Therefore, the study group considered that it was essential that NATO provides its commanders with a range of capabilities for dealing with the varying conditions of operations in urban areas.

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) [4]. 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.

The UO2020 study group report [4] outlined a description of the likely nature of the future urban environment and it "observed 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 NATO commander which are not adequately addressed by those military capabilities designed for open environments."

The report covered a range of issues related to conducting military operations in urban environments and identified 42 areas where it felt that NATO could enhance or deliver new capabilities. It also highlighted training as an area for improvement, stating:

> *Specific training in urban areas is considered the best short-term enhancement available to NATO. While training is the responsibility of individual NATO nations, the lessons learned from training can be shared. Wherever possible, training should be focused upon joint and coalition operations in urban areas, featuring all aspects of the '3 Block War'[1]. Specific training/exercises would allow commanders to employ forces with more confidence while taking acceptable risks. However, there is the need for more urban-specific training facilities. There is also a need to combine these training facilities with simulation system(s) to portray more accurately the complexity of the urban battlespace. The training should be able to*

[1] General C.C. Krulak, Commandant U.S. Marine Corps, "The Three Block War: Fighting in Urban Areas", presented at the National Press Club, Washington, D.C., 10 October 1997.

present the complexity of the urban battlespace at the operational level. The requirement to train and educate commanders in the cultural, political and ethnic background pertaining to the urban area will enhance their capability to deal successfully with such operations if and when they occur.

The study group produced a roadmap which is at Figure 1-3. The development of training facilities is one of the key activities to enable NATO/PfP nations to train more effectively by 2020. By implication training facilities need to be in place before that date and migration actions must commence now.

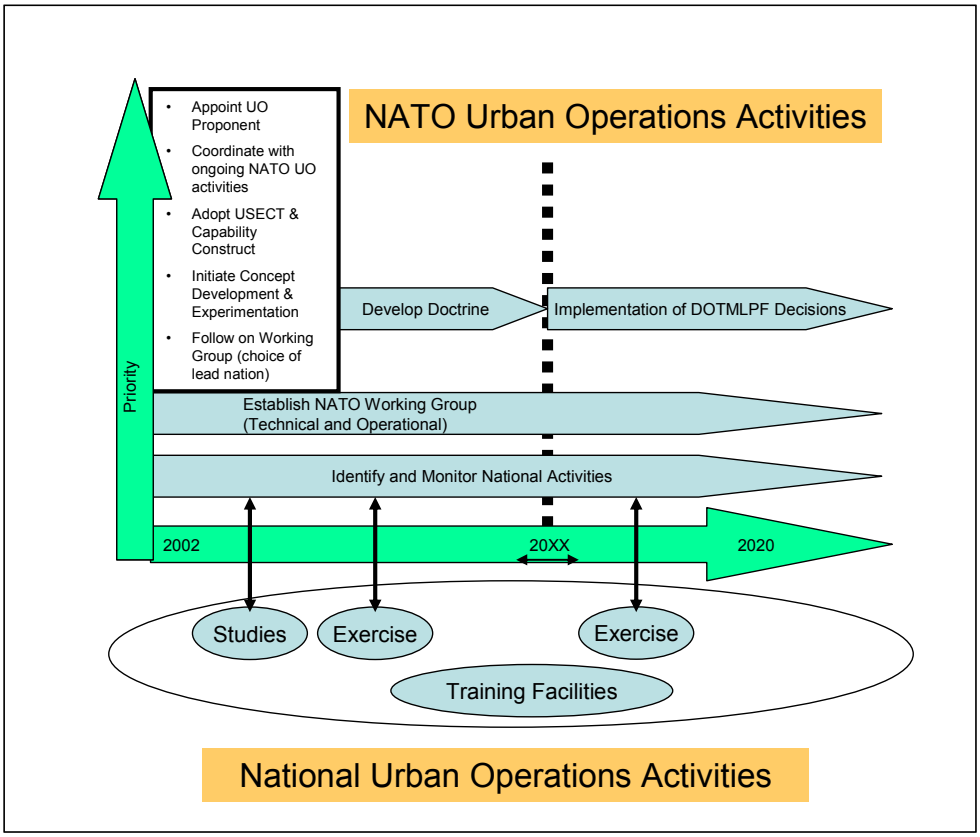


Figure 1-3: Roadmap for Improving Capability in Conducting Urban Operations [4].

1.2.2 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 [5]. 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."

The team identified some key interoperability issues:

a) **Operational Concepts**: The requirement for a user led group that would examine common user requirements for the timeframe 2010, and greater harmonisation of doctrine (Tactics, Training and Procedures (TTPs)).

b) **Battlefield Effects**: The achievement of common objectives between nations in the following areas: pyrotechnics' techniques and visual cueing, collateral effects (shooting through walls – effects of artillery/armour).

c) **TES Interoperability**: Tactical Engagement Simulations (TES) capability should be a specialist sub-set of Battlefield effects. TES capability should examine laser code, class and vulnerability code to ensure interoperability. The team envisaged three levels of TES interoperability:
   - To borrow/use existing equipment from other nations, i.e. Dutch troops borrowing German equipment when training at German facility;
   - To develop interoperability between existing TES by adapting current equipment. It considered that 2010 would be a realistic date for this to be achieved; and
   - Development of common standards and new TES equipment which was recognised might not be possible until 2020.

d) **Sensory Cueing**: Sensory cueing should be as close as possible to reality representing visual, audio, shock, Haptic/tactile, pressure, smell, effects of direct and indirect fire, explosives, non-lethal weapons and Nuclear, Biological and Chemical (NBC) weapon effects.

e) **Pyrotechnics**: The major issues here were with regards to safety regulations and common representation of effects.

f) **Exercise Control (EXCON) / After Action Review (AAR)**: EXCON conducts the following: planning, preparation, conducting an exercise, preparing and providing an interactive AAR (provides feedback, is interactive, objective and flexible). It considered that a possible way ahead was to incorporate a Synthetic Environment (SE) to provide contextual information, i.e. a platoon in MOUT operates within a company context. It pointed out that integration of training functionality with operational equipment is necessary but there was a need to avoid data contamination between the two domains. Major issues and potential areas for interoperability included:
   - The need to minimise training staff particularly Observer Controllers (O/C) in the field;
   - The requirement to capture all data to provide situational awareness and statistical analysis; and
   - The consequent need for smart tools to present the right information at the right time, in the right format.

g) **System Architecture**: The generic architecture for future systems – interfaces with communications / Command, Control, Communications, Computers and Intelligence systems (C4I) – and compatibility with LO2020 concept.

1.2.3 Key Conclusions/Recommendation from MOUT/TOE Study

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.
- 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 WG be formed to conduct an in depth examination of identified issues.

1.3 ESTABLISHMENT OF THE UCATT TASK GROUP

The report was approved by the NAAG and the UCATT TG was formally established. However as a result of a NATO summit in Prague in the autumn of 2002 approximately 30% of the groups where reduced, including LG/8, leaving the proposed UCATT TG without a parent organisation within NATO. After negotiations with the NMSG the work of the UCATT TG was brought under their control and held its first meeting in The Hague, The Netherlands in June 2003. A list of meetings held since then and the objective for each is at Annex A.

1.3.1 Purpose

The purpose of the UCATT 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 countries in the timeframe 2020.

1.3.2 Objectives

The UCATT TG had a number of key objectives [6] which evolved from the work carried out by the MOUT/TOE:

- Exchange and assess information on MOUT facilities and training/simulation systems;
- Gather military feedback as to the effectiveness of current solutions with a view toward establishing best practice;
- Identify a suitable architecture and standard set of interfaces that would enable interoperability of MOUT training components without inhibiting future research and enhancements;
- Identify limitations and constraints on MOUT development with a view toward recommending areas for future research;
- Provide a report detailing best practice for MOUT training facilities; and
- Establish a working relationship with industry partners and ensure that industrial participation was worthwhile.

It was recognised that it had to address the three areas highlighted by the NATO MOUT/TOE report:

- **Operational Concepts** – A comprehensive list of generic user requirements needed to be developed working in conjunction with NATO training groups and military users. In addition a generic set of data for lethality and vulnerability would be required to enable interoperability of each nation's simulation systems.
- **System Architecture** – It was calculated that there were in excess of 100 national MOUT facilities in existence or under construction. These facilities are expensive to construct and operate and most exhibit similar form and functionality but there was no common architecture or interface standards that enable interoperability of one nation's systems in another's MOUT training facility.
- **Technical Challenges** – That significant issues exist regarding frequency spectrum allocation and management, laser safety, laser compatibility, battlefield effects simulations, sensor cueing, NBC simulation, firing through walls, indirect fires, tracking and position/location in built up areas. It was concluded that many of these challenges could be solved if there was agreement on, and articulation of, future NATO training functional requirements. This would enable industry suppliers to better focus their independent research.

1.3.3 Participation

The UCATT TG consisted of a combination of NATO and Partners for Peace (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 TG has had a good balance between national Government (both military and civilian) and industrial representatives. The UCATT TG initially consisted of representatives from the following:

- NATO and PfP nations: DEU, CHE, FIN, GBR, GRC, NLD, SWE and USA. TUR subsequently attended one meeting; and
- Industrial participation from Cubic Defence Systems (USA), SAAB Training Systems (SWE), RUAG (CHE), COEL (DEU), Thales (FRA), Tenetec (CHE), EADS (FRA), TSF (DEU), NSC (SWE), COMET (DEU), OSCMAR (NZL) and C-ITS (SWE).

1.3.4 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. The contact with the TSWG was less frequent until 2005 because until then it was not examining TES interoperability. It was, however, recognised that the interoperability requirements and standards advocated by the UCATT TG are equally applicable outside the urban training environment.

1.4 STUDY METHODOLOGY

The starting point for the UCATT TG was the conclusions and the findings of the MOUT/TOE [1]. This report was approved by LG/8 and the NAAG. As one of the LO2020 report [2] conclusions was that a military operation was more likely to take place in an urban environment this was used as a framework reference document to guide the UCATT TG. The UO2020 report [3] provided more specific guidance for the work. Both documents indicated the capability gaps within NATO for conducting MOUT. These gaps were taken in account in the analysis.

1.4.1 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 manmade physical structures, associated urban infrastructures and non-combatant populations.

1.4.2 Staged Approach

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

- Identifying USE CASES in close co-operation with the FIBUA/MOUT WG (Chapter 2);
- Conducting an overview of existing FIBUA/MOUT training sites (Chapter 3); and
- Conducting an examination of the capabilities required which were mapped to the USE CASES (Chapter 4).

This was followed by:

- Developing a functional architecture and identification of internal and external interfaces (Chapter 5);
- Identifying data interoperability issues (Chapter 6);
- Work on interoperability code sets (Chapter 7); and
- A review of future research requirements (Chapter 8).

The overall output is this report which includes recommendations about the way ahead (Chapter 9).

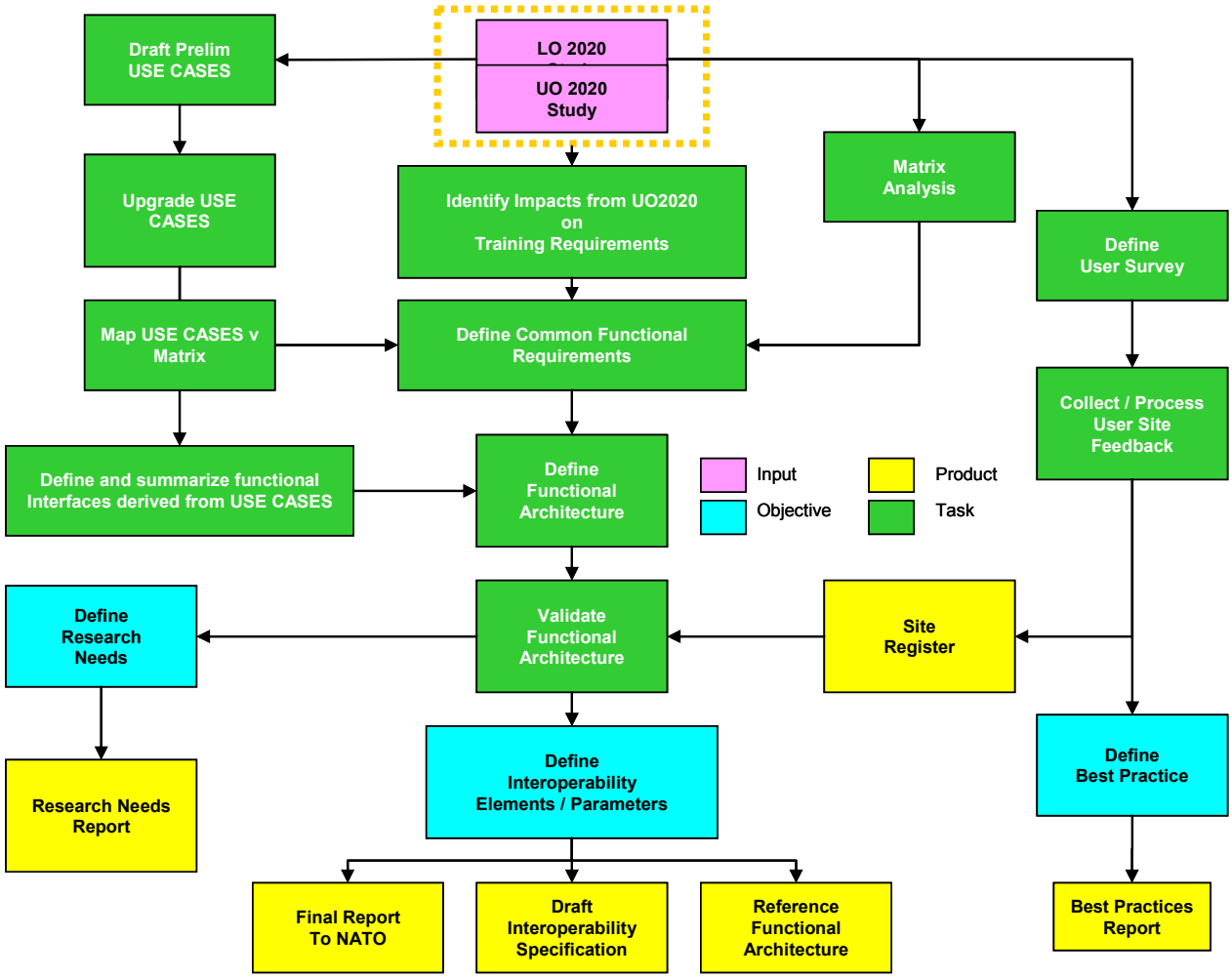


Figure 1-4: Study Approach.

Chapter 2 – USE CASES

2.1 INTRODUCTION

The main objective in developing a set of USE CASES was to ensure that all training requirements could be identified and that a generic architecture could be built that was able to accommodate each nation's requirement. It also provided an opportunity for beginning the process of cooperation with the FIBUA/ MOUT WG which would be asked to validate the USE CASES and answer a set of generic questions for each one.

The UO 2020 report [4] described the capabilities needed by NATO commanders to conduct operations in urban environment in that timeframe. In addition, to support the development process, the UCATT WG used a U.S. Army presentation of a *Vision of the Future Force 2020* to further ensure that members had an understanding of how the urban battle space might look at that time. Based on the report, presentation and thoughts of each of the national representatives, the UCATT TG developed a set of USE CASES and supporting scenarios, which not only described the current situation but accommodated how it was considered that nations might need to train in the future.

The USE CASES developed ranged from the conduct of national training on a national site with no need for any interoperability to staff training in a mission area with several nations participating in coalition operations. The results of the work were five USE CASES and supporting scenarios that it was thought would help to both visualise and understand the complexities in each case that had to be considered in order to determine training requirements. The USE CASES were verified in conjunction with the FIBUA/MOUT WG. This also helped in capturing the training needs of the different nations. The USE CASES provided a basis for the development of the Capability Requirement Matrix described in Chapter 4. The link between USE CASES and the Functional Architecture described in Chapter 5 is shown in Figure 2-1 below.

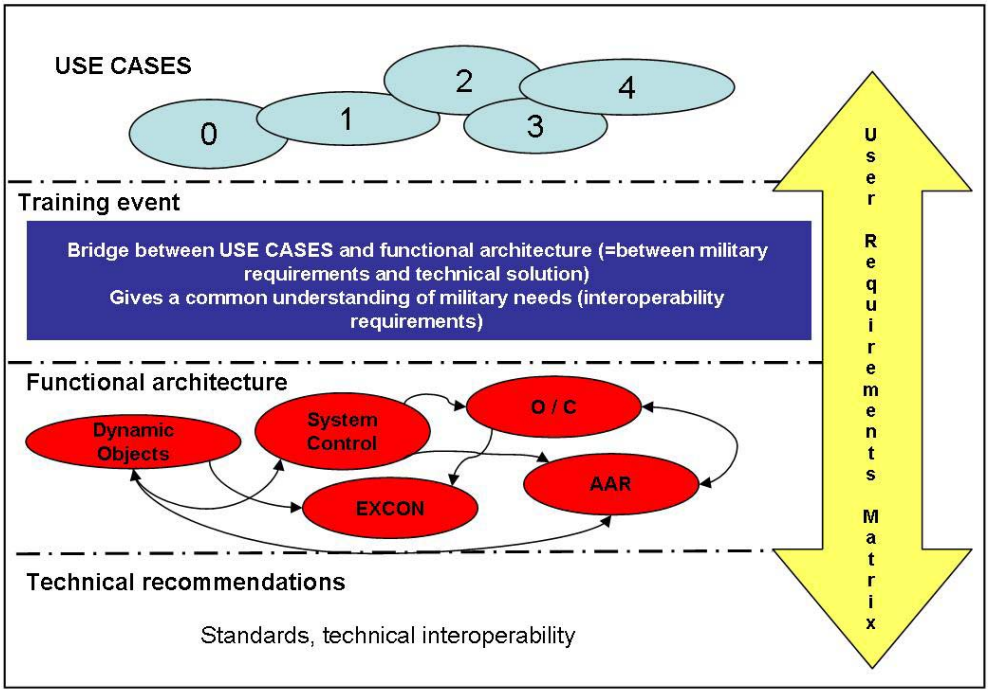


Figure 2-1: Link between USE CASES, Functional Architecture and Technical Recommendations.

Table 2-1: Overview on the Identified USE CASES for UO2020 Training

USE CASE 0	National training on national site
USE CASE 1	Live MOUT training – 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

Having identified a set of USE CASES, the UCATT TG developed a set of supporting scenarios (abstracts) for each one. These are listed in more detail below.

2.2 USE CASE 0: NATIONAL TRAINING ON NATIONAL SITE

2.2.1 Abstract (1)

In this scenario it is a national responsibility for education, training and certification of units conducting urban training. Priority is driven by individual national doctrine and policy.

As a result this USE CASE was not addressed by the FIBUA/MOUT WG, because this was seen as the responsibility of each individual nation and no harmonisation was considered necessary.

2.3 USE CASE 1: LIVE MOUT TRAINING – NATIONAL FORCE ON A NATIONAL SITE

2.3.1 Abstract (1)

In Europe a combined European Headquarters (EHQ) is established. From the European Union (EU) this EHQ is mandated to support international peace support/peace enforcement operations all over the world. Individual European countries will contribute their forces to the EHQ. The appointed commander is responsible for training any taskforce subordinated to it.

2.3.2 Abstract (2) – Operation BUGALAND

BUGALAND is a small country in the continent of Africa. The country is a City state similar to present day Singapore. The country is divided into three ethnic groups that have been fighting. This has resulted in the government being kicked out of power.

The local police force no longer exists and although the fighting is over the country is divided into three areas where the three groups are living.

The situation is still very fragile and extremely sensitive. The EU has been asked to control the situation in BUGALAND and help to re-establish local government so that elections can take place within a year from now. The EHQ has formed a taskforce to conduct the mission.

2.3.3 Abstract (3) – EHQ Orders/Directions

A battalion sized taskforce will be sent to BUGALAND for a peace support/peace enforcement operation. Key points are:

- The taskforce must be ready in two months from now.
- The taskforce will consist of a battalion HQ staff from NLD, two companies of military police from BEL and one light armored company from DEU.
- To provide training of the taskforce the Dutch Government has made its urban training centre at Marnehuizen available. Assigned units will use their own operational equipment and Marnehuizen is instrumented with training equipment.

2.4 USE CASE 2: USE OTHER NATIONS TRAINING FACILITY AND STAFF

2.4.1 Abstract (1)

The situation in REDLAND has not been stable for some time and a small fraction in the country has decided to take militant action and has taken ten ministers/politicians as hostages.

The United Nations (UN) has decided that military force is the only way to deal with the situation as negotiations with the fraction have stalled. The UN plans to rescue the hostages. The Italian Government has volunteered its special forces and can be prepared in five days.

The intelligence services know that the hostages are in basement of a house in a small mountain village in the middle of REDLAND. The immediate surrounding area will be defended by 30 militants.

It is winter and the temperature is -10°C and it will be daylight between 0800 and 1800.

2.4.2 Abstract (2)

The Commander of the Italian Special Forces Company who is responsible for the mission is looking for a training site with the right facilities. He has heard about a potential training facility in Switzerland and makes a call to the commander at Walenstadt to see whether the facility is available and suitable to his mission.

What he is searching for is a site that provides the right conditions, a staff that is able to provide training support and an Opposing Force (OPFOR) which speaks a different language.

2.4.3 Abstract (3)

The Italian unit will use its own operational and training equipment capability. This will require that it is interfaced with both the training site's instrumentation and OPFOR equipment/instrumentation.

2.5 USE CASE 3A: DISTRIBUTED COMBINED TRAINING

2.5.1 Abstract (1)

A Joint Coalition Task Force (JCTF) is preparing for a UN mission. It is going to Northern PASAMOWA where it will assume responsibility for the safety in PASA City and MOWA City for six months.

During this period the first "free" election will take place. There are numerous fractions/forces which will try to interfere with the electoral process.

The JCTF mission is a joint operation and involves forces from NATO, the EU and PfP countries.

The Commander is a Brigadier-General from Sweden and his deputy commander is a Colonel from Germany. The HQ is equally staffed with military personnel from SWE, USA, GBR, DEU, EST. Interoperability of C4I Systems and common database for operational and training data exists. All participants have access to a network to enable distributed training to take place. Live and virtual forces are available to support training in each country.

2.5.2 Abstract (2)

Step one is to conduct a "Command and staff training" (USE CASE 4) mission rehearsal exercise (MRE) in order to standardise proceedings and get to understand how the Commander and other staff members operate. The MRE will be distributed with the HQ and battalions' staffs participating from their own country. Staff from the UN will provide Exercise Control (EXCON) and will provide support for the scenarios and operate the Fractional Semi-Automated Force (SAF) representation in the system.

2.5.3 Abstract (3)

Step two is to conduct a "Distributed combined" exercise (USE CASE 3a). The exercise will be distributed with the HQ and battalions in each country using national operational and training equipment (Weapons Effects Systems (WES)) and training sites. Fractions/OPFOR will be provided locally but their actions will be controlled by UN EXCON.

2.6 USE CASE 3B: COMBINED TRAINING IN MISSION AREA

2.6.1 Abstract (1)

A Combined Joint Task Force (CJTF) is deployed in the country of MIINNIMALI in the continent of Africa. The first task of the CJTF was to stabilise the situation by conducting peace enforcement. This was successfully achieved and at this moment they are in a Peacekeeping phase of the operation.

The CJTF has been tasked to control the elections for a new government. The country MIINNIMALI consists of one large city known as "The Capital" and a number of smaller cities/towns. For historical reasons the elections will only take place in "The Capital" city and not in the smaller cities/towns in the rest of the country.

2.6.2 Abstract (2) – The Capital

"The Capital" has a population of 5 million people with a further 10 million people living elsewhere in the country. The elections will take one week and in that week it is expected that millions of people will occupy "The Capital". The city itself is built on ten small hills and is a combination of industrial areas, apartment type housing estates and office complexes.

2.6.3 Abstract (3) – The New Mission

The CJTF commander has the possibility of training for the next phase of his mission. He has a mobile instrumented system and a village available to conduct his training. The units are now in place and available for training. The elections are not supported by the whole community and situations where enforcement may be necessary are expected.

2.6.4 Abstract (4) – Forces

The CJTF commander and staff are from HUN and other force elements are as follows:

- Air Force: 1 Squadron from FRA, 1 Squadron from FIN and 1 Squadron from GRC;
- Navy (Marines): 1 Battalion from ESP, 1 Company from NOR;
- Army: ` 1 Battalion each from POL, CZE, TUR and AUS; and
- UN and EU: Observers.

2.7 USE CASE 4: COMMAND AND STAFF TRAINING FOR ENGAGEMENTS IN DIFFERENT MISSION AREAS

2.7.1 Abstract (1)

A Joint Coalition Task Force (JCTF) is preparing for a UN mission. It is going to Northern PASSAMOWA where it will assume responsibility for the safety in PASSA City and MOWA City for six months.

During this period the first "free" election will take place. There are numerous fractions/forces which will try to interfere with the electoral process.

The JCTF mission is a joint operation and involves forces from NATO, the EU and PfP countries.

The Commander is a Brigadier-General from Sweden and his deputy commander is a Colonel from Germany. The HQ are equally staffed from military personnel from SWE, USA, GBR, DEU, EST. Interoperability of C4I Systems and common database for operational and training data exists. All participants have access to a network to enable distributed training to take place. Live and virtual forces are available to support training in each country.

2.7.2 Abstract (2)

Step one is to conduct a "Command and staff training" (USE CASE 4) mission rehearsal exercise (MRE) in order to standardise proceedings and get to understand how the Commander and other staff members operate. The MRE will be distributed with the HQ and battalions' staffs participating from their own country. Staff from the UN will provide Exercise Control (EXCON) and will provide support for the scenarios and operate the fractional Semi-Automated Forces (SAF) representation in the system.

2.7.3 Abstract (3)

Step two is to conduct a "Distributed combined" exercise (USE CASE 3a). The exercise will be distributed with the HQ and battalions' in each country using national operational and training equipment (i.e. WES) and training sites. Fractions/OPFOR will be provided locally but their actions will be controlled by UN EXCON.

2.8 VERIFICATION OF USE CASES BY FIBUA/MOUT WG

In order to work together with the FIBUA/MOUT WG it was necessary that it understood the basic tenets of UO 2020 [3].

One of the main questions to answer was: "What level of training will be required, when operating at national sites and in the area of operations?"

The FIBUA/MOUT WG was then asked to review the USE CASES and answer the following 10 questions:

- What objective(s) do you think the commander would like to train?
- What kind of risks does the training eliminate?

- What type of actions/situations would you like to train?
- What are the most important training events for the individual soldiers/units?
- Make a time schedule of this Exercise, Planning, Preparation, Exercise, and AAR.
- Do you think it is necessary to train together as a taskforce?
- Do you think that this USE CASE is or will be a realistic scenario?
- Could you describe the training system that you would like to have for this training event?
- Make a list of interoperability aspects.
- Make a list of legal aspects.

The answers from FIBUA/MOUT WG as a result of the questions above are at Annex C.

2.9 SUMMARY OF ANSWERS TO QUESTIONS

To complete the questions for each USE CASE the FIBUA/MOUT WG were divided into syndicates. The majority of participants considered that the USE CASE as described was both realistic and most likely in the 2020 timeframe. Inevitably as subject matter experts on current FIBUA/MOUT training they were able to utilise their collected experiences to determine training needs but their knowledge of how future technology might provide solutions to their needs were limited. This is clearly a task for the UCATT TG in order to identify the right training technology for supporting training for MOUT.

It is clear however that USE CASES will need to be checked and certainly modified as we begin to move towards 2020, because the situations and "point-of-focus" will inevitably change and be adapted. A decision by the TSWG to utilise the UCATT USE CASES in support of their requirement for overall TES interoperability will enrich the work already undertaken in this area.

2.10 CONCLUSIONS

The method of using USE CASES for the UCATT TG helped participants to have a common understanding of the problem.

USE CASES and more importantly operational experience show that interoperability must apply at levels below battalion as more composite coalition forces are brought together for operations.

2.11 RECOMMENDATIONS

These USE CASES should be updated and re-verified by a future UCATT TG.

Chapter 3 – SITE REGISTER AND COMPENDIUM OF BEST PRACTICE

3.1 INTRODUCTION

In the final report of the LG/8 MOUT TOE it recommended that, if approved, a MOUT WG should:

> *"... investigate certain emerging technologies that offer benefit to simulation systems addressing MOUT, standardise areas for future MOUT and potentially improve the interoperability between nations (should that be required). The technical document will focus on best practice, draft technical solutions, and if possible recommend open standards."*

A primary objective of the UCATT TG is to provide a generic set of unclassified requirements for the development of instrumented FIBUA/MOUT sites for urban training by the year 2020. To do this, the group felt it would be essential to have as a benchmark an overview of existing FIBUA/MOUT training facilities and best practice.

3.2 SITE SURVEY SUB-GROUP

To conduct this task a Site Survey Sub-Group was established and it was considered that the best source of information would come from the FIBUA/MOUT WG. A Site Survey Register Form was developed in the form of an Excel Spreadsheet and each nation represented in the FIBUA/MOUT WG was requested to complete this Form, detailing their respective facilities, contact details, capacity and equipment currently used or planned for use. It was agreed that the combined results were to be made available to all NATO nations and partners.

3.3 RESULTS OF THE SITE SURVEY

The Site Register Form was distributed both within the UCATT TG and the FIBUA/MOUT WG. A total of 13 completed forms were received from eight different nations at the first stage. The responses were combined in a single tabular report. The UCATT TG decided to publish the Site Register separately as a useful source of data for nations planning or expanding training facilities in the near term. It was considered that a website would be the best medium to publish this unclassified data.

Figure 3-1: Copehill Down, United Kingdom, One of the Many Sites Included in the Survey of Urban Training Facilities (Photograph – UK Urban Ops Wing).

In the FIBUA/MOUT WG there were discussions about the importance of having such a site. All countries were in favour of publishing to a Web site, and the Swedish delegates volunteered for the task. Germany requested that access to the completed form be restricted, so the Site Register is password-controlled. The information on the Web site as at December 2005 had grown to include 29 sites from 18 countries, and in addition it now contains information about training courses that are provided by some nations. Access to the website is at www.fibuamout.info. Figure 3-2 illustrates the site. In Annex D there are more detailed instructions and illustrations in relation to the site.

Figure 3-2: FIBUA/MOUT WG Website.

3.4 SUMMARY OF FINDINGS ON FIBUA/MOUT WEBSITE

The Site Register summary provides a valuable, albeit incomplete, overview of the current state of MOUT training. An analysis of the collected data reveals that the majority of these sites are used for force-on-force training up to company level. The sites are small- to medium-sized (up to 40 buildings) with two exceptions having 89 and 120 buildings – Copehill Down in the UK and Marnehuizen in The Netherlands. One-day exercises are usual, but longer exercises (to a maximum of 15 days) are also being conducted. The tendency is to exercise during the day only, but some of the longer exercises run day and night. Most of the respondents indicate that the training sites are also used by national police forces.

3.5 COMPENDIUM OF BEST PRACTICE

The "Compendium of Best Practice" could not be completed as expected because the input was not provided by the respondents. In retrospect, the Site Register Form was not ideally suited for the purpose of collecting specific hardware recommendations and best practices. The FIBUA/MOUT WG has however developed a NATO FIBUA/MOUT Handbook. Although this Handbook does not provide a "Compendium of Best Practices" *per se* it could provide a starting point in the development of best practices in training for urban operations. The Handbook can be accessed on the FIBUA/MOUT website. An example of what is being

suggested as Best Practice by the FIBUA/MOUT WG for the O/C function is at Annex E. This however would need to be validated by the FIBUA/MOUT WG.

3.6 CONCLUSION

Considerable effort was put in to developing the Site Register and this could not have been achieved without the close co-operation of the FIBUA/MOUT WG and the fact that a member of that group was also a member of the UCATT TG. This continued relationship will be essential to the success of any further work in this area.

3.7 RECOMMENDATIONS

It is recommended that Site Register Summary should be maintained and updated twice a year, after each meeting of the FIBUA/MOUT WG. The responsibility for administering the website lies with the FIBUA/ MOUT WG although support from a future UCATT TG would be available where technical details are needed. At present the UCATT TG has published its reports on this site but as these will be transferred to the RTO WISE site it is recommended that in the future, only a link is provided to the RTO WISE site.

A separate questionnaire aimed directly at collecting recommendations on best practice should be circulated by the FIBUA/MOUT WG and the result presented on the website. The UCATT TG should continue to support the FIBUA/MOUT WG in collating a “Compendium of Best Practice” if this is still required.

Chapter 4 – REQUIRED CAPABILITIES OF FIBUA/MOUT TRAINING FACILITIES

Figure 4-1: Urban Operations Training (Photograph – Matthew Wright).

4.1 INTRODUCTION

It was recognised in 2003 that doctrine published by individual NATO/PfP countries did not support or identify joint or multi-national requirements for conducting effective military operations in an urbanised environment. Very few training exercises were conducted at the joint or multi-national level in an urban training environment. Countries had different requirements for the level of live training conducted from team (2-4 personnel) through to brigade level. Even in 2006 urban training is not mandated by many of the countries. The UCATT TG, as one of its tasks, sought to identify the needs of the different countries' training capability requirements, evaluate those requirements, and make recommendations on a generic set of capability requirements for urban operations training in the Live, Virtual and Constructive (LVC) domains. In order to carry out this task a Requirements Matrix Sub-Group was established.

4.2 THE PURPOSE OF THE CAPABILITY REQUIREMENTS MATRIX

The purpose of the capability requirements matrix was to identify those components needed to support the training at all levels from team to brigade including non-military and Peace Support Operations (PSO). Although it was initially intended to include all three environments only the live training environment was completed. The development of the matrix and its subsequent analysis was used to identify common elements, interoperability issues and where standards could be applicable in conducting urban training. These were then addressed in the functional architecture and interfaces that are described in Chapter 5 through the definition of a common set of functional training requirements.

4.3 HOW THE MATRIX WAS CREATED

The UCATT TG aim was to form a set of requirements to allow all NATO and PfP nations the ability to conduct multi-national urban operations training exercises through the identification of interoperability

requirements and standards. A matrix, in Microsoft Excel, outlining all the required capabilities of FIBUA/MOUT training facilities, was developed. The U.S. Operational Requirements Document (ORD) for the Joint Readiness Training Center (JRTC) Military Operations on Urbanised Terrain (MOUT) Instrumentation System (JRTC MOUT-IS) was used as a foundation to layout the training requirements. Requirements were categorised in order to support the identification of different requirements for training in urban environments. This work resulted in an expansion of the existing capabilities in the matrix from the JRTC MOUT-IS ORD.

As these requirements are user driven the Matrix was briefed several times to the FIBUA/MOUT WG outlining the general operational capabilities and training environments. The intention was to gain concurrence on the approach and guidance on the capabilities (exercise planning, execution, control, targetry, data collection, data management, and training feedback) listed in the Matrix. This was required in order to define the different elements needed to support urban training that would feed into the functional architecture and interfaces.

The FIBUA/MOUT WG asked the UCATT TG to validate the Requirements Matrix against the LO 2020 and UO 2020 reports to address any variance in the recognised or perceived capabilities associated with urban training. The UCATT TG divided into two teams to review the reports against the Matrix. The teams were able to address a majority of the capabilities dealt with from each report and associated that competency with a capability requirement element from the UCATT Matrix. This resulted in 18 new requirements being added to the Matrix. Of those areas that were identified as a disparity between the two reports and the Matrix, the teams were able to discuss alternative approaches or a way ahead to address this gap especially between the training capabilities and operational capabilities in 2020.

Based on the input from the FIBUA/MOUT WG and the UCATT TG analysis of the capabilities requirements along with review of LO 2020 and UO 2020 Report cumulated in the final UCATT Requirements Matrix. The requirements of 12 nations were documented and aggregated in the Matrix, an extract of which is at Annex F.

4.4 OBSERVATIONS

One of the challenges in developing the Matrix within the FIBUA/MOUT WG was to get delegates whose knowledge of urban training was based on current training to think about requirements for training in 2020. In addition officers who had less experience found this task even more challenging.

Currently there is no training strategy to allow all NATO and PfP nations the ability to conduct joint or multi-national urban operations training exercises. The increasing prospect of joint and multi-national operations in urban environment highlights the increasing need for a common framework to support training in the urban environment.

One of the requirements not addressed was a common set of health, safety and environmental requirements. These are different in each country. The view of the FIBUA/MOUT WG was that these were a host country's responsibility but it is felt by the UCATT TG that there are certain aspects that should be standardised such as laser safety and use of specific colour coding for a particular purpose. This is an area that must be examined in more detail by the FIBUA/MOUT WG with support from a future UCATT TG if required.

When the work of the UCATT TG was started very few nations anticipated that they would participate below battalion/battle group in a multi-national operation. This may be true in general for large scale interventions but in PSO scenarios it is more likely that a battalion or battle group will be composed of sub-units from different nations. An example of this is the Nordic battle group. This may require nations to re-examine the Matrix to see if they would change their requirements.

The work was captured in an Excel Spreadsheet and, although this proved to a useful tool when used to capture requirements it was less useful in mapping of the functional architecture. The UK used a software application, MooD, developed to support the UK Ministry of Defence (MOD) Architectural Framework (MODAF) (similar to NATO Architectural Framework) to map the Functional Architecture to the requirements. This was demonstrated to the UCATT TG and it was recommended that it should be used to document and capture requirements and the Functional Architecture including associated information flows and data. This would also allow for future changes to be made and an expansion of the architecture as necessary.

4.5 CONCLUSION

The UCATT TG has taken the first step with the publication of the UCATT Capability Requirements Matrix which identifies the live training requirements and elements to support urban training. Although as stated it was intended to look at virtual and constructive requirements it was recognised that in the time frame that this task could not be comprehensively completed. It still needs to be done so that the requirements for the integration of LVC urban training can be documented and appropriate interoperability standards developed.

4.6 RECOMMENDATIONS

The following recommendations are made:

- The identification of an overarching approach to train within each nation's facilities, interoperability between training systems and devices of the different countries, and supporting legacy training devices needs to be further investigated, along with the identification of the training requirements for urban operations in the areas of virtual and constructive. This should be carried out by a follow on UCATT TG.
- The relationship with the FIBUA/MOUT WG was invaluable to the work of UCATT as it provided contact with 25 NATO/PfP countries. In the event that a follow on UCATT TG is approved with a remit to examine the areas of virtual and constructive urban training requirements and LVC integration it will be necessary to establish a more formal relationship with the Army Training Group and in particular both the FIBUA/MOUT WG and TSWG. This is because they represent the user community and will need to endorse future urban training capability requirements.
- Health, Safety and Environmental requirements are examined to see if a common standard can be developed in some areas. The FIBUA/MOUT WG is currently working on Health and Safety (H&S procedures and a follow on UCATT TG should be prepared to support this work.
- Adopt the MooD software and transfer requirements data into its associated database and taking a MODAF/NATO Architectural Framework approach to future development. This will require funding support from MSCO/RTO in Paris.

Chapter 5 – FUNCTIONAL ARCHITECTURE

5.1 PURPOSE OF THE FUNCTIONAL ARCHITECTURE

The capabilities identified in Chapter 4 describe the requirements for a FIBUA/MOUT training site from a user viewpoint. In order to derive from these capabilities a generic set of requirements for the development of instrumented FIBUA/MOUT sites, it is necessary to have a common understanding of the training system from a system point of view. This means that there must be insight into the functions of the training system, how they are grouped together into components and what types of interactions take place between those components. Only then it is possible to discuss interoperability issues and compose the desired requirements.

In order to gain this insight and bridge the gap between the capabilities on the one hand and requirements for the development of instrumented FIBUA/MOUT sites on the other hand, an architecture must be created and agreed upon.

Formally, an architecture is "the organisational structure of a system or component, their relationships, and the principles and guidelines governing their design and evolution over time" (IEEE 610.12). There are many different types of architecture, but two main categories are the functional and design architectures:

- A functional architecture is "an arrangement of functions and their sub-functions and interfaces (internal and external) that defines the execution sequencing, conditions for control or data flow, and the performance requirements to satisfy the requirements baseline".
- A design architecture is "an arrangement of design elements that provides the design solution for a product or life cycle process intended to satisfy the functional architecture and the requirements baseline" (IEEE 1220).

It is the purpose of the UCATT TG to set requirements for interoperability, which is the ability of systems to exchange data, information and services to enable them to operate effectively together. At the same time, industry should have the freedom to propose and implement the most cost-effective solutions, as long as they satisfy the interoperability requirements. So in fact, we are interested mostly in the system interfaces. In this context, an interface describes the characteristics at a common boundary or connection between systems or components.

To identify and define the system boundaries and interactions with other systems (external interfaces), it is sufficient to create and analyse a functional architecture of an instrumented FIBUA/MOUT site. This functional architecture must be representative enough to cover all of the USE CASES defined in Chapter 2 and the requirements from the capability matrix, while not touching specific design or implementation issues. The functional architecture captures what the system can do, not how it does it (e.g. by wireless transmission or through a cable).

Another subject of particular interest is the level of detail of the functional architecture. Too few details will result in insufficient possibilities for interoperability, while too many details will result in losing oversight and identifying irrelevant interfaces for interoperability.

5.2 FUNCTIONAL COMPONENTS

In practice, an instrumented FIBUA/MOUT site is composed of several sub-systems. In order to understand the system and to provide a proper context to examine the capabilities in the matrix, it helps to distinguish functional components. Within this background, a functional component is a logical sub-system of the instrumented FIBUA/MOUT site that performs a group of related functions.

Although functional components do have a relation with physical components or facilities, in this study it is definitely not intended to influence the physical implementation or location of the FIBUA/MOUT site. The breakdown of the system into functional components serves purely to facilitate in defining interoperability.

The UCATT TG distinguished the following 6 main functional components of a FIBUA/MOUT training system:

- **Dynamic Object (DO)** – This is an entity that has a status that can be changed and/or can perform activities (influencing the environment). It could be a player (e.g. a human being, a weapon system), a weapon that can be transferred to other players (e.g. a rifle), a target (e.g. a pop-up board, a dummy), a wall that can be breached, etc., a DO can be nested, e.g. a weapon can be carried by a soldier who is mounted in a vehicle.
- **Exercise Control (EXCON)** – The capability to define and (remotely) monitor and control an exercise. Generally this is done from a central location.
- **Observer Controller (O/C)** – The capability to monitor and control an exercise by distributed, local means.
- **After Action Review (AAR)** – The capability to analyse the results of an exercise and provide feedback to the trainees.
- **System Control (SC)** – The capability to monitor and control the training system itself, necessary to support the training exercise.
- **Facility Control (FC)** – The capability to represent the static training environment (the infrastructure, buildings, roads, etc.). This can be either fixed or mobile (e.g. containers).

The O/C component might seem a logical part of EXCON. They share a lot of functionality, but the O/C capability also has some other functionality that clearly distinguishes it from EXCON and therefore it is justified to consider the O/C as a separate component.

The following figure gives an overview of the different components. A more detailed description of all the sub-components is given in Annex G.

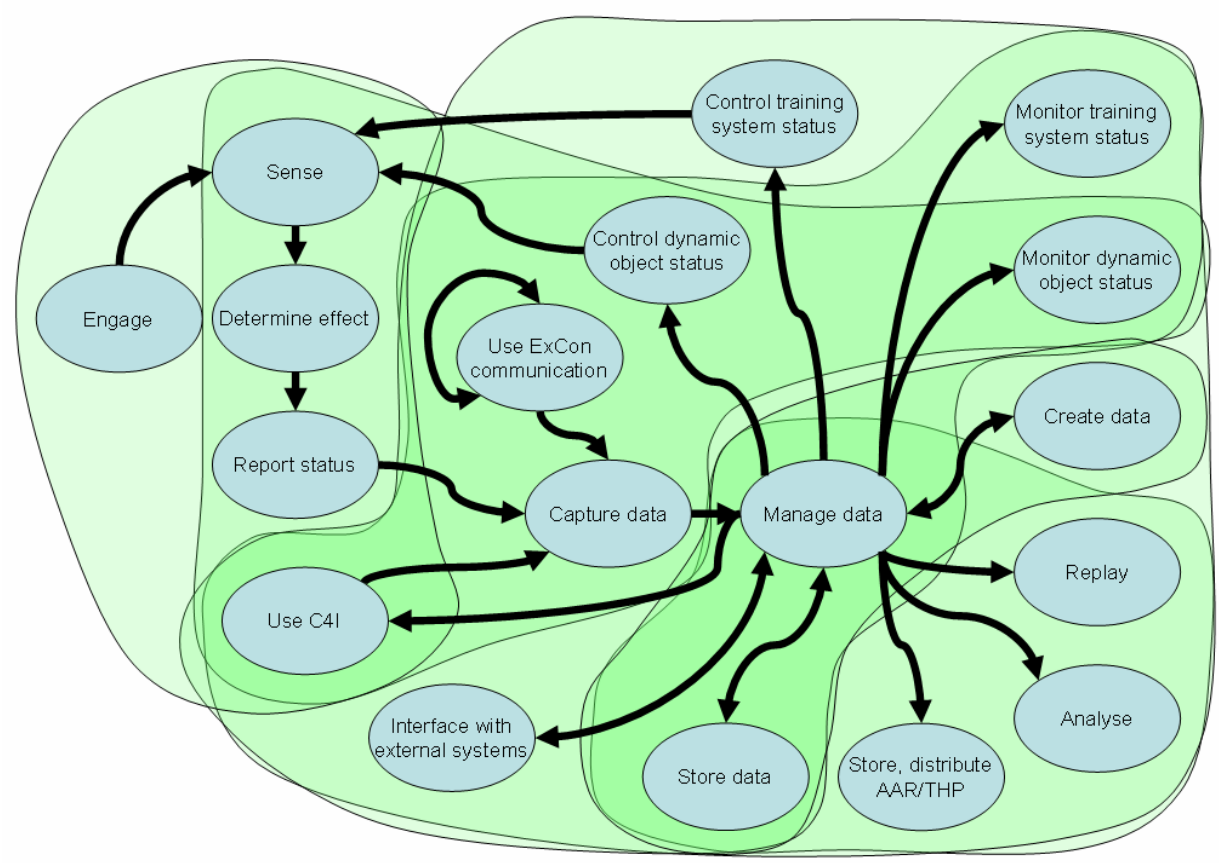


Figure 5-1: Functional Components.

5.3 CONSIDERATIONS REGARDING THE FUNCTIONAL ARCHITECTURE

Special care has been taken in the definition of the architecture to allow for different implementations. For example, an engagement between a shooter and a target can be modelled in two different ways:

- **Distributed solution** – The shooter (DO1) engages the target (DO2). Subsequently, the target senses this engagement through its "Sense" capability and activates its "Determine effect" capability. The resulting change of status is then reported.
- **Centralised solution** – If the "Determine effect" capability does not reside locally in a DO, the result of engagements is determined centrally in the capability "Control dynamic object status". The data flow will then be: the target senses an engagement, the local "Determine effect" is not present or will have no effect, the target reports the characteristics of the engagement, which is captured and through "Manage data" provided to "Control dynamic object status". That capability determines the effects of the engagement and subsequently provides the results to the target. The target senses the command to change its status, performs the status change and reports its new status, so other components of the system are aware of this.

It is also envisioned that a weapon can be modelled as a DO. In that case it should also be possible to transfer such a weapon to another operator (also a DO), possibly applying restrictions regarding the pairing of the type of operator and the type of weapon. Because in this situation the weapon has its own "Sense" capability, it is possible to damage or destroy the weapon without affecting the operator or that killing the operator affects the operational status of the weapon.

5.4 INTERNAL AND EXTERNAL INTERFACES

In the context of our functional architecture, an interface is a connection between system functions over which data is exchanged. Those interfaces must be identified and the type of data which is transferred over those interfaces must be specified, as part of the guidelines for interoperability. Annex H describes in more detail the internal and external interfaces.

A distinction can be made between internal interfaces and external interfaces. An external interface is a possible connection between two different systems, while an internal interface is never involved in transferring data between different systems. For the purposes of interoperability, and thus for the objectives of the UCATT, internal interfaces are not of interest and do not have to be specified any further.

Considering every interface as an external interface would yield the greatest flexibility regarding interoperability: communication can be established irrespective of the system to which the involved system functions belong. However, this solution would also pose the most restrictive demands on the design of FIBUA/MOUT sites.

As stated before, the starting point of this study is the USE CASES and those determine the external interfaces. For example, it cannot be deduced from the USE CASES that a sensor from a DO should be replaced by a sensor from another system. Instead, the DO as a whole is seen as the indivisible entity that interoperates with other systems. Therefore the interface between the system functions “Sense” and “Determine effect” is considered as an internal interface.

Another decision to limit the number of external interfaces is to assume that once data has arrived within a system, it will be managed by the system’s central function “Manage data”. That function will provide other functions access to the data they require through internal interfaces.

Data will arrive within a system through the functions “Capture data” and “Interface with external systems”. “Capture data” is a function that receives real-time data from a DO and C4I systems. The function “Interface with external systems” was created to exchange data between systems real-time and off-line. For example, it must be possible to execute an exercise in System A and analyse the recorded data in System B. Instead of declaring the interface between “Manage data” and “Analyse” as an external interface, the recorded data will be sent to System B, using “Interface with external systems”, whereupon System B will provide its relevant functions access to that data.

Based on the analysis of the USE CASES, the following external interfaces, as illustrated in Figure 5-2 were identified.

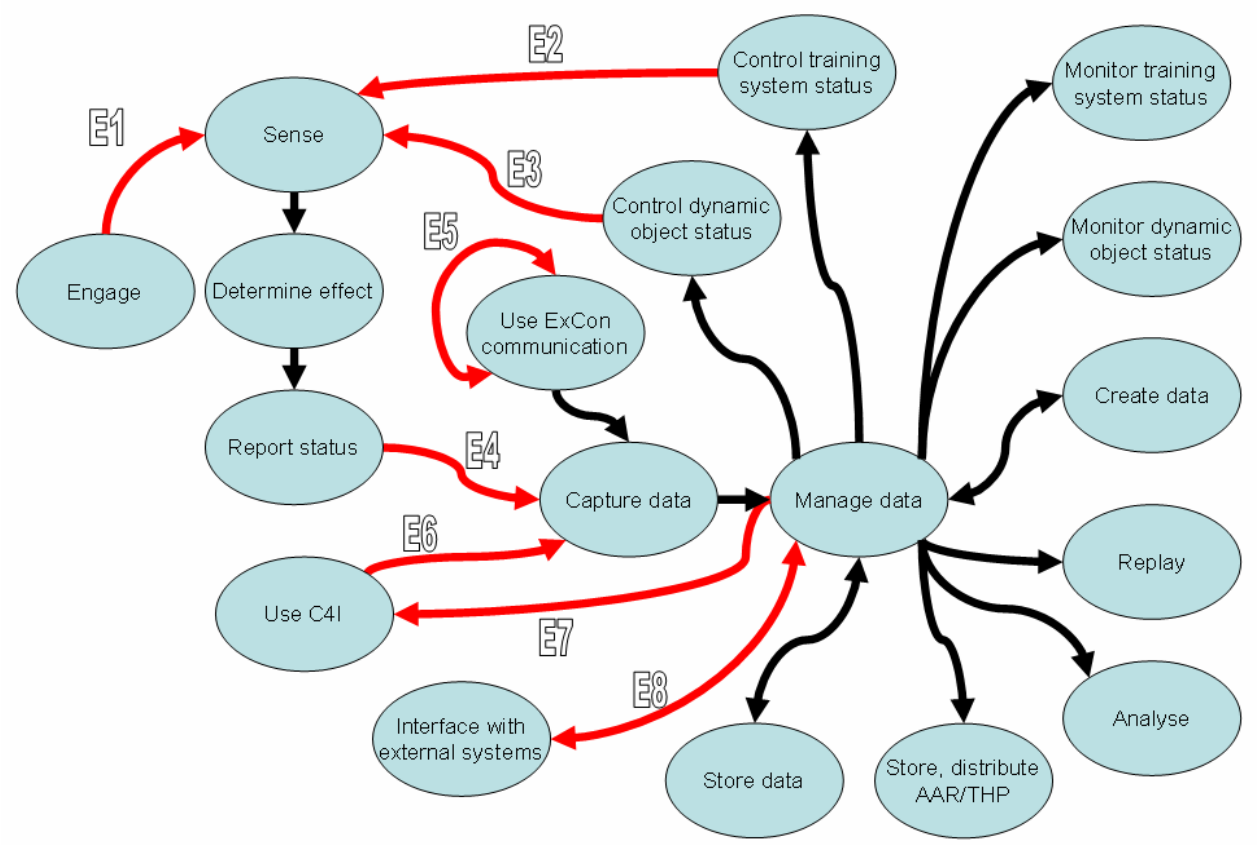


Figure 5-2: External Interfaces (E1 to E8).

5.4.1 Engage ⇒ Sense (E1) (⇒ is the direction that data flows)

This interface is the interaction between dynamic objects and implements for example the direct fire from a shooter (DO1 from System A) on a target (DO2 from System B).

5.4.2 Control Training System Status ⇒ Sense (E2)

This interface controls the technical status of a dynamic object. Through this interface it is possible that system control from System A starts up or calibrates DO2 from System B.

5.4.3 Control Dynamic Object Status ⇒ Sense (E3)

This interface controls the operational status of a dynamic object. An example is that EXCON from System A assigns a kill to DO2 of System B, either as a direct action or to simulate the effects from an artillery strike.

5.4.4 Report Status ⇒ Capture Data (E4)

The status of DOs is communicated through this interface. It includes for example DO2 of System B signalling it being damaged to EXCON of System A.

5.4.5 Use EXCON Communication ⇔ Use EXCON Communication (E5) (⇔ implies a two way flow of data)

This interface enables the communication between training staff members of different systems operating in the same exercise. For example, an O/C wearing equipment from System B must be able to communicate with the O/C and training staff in EXCON of System A.

The interface between "Use EXCON communication" and "Capture data" is not considered as an external interface. The reason for this is that since the EXCON communication capability is already interoperable, each system can capture the training staff communication using its own mechanisms.

5.4.6 Use C4I ⇒ Capture Data (E6)

When military personnel are equipped with C4I systems, it is assumed that the training staff are also equipped with those C4I systems, to monitor the situational awareness of the troops or to provide input to those C4I systems (for example to represent a higher control headquarters).

This interface provides data from C4I systems to the FIBUA/MOUT site. This includes for example a report from a scout that he has detected an enemy vehicle or a graphical sketch showing the situation. This data can be stored in the training system for analyses purposes and can be used during AAR.

It is recommendable that different C4I systems should be interoperable among themselves, but that is considered outside the scope of this study and within NATO it is the responsibility of NC3A.

5.4.7 Manage Data ⇒ Use C4I (E7)

This interface provides data from a training system to a C4I system.

An operational overlay created by the training staff and used in EXCON can be distributed to the C4I systems of the troops that are training. It could also be possible that the training system provides status information of entities (either "live" dynamic objects or "virtual" players) to the C4I systems.

5.4.8 Manage Data ⇔ Interface with External Systems (E8)

This interface enables the exchange of data between training systems. This interface can be either off-line or real-time. Examples of off-line data exchange are the transfer of a created scenario from System A to System B and the transfer of a recorded exercise from System A to System B. An example of a real-time data exchange is the creation of a minefield in System A, which is communicated to System B.

5.5 CONCLUSION

Based on the USE CASES and the capability requirements matrix the UCATT TG defined a functional architecture, which provides the context to define requirements for interoperability. The functional architecture reflects the capabilities that a FIBUA/MOUT site must possess, finding a balance between applicability and complexity, without addressing implementation issues. Since the purpose of the UCATT TG is to set requirements for interoperability, it is recommended that the external interfaces defined in this chapter have to be standardised. This is the subject of Chapters 6 and 7.

Chapter 6 – DATA INTEROPERABILITY ANALYSIS

6.1 PURPOSE

The purpose of the data interoperability analysis is to identify those components of the overall training system (based on the Functional Architecture, Chapter 5) that have external interfaces and therefore require standardisation if multi-national training is to be supported by future MOUT sites. The data interoperability analysis does not include specific recommendations regarding the structure of data or the method of transmission, but it does detail the content of data transmissions.

6.2 APPROACH

6.2.1 Focus of Analysis

Dynamic Objects (DO) (participants, weapons and platforms) were the primary focus of this analysis since these are the elements of the system that are likely to travel to another location for training purposes (see the USE CASES in Chapter 2). The training buildings, in some cases also dynamic objects, must also be able to react to attacks from visiting troops and the analysis therefore examined these external interfaces as well.

This analysis focuses on the interactions of DOs. The external interfaces are E1 (between DOs) and E4 (from DO to EXCON), as identified in Chapter 5. The UCATT TG described the categories of data being transferred between functional components, distinguishing between trigger events, outgoing events and effects. This analysis takes into consideration all conceivable weapon types (direct fire, area weapon, chemical attacks, and so on), platforms and infrastructure, to ensure that interoperability can be defined for multi-national exercises. This analysis is presented in Annex I.

The data interoperability analysis is presented as a tabular account of what takes place from the time a weapon is fired until an engagement report is available at the EXCON. This sequence is populated with some exemplar interactions for major weapon and target types.

6.2.2 Assumptions

The main assumption is that before any country can be interoperable internationally, it must be internally interoperable: each country should have the capability to operate instrumented combined arms exercises. To enable interoperability, this core capability is then subject to the external interfaces identified in Chapter 5. If any of these core features exist for one country and not the other, then interoperability will only be possible at the lowest common feature set. However, if both countries populate the feature set, then interoperability is feasible, even if the actual mechanisms differ between countries.

To help define these feature sets, the UCATT WG has described the case of a DO vs. DO engagement. Annex I shows how the sequence of events moves from the initial trigger pull or detonation through to reporting to EXCON and any secondary effects. The information within these events is provided as a complete feature set which can include *non-transmitted information*. This is important as certain assumptions about the data are made in the process of physically implementing a system.

Take the example of a DO to DO engagement event: the sequence of shooting to engagement report can be achieved using two methods:

- Local engagement adjudication; and
- Remote/centralised engagement adjudication.

The former of these options means that either the firer or the target is furnished with all the information needed to calculate damage from the simulated round. The latter option requires a separate system to arbitrate the weapon's effect, and then inform those entities affected.

In both cases, the information transferred is the same – there needs to be a geometric pairing process somewhere in the engagement, whether explicitly in a computerised model, or implicitly by interaction with the environment, for example, laser engagement. The events listed in Annex I show this full set of information for each.

6.3 RESULTS

The flow diagrams below illustrate the sequence of events described in the data interoperability analysis (Annex I) for the engage interaction (E1). The data interoperability analysis presents the data sets needed to create a weapon effect and to furnish EXCON with training data. The input to the geometric pairing process is called the Firing Report. The output from this (and the input to the adjudication process) is another Firing Report. Both the firer and target may then create status reports respectively. This interface is E4, between 'report status' and 'capture data'. Changes of the status of the target system may also affect other DO. For example, when a vehicle is hit, its occupants may be incapacitated; when a vehicle explodes, it may injure personnel that are located in its vicinity; when a building collapses, it may injure or damage personnel and equipment residing inside. Although not primarily targeted, DOs can suffer "collateral" damage. These effects are called secondary effects. Figure 6-1 and Figure 6-2 illustrate these processes. The data interoperability analysis at Annex I include the minimum data set that each of these reports must contain.

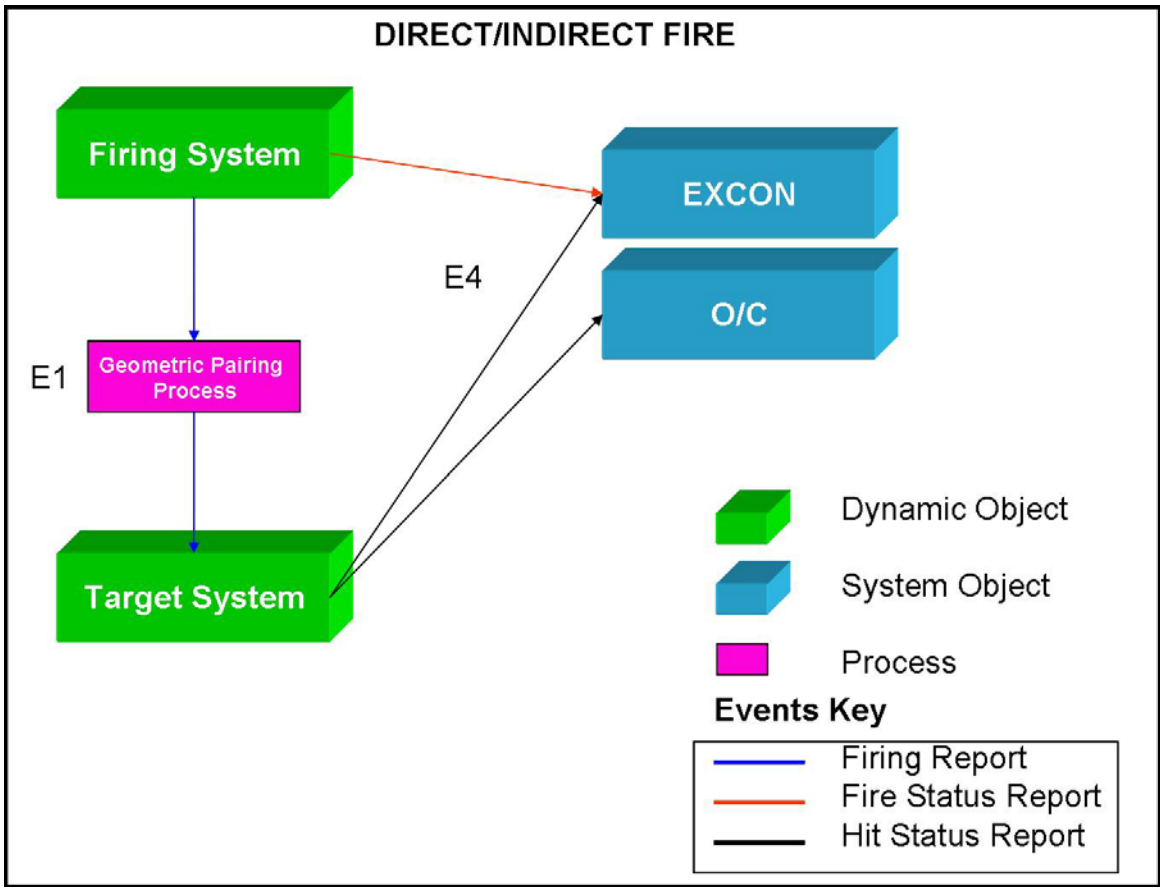


Figure 6-1: Direct/Indirect Fire Case.

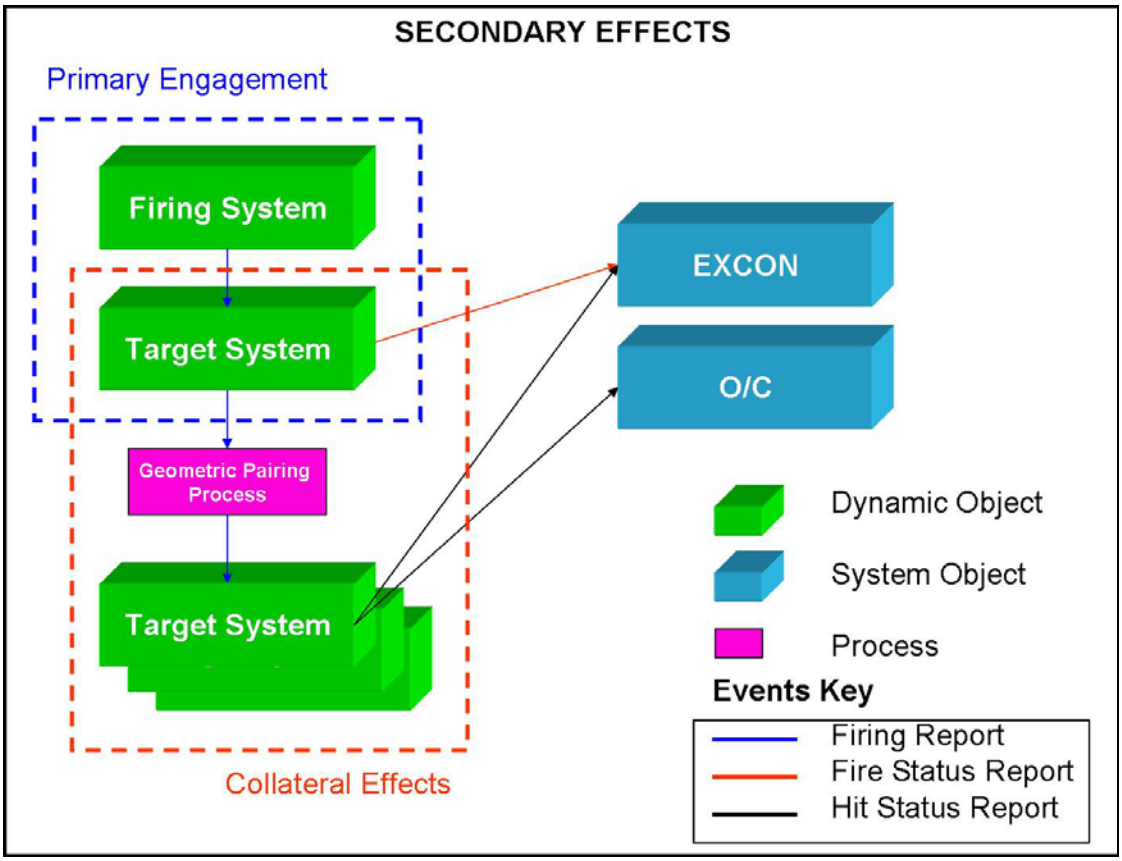


Figure 6-2: Secondary Effects.

6.4 FURTHER WORK

6.4.1 Training Environment Standardisation

There is more to training interoperability than just the system interoperability described in Chapter 5. The need for common training procedures is known in as much as when a visiting unit is briefed at a foreign training facility, they are told the local 'rules', both for safety and integration with other national forces. The UCATT TG has identified interoperability areas that result in the need for hardware standards, but are actually driven by training methodology. An example is the indication of battle damage to vehicles: Swiss forces use orange smoke to indicate a kill, whereas in the UK, a flashing white strobe light is used. The UCATT sister group, the FIBUA/MOUT WG, will be advised on training interoperability areas that need a military resolution. However, where a generic response is required from the technical system, the UCATT TG will provide advice. For example, indication of a round's effect on a target will usually require some kind of visual response, whether it is smoke, light or other pyrotechnic device. Annex J, Appendix J2 shows examples of effects that might be required for each event.

There is a need for continued development of internationally recognised training standards. The UCATT TG has compiled a table of effects expected to be encountered. These encompass audio and visual effects – final ratification of these effects will be provided by further development of international training standards.

There is a need for a set of vulnerability tables that can be used by different countries, whilst maintaining each country's proprietary capability data. This could either be a generic data set, or an agreed simplified set of data provided by each country or vehicle provider.

6.4.2 Health and Safety

As well as training coherence issues, H&S must be addressed. For example, laser training in the United States uses Class 3a, whilst in the UK eye-safe is considered as Class 1. This safety issue would prohibit the use of US training equipment against UK troops, regardless of technical interoperability.

H&S issues would fall into three categories:

- Training procedures and reporting;
- Physical impact of training equipment; and
- Radiation impact of training equipment.

The FIBUA/MOUT WG is currently working on H&S procedures and standards for urban training.

The physical impact of training equipment needs to be standardised across countries – this might take the form of existing military or civilian safety standards (e.g. MILSTD, BS Kite Mark). These standards can be reviewed to assess if a suitable lowest common safety standard can be implemented.

Safe levels of radiation from radio antennas and laser emitters, is an area that is being researched. As most military RF systems are based on civilian systems (e.g. microwave, cellular phones) any safety standards should leverage off these developments.

6.4.3 Other External Interfaces

The focus on dynamic object interfaces E1 and E4 provides an immediate way forward for inter-entity level interoperability. The next chapter sets out a standard coding for the E1 interaction. However, to fully develop the dynamic object interoperability, E4 must also be considered.

There is still a requirement for the other external interfaces, described in Chapter 5, to be explored. However, not all these capabilities are extant in most country's training systems, particularly for integration with C4I systems. Further work to define these interactions is needed before a complete standard can be produced. In some cases, operational interoperability standards may be re-useable within a training system. The decision by the U.S. Army in September 2005 to use the Command and Control Information Exchange Data Model (C2IEDM) (now replaced by the Joint Consultation, Command and Control Information Exchange Data Model (JC3IEDM)) as the interface between Modeling and Simulation (M&S) systems and C4I system, and the fact that JC3IEDM is being developed by 26 nations under the Multi-national Interoperability Program (MIP) would be the logical starting point in conducting further analysis.

Chapter 7 – INTEROPERABILITY CODE SETS

7.1 OBJECTIVE

This chapter, as the rest of this report, is dedicated to the growing need for multi-national military training in urban environments. The UCATT TG proposes a methodology to achieve a standard for live (force-on-force) urban combat engagement codes (referred to as the UCATT Code). In order to approach this goal the group has undertaken all the research and discussions depicted in the previous chapters. The architecture as described in Chapter 5 and expanded in Chapter 6 provided the External Interfaces that were required to be interoperable (E1-E4). This was done to gain an understanding of the military training needs of all participating nations. This chapter focuses on the External Interface E1.

The approach to this subject has been governed by the needs and capabilities of the future. Future technology and capabilities have been predicted by the UCATT TG, using a conservative approach. These capabilities need to be included into the design of the future engagement standard. This must be done to create a powerful innovative standard that shall be capable of handling future needs rather than trying to accommodate worldwide existing standards (legacy standards) and downsizing future requirements to old or existing capabilities. However legacy systems are a fact and any standard proposed that does not consider these existing systems will be destined to exist as a perfect technical solution that will never be used in the real world. Therefore this chapter proposes mechanisms that will guarantee the migration from existing systems to a future standard.

Upon closer investigation it became clear to the UCATT TG that engagements need to be standardised not only in the mere process of the actual engagement but in all aspects of its manifestation in the training environment. The UCATT TG identified the following engagement aspects that need to be standardised:

- The actual engagement – the simulation of a weapon firing event and the transaction between shooter and target;
- The vulnerability (model) of the target – the definition of a target's susceptibility to a given threat type;
- The effect representation – the characterisation of the multi-sensory (e.g. acoustic, optical) response to an engagement; and
- The data communication aspect of the engagement – the process of sharing information through technological media.

The scope of these issues is beyond the capacity of the group at this time. A future UCATT TG should continue to investigate and pursue the implementation of the issues outlined in this chapter. As an example of the process the following sections attempt to outline the elements of standardisation of the first three bulleted points above.

7.2 STANDARDS TO SUPPORT URBAN TRAINING IN 2020

The need to conduct a range of different urban training scenarios by 2020 was outlined in Chapters 1, 2 and 4 and the UCATT capability requirement matrix (Annex F). Those requirements will dictate the level of fidelity that goes into this standardisation process.

The weapon systems of the near future will have greater range, better effects and an increased Non-Line of Sight capability (NLOS). "Fire and Forget", "Less Than Lethal" weapons and "Cooperative Engagement" capabilities will have more impact on the training environment. A list of the weapon systems currently used in the military FIBUA/MOUT training community was initiated by the FIBUA/MOUT WG and can be found in the Appendix J1.

The current simulators are mostly capable of supporting line of sight interaction. The capabilities needed for the future NLOS are presently under development and will potentially be fielded in the near future. A future standard needs to implement all principles and methods to negotiate between the possible implementations.

7.3 LEGACY SYSTEMS AND TRANSITION

Many countries have already procured force-on-force simulation equipment of various kinds. Some other countries are presently procuring equipment or CTC systems. Some examples of existing codes can be found below (and there might be systems currently under development with proprietary code sets that will have to be considered up until the year 2020 and potentially beyond):

- MILES I/II
- AMSTI-90 'MILES'
- OSAG (Optical System Interface for AGDUS and the German CTC)
- COSIM
- TALISSI
- SIMLAS
- REACT
- ENCL, NCL, ACL
- SIM FIRE
- FAST-CODE

This list is only included to give the reader an insight into the diversity of present systems. It does not try to evaluate the capabilities of the depicted main suppliers. Some of the codes are proprietary to the main supplier, other codes are public domain and some codes are government confidential.

Since legacy systems are a fact in the real world and it is highly unlikely that a government will decide to discard their investment in current simulation equipment, an orderly transition solution from legacy, to "UCATT code" systems would be optimal. This transition is described in more detail in Section 7.8 and illustrates proven methods and procedures to obtain a transitional capability that allows the continued usage of the legacy systems while the UCATT code capable systems are gradually implemented.

7.4 ENGAGEMENT ASPECTS

This section deals with the functions of the Functional Components as outlined in the previous chapters. It identifies the different data sets needed to engage a target:

- Engagement data set (see Section 7.4.1); and
- Vulnerability data set (see Section 7.4.2).

7.4.1 Engagement Data Set (TES-Code)

The UCATT code has to be open source covering the information needs of modern simulation training. It needs to be free of company intellectual property rights (IPR), provided under Open Content License and standardized (see Section 7.10.1).

7.4.1.1 Dual Structure of the Code Sets

The UCATT TG has identified the following parameters for the external interface E1 as defined in the External Interface information sets (Annex I) and illustrated in Table 7-1 below.

Table 7-1: External Interface Information Set

Object Report Types	Must Know Data	Inherent in Must Know Data
Firing Report	Shooter Platform ID	Type (vehicle, person, aircraft)
		Call-sign
		Affiliation (red force, blue force, civilian, etc.)
		Assignment (leader squad 1, supply vehicle, etc.)
	Shooter Platform Location	X position
		Y position
		Z position
	Weapon ID	Weapon Type
	Ammunition	Ammunition Type
		Type of delivery (direct, indirect)
		Type of effect (explosive, smoke, biological, etc.)
		Duration of effect (immediate, temporary, lingering, etc.)
	Aim point	Location
		Orientation
		Angle
		Charge
		External conditions (wind, etc.)
		Weapon conditions (barrel temperature, etc.)
	Type of detonation	Impact
		Proximity
		Time

This comprehensive approach to the engagement procedure (transmitting all data that might be required by non-target designating systems) leads to:

- The creation of a large engagement data set (namely all data required to specify the lethal envelope); and
- The need to transfer the larger engagement data set to every DO in the field.

Every single engagement therefore results in a large number of transmissions or information “broadcast” to all DO while only one or eventually a few DOs need to receive the data.

On the other hand only a small sub-set of this data is required and sent to only one (or a few) DO if the attacker has the ability to designate an individual target and already determine the point of impact on the target as it is standard with sophisticated TES systems (2nd generation precision systems).

It is therefore desired to create a code set that can serve both situations depending on the target designating capability of the attacking DO.

If possible it is recommended to compress the transmitted data using a non-mutating compression algorithm. It might actually be desirable to use an error correcting code to prevent code re-transmissions.

7.4.1.2 Data Encoding Needs

The UCATT TG found that the number of DOs (e.g. Players) will increase as a result of the proposed concept. The UO2020 report [4] also indicates that the number of weapon systems and ammunitions used will increase in the future.

Summing up the expected code needs for 2020 we can safely assume that the code will have to accommodate large numbers (the UCATT TG definition of DO mandates a player number for any active portion of a building such as windows, doors, walls, roofs, rooms, etc.). Therefore the proposed data structure needs to include an extensive number of possible DO of various types (as described in Section 5.2). The structure needs to provide a large number of weapons and ammunitions that should be sufficient to last well past the year 2020. The accuracy of the engagement itself (hit position values) needs to be increased in order to satisfy the needs of 2020.

7.4.1.3 Target Designating Engagements

Systems that are able to designate targets during the engagement process are able to operate with a smaller set of the UCATT code. Designating engagement parameters may therefore be transmitted using a sub-set of the UCATT code. This sub-set will also be used for other DO (e.g. O/C) if applicable.

Table 7-2: Data Set Required for Target Designating Engagements

Object Report Types	Must Know Data	Inherent in Must Know Data
Firing Report	Platform ID	Unique player code
	Weapon ID	Weapon Type
	Ammunition	Ammunition Type (determines: effect, duration, …)
	Hit Position	X,Y coordinate of the impact
	Flight Time	Time till impact
	Hit Distance	Proximity of the target

7.4.1.4 Possible Code Set for Target Designating Systems

The described UCATT target designating code sub-set is designed in a way to mature during the time of usage by using a fixed system of code population (see Appendix J2 for details). This creates an ability to adapt to the technological advancements that are expected during the life-time of the code without the need to change the code itself.

7.4.1.4.1 Capabilities of the UCATT Target Designation Code Sub-Set

The capabilities are:

- More than 42 million DO – Players (42,515,279).
- More than 500 thousand different weapon systems (524,879).
- More than 6000 different ammunitions per weapon system (6480).
- Target accuracy from 1 mm up to 500 m.
- Distance from 0 m up to 500,000 m.

7.4.1.4.2 Structure

The structure of the UCATT target designation code sub-set is targeted towards TES interoperability. The described structure can currently be implemented within the limits of eye safety if used for laser simulation and should pose no difficulty in future implementations. The UCATT code structure as described is intended to operate in a manner that enables a single data word to transfer all necessary data to complete an engagement. One data word includes a complete shot result or a complete control/test instruction respectively. The information is not divided into several data words. Each data word comprises 24 elements each. Each element offers 80 possible data positions. For safe detection each data word is transmitted four times.

Bottom Up definition:

- 80 bits form one element.
- 24 elements form one word.
- One word is one data set.

7.4.1.4.3 Data Word Contents

The elements of each data word are defined as follows:

- **Elements 1 and 2: Sync**

  The first pulse positions in Elements 1 and 2 are always occupied, resulting in a pulse distance of 40 µs.

- **Element 3 to 5: Weapon ID Code**

  The weapon type of the attacking dynamic object is encoded in Elements 3 to 5, thus offering a range of 524,879 individual weapon types.

- **Elements 6 and 7: Ammunition Code**

  In these elements the ammunition type is encoded. This element has to be evaluated in combination with Elements 3 to 5, offering 6480 different ammunition types per weapon. An example of this element would be:

  5 calibre 7.62 standard

  6 calibre 7.62 tracer

  7 calibre 7.62 full metal

  8 …

  The Elements 3 to 7 are providing enough code capability for 524,879 weapons with 6480 ammunition types per weapon.

- **Elements 8 to 12 and 14: Hit Position Code (azimuth: x and elevation: y)**

  These elements describe the deviation of hit position in azimuth and elevation as measured by the attacking system in relation to the centre of the target. The value range is from 1 mm up to more than 500 m.

  This element ensures that even a 500 m miss can still be transferred to the target.

- **Elements 16 to 18: Hit Distance**

  The hit distance is the sum of the values given in Elements 16 to 18 in meters. This value ranges from 0 m all the way to 505,600 m.

  The Element 18 codes 18-79 and 18-80 are used to transmit alternate code selection information to the other system to enhance the code scheme even more (providing two possible sub-sets of the code).

- **Elements 19 to 22: Platform ID Code**

  The Player ID (PID) number of the attacking simulator is encoded in Element 19 to 22, thus offering a range of more than 41 million possible players.

- **Element 23: Flight Time Code**

  The flight time of any ammunition can be coded into Element 23 offering a flight time in seconds up to 80 sec.

- **Element 24: Checksum**

  The checksum is derived summing up the Elements 3 to 23, modulo 80. It is used to determine the validity of any received code.

- **Elements 13, 15: Reserved**

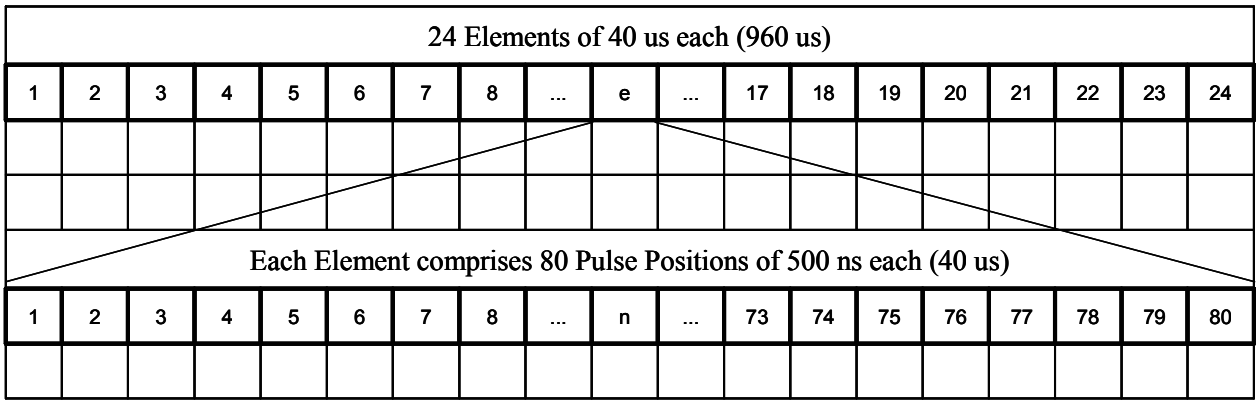
  The code provides 2 reserved elements that can be used to implement special codes and other elements needed in the future.

7.4.1.4.5 Timing for Time Based Coding Systems (e.g. Laser Simulation)

For time based coding systems the following timing can be used to ensure a data transmission that covers the needs of 2020 scenarios. The values described below are within the technological capacity of present systems. The timing, if applied with laser simulators, can currently be implemented within the limits of eye safety and should pose no difficulty in future implementations:

- Each Pulse Interval (PI) has a length of 500 ns.
- Each element (80 PI) has a duration of 40 µs.
- 24 elements form one word with a duration of 960 µs.
- Each word is repeated 4 times with a spacing of 1 ms.
- A complete time based transmission therefore requires about 7 ms.
- Short transmission time to ensure code transmission without restrictions on weapon handling.

The timing is depicted in the Graph 7-1 below.



Graph 7-1: Overview of Timing.

In each element up to one data position may be occupied. The first pulse positions in Elements 1 and 2 are always occupied, resulting in a pulse distance of 40 µs.

In all elements exactly one pulse position has to be occupied. This results in 22 elements which are used for information encoding. Together with the two synchronization pulses mentioned before, each data word comprises exactly 24 pulses.

Information on which pulse position is occupied is defined by the leading edge of the pulse, while the pulse itself as a rule is significantly longer than one pulse position.

7.4.1.5 Non-Target Designating Engagements

Target designating engagements between a shooter and a target are defined as interactions where the involved DOs can directly exchange information. Examples are a soldier firing his rifle at another soldier or a tank firing at a building.

Non-target designating engagements are interactions between a weapon system (ammunition) and other DOs where the other DOs can only be determined during activation of the weapon. Often this applies to Area Weapon Effects, indirect weapons or guided munitions. Examples are the explosion of an artillery shell, a hand grenade or a chemical cloud. Information for non-target designating systems (e.g. hand grenades that have area weapon effects) may include the data described in Table 7-1.

Non-designating engagement parameters may be transmitted using the entire UCATT code. This code will be used for other DO if applicable. The UCATT TG has identified the need for an extended non-target designating code portion. A future UCATT TG needs to pursue a compatible, non-target designating code addition. This addition would determine how to send TES data for non-target designating weapon systems. The UCATT TG did not complete this portion of the code definition but it is recommended that this is addressed in the near future.

7.5 VULNERABILITY DATA SET

This section deals with the necessity to have standardised vulnerabilities if multi-system (synonym for multi-national) exercises shall be conducted. Interoperability is not only achieved by the ability to engage the other system. Similar engagements (e.g. the same calibre on the same type of vehicle) need to cause similar damage.

Vulnerability is included in the force-on-force simulation world by a representation of the objects vulnerability parameters (commonly known as vulnerability models). Vulnerability and engagement

parameters are assessed to determine the outcome of any engagement. It is therefore obvious that vulnerability and engagement parameters need to be of one kind (one code) in order to get appropriate results. The restriction is actually even harder in such a way that a given code set does not define the outcome of the engagement since the vulnerability model finally defines the object's post engagement status. Only a matched code set plus matched vulnerability models ensure the desired object interaction.

The UCATT TG proposes to develop standardised training vulnerability models that can be used instead of "classified" national vulnerability models during joint exercises. The overall architecture will also need to support the use of classified models in individual countries' indigenous exercises.

7.6 EFFECT REPRESENTATION (ER) DATA SET

This section deals with the necessity to use similar or identical means of effect representation (ER) for defined engagement results (acoustical, visual, etc.). The ER feedback has to be aligned under multi-national training conditions in order to guarantee identical action and behavior on the recipient side of the ER process (e.g. soldiers will expect identical visualization of a certain weapon effect).

This section acknowledges the need for ER but the final decision should be agreed upon by the NATO FIBUA/MOUT WG and TSWG since they represent the user community and have the relevant military experience to evaluate possible solutions. The tables in Appendix J3 are intentionally provided in order to initiate the thought process. The UCATT TG expects changes to this table to be completed by the military subject matter experts. The content was provided by populating the tables at Appendices I1 and I2 (Fire and Target Entity Events) that supported the data interoperability analysis in Chapter 6.

There is no need to standardise "system internal" ER (e.g. messages displayed inside a vehicle). These representations do not influence the behavior of other players and – if well designed – do not lead to misinterpretation of certain engagement situations. It is up to the respective nation/system manufacturer to implement appropriate "system internal" ER.

7.7 DATA COMMUNICATION ASPECTS OF THE ENGAGEMENT

The UCATT TG has identified the need for a standardised data communication protocol on the level of the DO external interfaces. A future UCATT TG needs to pursue a common data communication interface in order to address the need for a common data communication. The standard determines how to receive and evaluate incoming data. The UCATT TG refrains from a definition of the final physical layer that eventually transports the data. This exceeded the current capabilities of the group and needs to be addressed in the near future.

7.8 TRANSITION PHASE

7.8.1 Background

The procedures and technologies proposed in this chapter have been implemented and used successfully on various projects already. They are designed to provide the ability to transition from a multi-code to a standardised universal code. The depicted solution ensures a safe and gradual transition from the old code set to the new set while maintaining the usual training capabilities.

Looking at Section 7.4.2 it might sound contradictory to state that the key to interoperability is actually the capability to use or provide better support to several vulnerability models. Upon closer examination however the first paragraph mandates only matched vulnerability models but does not exclude additional

models. As long as the models are clearly distinguished (e.g. by code) it is possible to match attacker parameters with the corresponding vulnerability model.

The general concept is to support the transition phase by allowing two or more code sets (legacy1, legacy2 and the UCATT code set) to be used in parallel. A code discriminator will identify the received code and provide it to the "responsible central interface". This would be done by first selecting the vulnerability model (e.g. by the attacker's code) and secondly by applying this attacker code to the chosen (matching) vulnerability model.

This concept has the advantage that it is not bound to a certain means of data transmission (e.g. laser) but offers the ability of being interoperable with different TES implementations. It is a proven technological standard and it can be implemented in a cost efficient way during the normal upgrade cycles of the systems.

7.8.2 General Concept

The main idea is to support the transition phase by allowing two or multiple code sets to be received. A code discriminator will identify the received code and provide it to the "responsible central interface". This is illustrated in Figure 7-1.

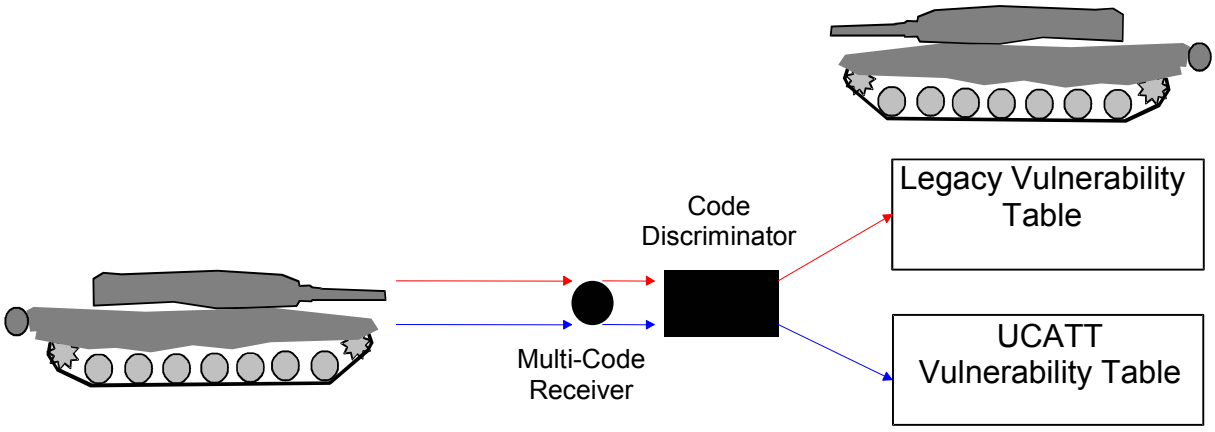


Figure 7-1: General Concept.

The general transition concept might require additional hardware for the legacy systems but this additional hardware can still be used after the transition. If the legacy receivers can be programmed to accept the UCATT code it might be possible to initiate the transition by upgrading the decoding software.

7.8.3 Definitions

The following definitions are given for the sake of clarity and are not intended as hardware design guidelines. Functions may be manifested in one or several pieces of hardware. The definitions are based on a hardware concept that is typical for present TES systems, but as said before the design is not mandatory:

- **Multi-Code Receiver:** A receiver that is able to receive the legacy code as well as the UCATT code. This receiver will be typical to the legacy code; it might be a universal (multi-legacy code capable) version.
- **Code Discriminator/Translator (CDT):** The CDT decodes the received data and decides which central interface is responsible for the received code. It can also translate received codes into another legacy code scheme. Translation is always limited to the capabilities of the legacy code (the UCATT code is stronger than legacy codes; it cannot fully be translated into legacy code).

- **Central Interface (CI):** The CI stores the vulnerability tables and reports engagement results according to the legacy or UCATT code requirements.

7.8.4 Legacy System Engaging UCATT System

7.8.4.1 Legacy System Engaging UCATT System with Legacy CI on Target

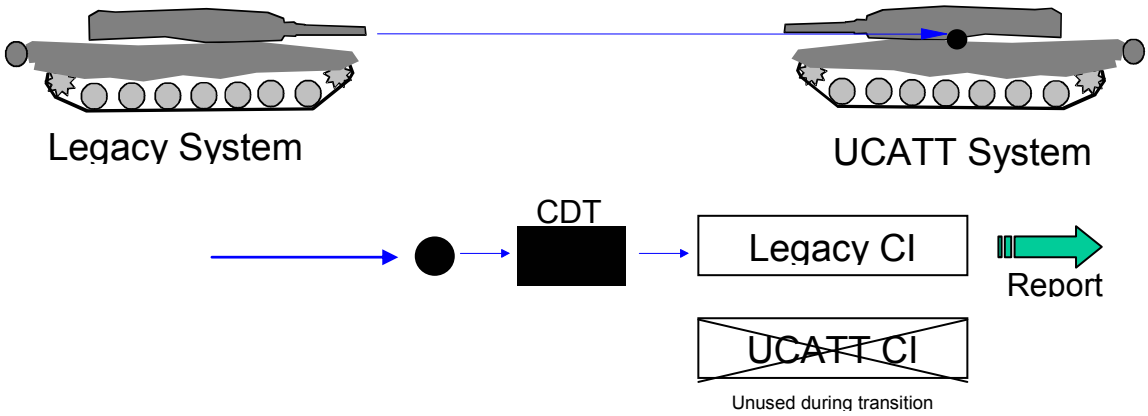


Figure 7-2: Legacy -> UCATT (Legacy CI).

If a legacy system engages a UCATT system the CDT will identify the legacy code and send the code to the legacy CI. This might be necessary during an early stage of the transition that is governed by a large number of existing legacy systems. The UCATT CI would be part of the UCATT system but not yet activated in this early stage of the transition.

7.8.4.2 Legacy System Engaging a UCATT System

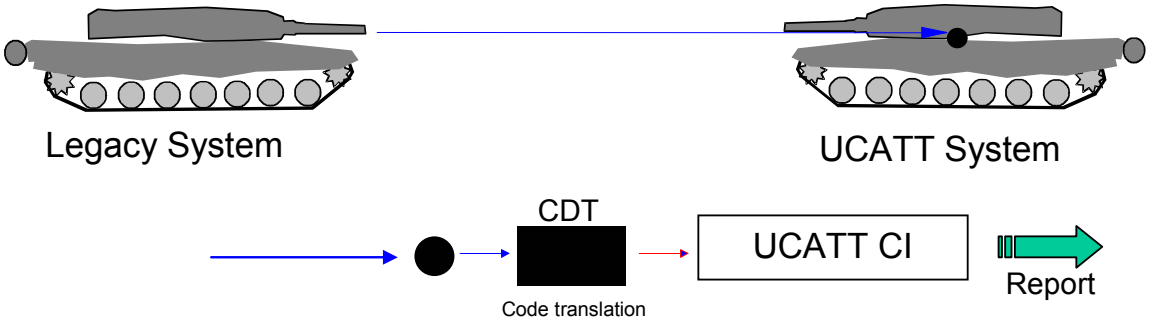


Figure 7-3: Legacy -> UCATT.

If fewer legacy systems exist it will be possible to activate the UCATT CI on the target systems and use the extended functionality of the UCATT code. If a legacy system engages a UCATT system the CDT will identify and translate the legacy code into the UCATT code and send the code to the UCATT CI.

7.8.5 UCATT System Engaging Legacy System

7.8.5.1 UCATT System Engaging Legacy System with UCATT CI on Target

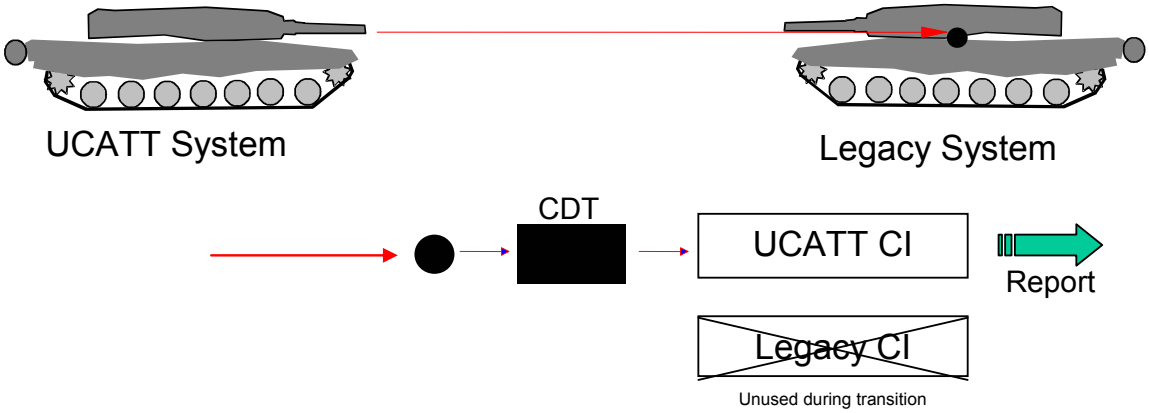


Figure 7-4: UCATT -> Legacy (with UCATT CI).

If a UCATT system engages a legacy system the CDT will identify the UCATT code and send the code to the UCATT CI. This solution ensures that all UCATT code features can be used at an early stage of the transition process. However it requires an additional UCATT CI on all involved legacy systems.

7.8.5.2 UCATT System Engaging Legacy System with Legacy CI on Target

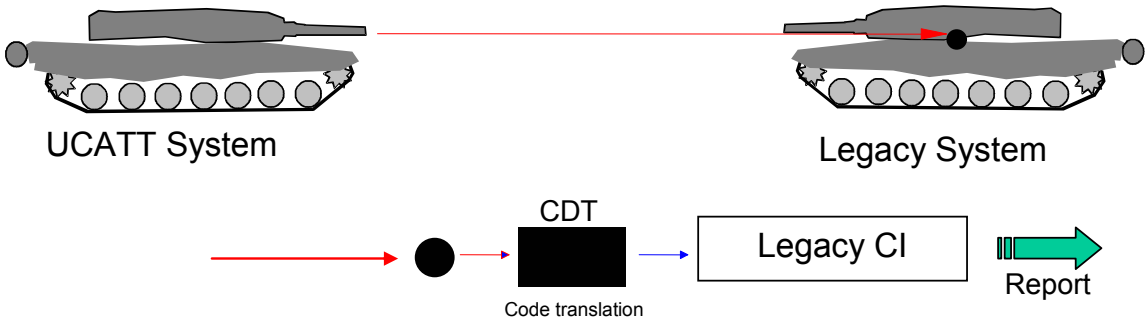


Figure 7-5: UCATT -> Legacy.

If a UCATT system engages a legacy system the CDT will identify and translate the UCATT Code into the legacy code and send the code to the legacy CI. This is done during a transition phase to ensure operation of existing equipment. This solution requires the need to solve over-capacity problems (e.g. avoid large PID numbers possible in the UCATT code) in the training organization structure.

7.9 OSAG CODE TRANSITION PHASE SUPPORT CONCEPT

The UCATT TG proposes to finish the code transition phase by the year 2020 which is 13 years after the publication of this report. Appendix J4 depicts how the OSAG code can be modified to achieve a level of interoperation that would enable the OSAG code community to conduct joint training operations in the near future, in effect at the beginning of the 13 year transition phase.

Appendix J4 shows in detail how to modify existing OSAG systems to support the increase in number of weapon systems already used. This next section is an extract from that appendix. The total number of possible ammunition codes is increased by the factor 2.5. The total number of weapon systems classes is raised to 38 classes using 2 to 10 different ammunition types. During international exercises all codes will be interpreted as the generic ammunition type of the applicable class.

7.9.1 Guiding Principles

The following are guiding principles on how to achieve a code system that has a defined ammunition code structure and which allows unique user defined ammunitions to be implemented. A brief description would be to say that the OSAG II proposal is an introduction of 38 ammunition classes (categories) which are described in Appendix J4. Every single one of these classes is defined by a generic ammunition code and the first ammunition code within the sequence of codes belonging to the applicable class is to be implemented and interpreted in the same way in every system supporting this new approach.

Each user nation can then choose and define unique ammunitions within the appropriate class, based on ammunition effect, using the remaining ammunition codes. These codes can be used during national exercises. During joint training the 38 ammunition classes will be used to determine the effects of an engagement. The more precise, user nation specific ammunitions can be used during national (single user) training, enhancing the training fidelity by providing detailed information about the particular ammunition. During national training exercises the proposed concept ensures that all simulators will still be able to interpret the ammunition codes according to the locally defined tailoring with the unique ammunition code implementations that exist today. During international exercises, the proposal eliminates the problem with undefined codes as all codes, unless identically defined, will be interpreted as the generic ammunition type of the applicable class. As an example all rocket propelled grenade type weapons (Carl Gustav, Panzerfaust, Bazooka, RPG7, etc.) are interpreted as the same generic weapon (AT Rocket).

7.10 WAY AHEAD

7.10.1 SISO Standardisation

SISO is an organisation supporting standards development. SISO is well established in the military simulation community, and has several yearly conferences focusing on interoperability. SISO has among its record of products the Distributed Interactive Simulation (DIS) and the High Level Architecture (HLA). Both DIS and HLA standards are cornerstones of interoperability in all types of simulation today.

The UCATT TG proposes the identified engagement aspects to be standardised utilising the SISO process and be recognised by NATO as the definitive standard for training system development. It is recommended that a future UCATT TG and SISO establish a formal relationship in order to produce the standard according to SISO proven procedures. A follow on UCATT TG would contribute to the process and send representatives to support a SISO Product Development Group (PDG) and retain final responsibility for the development of the standard. The UCATT TG recommends following the SISO six-step development and support process as outlined below [6]:

- **Step 1 – Activity Approval**: Groups like the UCATT TG can apply for formal SISO approval to begin product work, which will initiate the SISO Balloted Product process. The group proposing the product develops a SISO Product Nomination (PN).
- **Step 2 – Product Development**: A PDG is created to produce the Product(s). Consensus is sought in meeting the terms of the Product Nomination.
- **Step 3 – Product Balloting**: Once the PDG has completed Step 2, the next phase is balloting. The PDG resolves comments resulting from the ballot.

- **Step 4 – Product Approval**: The product and its development must adhere to SISO principles for inclusion as a SISO product.
- **Step 5 – Interpretation, Distribution and Configuration Management**: A Product Support Group (PSG) will be responsible for interpretation of a SISO balloted product.
- **Step 6 – Periodic Review**: Products are reviewed timely to ensure their usefulness, relevance and quality.

7.10.2 Review and Development of USE CASES

A future UCATT TG will need continue to review the USE CASES and consider development of additional USE CASES with greater detail to support evolving training requirements. The follow on UCATT TG should utilise the USE CASES as definitions for future test exercises in support of the overall standardisation efforts.

7.10.3 Funded Experiments

The UCATT TG believes it is essential to conduct test experiments for the purpose of evaluation and validation of the standards in development for urban training technologies. These experiments provide an iterative process through which theses standards and compliant systems may be developed. It is recommended that funding of these experiments shall be provided by individual countries' defence organizations or NATO Allied Command Transformation (ACT).

Chapter 8 – RESEARCH REQUIREMENTS

8.1 INTRODUCTION

In order to progress towards the USE CASES identified in Chapter 2, there needs to be further investigation in the following areas:

- DO;
- Simulation of the urban environment;
- EXCON and C4I; and
- Urban AAR.

8.2 DYNAMIC OBJECTS

8.2.1 Dynamic Object Interfaces

USE CASE 2 shows an example of interoperability of vehicle-mounted training equipment. This can be achieved by either a whole training system, or by appending parts of a foreign training system onto a country's existing systems (see Figure 8-1).

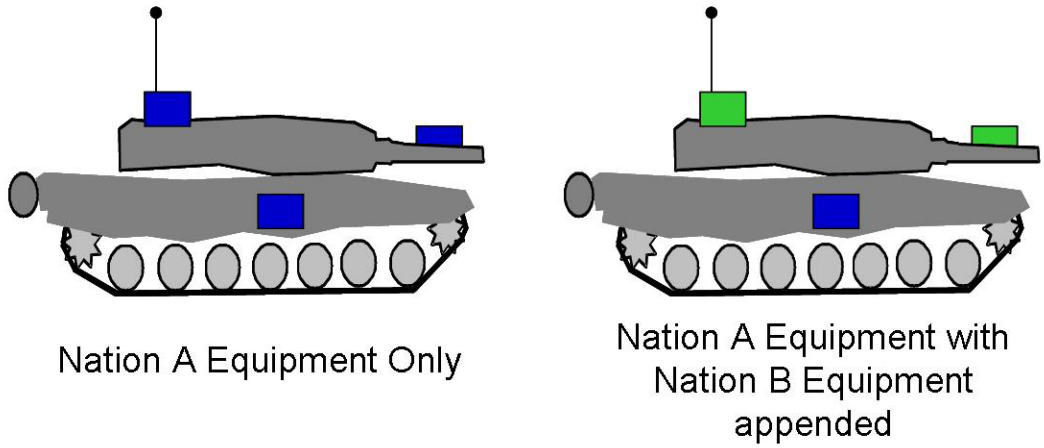


Figure 8-1: Diagram Illustrating USE CASE 2.

The need is for an intra-vehicle interface standard. Such a standard would allow training capabilities to be extended when needed. This might take the form of a generic vehicle interface (such as CANBUS) along with a standard data format.

8.2.2 Power and Data Connection

Cabling is an issue with vehicles; in order to connect all sensors, radios, etc., the wiring looms can become complex, and are often fragile. Additionally, connections are often needed inside the vehicle for power and data. By adding a standardised external training system interface, routing issues can be resolved. The problem of cabling might be resolved with a short-range radio link – if this link were to be used for appending training equipment as in USE CASE 2, there is a requirement for a standard also.

All these issues for vehicles are equally valid for other DO, such as buildings and dismounted infantry.

8.3 EXCON AND C4I

8.3.1 Dynamic Object to EXCON

Chapter 7 describes a standard for interface E1; Chapter 6 shows that in order to have a fully interoperable DO, interfaces E4 and E3/2 need standards. This will form the reporting system from each DO to EXCON, and remote system control functionality.

8.3.2 C4I Interoperability

C4I systems can transmit data either at the platform level, via interface E4, or at EXCON via interfaces E6/7. It is not the remit of the UCATT TG to decide on standards for C4I system interoperability. There is however considerable investment in developing C4I interoperability standards, in particular within NATO. The MIP (although not a NATO body) is the current body that is charged with developing a standardised information exchange data model. This model is currently JC3IEDM Version 3.0. There are 26 nations and organisations involved in the development process and given recent decisions in the United States by both the U.S. Army and the U.S. Marine Corps to use the JC3IEDM as the interface between C2 and M&S it would seem the most logical starting place. As a result, JC3IEDM should be fully explored and where possible carried into the UCATT standard. Where JC3IEDM does not provide a means of exchanging data required to support training in an urban environment then extensions may need to be added or taken into the core JC3IEDM.

In addition within SISO there is a PDG that is focussing on C2-to-M&S interoperability and are developing a standard, Coalition Battle Management Language (C-BML). Within the NMSG, MSG-048 is tasked with assessing the phase 1 standard that the C-BML PDG are developing and it is possible that this standard will be applicable to a UCATT standard for exchanging data between urban training and C4I systems.

8.3.3 EXCON to EXCON

An interface between different EXCON systems is required to fulfil USE CASES 3a and 4. This should allow for operations in different training areas to be interconnected at the command level. Interfacing at this level is most commonly encountered in computer simulation systems, e.g. DIS and HLA, and the United States are developing live training interface standards in the form of CTIA and TENA.

8.4 SIMULATION OF THE URBAN ENVIRONMENT

8.4.1 Best Practice for Urban Effects

Simulation of the urban environment will encompass the determination of any effect and the representation of that effect. Chapter 6 has already noted that there is a need for standardised damage tables and for common simulation effects. In the urban environment, there is a need for a standard practice for representation of on-building effects. Interoperable or common damage tables are problematic due to the conflicting needs for unclassified data versus realistic weapon effects. Further research is required to define a set of standard weapon effects that can be ratified for international training events.

8.4.2 Common Terrain Fidelity

If a geometric pairing system is to be used successfully in an interoperable environment, there needs to be a compatible process in determining engagements. This is driven by interoperable damage tables, mentioned above, and an interoperable simulation of the urban environment. The requirement is for standardised terrain database fidelity to prevent conflicts in engagement resolution.

8.4.3 Common Human Representation

Human representation is important in the urban training environment: Participants need to react to non-lethal weapons, and OPFOR should react to effects-based operations. There is a need for a standardised representation of human effects, such as suppression, to enable interoperability.

8.5 URBAN AAR

Given the complexity of the urban environment and the importance of good communication and control skills, AAR must provide sufficient information to allow an instructor to show evidence for the training audience. The nature of this evidence must be presented in a manner that is easy for a military audience to understand and assimilate. NATO standard symbology and mapping conventions exist for 2D representations (this includes "2.5D"; icons placed on to a 3D terrain). However, the visual complexity of the urban environment presents a great challenge to understanding of the battle space. Showing each individual is a method to comprehend the details of the battle, but this can quickly clutter a display. A common standard for symbology would allow entities to be aggregated by unit and/or by geographic location (i.e. within a building). There are existing NATO groups looking at common visualisation – AAR visualisation for urban operations needs to leverage from developments in these areas (e.g. IST-043 Visualisation and the Common Operational Picture WG).

8.6 CONCLUSIONS

The two main emphasises of this chapter have been on defining equipment interoperability for DOs, EXCON and C4I, and secondly for process standards, urban representation and training tools.

Equipment interoperability research falls into defining standards for military training data transfer, and physical standards for connectivity and safety. Both have the potential to leverage off other standards (e.g. JC3IEDM and C-BML) and international industrial standards (e.g. Bluetooth).

The representation of the urban environment is a training process issue, which needs to be addressed by the appropriate NATO group (most likely the TSWG and FIBUA/MOUT WG), with technical support from industry partners where required for modelling standards, etc.

8.7 RECOMMENDATIONS

The following areas are recommended for future research:

Research to be assigned to a follow on UCATT TG:

- Develop intra-DO interface standards.
- Develop EXCON to DO and EXCON to EXCON interface standards.
- Develop DO/EXCON to C4I interface standards.
- Define and ratify a set of expandable damage tables for representing urban effects.

Research to monitor, provide advice on and pull-through from other NATO research areas:

- Develop training process standards for multi-national interoperability.
- Develop AAR standards for common visualisation of training information.

Chapter 9 – RECOMMENDATIONS

9.1 INTRODUCTION

The UCATT TG in the preceding chapters of this report has made a number of recommendations to improve overall approaches to training in an urban environment. Although all recommendations have been agreed by the members of group, it is recognised that nations can and will each have their own, potentially diverse emphasises on their technical, operational or tactical needs. In addition, each of the different industrial members of UCATT have their own visions of what they see as a future urban training system related on their past R&D, legacy technical solutions and understanding of customer requirements. Regardless of these facts all of the recommendations that have been listed in this chapter are, as stated, commonly agreed and are intended to provide a common baseline for each nation in order to deliver interoperability and give industry direction in their respective efforts as well as future R&D in more focused areas.

9.2 RECOMMENDATIONS

In order to improve overall approaches to training in an urban environment the UCATT TG is making the following recommendations as listed in the sub-sections below.

9.2.1 Maintenance of UCATT Report

The work undertaken by the UCATT TG and encapsulated within this report is based on a vision of urban operations as laid out in UO2020 [4] 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;
- Increasingly that training will be coalition; and
- 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 facilities through to 2020 and beyond.

The maintenance of the UCATT report can be conducted by a small group of UCATT TG members that would meet once every year to discuss and update the report based on a continued understanding of the military context, changes in technology and progress towards interoperability through the standardisation process.

9.2.2 Related Working Groups

The UCATT TG 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, FIBUA/MOUT WG and other RTA 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.

9.2.3 Benefit and Continued Involvement of Industry

Industry partners were invited to work within the UCATT 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 guidance on areas where they should invest and by their participation it is hoped that nations will follow the guidelines in this report although it is recognised that there will be technological development and solutions which are beyond the group's knowledge at the time the report was completed which will need to be considered when both industry and nation invest in urban training facilities. To deliver interoperability it will require industry to work together and it is hoped that they will continue to provide support for the development of the proposed standards and continue to participate in a future UCATT TG. It is also recognised that in looking at other areas in the constructive and virtual simulations areas that need to be integrated with the live environment that other industry participants may join a future UCATT TG.

9.2.4 Continuation of the UCATT TG

The work of the UCATT TG is not finalised – a report is 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 FIBUA/MOUT training, ER (e.g. coloured smoke), 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 2 is at Annex K. Figure 9-1 is an elaboration together with NATO FIBUA/MOUT working group and is describing how the work of a new UCATT TAP will potentially contribute in the future. As the overall goal for UCATT work has been stated to be year 2020, also this figure will cover the different milestones until then [Section 4.6].

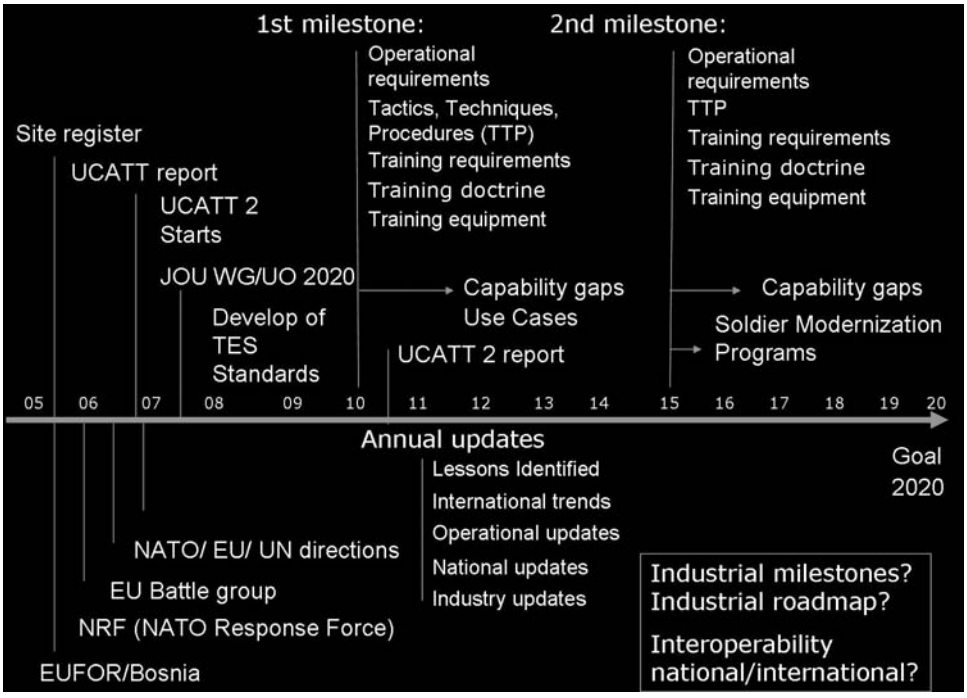


Figure 9-1: UCATT Continuation in the Context of Work by the FIBUA/MOUT WG.

9.2.5 Standardisation of External Interfaces of the Functional Architecture

Since the purpose of the UCATT TG is to set requirements for interoperability, it is recommended that the external interfaces defined in the functional architecture have to be standardised. In taking an architectural approach it is also recommended that the MooD software used to demonstrate how data can be captured and linked to requirements data into its associated database is used to develop the Functional Architecture. This will require funding support from MSCO/RTO in Paris [Section 4.6].

9.2.6 Standard Engagement Codes

9.2.6.1 Standard on Laser Communication

The UCATT TG agreed on the urgent need of a standardised (laser) communication code. This UCATT code has to be an open code covering the information needs of modern simulation training. It needs to be free of company IPR, provided under Open Content License and standardised at the SISO/NATO level. When a decision towards a continuation of the UCATT TG is made, one of the focuses of this group must be the continuing support and survey of the code standardisation process [Section 7.4.1].

Industrial participants within the UCATT TG have been working on the first step towards standardisation of laser communication for Direct Fire Weapon Effect Simulation (DFWES). Their efforts can lead into the development of an open standard. This standard, which is presently today based on laser technology, can make interoperability between different national soldier/weapon systems possible.

The report contains examples of possible future code structures and ways to migrate legacy codes to a standardised UCATT code set. The UCATT TG recommends following the proposed migration path so that the process can be finished by 2020.

9.2.6.2 Non-Target Designating Code Addition

The UCATT TG has identified the need for an extended NTD code portion. A future UCATT TG needs to pursue a compatible NTD code addition as this was not completed. This NTD addition would determine how to send TES data for non-target designating weapon systems.

9.2.6.3 Standard on Vulnerability

To avoid negative training effects and classification issues, a future UCATT TG proposes to develop standardised training vulnerability models that can be used instead of “classified” national vulnerability models during joint exercises. The overall UCATT architecture will nevertheless support the use of classified models in individual countries’ indigenous exercises.

9.6.2.4 Standard on Effect Representation (ER)

Effect Representation (ER) is a vital part of the engagement simulation process (see Chapter 7 for details). A common “ER-language” is essential for multi-national exercises. ER-needs and ER-means should be agreed upon by the FIBUA/MOUT WG and TSWG since they represent the user community and can evaluate possible solutions.

9.6.2.5 Standard on Data Communication Protocols

The UCATT TG has identified the need for a standardised data communication protocol on the level of the DO external interfaces. A future UCATT TG needs to pursue a common data communication interface in order to address the need for a common data communication. The standard should determine how to receive and evaluate incoming data. A future task should be to continue research on the data communication protocol, leading to the definition of the physical layer that transports the data.

9.2.7 Continuous Review of the USE CASES

A review and development of additional USE CASES with greater detail to support evolving training requirements is essential. A follow on UCATT TG plans to utilise the USE CASES as definitions for future experiments in support of the depicted standardisation efforts.

9.2.8 Funded Experiments

The UCATT TG believes it is essential to conduct test experiments for the purpose of evaluation and validation of the standards in development for urban training technologies. These experiments would provide an iterative process through which standards and compliant systems may be developed. The funding of these experiments should be provided by the national defence organisations or by NATO ACT.

9.2.9 Site Register Update and Best Practice

It is recommended that Site Register summary should be maintained and updated twice a year, after each meeting of the FIBUA/MOUT WG. The responsibility for administering the website lies with the FIBUA/ MOUT WG although support from a future UCATT TG would be available where technical details are needed. At present the UCATT TG have published its reports on this site but as this will be transferred to the RTO WISE site. It is recommended that in future only a link is provided to the RTO WISE site.

A separate questionnaire aimed directly at collecting best practice recommendations should be circulated by the FIBUA/MOUT WG and the result presented on the website. A future UCATT TG should continue to support the FIBUA/MOUT WG in collating a “Compendium of Best Practice”. The NATO Urban Operations Handbook could potentially incorporate best practice.

9.2.10 Training Facility Recommendation

The identification of an overarching approach to train within each nation’s facilities, interoperability between training systems and devices of different countries, and supporting legacy training devices needs to be further investigated, along with the identification of the training requirements for urban operations in the areas of virtual and constructive.

The relationship with the FIBUA/MOUT WG was invaluable to the work of the UCATT TG because it provided contact with 25 NATO/PfP countries. In the event that the work of the UCATT TG is continued to examine the areas of virtual and constructive requirements and LVC integration then a more formalised relationship should be developed with the Army Sub-Group and both the FIBUA/MOUT WG and TSWG because they are key users and need to endorse future requirements.

9.2.11 Health, Safety and Environmental

Health, Safety and Environmental requirements need to be examined to see if a common standard can be developed in appropriate areas.

Chapter 10 – REFERENCES

[1] NATO Land Operations 2020 (NATO reference RTO-TR-8 dated 1999).

[2] Jones, Col S.M., U.S. Army, "Re-Examining Tomorrow's Battlefield: Taking the Fight into the Cities", Student Issue Paper, Centre for Strategic Leadership, U.S. Army War College, June 2003, Volume S03-01.

[3] Hahn II, Robert F., and Jezior, B., "Urban Warfare and the Urban Warfighter of 2025", *Parameters*, Summer 1999, pp 74-86.

[4] NATO Urban Operations 2020 (NATO reference RTO-TR-071 – AC/323 (SAS-030) TP/35 dated April 2003).

[5] NATO Land Group 8 Military Operations in Urban Terrain (MOUT) Team of Experts (TOE) Report to NATO Land Group 8 – April 2002 dated 25 March 2002.

[6] Simulation Interoperability Standards Organization, "Balloted Products Development Process", SISO-ADM-003-2005.1, 26th August 2005.

Annex A – LIST OF MEETINGS AND OBJECTIVES

Serial	Date	Location	Objectives
1	11-13 June 2003	The Hague, Netherlands	Agree task plan Identify preliminary requirements Develop USE CASES Develop MOUT site register plan
2	13-15 Sept. 2003	Paris, France	Refine USE CASES Develop capability requirements matrix Review status of MOUT site register
3	4-5 Dec. 2003	Orlando, USA	Mapping of requirements to UO2020
4	22-23 April 2004	Shrivenham, UK	Complete USE CASES Work on capability requirements matrix
5	September 2004	Stockholm, Sweden	Identify logical components and develop draft functional architecture from USE CASES Finalise capability requirements matrix Review MOUT site register
6	6-7 Dec. 2004	Orlando, USA	Review functional architecture and sub-systems Review definitions of functional sub-systems Review interfaces between sub-systems Establish internal and external interfaces to functional sub-systems
7	24-28 April 2005	Amsterdam, Netherlands	Review capability requirements matrix Review interfaces between sub-systems Develop external interface data sets
8	26-28 Sept. 2005	Walenstadt, Switzerland	Identify interoperability elements Draft interoperability report
9	27-29 Nov. 2005	Orlando, USA	Develop report structure
10	15-19 May 2006	Farnborough, UK	Develop interoperability specification Discuss best practice, site register
11	4-6 Sept. 2006	Amsterdam, Netherlands	Draft task group report
12	7-8 Dec. 2006	Orlando, USA	Finalise task group report

NORTH ATLANTIC TREATY ORGANIZATION

25 March 2002

Reference: ##

NATO LAND GROUP 8 MILITARY OPERATIONS IN URBAN TERRAIN (MOUT) TEAM OF EXPERTS (TOE) REPORT TO NATO LAND GROUP 8 - APRIL 2002

Reference: NATO Land Operations 2020 – (NATO Reference RTO-TR-8)

"By 2010 75% of the world's population will live in large urban areas.

ERGO

Cities are the most likely battlefields in the 21st Century"

Netherlands Defence Science Board

"There is no Western technological dominance on the Urban Battlefield".

Maj. Ronald Poetiray RNLMC

ABSTRACT

1. This aim of this paper is to report on the findings of the activities of the NATO LG/8 Military Operations in Urban Terrain (MOUT) Team of Experts (TOE). The subject of the paper is to identify areas in which potential MOUT Training solutions may benefit from standardisation thus enhancing interoperability between nations. The move into live simulation has produced no real interoperability standards over the last 15 years. The growing importance of live simulation and the deeper integration of allied forces in training may require a degree of system interoperability. A number of MOUT simulation applications or sub-systems lend themselves to being better defined and investigated as possible areas for standardisation. The MOUT TOE invited representatives from industry to share their thoughts as to future developments. In return the MOUT TOE proposes to better define the NATO User requirement.

2. The paper is intended for consideration by NATO LG/8 at the Spring Meeting of LG/8 2nd Week in April). This paper acts as a summary of progress to date and makes recommendation to LG/8 regarding the potential for possible NATO sponsored practical Programmes of Work (POW).[1]

INTRODUCTION

3. **A Changed Environment.** By 2010 75% of the world's population will live in large urban areas. These urban areas will have many different characteristics according to their location, function and ethnic makeup. However, a major factor they will have in common is the growing tendency to be used as a combat arena. The difficulties of conducting military operations in Urban terrain are well documented and litter the pages of recent history including Stalingrad 1942, Hue City 1968 and Palestine 2002. In general MOUT is expensive in military manpower and high in casualties to both military and civilian alike. Urban environments also degrade the use of current weapon systems due to limited arcs, visibility and importantly the existence of a civilian population[2] and resultant restrictive Rules of Engagement.

4. **The Capability Gap**. The problems and limitations associated with developing training environments to better enable MOUT are only just beginning to be understood as first generation systems are fielded. Whilst Combat Training Centres (CTC) making use of laser Tactical Engagement Systems (TES) for force on force manoeuvre & combat are becoming "de rigeur" for most Western nations, the ability to conduct meaningful training within the MOUT environment is limited. There is a growing interest amongst NATO nations into developing training solutions for better MOUT training. Current TES have limited applicability for MOUT due to shorter ranges and associated beamwidth/sensor density. The range of pyrotechnic effects is also limited and certain weapon types are not represented. Additionally, the need to provide training experience is missing.

5. **NATO Response**. NATO Land Group 8 (LG/8) Simulation Interoperability for joint training and operational support, formed a Team Of Experts (TOE) to investigate the MOUT training problem in conjunction with industry and relevant research authorities. NATO LG/8 has the remit to anticipate future training requirements and to shape future policy in line with extant Defence Capabilities Initiative (DCI) EE9[3] and relevant NATO training policy documents/papers.[4] Current military requirements focus on the development of standardisation for virtual and constructive simulations. However, there is growing recognition between the Group members that live simulation standards have been neglected for some time,

1 The timeframe for this report may enable discussion and possible approval of practical investigations to be made at the NMSG Fall 02 Mtg.
2. Whilst an "enemy" civilian population may not be friendly in the sense that they aid an invader, their status as civilians protects them under the Geneva Convention and basic laws on human rights.
3. Defence Capabilities Initiative (DCI) EE9 – "Develop and implement operational simulation devices within the NAAG by identifying standards and seeking opportunities for collaboration between nations
4. Currently, Land Operations 2020, SHAPE – NATO policy for Training, Evaluation and Exercises & NATO Modelling and Simulation Master Plan

hence the focus on MOUT. The MOUT TOE restricted itself to examining potential areas of interoperability within future training system solutions and also sought to identify and make contact with NATO Military User Groups in order to provide coherency to the investigation. In line with current NATO practice, the TOE met three times during an initial 12 month period in order to examine feasibility prior to making a report and recommendation to the parent body, NATO LG/8.

AIM

6. **Aim**. The NAAG Land Group (LG) 8 MOUT TOE set itself the following task:

"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".

The specific aim of the MOUT TOE was to see if this investigation was practicable and if so to recommend to NATO LG/8 a way ahead/Programme of Work (POW).

LG/8 MOUT TOE – SUMMARY OF ACTIVITY

HELSINKI –OCT 01

7. Helsinki – Oct 01. The first meetings of the NATO MOUT TOE took place in Helsinki, Finland over the period 5 –10 Oct 01:

a. MOUT TOE NATO Members Pre-Meeting – 5 Oct 01. This meeting sought to confirm how the MOUT TOE would operate and to identify potential areas for NATO standardisation. These specific areas relate to areas where either Government/NATO Furnished Information could be applied or where standardisation does not constrain potential industrial solutions:

(1) Laser Information Coding, Positional Reference, Percentage Kill (PK) Frequency/Bandwidth Issues, Weapon Effect, Timestamp for engagement. Power, After Action Review, Standard Application Programmable Interface (API), Binary Laser Code for Projectiles, etc.

(2) The pre-meeting also recognised that there were areas in which Subject Matter Expertise (SME) is required in order to assist the TOE:

(a) STANAG for Laser Safety. Eye safety especially relating to GaAs sensors in the range .9-1.1um.

(b) Future Proofing. Ongoing developments into instrumented range facilities to ensure future proofing of interoperability standards.

(3) The pre-meeting concluded that SHAPE/NC3A were the legitimate end users of the products. SHAPE was supportive of the drive toward a "MOUT" STANAG and the NATO Training Simulation Working Group (TSWG) was seen as representative of national User requirements.

b. MOUT TOE – 8-10 Oct 01. The main meeting focused on examination of the potential for harmonisation of user requirements for the future MOUT environment[5]. In the spirit of openness

5. For future read 10-15 years hence circa 2015.

and trust, industrial participants were invited to share commercial-in-confidence information with the Government representatives. This first meeting between User representatives and industrial was generally thought to be a good idea as it created an informed arena for continuing dialogue regarding future MOUT technical challenges circa 2010/2020. It was felt that there were potential areas for standardisation and that NATO (amongst other agencies and user groups) needed to support such a venture. A number of detailed industrial presentations were delivered. Industry saw a generic set of requirements for future MOUT as being helpful to better focus their efforts but a note of caution was sounded regarding the desire to be too overly prescriptive thus constraining novel ideas and applications.

ORLANDO – DEC 01

8. Orlando – Dec 01 - General. The second meeting of the MOUT TOE was held on 27th Nov 2001 at the US Army Simulation Training and Instrument Command (STRICOM). The meeting followed the same format as the Helsinki Meeting, namely an introduction by NATO as to the aims and objectives of the MOUT TOE followed by presentations from industry as to the perceived way ahead. Of particular interest to the MOUT TOE was the US Army STRICOM vision for future training for which sought evolutionary progression to ensure that the training support will become much more interoperable through current initiatives including:

a. Common Training Information Architecture (CTIA). Defining the products that will be needed to provide for that level of interoperability. Working between live, virtual and constructive simulations. An ongoing research programme.

b. "One TES" (Tactical Engagement Simulation (generic term for MILES). Within US there are many variants of TES. "One TES" is seen as the evolving standard to best define the future standards.

9. Orlando – Discussion Topics. Some themes raised at Helsinki were further discussed and areas for interoperability examined:

a. Generic NATO set of Tables for Vulnerability, Lethality. A common set of tables for vulnerability/Lethality would assist interoperability. This is "doable" and will assist industry.

b. Health and Safety. Laser standards regarding health and safety are not consistent between NATO nations.

c. Physical Transition between Open and Restricted Environments. Many MOUT facilities are being designed as integral parts of Combat Training Centres (CTCs). This may imply specific MOUT simulation solutions, which are not applicable to more open terrain where current TES systems operate. In the future, will there be two diverging technologies at play?

d. Frequency Requirements for Instrumented Ranges. The frequency requirements for instrumented ranges may not be universally applicable due to national bandwidth constraints.

e. Quantification of Training Standards. The NATO aspiration to quantify training standards will likely lead to some form of standardisation of test exercise and After Action Review process. This process standardisation for training is still in a nascent form.

10. **Orlando – Summary**. In summary:

a. "De-facto Standards". The evolving US standards for instrumented ranges (CTIA) were recognised.

b. Areas for Standardisation. Certain areas such as Ph/Pk may offer themselves open to standardisation within NATO to enable meaningful force on force training in pursuit of further quantifying training benefit.

c. Subject Matter Expertise. The need to involve further SMEs was understood, especially relating to specific issues such as Health and Safety.

THUN – FEB 02

11. Thun – Feb 02 - General. The 3rd Meeting of the NATO Military Operations in Urban Terrain (MOUT) Team of Experts (TOE) was conducted in Thun, Switzerland over the period 5-8 Feb 02. The meeting was in two parts:

a. A pre-meeting on Tue 5th Feb of NATO/PfP LG/8 delegates which agreed the agenda and method of working for the main meeting.

b. The main meeting (Wed 6th – Fri 8th Feb) further examined the nature and scope of the MOUT training capability gap and explored areas that may benefit NATO/PfP nations by adopting some form of standardisation of equipments and/or procedures.

12. User Focus. Of interest at Thun, was the number of User briefings given which exposed some of the limitations of current MOUT Training:

a. Lack of Variety of Urban Terrain Types/Inability to Support the All Arms Battle. A major limitation in MOUT was the lack of variety of urban terrain types and ability to support the all arms battle i.e. Artillery and Armour representation in simulation. A possible way to better replicate urban terrain types in terms of size, area and types of building may be representation in the virtual world augmenting current live elements. However, the limitations of the virtual world are themselves recognised. Urban Ops are not purely infantry but infantry is the current focus for simulation. The UK experience of WW2 showed that towards the end of the war, firepower became the dominant factor in MOUT. The role of the man in individual FIBUA skills became secondary to better and more co-ordination of other battlefield assets. The shock effect of armour, the use of artillery & air all need to be replicated within MOUT training facilities of the future or else false lessons may be learned.

b. Limitations in technology/TES equipment to support FIBUA.[6] Too many simulation systems and new technology can serve to distract uses from the "job in hand". An example - Virtual technology was seen as the de-facto means of training some yeas ago; the reality nowadays is somewhat different.

c. Lack of opportunity to train at formation level.[7] Most nations live MOUT facilities can only cope with a company sized group or Battle Group at best. However, formation level is perceived as being a critical level of command and resourcing MOUT. There is little opportunity for testing this level of command less than in the constructive environment. It may be that the fusion of the live/constructive world is a positive step in initially addressing this problem

d. Home Station Training. Individual MOUT training is required at homestation not purely at Combat Training Centres (CTCs).

6. Laser cannot shoot through walls, opportunities for TES cheating, ability to portray tank and artillery rounds etc. Battlefield Effects.
7. Lack of opportunity to train above unit level. There is a need to portray Brigade level operations.

e. Merging of Tactical/Operational Levels of Warfighting. The "distance" between tactical and operational levels within MOUT is fast becoming minimised. Development of doctrine is required to recognise this closing gap.

f. Emerging Threats. There are a number of emerging threats that will profoundly alter the way we conduct MOUT. Of note is the growing use and widespread availability of Thermobaric weapons – "overpressure weapons". These are weapons that are optimised for blast and have a longer effect then conventional High Explosive. The use of these weapons will render conventional tactics, training and procedures for MOUT largely obsolescent.

13. NATO Organisation and the Relationship between NATO MOUT/FIBUA Groups. The relationship between the three identified groups that had specific Urban training (simulation) responsibilities was discussed. NATO LG/8 MOUT TOE was seeking a representative NATO group that could act as a focus for User MOUT requirements. Both the Training Simulation Working Group (TSWG) and the MOUT/FIBUA WG Chairmen were present at the meeting[8] and an outline relationship discussed.

RELATIONSHIP WITH OTHER NATO GROUPS

14. Research Technology Board (RTB) – SAS Groups. One Research Technology Board (RTB) SAS study has been identified which will provide LG/8 MOUT TOE with a guideline for future activity: NATO-SAS 30 Study "Military Operations in Urban Terrain in 2020".

15. NATO Training and Simulation Working Group (TSWG). The need to define the relationship, establish liaison and de-conflict with other groups working in the MOUT field is paramount. The NATO Training and Simulation Working Group (TSWG) [Doctrinal – and User focus] & the FIBUA/MOUT WG [Operational requirement provider] are key elements in the LG/8 work to develop interoperability standards. Both the TSWG & FIBUA/MOUT WG report to the Army Simulation Group (ASG) under the NATO Training Group. It was agreed that the "formalisation" of the relationship with respect to the specific MOUT/TOE work, through the respective NATO chains of command, should be an action conducted by the NATO LG/8.

IDENTIFIED ISSUES & POTENTIAL AREAS FOR INTEROPERABILITY

16. General. A number of potential interoperability areas have been identified by the MOUT TOE, and are assessed to be worthy of follow up investigation and activity:

a. Operational Concepts. A User led group that would examine common user requirements for the timeframe 2010, Tactics, Training and Procedures.

b. Battlefield Effects. An investigation onto pyrotechnics techniques & visual cueing, collateral effects (shooting though walls – effects of artillery/armour.

c. Exercise Control (EXCON) /After Action Review (AAR). Formalising the concept of AAR, quantification of training benefit ergo requirement to capture certain information.

d. System Architecture. The generic architecture for future systems – interfaces with communivcations/C4I systems. Compatibility with Land Operations 2020 concept.

17. Operational Concepts. There is a recognised overall capability requirement and gap for MOUT/FIBUA training but these requirements differ between nations. Greater harmonisation of User requirements and doctrine is necessary before proceeding to standardisation of equipment and procedures.

8. Lt. Col. L Cyr CA and Maj. A Rule UK respectively.

An investigation into Mission Essential Tasks is required. A potential action placed on LG/8 was to request ASG to conduct this study – possibly through the MOUT/FIBUA WG.

18. Battlefield Effects. Tactical Engagement Simulations (TES) capability should be a specialist sub-set of Battlefield effects. TES capability should examine Laser Code, class and vulnerability[9] code to ensure interoperability. There is a fundamental requirement to achieve common objectives between nations in the following areas:

a. TES Interoperability. Three levels of TES interoperability are envisaged:

(1) To borrow/use existing equipment from other nations i.e. NL troops borrowing GE equipment when training at GE facility.

(2) To develop interoperability between existing TES. Adapt current equipment – 2010 is a realistic date for this to be achieved.

(3) Development of common standards and new TES equipment. Only really an option by 2020.

b. Sensory Cueing. Sensory cueing as close as possible to reality. Visual, audio, shock, Haptic/tactile, Pressure, smell, effects of direct and indirect fire, explosives, Non-Lethal weapons, NBC.

c. Pyrotechnics. The major issue here regards safety regulations and common representation of effects.

19. EXCON/AAR. Essentially, EXCON conducts the following; planning, preparation, conduct, preparing and providing an interactive AAR (provides feedback, is interactive, objective and flexible). Major issues and potential areas for interoperability include:

a. The need to minimise training staff particularly Observer Controllers in the field.

b. The requirement to capture **all** data[10] to provide situational awareness and statistical analysis.

c. The consequent need for smart tools to present the right information at the right time, in the right format.

A possible way ahead is to incorporate a Synthetic Environment (SE) to provide contextual information i.e. platoon in MOUT operates within a company context. An SE also provides means of examining "what ifs" – from a set point alternative actions and outcomes can be postulated. Integration of training functionality with operational equipment is necessary but there is a need to avoid data contamination between the two domains. A conclusion was the need to seek wider collaboration with industry e.g. entertainment industry working in Virtual Reality (VR).

20. System Architecture. The system architecture is the common core for all applications. The service core includes protocols, data collection & storage. A common object interface required connecting with applications; EXCON, AAR, Video, targetry etc. The feeling is that nothing is impossible but the will is to solicit consensus between nations. However, an objection to this approach was the perception that

9. Dividing into laser classes is done in different ways in the US & Europe. The US tolerates a 4 times higher figure than Europe.
10. For example; accurate position of individuals and units, weapon directions, contacts, resulting damage, communication, C4ISR, observation arcs, logistical expenditure, CSS etc.

industry would be micro-managed by Government and their role is relegated to supplying objects to be hosted on the common object architecture.

SUMMARY

21. LG/8 exists to promote the use of standards to aid interoperability. There is a fine balance between timely standards and constant innovation from industry. However, the meetings of the MOUT TOE opened up a constructive dialogue with industry and identified actions NATO can take to move toward interoperability.

22. It was recognised that the demands of industry with regard to commercial secrecy are reasonable and practical. It is hoped that these constraints on open dialogue will not prevent the definition of generic operational requirements for future MOUT.

23. A number of important areas may offer potential for future activity to support greater interoperability:

a. A revision of health and safety issues with respect to constraints imposed on developing a full range of battlefield effects.

b. Investigation into the vulnerability models used by different nations if force on force training is conducted using individual nation's equipment is seen as a potential first step in interoperability for 2010.

c. Need to provide a consistent view of operational requirement for MOUT training in the timeframe 2010. This requirement is not seen as a NATO LG/8 but a NATO ASG responsibility.

d. Capture of key data points derived from essential tasks in order to quantify training standards. These key data points will define the information capture requirement. Again this is a user led investigation to define together with training experts what elements have to be carried out and to what standard to satisfy the conduct of these tasks.

e. Specific key (legacy solution) areas such as: weapon effects, weapon laser coding, system interface(s), AAR.

CONCLUSIONS & RECOMMENDATION

24. Conclusions. The NATO LG/8 MOUT TOE has come to the conclusion that:

a. There are sufficient areas of interest where standardisation would add value to recommend continuing the activities of the group.

b. There is a requirement to formally identify and stimulate a representative User group to act as a focus for the work.

c. There are sufficient areas of potential interoperability for practical investigation by NATO bodies and agencies such as NC3A and NMSG.

25. Recommendation. The recommendation from the LG/8 MOUT TOE is that a NATO MOUT Simulation WG be formed to conduct in depth examination of identified MOUT TOE issues.

WAY AHEAD

26. Proposed Way Ahead. Subject to approval by NATO LG/8, the proposed output of the MOUT Simulation WG should be a technical document and briefing to NATO after a period not exceeding 2 years. The intention will be to investigate certain emerging technologies that offer benefit to simulation systems addressing MOUT, standardise areas for future MOUT and potentially improve the interoperability between nations (should that be required). The technical document will focus on best practice, draft technical solutions, and if possible recommend open standards.

Annex C – RESULTS OF QUESTIONS SUBMITTED TO FIBUA/MOUT WORKING GROUP ON USE CASES

C.1 INTRODUCTION

These are the results of the 10 questions submitted to the FIBUA/MOUT Working Group (WG) in April 2004 on the USE CASES described in Chapter 2. The answers provided an important cross-check of the USE CASES identified by the UCATT WG and the "needs and tasks", identified in the FIBUA/MOUT WG.

C.2 RESULTS

Questions	USE CASE 1: Live MOUT training – Multi-national force on national site	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

1) What objective(s) do you think the commander would like to train?	• PSO/PEO
	• Landscape
	• Social environment (language, economy, laws, traditions)
	• Population
	• Political situation
	• Factions
	• Logistics
	• Team building:
	  • Coordination
	  • Communications
	  • Rules of engagement
		• Destroying UAV/ Robots/etc.	• Co-operation/ working together/ team building/ procedures within staff, commanders lines, units (functional and technical)
			• Train/rehearse doctrine and ROE, if gaps are discovered, procedures should be extended
				• Peace-keeping during election period
				• Interoperability ground-sea-air and nations/unit levels
				• Staff training
				• Train your intelligence staff
				• Checkpoint
				• Crowd control
				• SWAT
				• Security controls (entrance to voting places)
					• Train staff in the way the commander operates
					• How he wants to be organised
					• Information flow
					• Understanding of doctrine and procedures

Questions	USE CASE 1: Live MOUT training – Multi-national force on national site	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
1) What objective(s) do you think the commander would like to train? (cont'd)	• Task Force • Organisation (chain of command) • House clearing • Patrolling • CRC (crowd riot control) • Information war (cyber space)		• Train/rehearse the specific mission, scenarios (aspects are plans, assets, units)	• Escorting convoys and people • Close air support • Evacuation	
2) What kind of risks does the training eliminate?	• BLUFOR identity, (reduce personnel losses, equipment damage) • Interaction within the units • Miscommunication • Escalation of power (show of force, controlled reaction)	• Eliminate enemy technical threats • Own casualties • Keep hostage alive	• Misunderstanding, misinterpretation of each other / mission / commander's intent • Weak elements in the planning • Improper use of assets	• Prevent situations getting out of control • Keeping law and order • Keeping the troops calm • Prevent misunderstanding between troops • Build up the minds • Not to have the right information • Not to over-react • To bring everybody on the same level and understanding of the situation	• Ensures staff understands how commander operates • Provides clear understanding of the organisation • Establishes work process and information handling • Common understanding of doctrine and procedures • Logistic problems • ROE inconsistencies • Misunderstanding of national capabilities

Questions	USE CASE 1: Live MOUT training – Multi-national force on national site	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
2) What kind of risks does the training eliminate? (cont'd)				• Govern the basic skill on each level • To be sure on the ROE • To be killed	

3) What type of actions/situations would you like to train for?	• Checkpoints (vehicle/people searches)
	• Objective approach
	• Crowd control
	• House clearing
	• Refugees
	• Rural and terrorist operations
	• Patrolling
	• NBC
	• Protection of Red Cross aid
	• Train new police force
		• Entering and fighting in a modern building	• The whole spectrum:
			  • Peace-keeping/ peace-enforcing
			  • High intensity conflict / urban ops / asymmetric warfare
			  • Non-combatant evacuation
			  • Humanitarian relief ops
			  • Hostage rescue ops
				• Adapted for each level, single and joint (army, navy, air force)
				• Riot control (day/night)
				• Rules of engagements
				• Check-points
				• Search operations (house, vehicles, ships…)
				• Staff training
				• Communication
				• Patrolling urban areas
				• Patrolling urban seaside, harbour (Navy)
				• How to support the organisation of election
					• Practice planning
					• Course of action analysis
					• Decision process
					• Dissemination of plan
					• Plan execution and monitoring

Questions	USE CASE 1: Live MOUT training – Multi-national force on national site	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
3) What type of actions/situations would you like to train for? (cont'd)				• Support the CIMIC/NGO activities (logistics/medics) • Worst case scenario, rapid reaction force • Insertion of snipers, recon, HUMINT, etc. • Support from Air/Navy	

4) What are the most important training moments for the individual soldiers/ units?	• Self defence
	• Threats
	• Communications
	• Live firing
	• Contact with local people (establish rapport)
	• Unwarranted attacks
	• Decisive actions
		• Close in on the enemy
		• Opening a building
		• Worse case scenario
		• Fighting with integrated IT environment
			• To experience the transition from the training situation to the "real situation" as close to reality as possible (at distributed locations)	• Soldiers:
				  • Basic skills
				  • Situation awareness (ROE)
				  • Social and political environment
				• Units:
				  • Working together
				  • Capability (100 against 100,000)
				  • Where are our limits?
				• Understanding the situation and keeping focussed on the task
				• Minimise use of force
					• Gain understanding of the overall command process that will be in place once deployed (gathering and sharing background information)
					• Gain an awareness of the capabilities of each nations forces assigned
					• Gain an understanding of how the staff intends to operate (collaborative planning process)

Questions	USE CASE 1: Live MOUT training – Multi-national force on national site	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
4) What are the most important training moments for the individual soldiers/ units? (cont'd)					• Operating efficiently (event driven practice) • Analyze and assess performance (prepare and conduct AAR)

5) Make a time schedule of this exercise, Planning, Preparation, Exercise, AAR?	• Schedule block time for the range
	• Staff – build multiple scenarios within first 2 weeks
	• 1 week training of basics engagement skills
	• 1 week joint training
	• 1 week on attack procedures/process
	• Ensure targetry has right silhouettes available and sufficient supply
	• Expedite the AAR turn time, use results for additional training requirements
		• Preparatory planning (Can be weeks before):
		  • Schedule period
		  • Intel gathering (photos, building, area, weather, etc.)
		• Preparation (Can be weeks before):
		  • Developing scenario, OPORD, etc.
		  • Coordination with Swiss training centre
		  • Basic training with ADL and SIM
			• There should be several exercises, from low (unit) level to CJTF, to include staff exercises
			• Planning and preparation should be as short as possible
			• Exercises should be as intense as is possible
			• AAR should be delivered as quickly as possible (multi-level)
				• Schedule
				• D-45 Scheduling training
				• D-35 Staff training, basic skills
				• D-25 Unit training (staff integrated)
				• D-15 Examine, rehearsal
				• D-10 Training and preparing theatre area
				• D-0 Be prepared
					• Does not drive training requirements
					• D-130 Stand up Bde HQ
					• D-120 Train Bde HQ
					• D-60 CPX I at Bde/Bn level/AAR following
					• D-30 CPX II/AAR following
					• D-Deployment

Questions	USE CASE 1: Live MOUT training – Multi-national force on national site	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

5) Make a time schedule of this exercise, Planning, Preparation, Exercise, AAR? (cont'd)		• Breakdown of training:
		  • Day 1: Training in use of own electro tech equipment
		  • Day 2: Individual drills in urban fighting
		  • Day 3: Group training
		  • Day 4: Task related
		  • Day 5: Task related
		  • Every day an AAR will be conducted			

6) Do you think it is necessary to train together as a task force? (Explain your answer)	• Absolutely as the task force must understand how each other operate in order to identify the weaknesses/ capabilities of each other. This will help establish the training objectives that must be accomplished	• Yes it is necessary, because we always have to do. For example:
		  • To work together with helicopters for entering the house from the top and/or by coming down by rope
			• Yes, "train as you fight"	• Yes
				• Staff training up to brigade level
				• Live training up to company (battalion) level
				• Yes, because we have:
				  • Different languages, TTPs, systems, logistics
					• Yes in order to achieve operational effectiveness you must train together prior to operational deployment
					• Ideal solution is centralised staff, optional is distributed)

Questions	USE CASE 1: Live MOUT training – Multi-national force on national site	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
6) Do you think it is necessary to train together as a task force? (Explain your answer) (cont'd)	• Need to understand different national procedures/ equipment, special compositions of forces	• To work together with a doctor/ medical squad/ section • To work together with an engineer platoon/troop • To work together with a CIMIC		• Mainly staffs but also be able to support/ reinforce units	
7) Do you think that this USE CASE is or will be a realistic scenario?	• Yes, however the task force identified is too small. Would also need to know how long the operation will last?	• Could be	• Yes	• All 15 million people in one city? Is not really realistic, even if it is about historical reasons • Yes. But need more units to solve	• Yes but needs to be more precise in wording
8) Could you describe (in headlines) the training system that you would like to have for this training (2 slides	• OPFOR (force on force capability) • Live fire training • Fully instrumented indoor/outdoor system • Staff and commanders should be training different scenarios	• Advance TES (non-laser based), to shoot through walls • NLW • Live/virtual training facility	• Embedded exercise control at all levels (e.g. data capture, integrate several local situations into one common scenario) • Layered exercise control: • Distributed staff (including C-CJTF)	• Staff training – multi-media training system (online video, online pictures on a constructive/virtual training system, or embedded system in our C4I with access to public information sources	• Distributed • Secure • Real time voice and video to emulate tactical comms • Full tactical digital information exchange • Common operational lexicon

Questions	USE CASE 1: Live MOUT training – Multi-national force on national site	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
8) Could you describe (in headlines) the training system that you would like to have for this training (2 slides) (cont'd)	• Task force to build upon those scenarios • Interactive training (tactical training for the task force) • Perhaps a language conversion system (Interpreter device) • Add BUGALAND virtual environment to scenarios, if possible • Mobile training systems to take to BUGALAND (mission area)		• National staff elements • National units • Highly automated AAR functions to minimise training staff personnel • Integration between live and virtual. Only down to certain levels (e.g. company/ squadron)	• Unit training – Live training system which allows to train to the engagement of all engaged weapon systems including non-lethal weapons, etc., in urban environment • Staff trainer – Computer Assisted Exercises (CAX) • PsyOps • Force-On-Force trainer system (laser)	• Reliable exercise comms and network • Comprehensive and compatible constructive simulation • Common terrain and environment database • Exercise management system • Capability to prepare and distribute AAR to training audience
9) Make a list of interoperability aspects?	• Command, Control, Communication, Computers, Intelligence, Reconnaissance (C4ISR) systems • Logistics • Command and Control • Sight Recognition (presentation devices)	• High speed data • Coded data (security) • TES • Non-laser based	• C4I interoperability is given/assumed • Supply/medivac procedures, also legal aspects of cross supply (for example use of ammunition) • Data-exchange between national training sites and C4I systems	• C4I training system (for staff training) • Interoperability with WESS and TESS • C4I • ROE • Training systems • Tactics/techniques/ procedures (TTP)	• C4I information sharing • Training information sharing • System performance to support common environment and terrain database • Language translation and interoperability

Questions	USE CASE 1: Live MOUT training – Multi-national force on national site	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
9) Make a list of interoperability aspects? (cont'd)	• Feedback (AAR)				
10) Make a list of legal aspects?	• Safety regulations • Environmental regulations • Rules of engagement • Local culture (Religion, structure) • Is there a UN procedure already in place to handle legal issues? • Treatment of prisoners of war • Personal rights	• NLW • Opening fire • ROE	• C-CJTF must have authority to give orders to and to control staff and units • Authorised and safe communication lines • ROE, including cultural/religious heritage • Treatment of POW, refugees • Understand legal aspects of cultural differences	• Mandates • ROE • Training (safety) • Use of civilian property	• National/ International ROE • UN mandates • Cultural awareness • National boundaries • National political sensitivities • Alliances and treaties • Frequency allocations

Annex D – FIBUA/MOUT REGISTER

The FIBUA/MOUT Website is a restricted website that is accessible by password and is located at www.fibuamoutsite.info. Its purpose is to provide information related to FIBUA/MOUT training sites, best practice (tactics and training), new technology and general news items related to urban training.

Figure D-1 illustrates the MOUT Sites webpage. As clearly stated in the text at the top of the page it relies on member nations to input the necessary detail.

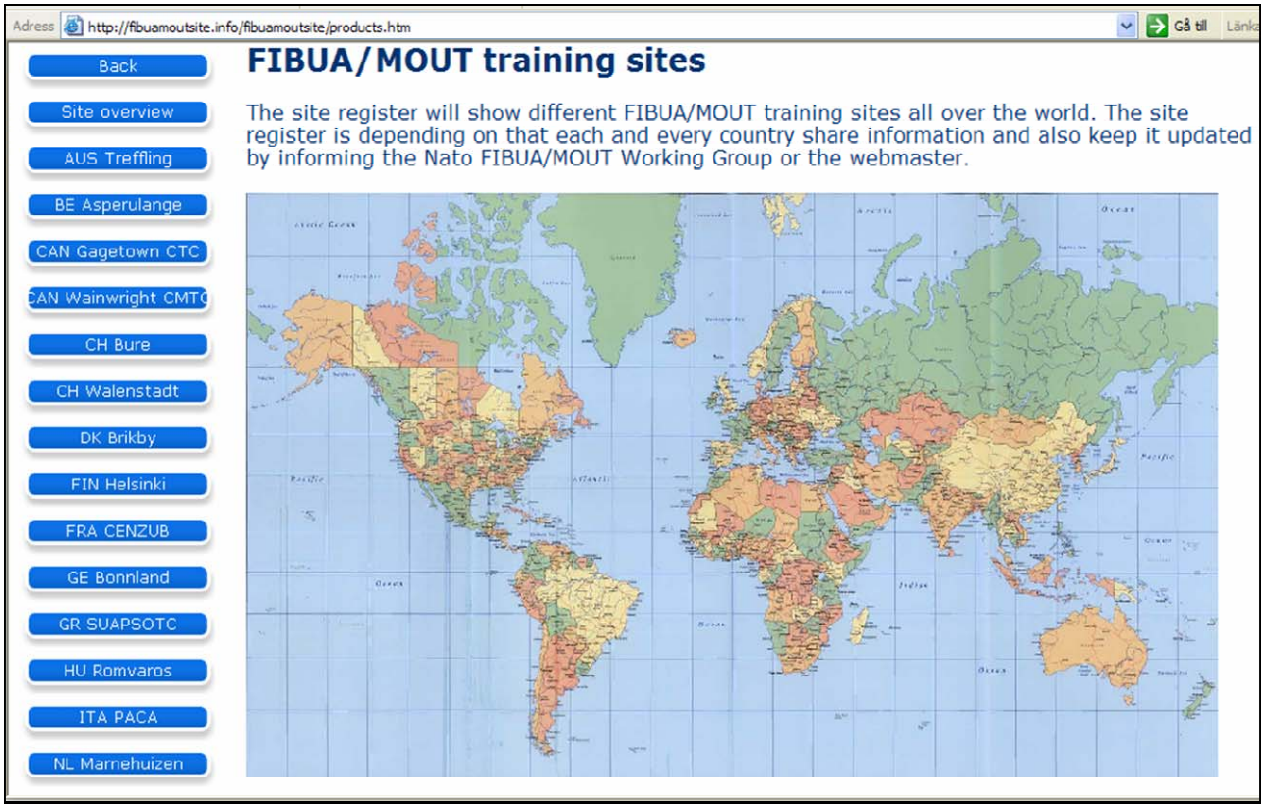


Figure D-1: Screenshot from FIBUA/MOUT Website.

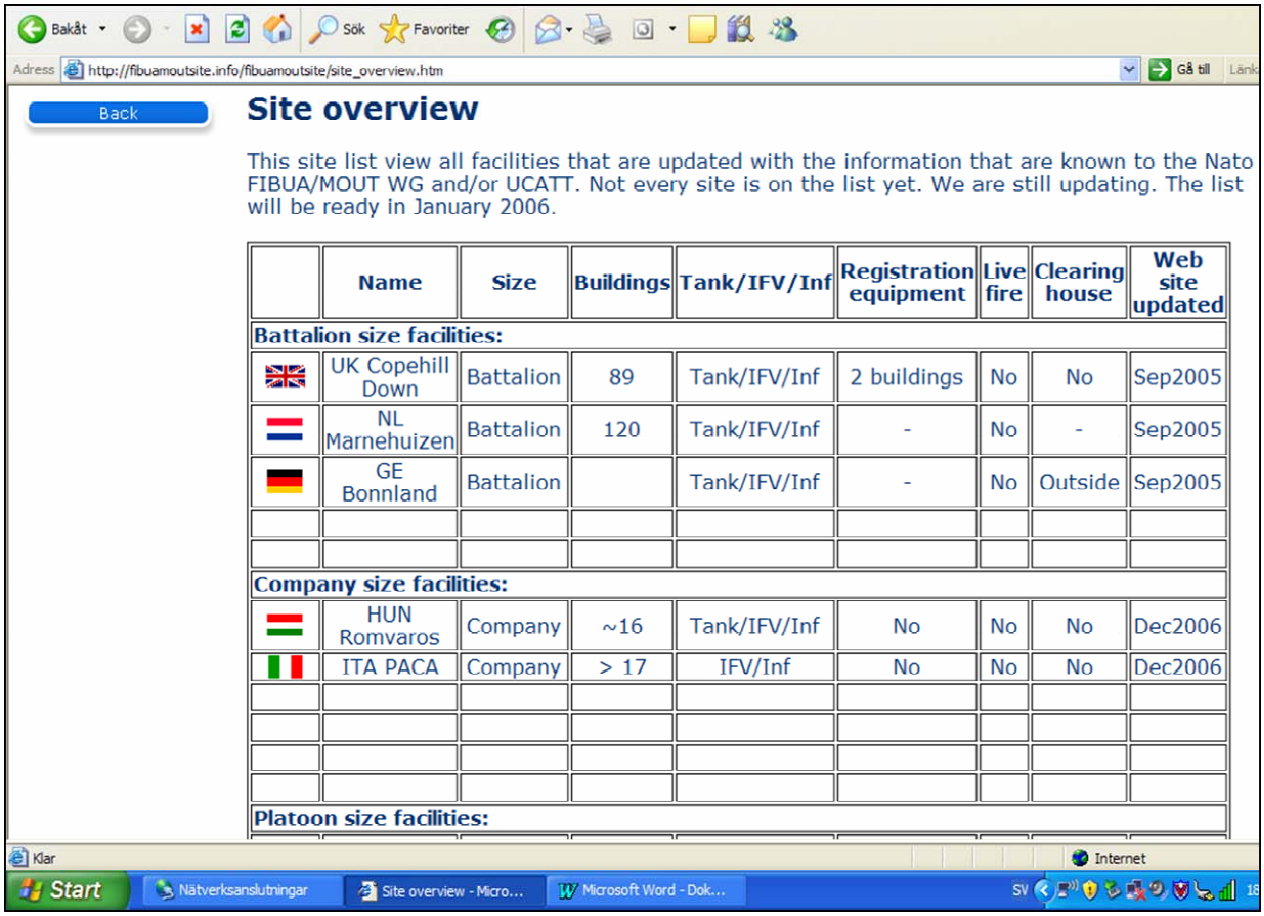


Figure D-2: Site Overview Screenshot from FIBUA/MOUT Website.

Annex E – EXAMPLE OF BEST PRACTICE FOR THE OBSERVER CONTROLLER FUNCTION IN SUPPORT OF INFANTRY BATTALION EXERCISE

E.1 INTRODUCTION

As a result of a Syndicate discussion at a meeting of the FIBUA/MOUT WG they made the following suggestions regarding the functions of an Observer Controller (O/C). They defined the function as having two sub-functions:

- **Observer** – Observing and taking notes (Monitoring); and
- **Controller** – Should/can interfere in the conduct of the exercise and supports the conduct of the After Action Review (AAR).

E.2 O/C REQUIREMENTS IN SUPPORT OF AN INFANTRY BATTALION EXERCISE

The following are the O/C requirements for an Infantry battalion exercise suggested as best practice:

- **O/C Capabilities** – The O/C will require the capability to:
  - Monitoring of radio/communication on the unit/sub-unit network; and
  - Monitoring of radio/communication on the O/C net.
- **Soldier/Two-Man Team (1-2)** – 1 x O/C unless training is at a basic level, in this case the task may need additional O/C. Main responsibility will be:
  - Monitoring every soldier (by eyes on observation) focussing on basic skills/drills.
- **Squad/Section Group (6-10)** – 1 or 2 x O/C unless training is at a basic level, in this case the task may need additional O/C. Responsible for monitoring squad/section network, (platoon network) and the O/C network both Blue Forces and Opposing Forces (OPFOR). Key tasks are to:
  - Focus on squad/section leadership and Command and Control (C2);
  - Focus on use of support weapons and Infantry Fighting Vehicles (IFV);
  - Monitoring 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);
  - Be able to switch between graphics/images by clicking icons (soldier/weapon/sensors);
  - Be able to activate/deactivate the enemy;
  - Be able to activate/deactivate targets/effects; and
  - Be able to split up into two O/C (with communications).

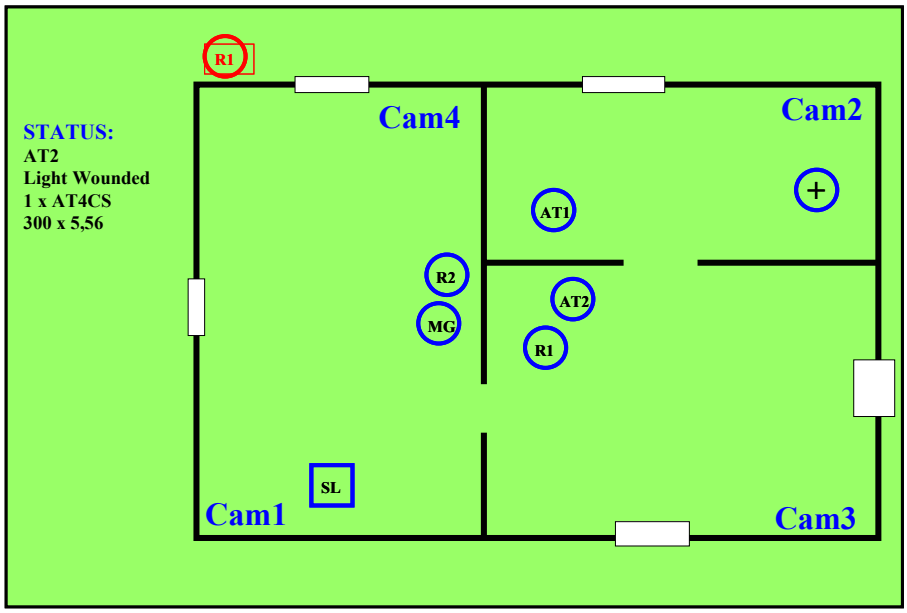


Figure E-1: PDA Type Display.

- **Platoon** – 1 x O/C to follow Platoon Leader/Commander, 1 x O/C per squad/section (maximum effort). Responsible for monitoring platoon network, (company network) and the O/C network both Blue Forces and Opposing Forces (OPFOR). Key tasks are to:
  - Focus on platoon leadership and C2;
  - Focus on use of support weapons and IFV;
  - Monitoring every squad (soldier), support weapon in platoon using where available "on-line" portable display type equipment such as PDA to provide dynamic information (e.g. location, status, images and overlays);
  - Be able to switch between graphics/images by clicking icons (soldier/weapon/sensors);
  - Be able to activate/deactivate OPFOR; and
  - Be able to activate/deactivate targets/effects.
- **Company** – 1 x O/C to follow Company Commander, 1 x 2ic, 1 x O/C per platoon (maximum effort) and 1 to 3 x O/C to monitor Support systems (combat support, combat service support). Responsible for monitoring company network, (battalion network) and the O/C network both Blue Forces and Opposing Forces (OPFOR). Need for controlling safety on squad/section (Safety team dependent on scenario). Key tasks are to:
  - Focus on company leadership and C2;
  - Focus on support weapons and IFV and Tanks);
  - Monitoring every platoon (squad), support weapon in company using where available "on-line" portable display type equipment such as PDA to provide dynamic information (e.g. location, status, images and overlays);
  - Be able to switch between graphics/images by clicking icons (soldier/weapon/sensors);
  - Be able to activate/deactivate the enemy; and
  - Be able to activate/deactivate targets/effects.

- **Battalion** – 4 x O/C to follow Battalion Staff, 2 x O/C per company (maximum effort). O/C employment will depend on battalion organisation and exercise scenario. Responsibility for monitoring battalion network, (brigade network) and the O/C network both Blue Forces and Opposing Forces (OPFOR). Need for controlling safety on squad (Safety team dependent on scenario):
  - Focus on Battalion leadership and C2;
  - Focus on support weapon and battalion level functions;
  - Monitoring every company (platoon), support weapons in battalion using where available "on-line" portable display type equipment such as PDA to provide dynamic information (e.g. location, status, images and overlays);
  - Be able to switch between graphics/images by clicking icons (soldier/weapon/sensors); and
  - Be able to activate/deactivate the enemy.

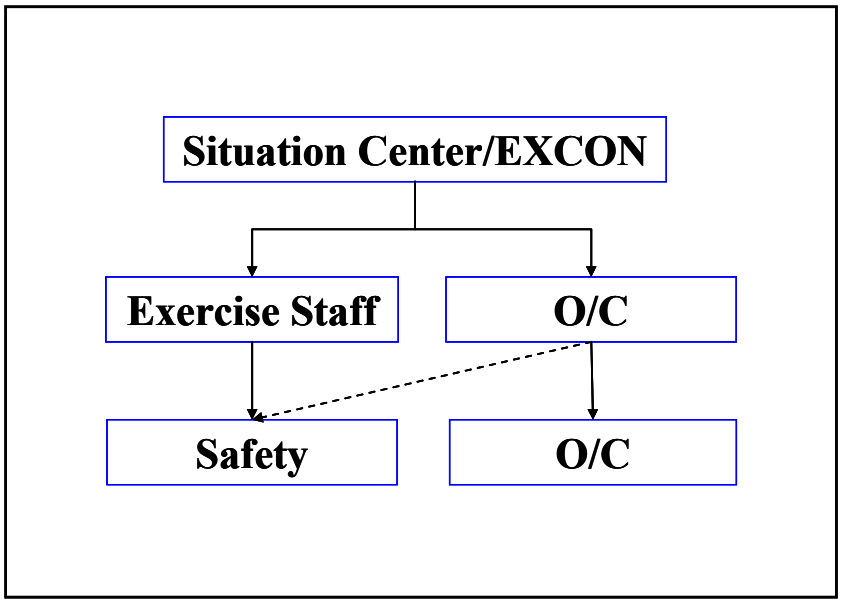


Figure E-2: Exercise Supporting Staff Structure.

Annex F – CAPABILITY REQUIREMENTS MATRIX

Colour Coding of the Requirements	
G	This is a functional requirement relevant to the functional architecture
Y	Design constraint
A	This requirement is a duplicate, it is covered by one or more other requirements
R	This is not a functional requirement relevant to the functional architecture

GENERAL OPERATIONAL CAPABILITIES					
	1) Provide Linkages to:				
G		a) Virtual training environment			
G		b) Constructive training environment			
G		c) C4I systems			
G		d) Other live instrumentation systems			
	2) Support:				
G		a) Legacy/analogue training units			
G		b) Modernised/digital training units			
G		c) Unclassified training events			
G		d) Classified training events			
G		e) Training level from individual soldier up through brigade staff (including multi-national joint and 3 block war)			
G		f) Current multi-national doctrine and TTPs			
	3) Support Operational Concept – Continuous Support:				
Y		a) Up to 24 hours/day			
Y		b) Up to 300 days/year			
Y		c) Maximum exercise duration:			
Y			1) 1 day		
Y			2) 3 days		
Y			3) 5 days		

GENERAL OPERATIONAL CAPABILITIES (cont'd)					
		3) Support Operational Concept – Continuous Support (cont'd):			
Y		c) Maximum exercise duration (cont'd):			
Y			4) 7 days		
Y			5) 10 days		
		4) Support Concept:			
R		a) Military organisational			
R		b) Contractor support			
		5) Must:			
Y		a) Not interfere with surrounding systems such as tactical systems or aircraft			
Y		b) Function effectively for a minimum of 10 years			
G		c) Frequency assignment – maximise use of tactical spectrum/adjustable/ tuneable via software			
		6) Training Environment:			
G		a) Single house 1 floor			
G		b) Single house multi-floor			
G		c) Multi-storey building			
G		d) Small village 4 – 6 buildings (various types of buildings):			
G			1) 2 to 3 Streets		
G			2) Cellar/basements		
G			3) Sewer system		
G		e) Small town up to 16 buildings (various types of buildings):			
G			1) 3 Streets		
G			2) Cellar/basements		
G			3) Sewer system		
G		f) Average city 80 to 100 buildings (various types of buildings):			
G			1) Number of streets		

GENERAL OPERATIONAL CAPABILITIES (cont'd)					
	6) Training Environment (cont'd):				
G		f) Average city 80 to 100 buildings (various types of buildings) (cont'd):			
G			2) Cellar/basements		
G			3) Sewer system		
G		g) Provide the capability to replicate basic infrastructure (such as medical support, food, water, power, etc.) of the training environment for a small village to average city			
	7) Training Exercises:				
G		a) Support live fire accommodating:			
G			1) Short Range Training Ammunition (SRTA)		
G			2) Long Range Training Ammunition (LRTA)		
G			3) Frangible ammunition		
G			4) Universal Training Ammunition (UTM)		
G			5) Sub-calibre Special Effect Small Arms Marking system (SESAM)		
G			6) Sim munition (F/X)		
G			7) Precision gunnery simulation		
G			8) Direct Fire Weapon Effects System (DFWES)		
G			9) Live or ball ammunition		
G		b) Support Force-On-Force (FOF) accommodating:			
G			1) Sub-calibre Special Effect Small Arms Marking system (SESAM)		
			2) Sim munition (F/X)		
G			3) Precision gunnery simulation		

GENERAL OPERATIONAL CAPABILITIES (cont'd)					
		7) Training Exercises (cont'd):			
G		b) Support Force-On-Force (FOF) accommodating (cont'd):			
G			4) Tactical Engagement Simulation (TES)		
G		c) Support Force-On-Target (FOT) accommodating:			
G			1) Sub-calibre Special Effect Small Arms Marking system (SESAM)		
G			2) Sim munition (F/X)		
G			3) Precision gunnery simulation		
G			4) Tactical Engagement Simulation (TES)		

PERFORMANCE CAPABILITIES					
		1) Exercise Planning:			
Y		a) Long-range (180+ day out):			
Y			1) Selection of missions		
Y			2) Determination of tasks		
Y			3) Establishment of training objectives and measures		
Y			4) Development of task organisation		
Y		b) Short-range (90 – 180 day out):			
Y			1) Cross-reference of training events and objectives		
Y			2) Identification and allocation of resources		
Y			3) Coordination with support agencies		
Y			4) Publication of training guidance and a planning calendar		

PERFORMANCE CAPABILITIES (cont'd)					
	1) Exercise Planning (cont'd):				
Y		c) Near-term (30 – 90 days out):			
Y			1) Allocation of resources		
Y			2) Publication of schedule		
Y			3) Provision of training execution and evaluation		
	2) Scenario Development:				
G		a) Create/modify operational plans			
G		b) Use/modify archived scenarios			
G		c) Create custom-designed graphics and symbols			
G		d) Use/generate digital terrain data			
G		e) Provide scenarios with the capability to:			
R			1) Represent appropriate tactics and behaviours for civilian paramilitary forces, non-combatants, and vehicles		
G			2) Provide multi-sided, multi-force combat operations; i.e. more than two-sided, red versus blue, to include Civilians On the Battlefield (COB), guerrilla forces, and other friendly and opposing forces as required for realistic combat operations		
R			3) Represent appropriate international, regional, and local situation in the context of population, ethnic, cultural and political factions		

PERFORMANCE CAPABILITIES (cont'd)					
	3) System Preparation:				
G		a) System installation:			
G			1) Mount or embed Tactical Engagement System (TES):		
G				a) Dismounted personnel	
G				b) Vehicles	
G				c) Weapons	
G				d) Aircraft	
G				e) Combat boats	
Y			2) Install must not require any permanent or irreversible modification to personal equipment or platforms (unless modifications are approved by systems manager)		
Y			3) Use vehicle/weapon platform power sources, sensors, etc. (to use existing power sources to reduce additional power sources needed to operate the system)		
Y			4) Install on/interface with host prior to unit draw and perform function within 5 minutes of power application		
Y			5) Install on/interface with host prior to unit draw and perform function within 25 minutes of power application for aircraft		

PERFORMANCE CAPABILITIES (cont'd)					
	3) System Preparation (cont'd):				
G		a) System installation (cont'd):			
Y			6) Mobile and conformable components:		
Y				a) Automatically recognised, control and communicate with system peripherals	
Y				b) Standardised "quick" connect/disconnect plug	
Y		b) Site preparation:			
Y			1) Type of facility:		
Y				a) Fixed site	
Y				b) Mobile or transportable unit	
Y				c) Distributed	
Y			2) Standardised "quick" connect/disconnect plug		
Y			3) Mission capable:		
Y				a) Fixed site within 6 hours of notification	
Y				b) Mobile or transportable unit within 4 hours of notification	
Y			4) Mobile or transportable unit must be configured and tested within 24 hours of arrival at training site		
A		c) Scenario preparation:			
A			1) Capable to develop and use standardised and tailorable scenario to meet training objectives		

PERFORMANCE CAPABILITIES (cont'd)					
	3) System Preparation (cont'd):				
A		c) Scenario preparation (cont'd):			
A			2) Provide for exercises control required to support training objectives through:		
A				a) Target and sensor actuation events	
A				b) Battlefield visualisations simulation/ stimulation	
A				c) Threat simulations	
G		d) System initialisation:			
G			1) Capable to bring to a mission-capable condition to support the exercises		
G			2) Be able to initialise all or selected part of the system on command		
G			3) Resume initialisation on command		
G			4) Set system components and software to unit-specific condition to establish the configuration required to support the exercise		
G			5) Enter unit-specific initialisation data to support the exercise		
G		e) Exercise rehearsal – verify functions before full initialisation (self-test subcomponents)			
G		f) Readiness verification – verify readiness of system to support:			
G			1) Perform pre-exercise checks/test to report ready status of system components		

PERFORMANCE CAPABILITIES (cont'd)					
	3) System Preparation (cont'd):				
G		f) Readiness verification – verify readiness of system to support (cont'd):			
G			2) Generate listing of initialisation data and results		
	4) Exercise Execution:				
G		a) Capable of:			
G			1) Collect, manage, and analyze voice data		
G			2) Collect, manage and analyze video data		
G			3) Collect, manage, and analyze digital exercise data		
R			4) Live role playing		
G			5) Communications with field components		
G			6) Communications with trainers (Observers/ Controllers)		
G			7) Communications with staff components		
G			8) Monitor status of the total system, including distributed components (e.g. other sites)		
G		b) Combat area simulation:			
G			1) Provide doctrinally accurate representation of terrain:		
G				a) Leveraging synthetic environment	
G				b) Warfighting system battlefield visualisation	
G				c) Tactical system digital terrain	

PERFORMANCE CAPABILITIES (cont'd)					
		4) Exercise Execution (cont'd):			
G		c) Weapon simulation:			
G			1) Simulate the engagement and physical/structure damage and casualty producing effects of:		
G				a) Direct weapons and munitions	
G				b) Indirect weapons and munitions	
G				c) Air delivered weapons and munitions	
G				d) Non-lethal weapons and munitions	
G				e) Hand grenades	
G				f) Thermo baric	
G			2) Simulate the effects of weapon engagement data causing visual collateral damage without any permanent damage to the structure		
G		d) Environment hazards simulation:			
G			1) Simulate the physical/structure damage and casualty producing effects of:		
G				a) Environmental	
G				b) Industrial	
G			2) Simulate the effects of environmental and/or industrial without any permanent damage to the structure or inducing health factors on role players or soldiers		

PERFORMANCE CAPABILITIES (cont'd)					
		4) Exercise Execution (cont'd):			
G		e) Target control:			
G			1) Provide or enable the capability to synchronise target, sensor or stimulator presentation functions for:		
G				a) Live fire exercises	
G				b) Force-On-Target exercises	
G				c) Force-On-Force (FOF) exercises	
G			2) Allow to interface with existing or future targets system		
G			3) Allow the operator the ability to:		
G				a) Run complete scenario automatically by time control	
G				b) Run complete scenario automatically by event control	
G				c) Run scenario on command	
G				d) Start scenario from any step in the scenario	
G				e) Stop the scenario on command at any step in the scenario	
G				f) Restart the scenario at any step in the scenario	
G				g) Modify the scenario	
G				h) Change from on scenario to another scenario	
G			4) Enable targets or stimulator randomly		

PERFORMANCE CAPABILITIES (cont'd)					
	4) Exercise Execution (cont'd):				
G		f) Target control (cont'd):			
G			5) Use or enable pre-selected scenarios for targetry stimulator arrays		
	5) Role Players:				
G		a) Provide multi-sided faceted urban environment to include Civilians On the Battlefield (COB), guerrilla forces, and other friendly and opposing forces as required for realistic combat operations			
G		b) Provide the capability to replicate the basic urban infrastructure of civil administration (justice, law enforcement, etc.) as required for realistic combat operations			
	6) Targetry:				
G		a) Human target presentation:			
G			1) Presentation of thermal signature and exposure of:		
G				a) Friendly target	
G				b) Neutral target	
G				c) Threat target	
G			2) Reconfigurable targets in:		
G				a) Sitting	
G				b) Standing	
G				c) Kneeling	
G				d) Prone position	
G			3) Targets must react to the effect of a variety of hand grenades		
G			4) Targets must respond appropriately after a realistic weapon engagement		

PERFORMANCE CAPABILITIES (cont'd)					
		6) Targetry (cont'd):			
G		a) Human target presentation (cont'd):			
G			5) Shoot back target signature/simulate flash, bang and smoke of threat weapon engagement		
G			6) Will have the capability to adjust to response from 1 – 10 seconds		
G			7) Provide two way audio to replicate normal human interaction		
G			8) Provide animation to replicate normal human interaction		
Y			9) Provide a thermal signature		
Y			10) Must be able to react to all types of training exercises		
G			11) Will stimulate battlefield combat identification capabilities at extended ranges		
G		b) Vehicle target presentation:			
G			1) Wheeled vehicle targetry must be:		
G				a) 2 dimensional	
G				b) 3 dimensional	
G			2) Provide a thermal signature		
G			3) Must provide audio and visual feedback after a realistic weapon engagement		
G			4) Must be programmable and operate by remote control/self propel		

PERFORMANCE CAPABILITIES (cont'd)					
		6) Targetry (cont'd):			
G		b) Vehicle target presentation (cont'd):			
G			5) Must respond to hit placement recognition		
G			6) Shoot back target signature/simulate flash, bang, and smoke of threat weapon engagement		
G			7) Provide two-way audio to replicate normal vehicle interaction		
G			8) Provide animation to replicate normal vehicle interaction		
Y			9) Provide a thermal signature		
Y			10) Must be able to react to all types of training exercises		
G			11) Will stimulate battlefield combat identification capabilities at extended ranges		
		7) Data Collection:			
G		a) Capable of:			
G			1) Collect, verify, record, transmit and receive voice:		
G				a) Inside buildings; at minimum:	
G					i) Stairwell
G					ii) Room
G					iii) Hallway
G					iv) Tunnel/sewer system
G					v) Tunnel entry/access areas to include basement
G				b) Rooftops	
G				c) Outside buildings	

PERFORMANCE CAPABILITIES (cont'd)					
		7) Data Collection (cont'd):			
G		a) Capable of (cont'd):			
G			2) Collect, verify, and record video:		
G				a) Inside buildings; at minimum:	
G					i) Stairwell
G					ii) Room
G					iii) Hallway
G					iv) Tunnel/sewer system
G					v) Tunnel entry/access areas to include basement
G				b) Primary approach into:	
G					i) Rooftops
G					ii) Outside buildings
G			3) Collect, verify, and record digital force-on-force exercise data		
			4) Collect, verify, and record live fire exercise data		
G			5) Interface with exercise systems		
G			6) Interface with external systems:		
G				a) Constructive systems	
G				b) Virtual systems	
G				c) Other live training systems	
R			7) Interface with devices link to and supporting the exercise		
G			8) Data must be collected by:		
G				a) Force (combat, combat support and combat service support, special operations forces (SOF), etc.):	
G					i) Battle status by echelon
G					ii) Troop status by echelon

PERFORMANCE CAPABILITIES (cont'd)					
		7) Data Collection (cont'd):			
G		a) Capable of (cont'd):			
G			8) Data must be collected by (cont'd):		
G				b) Warfighting platform (weapon type and unique ID)	
G				c) Echelon (team, squad, platoon, and company team)	
G				d) Army universal task list and battlefield operation system	
G			9) Collect and interpret/ process digital training performance data to minimise training staff		
G			10) Time tag in near real-time:		
G				a) Position location	
G				b) System status	
G				c) Voice/video	
G				d) Tactical Engagement Simulation (TES) data for:	
G					i) Exercise participants
G					ii) Vehicles
G					iii) Aircraft
G					iv) Selected support personnel, vehicles, aircraft within maneuver area and surrounding airspace
G			11) Store all essential exercise data		
G			12) Provide position location (X,Y,Z axis) down to individual instrumented level:		
G				a) Indoor	
G				b) Outdoor	

PERFORMANCE CAPABILITIES (cont'd)					
	7) Data Collection (cont'd):				
G		a) Capable of (cont'd):			
R			13) Record and display position location for fixed and rotary wing (transport, scout, and attack) aircraft operating in the urban training maneuver area		
Y			14) All collection devices must:		
Y				a) Be unobtrusive to the training unit	
Y				b) Operate and withstand all type of environmental conditions	
Y				c) Operate and withstand all type of scenarios:	
Y					i) Short Range Training Ammunition (SRTA)
Y					ii) Long Range Training Ammunition (LRTA)
Y					iii) Universal Training Ammunition (UTM)
Y					iv) Sub-calibre Special Effect Small Arms Marking system (SESAM)
Y					v) Precision gunnery simulation
Y					vi) Tactical Engagement Simulation (TES)
Y					vii) Ball ammunition /service ammunition
Y				d) Operate in artificial conditions (i.e. obscurants (smoke))	

PERFORMANCE CAPABILITIES (cont'd)					
	7) Data Collection (cont'd):				
G		b) Interface with and integrate rotational units:			
G			1) Tactical command, control, communications, computer and intelligence system		
G			2) External simulator or simulations linked to constructive and virtual synthetic environment exercises		
G		c) Display:			
G			1) Computer generated position location graphics showing location of all players (personnel, vehicles, aircraft, etc.) and movement throughout the urban operation training area		
G			2) Alerts when fratricide incident occur		
G			3) Engagement simulation events		
G			4) Battlefield situation using:		
G				a) Joint graphics/ symbols	
G				b) NATO graphics/ symbols	
G				c) Other country specific graphics/ symbols	
	8) Data Management:				
G		a) Capable of:			
G			1) Editing, recording, retrieving and processing:		
G				a) Targetry exercise data	

PERFORMANCE CAPABILITIES (cont'd)					
	8) Data Management (cont'd):				
G		a) Capable of (cont'd):			
G			1) Editing, recording, retrieving and processing (cont'd):		
G				b) Tactical engagement simulation exercise data	
G				c) Voice exercise data	
G				d) Video exercise data	
G				e) Digital exercise data	
G			2) Manipulating data to display battle events at workstations with:		
G				a) Position location	
G				b) Date/time synchronisation	
G				c) Textual and graphical data	
G			3) Organise, sort, collate, distribute and display:		
G				a) Targetry exercise data	
G				b) Tactical engagement simulation exercise data	
G				c) Voice exercise data	
G				d) Video exercise data	
G				e) Digital exercise data	
G			4) Retrieve and process casualty/damage assess for:		
G				a) Direct weapons engagement simulations	
G				b) Area weapons engagement simulations	
G				c) Nuclear, biological, and chemical engagement simulations	

PERFORMANCE CAPABILITIES (cont'd)					
	8) Data Management (cont'd):				
G		a) Capable of (cont'd):			
G			4) Retrieve and process casualty/damage assess for (cont'd):		
G				d) Electronic warfare engagement simulations (including jamming)	
G				e) Information warfare	
G			5) Selectively retrieving, process, distributing and displaying exercise data at:		
G				a) Group workstations	
G				b) Individual workstations	
G				c) In central analysis facilities	
G				d) In remote analysis facilities	
G			6) Entering, recording, retrieving, editing and displaying textual and graphical data at workstations		
G			7) Determine movement and speed of movement of exercise players		
G			8) Organise digital training performance data in data structures to prepare to build the after action review		
G			9) Retrieve and process digital training performance data to replay exercise history to support performance analysis and feedback		
G			10) Provide capability to prepare, scan, and edit graphic control measures in accordance with current operational symbology and graphics		

PERFORMANCE CAPABILITIES (cont'd)					
	8) Data Management (cont'd):				
G		a) Capable of (cont'd):			
G			11) Provide capability to translate between different languages when handling tactical and training data from multi-national participants/ systems		
	9) Exercise Control:				
G		a) Capable of:			
G			1) Provide two-way non-tactical communications between analysts and controller in the central or remote analysis facilities		
G			2) Provide two-way tactical communications between exercise controller in the central and remote analysis facilities and the unit in the field to assist in role playing and controlling the exercise		
G			3) Provide two-way non-tactical communications between analysts, scenario controller and role players in the central or remote areas		
G			4) Monitor voice, video, RF and digital representation replicating the battlefield and tactical engagement simulations		
G			5) Generate and transmit control commands from workstation to warfighting platforms/ embedded training system and Tactical Engagement Simulation (TES) in the field		

PERFORMANCE CAPABILITIES (cont'd)					
	9) Exercise Control (cont'd):				
G		a) Capable of (cont'd):			
G			6) Exchange exercise data with external simulations and system to control the conduct of the exercise		
G			7) Must generate audio/ voice alerts when pre-defined significant safety or controller events occur		
A			8) Provide, on demand, current tactical status of fully instrumented players in exercise area		
A			9) Monitor and display instrumented direct and indirect fire engagement battlefield damage and assessment		
G			10) Record control commands from the central or remote analysis facilities and controller devices in the field for later replay and review		
G			11) Provide the capability to control and continuously monitor the operational status of all discrete digital and analogue devices		
G			12) Provide the capability from a central point:		
G				a) Inside buildings; at minimum:	
G					i) Alert system (safety)
G					ii) Locking doors

PERFORMANCE CAPABILITIES (cont'd)					
		9) Exercise Control (cont'd):			
G		a) Capable of (cont'd):	12) Provide the capability from a central point (cont'd):		
G				a) Inside buildings; at minimum (cont'd):	
G					iii) Lighting
G					iv) Battlefield effects
G					v) Targets
G					vi) Audio
G					vii) Video
G				b) Outside buildings; at minimum:	
G					i) Alert system (safety)
G					ii) Lighting
G					iii) Battlefield effects
G					iv) Targets
G					v) Audio
G					vi) Video
G			13) Provide the capability to administratively kill or resurrect any instrumented player within training area		
A			14) Exchange digital data to control the conduct of the exercise with:		
A				a) Live simulations	
A				b) Virtual simulations	
A				c) Constructive simulations	
G		b) Generate and display:			
G			1) Exercise report and summaries		
G			2) Information to perform near real-time casualty and damage assessments for area weapons engagement simulations		

PERFORMANCE CAPABILITIES (cont'd)					
	9) Exercise Control (cont'd):				
G		b) Generate and display (cont'd):			
G			3) Alarms and alerts when operating limits are not maintained		
G			4) Weather data		
G		c) Be able to control up to multiple different exercises simultaneously			
	10) Data Analysis:				
G		a) Capable of:			
G			1) Query data		
G			2) Correlate and analyze:		
G				a) Targerty exercise data	
G				b) Tactical Engagement Simulation (TES) exercise data	
G				c) Voice exercise data	
G				d) Video exercise data	
G				e) Digital exercise data	
G			3) Selectively retrieve and display exercise data		
G			4) Store, edit, and replay voice and video data		
G			5) Export data		
G			6) Replay exercise history		
G		b) Archive data			
	11) Training Feedback:				
G		a) Preparation:			
G			1) Provide the ability to mix		
G				a) Voice recordings	
G				b) Video recordings	
G				c) Graphics	
G				d) Digital data	

PERFORMANCE CAPABILITIES (cont'd)					
	11) Training Feedback (cont'd):				
G		a) Preparation (cont'd):			
G			2) Provide the capability to archive and replay at selected:		
G				a) Speeds	
G				b) Sources	
G				c) Specific time	
G				d) Time period	
G			3) Archive exercise data for post-exercise use		
G			4) Prepare and present in multi-media for:		
G				a) After action reviews	
G				b) Take home packages	
G			5) Generate and display statistical report for after action reviews		
G			6) Store exercise feedback data used to conduct after action review for later retrieval, editing, and presentation		
G			7) Retrieve, edit and replay stored:		
G				a) Video training data	
G				b) Voice training data	
G				c) Digital training data	
G		b) Presentation:			
G			1) Provide the ability to present at:		
G				a) Mobile facilities	
G				b) Fixed facilities	
G			2) Ability to provide data:		
G				a) Immediately anytime during exercise	
G				b) Immediately after the exercise	

PERFORMANCE CAPABILITIES (cont'd)					
		11) Training Feedback (cont'd):			
G		b) Presentation (cont'd):			
G			2) Ability to provide data (cont'd):		
G				c) After change of mission + 2 hours	
G				d) After change of mission + 4 hours	
G				e) After change of mission + 6 hours	
G			3) Capture the discussion and points/lesson learned generated during the conduct of the after action review		
G			4) Provide the delivery of the presentation in:		
G				a) Hard copy	
G				b) Removable electronic media	
G		c) Take home package:			
G			1) Provide the delivery in:		
G				a) Hard copy	
G				b) Removable electronic media	
G		d) Archive:			
G			1) Transfer to removable media:		
G				a) Video training data	
G				b) Voice training data	
G				c) Digital training data	
G				d) Exercise history data	

Annex G – FUNCTIONAL ARCHITECTURE

G-1 SYSTEM FUNCTIONS

This annex describes the identification of system functions, making sure that all requirements from the capability matrix are captured by (at least) one function. The system functions are grouped together logically, thus defining the functional components. However, it is possible that a particular system function resides in more than one functional component.

Figure G-1 contains the overview of all identified system functions in a FIBUA/MOUT training site. In the following paragraphs each of the system functions is described in the context of the functional component(s) to which it belongs.

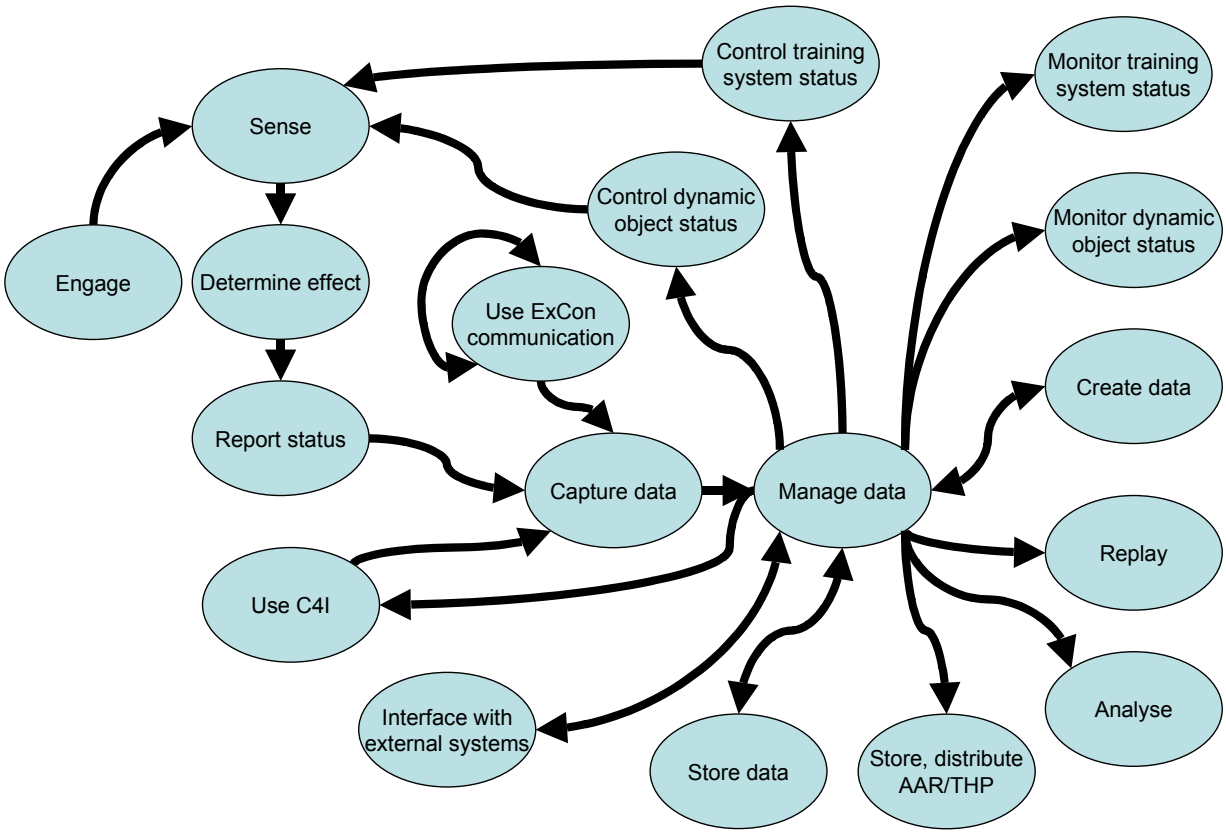


Figure G-1: The System Functions of a FIBUA/MOUT Site.

G-2 DYNAMIC OBJECTS

The functional component Dynamic Object is composed of the following system functions, as depicted in Figure G-2.

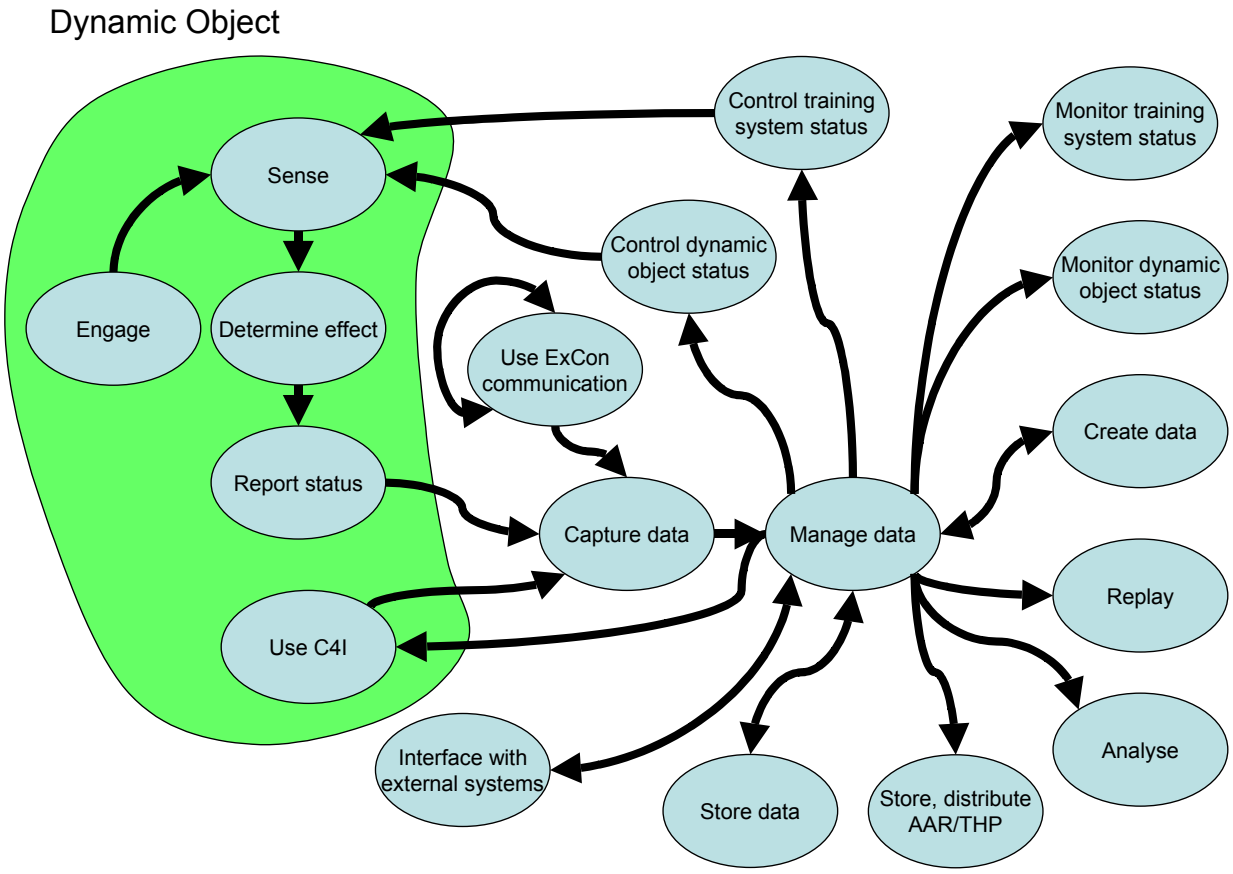


Figure G-2: The System Functions of a Dynamic Object.

Engage	The capability to actively interact with other dynamic objects (e.g. for a rifle: firing a projectile, for a hand grenade: explode).
Sense	The capability to sense an event concerning the dynamic object. This could be that the dynamic object is being engaged (e.g. being hit) or that the dynamic object performs an action ("self-sense", e.g. fire a weapon, changing location as can be sensed by GPS). Also, the dynamic object can receive a direct command to change its status.
Determine Effect	The capability to change the status of the dynamic object, depending on the characteristics of the dynamic object and the characteristics of the triggering event (e.g. for a player: get injured, for a target: drop down). This capability resides locally in each dynamic object.
Report Status	The capability to represent the current (change of) status of the dynamic object. Depending on the implementation, it can be activated in regular time steps or when a relevant change has occurred. This capability includes the communication of its status within the training system (e.g. location, operational status) and the physical representation in terms of several different effects (visual, audio, smell, taste, movement, electromagnetic, etc.).
Use C4I	The capability to monitor and interact with C4I systems (e.g. those issued to personnel, those embedded within weapon systems).

G-3 EXERCISE CONTROL

The functional component Exercise Control (EXCON) is composed of the following system functions, as depicted in Figure G-3.

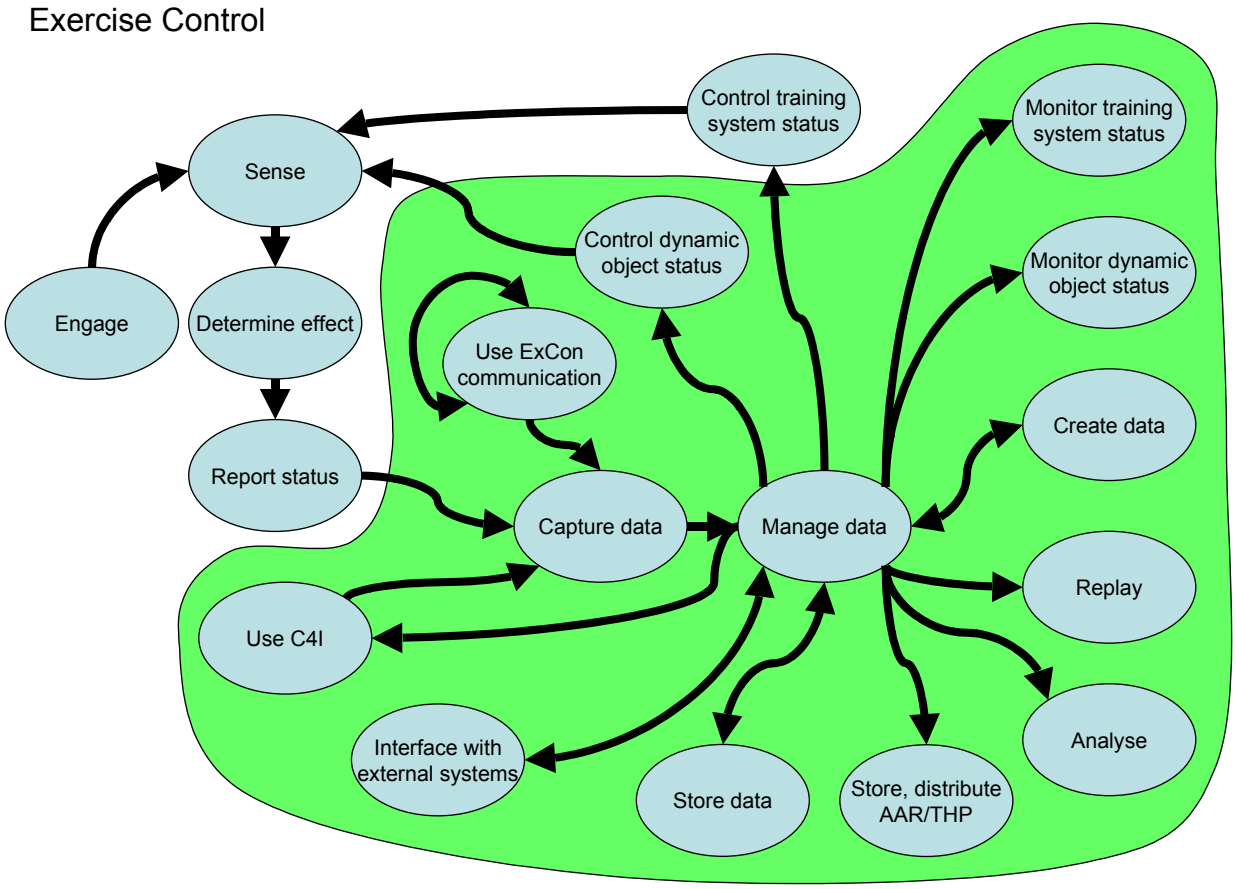


Figure G-3: Exercise Control.

Create Data	The capability to define exercises, e.g. defining the dynamic objects that will take part, their initial status, planned events (e.g. artillery strike).
Capture Data	The capability to receive information from training system components and C4I systems.
Store Data	The capability to retain data.
Replay	The capability to review the events that have occurred and have been stored during a certain exercise (e.g. actions of dynamic objects, communications, C4I information).
Analyse	The capability to evaluate the results of an exercise.
Store and Distribute AAR/THP	The capability to create, save and issue evaluation material and THP.

Manage Data	The capability to process data. It includes administering data (e.g. creating back-ups, (re)organising files), but also processing data regarding its content (e.g. formatting, combining).
Monitor Training System Status	The capability to present the (technical) status of the training system and its components (e.g. not activated, operational, malfunction). This way, the training staff can detect malfunctions.
Monitor Dynamic Object Status	The capability to present the (operational) status of the dynamic objects (e.g. accessing the status reports that were sent by the dynamic object).
Control Dynamic Object Status	The capability to change the status of dynamic objects: • As a deliberate training staff action (e.g. to inflict a cheat kill or to activate a reset); • In order to provide information regarding (the activation of) Area Weapon Effect Systems (AWES, e.g. artillery strikes, minefields, NBC areas). This is in fact the "engage" capability of EXCON; • To centrally determine the effects of engagements between dynamic objects (useful when this capability does not reside locally in a dynamic object); and • To model secondary weapon effects, e.g. a munition destroys a vehicle, which explodes and in its turn affects dismounted soldiers in its neighbourhood.
Use EXCON Communication	The capability to communicate between members of the training staff.
Use C4I	The capability to monitor and interact with C4I systems (e.g. as higher control, lower control, flanking control). Regarding the C4I systems, EXCON must at least have the same situational awareness as the players.
Interface with External Systems	The capability to exchange data with other systems (from the operational point of view regarding transfer of content).

G-4 OBSERVER CONTROLLER

The functional component Observer Controller is composed of the following system functions, as depicted in Figure G-4.

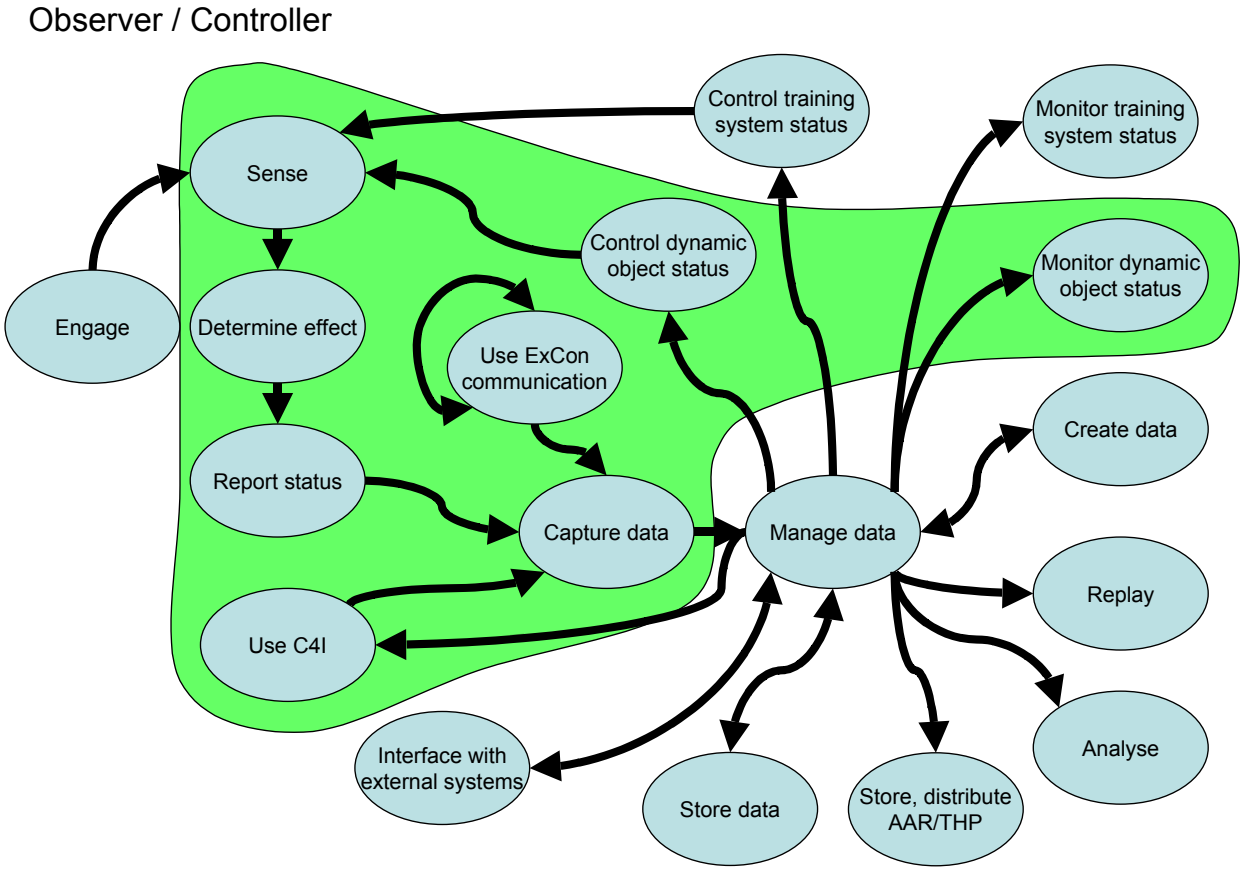


Figure G-4: Observer Controller.

Sense	Although O/Cs are not players, they operate within the training environment and need to have information about for example artillery zones, minefields, when they are engaged, etc.
Determine Effect	Many of the sensed events will result in reports to the O/C, not into the change of its status (e.g. an O/C should be notified when he enters a minefield, but he will not be injured by that minefield).
Report Status	For example in order to represent the position of an O/C in the training staff applications.
Use C4I	The capability to monitor and interact with C4I systems. Regarding the C4I systems, an O/C must at least have the same situational awareness as the players.
Capture Data	The capability to receive information from training system components and C4I systems.
Monitor Dynamic Object Status	Like the central training staff, an O/C must be able to monitor the (operational) status of the dynamic objects.
Control Dynamic Object Status	And to change the status of a dynamic object.
Use EXCON Communication	

G-5 AFTER ACTION REVIEW

The functional component After Action Review is composed of the following system functions, as depicted in Figure G-5.

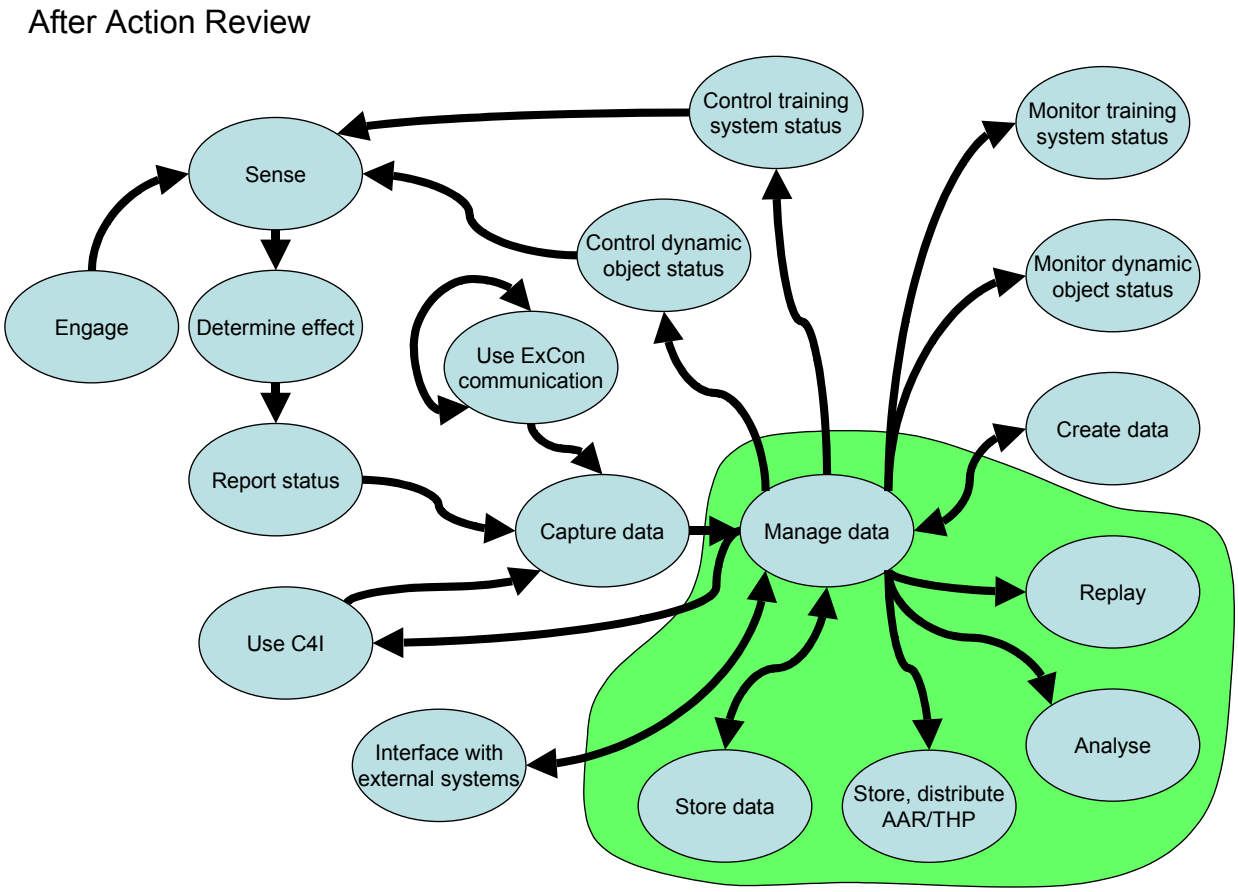


Figure G-5: After Action Review.

As can be deduced from the functional breakdown, AAR is functionally a full sub-component of EXCON, but is was considered very important to make this group of functions visible at the highest level as a functional component of a FIBUA/MOUT system.

G-6 SYSTEM CONTROL

The functional component System Control is composed of the following system functions, as depicted in Figure G-6.

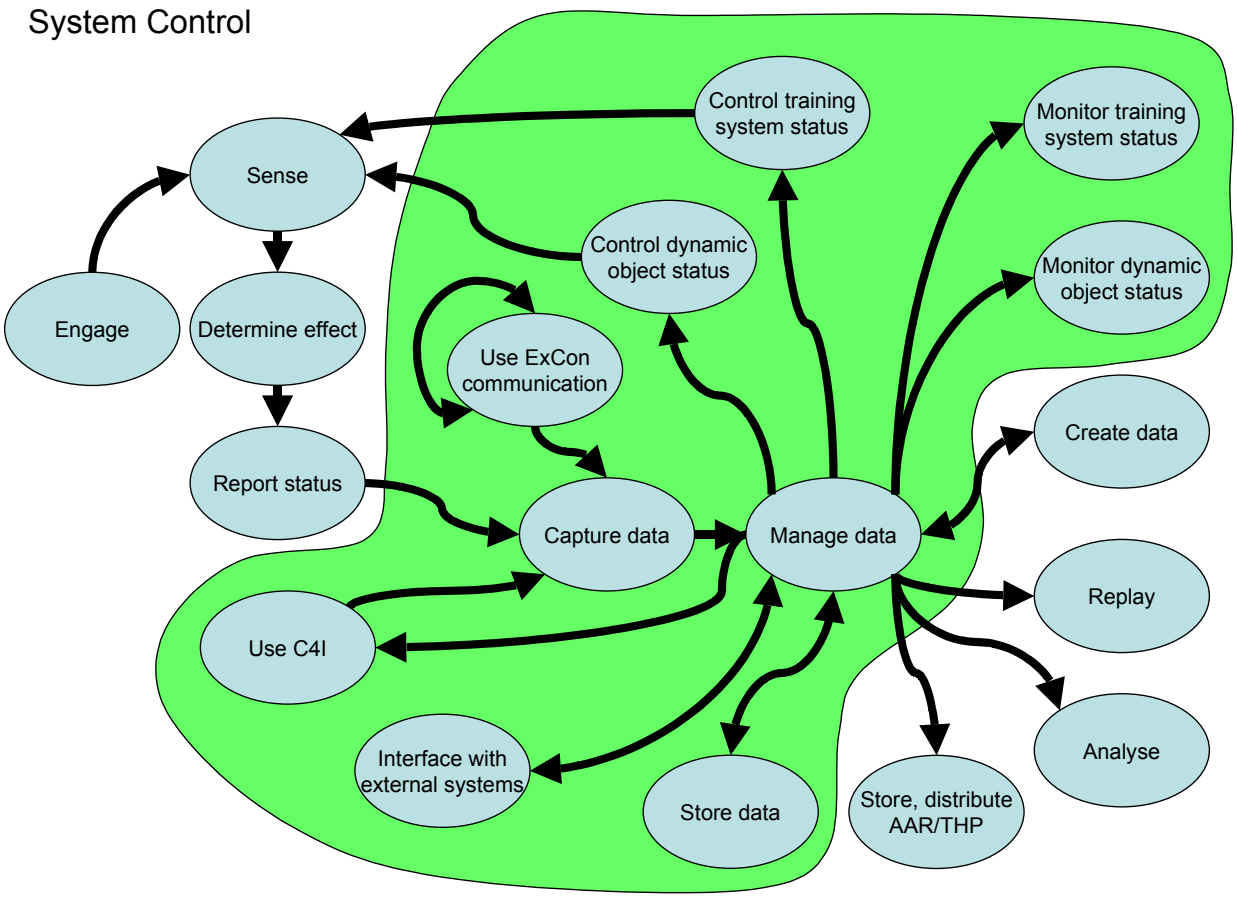


Figure G-6: System Control.

Capture Data	
Monitor Training System Status	The capability to present the (technical) status of the training system and its components (e.g. not activated, operational, malfunction).
Control Training System Status	The capability to change the (technical) status of the training system or its components. This concerns the system configuration only (e.g. start up, shut down).
Use EXCON Communication	The capability to communicate on the EXCON communication network (e.g. exchange information between system maintenance and the training staff).
Monitor Dynamic Object Status	The capability to present the (operational) status of the dynamic objects (e.g. in order to check the (technical) operational status).
Control Dynamic Object Status	The capability to change the (operational) status of the dynamic objects. This concerns the operational configuration only (e.g. to change set the damage status).
Manage Data	
Store Data	
Interface with External Systems	The capability to exchange data with other systems (from the technical point of view to establish data transfer).

G-7 FACILITY CONTROL

The functional component Facility Control is composed of the following system functions, as depicted in Figure G-7.

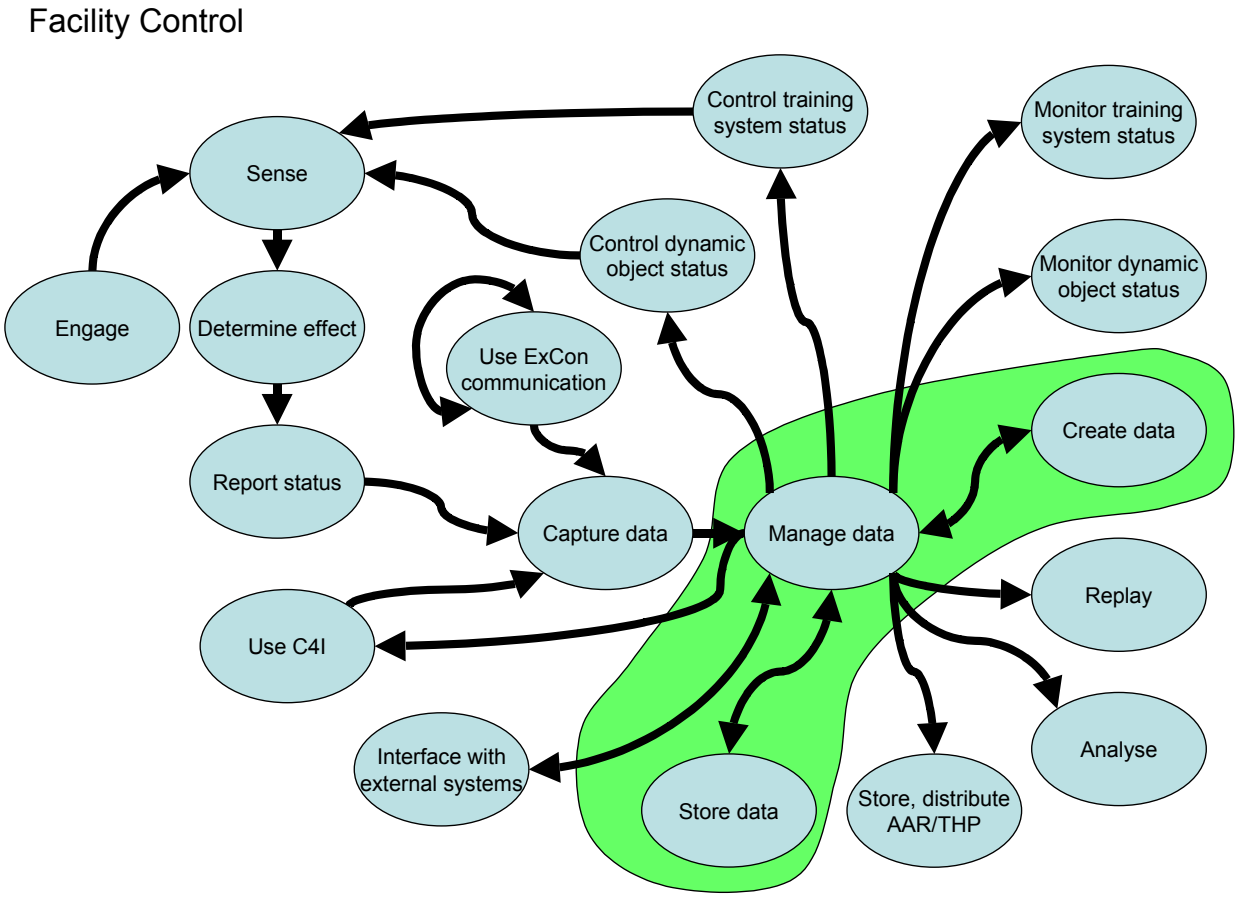


Figure G-7: Facility Control.

Create Data	The capability to create a representation of the training environment, e.g. for use as maps and 3D databases.
Store Data	
Manage Data	

Annex H – INTERFACES

This annex describes in more detail the internal and external interfaces as defined in the functional architecture.

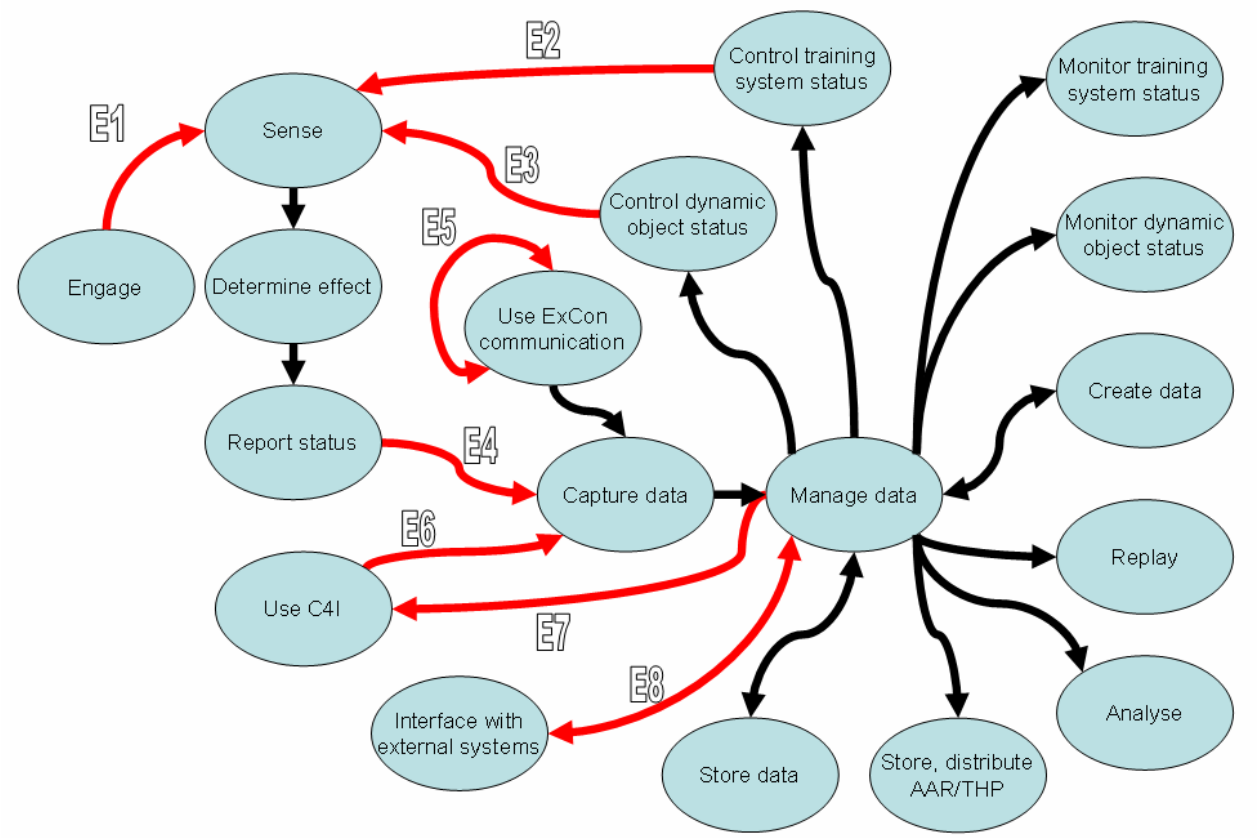


Figure H-1: Interfaces in the Functional Architecture.

ID	From	To	Description
E1	Engage	Sense	Provides the characteristics of an engagement of a dynamic object.
	Sense	Determine effect	Provides the characteristics of an engagement in order to determine the effects of that engagement.
	Determine effect	Report status	Provides the (change of) operational status of a dynamic object.
E4	Report status	Capture data	Provides the current status of a dynamic object, both operational status and technical status.
E2	Control training system status	Sense	Provides the (change of) technical status of a dynamic object.
E3	Control dynamic object status	Sense	Provides the (change of) operational status of a dynamic object.

ID	From	To	Description
	Use EXCON communication	Capture data	Provides data on the EXCON communication network that has to be logged.
E5	Use EXCON communication	Use EXCON communication	Provides to communication between EXCON members of different training systems.
E6	Use C4I	Capture data	Provides C4I data to the training system (e.g. to be used for AAR, to distribute to EXCON applications).
	Capture data	Manage data	Provides real-time data that has to be processed and/or stored.
	Manage data	Monitor dynamic object status	Provides data to monitor the operational status of dynamic objects.
	Manage data	Monitor training system status	Provides data to monitor the technical status of the training system components.
	Manage data	Control dynamic object status	Provides data to set the operational status of dynamic objects.
	Manage data	Control training system status	Provides data to set the technical status of training system components.
	Manage data	Store data	Provides processed data to be stored.
	Store data	Manage data	Provides stored data to be (re)processed.
	Manage data	Create data	Provides information about the resources and capabilities of the training system in order to create a scenario.
	Create data	Manage data	Provides scenario data to be stored. It includes initialisation data for all systems involved (e.g. training system, C4I systems).
	Manage data	Replay	Provides data to replay a recorded exercise.
	Manage data	Analyse	Provides data to evaluate.
	Manage data	Store and distribute AAR/THP	Provides data to create/modify AAR/THP.
	Store and distribute AAR/THP	Manage data	Provides AAR/THP data to be stored.
E7	Manage data	Use C4I	Provides data from the training system to C4I systems.
E8	Interface with external systems	Manage data	Provides external system data to the training system.
E8	Manage data	Interface with external systems	Provides training system data to external systems.

Annex I – EXTERNAL INTERFACES

Below are the basic assumptions concerning the information needed in the different reporting events. Appendices I1 and I2 provide a more detailed analysis of Firing and Target Data.

Object Report Types	Must Know Data	Inherent in Must Know Data	Might Know Data
Firing Report	Shooter platform ID	Type (vehicle, person, aircraft)	Target platform type
		Call-sign	
		Affiliation (red force, blue force, civilian, etc.)	Target platform affiliation
		Assignment (leader squad 1, supply vehicle, etc.)	Target platform assignment
	Shooter platform location	x, y, z	Target platform location
	Weapon ID	Type	Predicted point of impact on target
	Aim point	Location	
		Orientation	
		Angle	
		Charge	
		External conditions (wind, etc.)	
		Weapon conditions (barrel temperature, etc.)	
	Type of detonation	Impact	
		Proximity	
		Time	
	Munition	Type of delivery (direct, indirect)	
		Type of effect (explosive, smoke, biological, etc.)	
		Duration of effect (immediate, temporary, lingering, etc.)	
Hit Status Report	Target platform ID	Type (vehicle, person, aircraft)	Shooter platform type
		Call-sign	
		Affiliation (red force, blue force, civilian, etc.)	Shooter platform affiliation

Object Report Types	Must Know Data	Inherent in Must Know Data	Might Know Data
Hit Status Report (cont'd)	Target platform ID (cont'd)	Assignment (leader squad 1, supply vehicle, etc.)	Shooter platform assignment
	Target platform status	Health (dead, wounded, mobility kill, etc.) Resources (weapons available, rounds remaining, etc.)	Shooter platform status
	Target platform location	x, y, z	
	Damage sustained (total kill, tracks destroyed, etc.)	Point of impact on platform (arm, vehicle track, etc.) Weapon type Ammunition type Angle of hit Force of effect at target location Self-protection levels Vulnerability to munition	
	Shooter platform ID		
	Weapon ID		
	Ammunition ID		
Fire Status Report	Shooter platform ID	Type (vehicle, person, aircraft) Call-sign Affiliation (red force, blue force, civilian, etc.) Assignment (leader squad 1, supply vehicle, etc.)	
	Shooter platform status	Health (dead, wounded, mobility kill, etc.) Resources (weapons available, rounds remaining, etc.)	
	Shooter platform location	x, y, z	

Object Report Types	Must Know Data	Inherent in Must Know Data	Might Know Data
Fire Status Report (cont'd)	Weapon ID	Type	
	Aim point	Location Orientation Angle Charge External conditions (wind, etc.) Weapon conditions (barrel temperature, etc.)	
	Type of detonation	Impact Proximity Time	
	Munition	Type of delivery (direct, indirect) Type of effect (explosive, smoke, biological, etc.) Duration of effect (immediate, temporary, lingering, etc.)	
Status Report	Platform ID	Type (vehicle, person, aircraft) Call-sign Affiliation (red force, blue force, civilian, etc.) Assignment (leader squad 1, supply vehicle, etc.)	
	Platform status	Health (dead, wounded, mobility kill, etc.) Resources (weapons available, rounds remaining, etc.)	

Appendix I1: FIRING DATA

			INTRA							INTER		
			Internal				External					
Object Name	**Trigger Event**	**Trigger Event Data**	**Status Change**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Outgoing Event**	**Outgoing Event Data**	**Outgoing Event Recipient**
Shooter	Fire	Main Armament Fired, Secondary Armament Fired, Co-axial weapon Fired	Reduced Ammo, set Weapon Parameters, e.g. barrel temperature, Initiate temporal delays, Set wear and tear parameters	White smoke, temporary, to obscure vision, confirm shot, Cuing information injected into site, for example tracer, to show shooter flight path	Explosive sound, temporary, to impose stress on crew and to increase crew's situational awareness of crew	Impose firing rate constraints	Smoke, temporary, to indicate position, distance and direction, muzzle fire flash	Loud explosion, temporary, used to reveal position and direction		Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions	Dynamic Object
Shooter										Fire Status Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions, Observed target for scenario representation	EXCON

			INTRA							INTER		
			Internal				External					
Object Name	**Trigger Event**	**Trigger Event Data**	**Status Change**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Outgoing Event**	**Outgoing Event Data**	**Outgoing Event Recipient**
Shooter	Deploy/ Fire	Type of self-defence, start time, duration, smoke signature	Reduced assets		Popping sound to indication protection is launched awareness of crew	Not required	White smoke, temporary, to obscure vision			Fire Status Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions, Observed target for scenario representation	EXCON
Shooter	Fire	Small arms fired, hand grenade, AT weapon, NL weapon, machine gun	Reduced Ammo, set Weapon Parameters, e.g. barrel temperature, Initiate temporal delays, Set wear and tear parameters	Cueing information injected into field of view for example tracer, to show shooter flight path		Impose firing rate constraints	White smoke, temporary, to obscure vision, confirm shot	Explosive sound, temporary, to impose stress on shooter and to increase situation awareness of surrounding players	In case of hand grenade/ explosives dummies required to reveal location of threat	Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions, Observed target for scenario representation	Dynamic Object

			INTRA							INTER		
			Internal				External					
Object Name	**Trigger Event**	**Trigger Event Data**	**Status Change**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Outgoing Event**	**Outgoing Event Data**	**Outgoing Event Recipient**
Indirect Shooter	Fire	Artillery, mortar, NBC, mines	White smoke, temporary, to obscure vision, confirm shot, Cuing information injected into site, for example tracer, to show shooter flight path	White smoke, temporary, to obscure vision	Explosive sound, temporary, to impose stress on crew and to increase crew's situational awareness of crew	Impose firing rate constraints	Smoke, temporary, to indicate position, distance and direction, muzzle fire flash	Loud explosion, temporary, used to reveal position and direction		Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions, Observed target for scenario representation	Dynamic Object
										Fire Status Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions, Observed target for scenario representation	EXCON

Appendix I2: TARGET DATA

			INTRA							INTER		
			Internal				External					
Object Name	**Trigger Event**	**Trigger Event Data**	**Status Change**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Outgoing Event**	**Outgoing Event Data**	**Outgoing Event Recipient**
Platform System – Armed or Unarmed (e.g. tank or utility vehicle)	Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions	Total, mobility, crew, passenger, comms kill, degree of contamination (biological, chemical or radiological)	Engagement results on crew displays, Temporary visible indication to indicate temporary visible damage, e.g. rounds ricocheting off tank, mines exploding	Loud or minor explosion, near miss indication, Alarm (chemical)	Vehicle stopped, unable to communicate, unable to fire weapons, update own C4I systems	Permanent visible indication to indicate permanent visible damage, e.g. flashing light (permanent), to indicate visible total damage	Loud or minor explosion, Alarm	Vehicle Stopped, Unable to Fire and Communicate and marked according to damage criteria	Hit Status Report	Target Platform, Target Platform Status, Target Platform Location, Damage Sustained (Engagement results) (Shooter Platform ID) (Weapon ID) Ammunition ID), Damage Results	EXCON
										Hit Status Report	Target Platform, Target Platform Status, Target Platform Location, Damage Sustained (Engagement results) (Shooter Platform ID) (Weapon ID) Ammunition ID), Damage Results	O/C

			INTRA							INTER		
			Internal				External					
Object Name	**Trigger Event**	**Trigger Event Data**	**Status Change**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Outgoing Event**	**Outgoing Event Data**	**Outgoing Event Recipient**
										Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions	Dynamic Object
Platform System – Armed or Unarmed (e.g. tank or utility vehicle)	Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions	Total, mobility, crew, passenger, comms kill	Damage results on crew displays, Permanent or Temporary visible indication to indicate permanent or temporary visible damage	Loud Noise	Vehicle stopped, unable to communicate, unable to fire weapons, update own C4I systems	Permanent or Temporary visible indication to indicate permanent visible damage, e.g. flashing light (permanent), to indicate visible total damage	Loud Noise	Vehicle Stopped, Unable to Fire and Communicate and marked according to damage criteria	Hit Status Report	Target Platform, Target Platform Status, Target Platform Location, Damage Sustained (Engagement results) (Shooter Platform ID) (Weapon ID) Ammunition ID), Damage Results	EXCON

			INTRA							INTER		
			Internal				External					
Object Name	**Trigger Event**	**Trigger Event Data**	**Status Change**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Outgoing Event**	**Outgoing Event Data**	**Outgoing Event Recipient**
										Hit Status Report	Target Platform, Target Platform Status, Target Platform Location, Damage Sustained (Engagement results) (Shooter Platform ID) (Weapon ID) Ammunition ID), Damage Results	O/C
										Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions	Dynamic Object
Personnel	Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform	Casualty status, wounds	Engagement results on displays	Yes plus near miss indication	Unable to communicate, unable to fire weapons, update own C4I systems, mobility	Permanent visible indication to indicate permanent visible damage, e.g. flashing light (permanent), to indicate visible total damage		Unable to communicate, unable to fire weapons, update own C4I systems, mobility	Hit Status Report	Target Platform, Target Platform Status, Target Platform Location,	EXCON

			INTRA							INTER		
			Internal				External					
Object Name	**Trigger Event**	**Trigger Event Data**	**Status Change**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Outgoing Event**	**Outgoing Event Data**	**Outgoing Event Recipient**
		Location, Weapon ID, Aim Point, Type of Detonation, Munitions				reduction			reduction		Damage Sustained (Engagement results) (Shooter Platform ID) (Weapon ID) Ammunition ID), Damage Results	
										Hit Status Report	Target Platform, Target Platform Status, Target Platform Location, Damage Sustained (Engagement results) (Shooter Platform ID) (Weapon ID) Ammunition ID), Damage Results	O/C
Personnel	Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID,	Casualty status, wounds	Damage results on displays	Yes – Noise	Unable to communicate, unable to fire weapons, update own C4I systems, mobility reduction	Permanent visible indication to indicate permanent visible damage, e.g. flashing light (permanent), to indicate visible total damage		Unable to communicate, unable to fire weapons, update own C4I systems, mobility reduction	Hit Status Report	Target Platform, Target Platform Status, Target Platform Location, Damage Sustained	EXCON

			INTRA							INTER		
			Internal				External					
Object Name	**Trigger Event**	**Trigger Event Data**	**Status Change**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Outgoing Event**	**Outgoing Event Data**	**Outgoing Event Recipient**
		Aim Point, Type of Detonation, Munitions									(Engagement results) (Shooter Platform ID) (Weapon ID) Ammunition ID), Damage Results	
										Hit Status Report	Target Platform, Target Platform Status, Target Platform Location, Damage Sustained (Engagement results) (Shooter Platform ID) (Weapon ID) Ammunition ID), Damage Results	O/C

			INTRA							INTER		
			Internal				External					
Object Name	**Trigger Event**	**Trigger Event Data**	**Status Change**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Outgoing Event**	**Outgoing Event Data**	**Outgoing Event Recipient**
Building	Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions	Degree of Damage (Total Destruction, Partial Destruction (e.g. rooms, stairwell), Permanent or Temporary Unusable), Contamination State	Engagement results on inside of building, Permanent or Temporary visible indication to indicate permanent/ temporary visible damage, e.g. blocking doors/windows/ stairs, fire, smoke, rounds ricocheting off walls, lighting, building motion (shaking).	Yes plus near miss indication (e.g. loud bang, sound of rifle/ MG fire)	Unable to enter or exit a room inside, move up/down stairs, unable to provide protection, change in IR properties, lines of sight impacted, motion	Engagement results on outside of building, Permanent or Temporary visible indication to indicate permanent/ temporary visible damage, e.g. blocking doors/windows /outside stairwells, fire, smoke, rounds ricocheting off outside walls, lighting.	Yes plus near miss indication (loud bang)	Unable to enter or exit a building, unable to provide protection or cover, change in IR properties, lines of sight impacted	Hit Status Report	Target Platform, Target Platform Status, Target Platform Location, Damage Sustained (Engagement results) (Shooter Platform ID) (Weapon ID) Ammunition ID), Damage Results	EXCON
										Hit Status Report	Target Platform, Target Platform Status, Target Platform Location, Damage Sustained (Engagement results) (Shooter Platform ID) (Weapon ID) Ammunition ID), Damage Results	O/C

			INTRA							INTER		
			Internal				External					
Object Name	**Trigger Event**	**Trigger Event Data**	**Status Change**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Outgoing Event**	**Outgoing Event Data**	**Outgoing Event Recipient**
										Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions	Dynamic Object (impact on personnel/ vehicle inside or outside proximity of building)
Transferable Weapon (Rifle, ATK, Pistol, Mortar, Grenade, etc.)	Firing Report	Shooter Platform ID, Shooter Platform Status, Shooter Platform Location, Weapon ID, Aim Point, Type of Detonation, Munitions	Weapon disabled	None	None	Cannot operate weapon	Weapon status	Potentially in future when you have acoustic weapon effects instead of blank ammo, e.g. "no bang but click"	Cannot operate weapon	Hit Status Report	Shooter Platform ID (New), Weapon ID, Ammunition ID, Shooter Platform Status	EXCON
										Hit Status Report	Shooter Platform ID (New), Weapon ID, Ammunition ID, Shooter Platform Status	O/C

			INTRA							INTER		
			Internal				External					
Object Name	**Trigger Event**	**Trigger Event Data**	**Status Change**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Visual Effect**	**Acoustic Effect**	**Physical Effect**	**Outgoing Event**	**Outgoing Event Data**	**Outgoing Event Recipient**
All	Repair effect	Personnel or Automated Intervention	Repair Status	Removal of related damage visual effect on dynamic object	Removal of related audio effect on dynamic object	Repaired	Removal of related damage visual effect on dynamic object	Removal of related audio effect on dynamic object	Repaired	Status Report	Platform ID, Platform Status	EXCON
										Status Report	Platform ID, Platform Status	O/C
All	Status Change	O/C or EXCON imposition of desired state (e.g. kill, repair, reset)	New status	Dependent on new status	Dependent on new status	Dependent on new status	Dependent on new status	Dependent on new status	Dependent on new status	Status Report	Platform ID, Platform Status	EXCON
										Status Report	Platform ID, Platform Status	O/C
										Status Change	O/C or EXCON imposition of desired state (e.g. kill, repair, reset)	Dynamic Object

Annex J – INTEROPERABILITY CODE SETS

The following appendices support the UCATT proposals for standardisation proposed in Chapter 7:

- Appendix J1: Weapon System Table (Example);
- Appendix J2: Possible Target designating dynamic object code;
- Appendix J3 : Possible External Report Manifestations; and
- Appendix J4: Legacy OSAG – Code Enhancement Options.

Appendix J1: WEAPON SYSTEM TABLE (EXAMPLE)

The FIBUA/MOUT WG has started to populate weapon system tables in an effort to capture existing weapon systems that will have a role in the FIBUA/MOUT environment. As a general rule all weapon systems used for open terrain will be relevant for FIBUA/MOUT training because the FIBUA/MOUT scenario includes the approach towards the object (city, village, …), the military action inside the object and might also include the leaving of the object.

The weapon tables are incomplete and are provided as an example with the intent to initiate a thought process throughout the user community. The goal is to have every country that is interested in developing interoperability to support the process by entering it is non-confidential weapon type data into the appropriate table. New tables of weapon systems not yet included in this process can be created if necessary.

J1.1 ANTI-TANK (TO BE COMPLETED)

Classification	Range	Ammunition	Name	Guidance
VSRAT			**Panzerfaust 3**	Ballistic
	300	AT		
	300	AS		
	300	FAE		
			Carl Gustav	Ballistic
	TBD	TBD		
	TBD	TBD		
	TBD	TBD		
			AT4	Ballistic
	TBD	TBD		
	TBD	TBD		
	TBD	TBD		
			RPG	Ballistic
	TBD	TBD		
	TBD	TBD		
	TBD	TBD		
			XXXX	TBD
	TBD	TBD		
	TBD	TBD		
	TBD	TBD		
			YYYY	TBD
	TBD	TBD		
	TBD	TBD		
	TBD	TBD		
MRAT			**SPIKE MR**	Fire & Forget
	2000	AT		
	TBD	FAE		
			XXXX	TBD
	TBD	TBD		
	TBD	TBD		
	TBD	TBD		
			YYYY	TBD
	TBD	TBD		

Classification	Range	Ammunition	Name	Guidance
	TBD	TBD		
	TBD	TBD		
LRAT			**SPIKE LR**	Fire & Forget/Observe
	4000	AT		
	TBD	TBD		
	TBD	TBD		
			HOT	Wire Guided
	TBD	TBD		
	TBD	TBD		
	TBD	TBD		
			SAGGER	Wire Guided
	3000	TBD		
	TBD	TBD		
	TBD	TBD		
VLRAT			**KONKURS**	
	> 4000	AT		
	TBD	TBD		
	TBD	TBD		

J1.2 MINES (TO BE COMPLETED)

Classification	Use	Effect	Name	
Anti-Tank				
	Surface	Blast	UKM-63	
		Anti-Tank	DM 31	
	Horizontal	Anti-Tank	RL Schwer	
	TBD	TBD	TBD	
	TBD	TBD	TBD	
	TBD	TBD	TBD	
Anti-Personnel				
	Surface	Blast	TBD	
	Horizontal	Directed Bullets	Claymore	
	Jump Mine	Fragmentation	TBD	
	TBD	TBD	TBD	
	TBD	TBD	TBD	
	TBD	TBD	TBD	

J1.3 HAND GRENADES (TO BE COMPLETED)

Classification	Type	Range	Effect	Name
Lethal	**Fragmentation**			
		Thrown approx. 30 m	Lethal up to 25 m	DM 61
		TBD	TBD	TBD
		TBD	TBD	TBD
		TBD	TBD	TBD
	Concussion			
		Thrown approx. 30 m	Lethal up to 15 m in Closed Spaces	M 100
		TBD	TBD	TBD
		TBD	TBD	TBD
		TBD	TBD	TBD
	Anti-Tank			
		Thrown approx. 30 m	Thrown Directed by Parachute	58 K-100
		TBD	TBD	TBD
Less Lethal	**Concussion**			
		Thrown approx. 30 m		HGR 85
		TBD	TBD	TBD
		TBD	TBD	TBD
		TBD	TBD	TBD
Non-Lethal	**Stungrenade**			
		Thrown approx. 30 m		Flashbang
	Smoke			
		Thrown approx. 30 m		TBD
		TBD	TBD	TBD
	Teargas			
		Thrown approx. 30 m		TBD
		TBD	TBD	TBD
	Rubber Bullets			
		Thrown approx. 30 m	TBD	TBD
		TBD	TBD	TBD
		TBD	TBD	TBD

J1.4 RIFLES (TO BE COMPLETED)

Classification	Calibre	Effect	Range	Name	Remarks
Sub-MG					
	9 mm		0 – 150 m	MP5	
	9 mm		0 – 150 m	KGP9	
	4.7 mm			PPW	
			TBD	XXX	
			TBD	YYY	
			TBD	ZZZ	
Carbine					
	5.56 mm		0 – 300 m	C8	
	7.62 mm		TBD	TBD	
			TBD	XXX	
			TBD	YYY	
Assault					
	5.56 mm		0 – 600 m	C7	
	7.62 mm		0 – 600 m	AK63D	
			TBD	XXX	
			TBD	YYY	
			TBD	ZZZ	
MRSW					
	7.62 mm		500 – 1500 m	SVD	
	.338		TBD	Timberwolf	
			TBD	XXX	
			TBD	YYY	
			TBD	ZZZ	
LRSW					
	12.7 mm		+1500 m	Barret	
	12.7 mm		+1500 m	Gepard M1	
	14.5 mm		TBD	Elephant M1	
			TBD	XXX	
			TBD	YYY	
			TBD	ZZZ	

J1.5 MACHINE GUNS (TO BE COMPLETED)

Classification	Calibre	Effect range	Max Range	Name
Machine Guns				
Light				
	5.56 mm	400 m	800 m	Minimi
	5.56 mm	400 m	800 m	C9
	7.62 mm		800 m	RPK
	TBD	TBD	TBD	TBD
Medium				
	7.62 mm		1200 m	PKM
	7.62 mm		1200 m	M-60
	7.62 mm		1200 m	C6
	7.62 mm		1200 m	FN MAG
	TBD	TBD	TBD	TBD
Heavy				
	12.7 mm	800 m	1500 m	DSK
	12.7 mm	800 m	1500 m	M2 Browning
	14.5 mm	1200 m	2000 m	NSVT
	TBD	TBD	TBD	TBD
Chain Gun				
	7.62 mm	800 m	1200 m	PKT
	14.5 mm	1000 m	1800 m	KPVT
	20 mm	1500 m	2000 m	TBD
	25 mm	1500 m	3000 m	TBD
	30 mm	2500 m	3000 m	2A72
	30 mm	2500 m	3000 m	BushMaster
	TBD	TBD	TBD	TBD

J1.6 GRENADE LAUNCHERS

Classification	Calibre	Effect	Range	Name	Remarks
Low Velocity					
	40 mm	HE	300 m or less	HK-79	Underslung GL
	40 mm	HE	300 m or less	M-203	Underslung GL
	TBD	TBD	TBD	TBD	TBD
	TBD	HE/DP		M-79	Grenade Launcher
		FAE	TBD	TBD	TBD
		Smoke	TBD	TBD	TBD
		Teargas	TBD	TBD	TBD
		Non-Lethal	TBD	TBD	TBD
	TBD	TBD	TBD	TBD	TBD
	TBD	TBD	TBD	TBD	TBD
	TBD	TBD	TBD	TBD	TBD
High Velocity					
	40 mm	HE	2000 m or less	MK-19	Programmable Time of Explosion
	40 mm	HE	2000 m or less	AGS-17	Programmable Time of Explosion
	TBD	HE/DP			
	TBD	TBD	TBD	TBD	TBD
	TBD	TBD	TBD	TBD	TBD
	TBD	TBD	TBD	TBD	TBD

J1.7 MORTAR (TO BE COMPLETED)

Classification	Calibre	Effect	Fuse	Range	´Name
Light					
	60 mm				
		HE	Impact	Min.: Max.:	TBD
				TBD	TBD
		Illumination	TBD	TBD	TBD
			TBD	TBD	TBD
		Smoke	TBD	TBD	TBD
			TBD	TBD	TBD
		TBD	TBD	TBD	TBD
	TBD				
		TBD	TBD	TBD	TBD
Medium					
	82 mm				
		HE	Impact or Delay	Min.: Max.:	
				TBD	TBD
				TBD	TBD
		Illumination	TBD	TBD	TBD
			TBD	TBD	TBD
		Smoke	TBD	TBD	TBD
			TBD	TBD	TBD
		Anti-Tank	TBD	TBD	TBD
			TBD	TBD	TBD
Heavy					
	120 mm				
		HE			
			Impact or Delay	Min.: Max.:	
				TBD	TBD
				TBD	TBD
		Illumination			
			TBD	TBD	TBD
			TBD	TBD	TBD

Classification	Calibre	Effect	Fuse	Range	´Name
			TBD	TBD	TBD
		Smoke			
			TBD	TBD	TBD
			TBD	TBD	TBD
		Anti-Tank			
			TBD	TBD	TBD
			TBD	TBD	TBD

J1.8 ARTILLERY TUBE (TO BE COMPLETED)

Classification	Calibre	Effect	Fuse	Range	Name
Light (≤ 105)					
	105 mm				
		HE			
			Impact	TBD	TBD
			Delay	TBD	TBD
			TBD	TBD	TBD
		Illumination			
			TBD	TBD	TBD
		Smoke			
			TBD	TBD	TBD
		Anti-Tank			
			Guided	TBD	TBD
			Unguided	TBD	TBD
Medium 106 – 154					
	150 mm				.:
		HE			
			Impact	TBD	TBD
			Delay	TBD	TBD
			TBD	TBD	TBD
		Illumination			
			TBD	TBD	TBD
		Smoke			
			TBD	TBD	TBD
		Anti-Tank			
			Guided	TBD	TBD
			Unguided	TBD	TBD
		Scatter Mines			
			TBD	TBD	TBD
		Chemical Warheads			
			TBD	TBD	TBD
		Nuclear Warheads			
			TBD	TBD	TBD

Classification	Calibre	Effect	Fuse	Range	Name
Heavy 155 or More					
	155 mm				
		HE			
			Impact	TBD	TBD
			Delay	TBD	TBD
			TBD	TBD	TBD
		Illumination			
			TBD	TBD	TBD
		Smoke			
			TBD	TBD	TBD
		Anti-Tank			
			Guided	TBD	TBD
			Unguided	TBD	TBD
		Scatter Mines			
			TBD	TBD	TBD
		Chemical Warheads			
			TBD	TBD	TBD
		Nuclear Warheads			
			TBD	TBD	TBD
		TBD			
			TBD	TBD	TBD

J1.9 ARTILLERY ROCKET (TO BE COMPLETED)

Classification	Caliber	Effect	Fuse	Range	Name
Light					
	TBD				
		HE			
			Impact	TBD	TBD
			Delay	TBD	TBD
			Programmable	TBD	TBD
			TBD	TBD	TBD
		Bomblets			
			TBD	TBD	TBD
		Chemical Warheads			
			TBD	TBD	TBD
		Nuclear Warheads			
			TBD	TBD	TBD
		FAE			
			TBD	TBD	TBD
Heavy					
	122 mm				
		HE			
			Impact	TBD	TBD
			Delay	TBD	TBD
			Programmable	TBD	BM-21
			Programmable	TBD	MLRS
			TBD	TBD	TBD
		Bomblets			
			Impact	TBD	GRAD
			TBD	TBD	TBD
		Chemical Warheads			
			TBD	TBD	TBD
		Nuclear Warheads			
			TBD	TBD	TBD
		FAE			
			TBD	TBD	TBD

J1.10 THERMOBARIC (TO BE COMPLETED)

Classification	Delivery	Caliber	Effect	Range	Name
FAE					
	Bombs				
		TBD	FAE	TBD	TBD
		TBD	FAE	TBD	TBD
	Rocket Launcher				
		TBD	FAE	TBD	TBD
		TBD	FAE	TBD	TBD
	Artillery Grenades				
		TBD	FAE	TBD	TBD
		TBD	FAE	TBD	TBD
	Low Velocity Grenades				
		TBD	FAE	TBD	TBD
		TBD	FAE	TBD	TBD
Flamethrower					
		TBD	TBD	TBD	TBD
		TBD	TBD	TBD	TBD

J1.11 LESS LETHAL WEAPON (TO BE COMPLETED)

Classification	Delivery	Caliber	Effect	Range	Name
Non-Lethal					
	ShotGun				
		TBD	TBD	TBD	TBD
	Grenades				
		TBD	TBD	TBD	TBD
	Grenade Launchers				
		TBD	TBD	TBD	TBD
	Sprays				
		Liquid	TBD	TBD	TBD
		Moisture	TBD	TBD	TBD
		Gas	TBD	TBD	TBD
		TBD	TBD	TBD	TBD
	Gas				
		TBD	TBD	TBD	TBD
Less Lethal					
	ShotGun				
		TBD	TBD	TBD	TBD
	Grenades				
		TBD	TBD	TBD	TBD
	Grenade Launchers				
		TBD	TBD	TBD	TBD

Appendix J2: POSSIBLE TARGET DESIGNATING DYNAMIC OBJECT CODE

J2.1 CAPABILITIES OF THE CODE

- More than 42 million Dynamic Objects (DO) – Players (42,515,279).
- More than 500 thousand different weapon systems (524,879).
- More than 6000 different ammunitions per weapon system (6480).
- Target accuracy from 1 mm up to 500 m.
- Distance from 0 m up to 500,000 m.

J2.2 STRUCTURE

The structure of the code is targeted towards TES interoperability. The proposed structure is certified to be within the limits of eye safety if used for laser simulation. One Data Word includes a complete shot result or a complete control/test instruction respectively. The information is not divided into several Data Words. Each Data Word comprises 24 Elements each. Each Element offers 80 possible Data Positions. For save detection each Data Word is transmitted four times.

Bottom Up definition:

- 80 bits form one Element.
- 24 elements form one word.
- One word is one data set.

J2.3 CONTENTS

The Elements are defined as follows:

- **Elements 1 and 2: Sync**

  The first Pulse Positions in Elements 1 and 2 are always occupied, resulting in a pulse distance of 40 µs.

- **Element 3 to 5: Weapon Code**

  The weapon type of the attacking dynamic object is encoded in Elements 3 to 5, thus offering a range of 524,879 individual weapon types.

- **Elements 6 and 7: Ammunition Code**

  In these elements the ammunition type is encoded. This element has to be evaluated in combination with Elements 3 to 5, offering 6480 different ammunition types per weapon. An example of this element would be:

  1) Calibre 7.62 standard.
  2) Calibre 7.62 tracer.
  3) Calibre 7.62 full metal.
  4) …

Remark on ammunition code future capabilities: The Elements 3 to 7 are providing enough code capability for 524,879 weapons with 6480 ammunition types per weapon. This should be sufficient for the next 100 years of weapon and ammunition development.

- **Elements 8 to 12 and 14: Position Code (azimuth: x and elevation:** y)

  Deviation of hit position in azimuth and elevation as measured by the attacking system in relation to the centre of the target. The value range is from 1 mm up to more than 518 m.

  Remark on position code future capabilities: This element ensures that even a 500 m miss can still be transferred to the target. The resolution down to millimeters should be sufficient for all developments within the next 50 years.

- **Elements 16 to 18: Hit Distance**

  The hit distance is the sum of the values given in Elements 16 to 18 in meters. This value ranges from 0 m all the way to 505,600 m.

  The Element 18 codes 18-79 and 18-80 are used to transmit a switch information to the other system to enhance the code scheme even more (providing two possible sub-sets of the code).

- **Elements 19 to 22: Identity Code**

  The Player ID number (PID) of the attacking simulator is encoded in Element 19 to 22, thus offering a range of more than 41 million possible players.

- **Element 23: Flight Time Code**

  The flight time of any ammunition can be coded into Element 23 offering a flight time in seconds up to 80 sec.

- **Element 24: Checksum**

  The checksum is derived summing up the Elements 3 to 23, modulo 80. It is used to determine the validity of any received code.

  Code 18.79, 18.80: Switch (e.g. Umpire Definition Codes)

  The Element 18 codes 18.79 and 18.80 are used to transmit a switch information to the other system to enhance the code scheme even more (providing two possible sub-sets of the code).

- **Elements 13, 15 and 23: Reserve**

  The code provides 3 reserve elements that can be used to implement flight time codes, e.g. zero codes and other elements needed in the future.

J2.4 CONTENTS TABLES

	Element 1	Element 2	Element 3	Element 4	Element 5	Element 6
Number	Sync	Sync	Weapon2	Weapon1	Weapon3	Ammo1
1	Sync1	Sync2	80	0	6480	0
2	–	–	160	1	12960	1
3	–	–	240	2	19440	2
4	–	–	320	3	25920	3
5	–	–	400	4	32400	4
6	–	–	480	5	38880	5
7	–	–	560	6	45360	6
8	–	–	640	7	51840	7
9	–	–	720	8	58320	8
10	–	–	800	9	64800	9
11	–	–	880	10	71280	10
12	–	–	960	11	77760	11
13	–	–	1040	12	84240	12
14	–	–	1120	13	90720	13
15	–	–	1200	14	97200	14
16	–	–	1280	15	103680	15
17	–	–	1360	16	110160	16
18	–	–	1440	17	116640	17
19	–	–	1520	18	123120	18
20	–	–	1600	19	129600	19
21	–	–	1680	20	136080	20
22	–	–	1760	21	142560	21
23	–	–	1840	22	149040	22
24	–	–	1920	23	155520	23
25	–	–	2000	24	162000	24
26	–	–	2080	25	168480	25
27	–	–	2160	26	174960	26
28	–	–	2240	27	181440	27
29	–	–	2320	28	187920	28
30	–	–	2400	29	194400	29
31	–	–	2480	30	200880	30

	Element 1	Element 2	Element 3	Element 4	Element 5	Element 6
Number	Sync	Sync	Weapon2	Weapon1	Weapon3	Ammo1
71	–	–	5680	70	460080	70
72	–	–	5760	71	466560	71
73	–	–	5840	72	473040	72
74	–	–	5920	73	479520	73
75	–	–	6000	74	486000	74
76	–	–	6080	75	492480	75
77	–	–	6160	76	498960	76
78	–	–	6240	77	505440	77
79	–	–	6320	78	511920	78
80	–	–	6400	79	518400	79

	Element 7	Element 8	Element 9	Element 10	Element 11	Element 12
Number	Ammo2	delta x [cm]	delta y [mm]	delta y [cm]	delta x [mm]	delta y [m]
1	80	8	0	8	0	6,48
2	160	16	1	16	1	12,96
3	240	24	2	24	2	19,44
4	320	32	3	32	3	25,92
5	400	40	4	40	4	32,4
6	480	48	5	48	5	38,88
7	560	56	6	56	6	45,36
8	640	64	7	64	7	51,84
9	720	72	8	72	8	58,32
10	800	80	9	80	9	64,8
11	880	88	10	88	10	71,28
12	960	96	11	96	11	77,76
13	1040	104	12	104	12	84,24
14	1120	112	13	112	13	90,72
15	1200	120	14	120	14	97,2
16	1280	128	15	128	15	103,68
17	1360	136	16	136	16	110,16
18	1440	144	17	144	17	116,64
19	1520	152	18	152	18	123,12

	Element 7	Element 8	Element 9	Element 10	Element 11	Element 12
Number	Ammo2	delta x [cm]	delta y [mm]	delta y [cm]	delta x [mm]	delta y [m]
20	1600	160	19	160	19	129,6
21	1680	168	20	168	20	136,08
22	1760	176	21	176	21	142,56
23	1840	184	22	184	22	149,04
24	1920	192	23	192	23	155,52
25	2000	200	24	200	24	162
26	2080	208	25	208	25	168,48
27	2160	216	26	216	26	174,96
28	2240	224	27	224	27	181,44
29	2320	232	28	232	28	187,92
30	2400	240	29	240	29	194,4
31	2480	248	30	248	30	200,88
71	5680	568	70	568	70	460,08
72	5760	576	71	576	71	466,56
73	5840	584	72	584	72	473,04
74	5920	592	73	592	73	479,52
75	6000	600	74	600	74	486
76	6080	608	75	608	75	492,48
77	6160	616	76	616	76	498,96
78	6240	624	77	624	77	505,44
79	6320	632	78	632	78	511,92
80	6400	640	79	640	79	518,4

	Element 13	Element 14	Element 15	Element 16	Element 17	Element 18
Number	Reserve1	Delta x [m]	Reserve2	Distance1	Distance3	Distance2
1		6,48		0	6320	80
2		12,96		1	12640	160
3		19,44		2	18960	240
4		25,92		3	25280	320
5		32,4		4	31600	400
6		38,88		5	37920	480
7		45,36		6	44240	560

	Element 13	Element 14	Element 15	Element 16	Element 17	Element 18
Number	Reserve1	Delta x [m]	Reserve2	Distance1	Distance3	Distance2
8		51,84		7	50560	640
9		58,32		8	56880	720
10		64,8		9	63200	800
11		71,28		10	69520	880
12		77,76		11	75840	960
13		84,24		12	82160	1040
14		90,72		13	88480	1120
15		97,2		14	94800	1200
16		103,68		15	101120	1280
17		110,16		16	107440	1360
18		116,64		17	113760	1440
19		123,12		18	120080	1520
20		129,6		19	126400	1600
21		136,08		20	132720	1680
22		142,56		21	139040	1760
23		149,04		22	145360	1840
24		155,52		23	151680	1920
25		162		24	158000	2000
26		168,48		25	164320	2080
27		174,96		26	170640	2160
28		181,44		27	176960	2240
29		187,92		28	183280	2320
30		194,4		29	189600	2400
31		200,88		30	195920	2480
71		460,08		70	448720	5680
72		466,56		71	455040	5760
73		473,04		72	461360	5840
74		479,52		73	467680	5920
75		486		74	474000	6000
76		492,48		75	480320	6080
77		498,96		76	486640	6160
78		505,44		77	492960	6240

	Element 13	Element 14	Element 15	Element 16	Element 17	Element 18
Number	Reserve1	Delta x [m]	Reserve2	Distance1	Distance3	Distance2
79		511,92		78	499280	Switch 1
80		518,4		79	505600	Switch 2

	Element 19	Element 20	Element 21	Element 22	Element 23	Element 24
Number	PID4	PID1	PID3	PID2	Flight T [s]	CheckS
1	524880	0	6480	80	0	0
2	1049760	1	12960	160	1	1
3	1574640	2	19440	240	2	2
4	2099520	3	25920	320	3	3
5	2624400	4	32400	400	4	4
6	3149280	5	38880	480	5	5
7	3674160	6	45360	560	6	6
8	4199040	7	51840	640	7	7
9	4723920	8	58320	720	8	8
10	5248800	9	64800	800	9	9
11	5773680	10	71280	880	10	10
12	6298560	11	77760	960	11	11
13	6823440	12	84240	1040	12	12
14	7348320	13	90720	1120	13	13
15	7873200	14	97200	1200	14	14
16	8398080	15	103680	1280	15	15
17	8922960	16	110160	1360	16	16
18	9447840	17	116640	1440	17	17
19	9972720	18	123120	1520	18	18
20	10497600	19	129600	1600	19	19
21	11022480	20	136080	1680	20	20
22	11547360	21	142560	1760	21	21
23	12072240	22	149040	1840	22	22
24	12597120	23	155520	1920	23	23
25	13122000	24	162000	2000	24	24
26	13646880	25	168480	2080	25	25
27	14171760	26	174960	2160	26	26

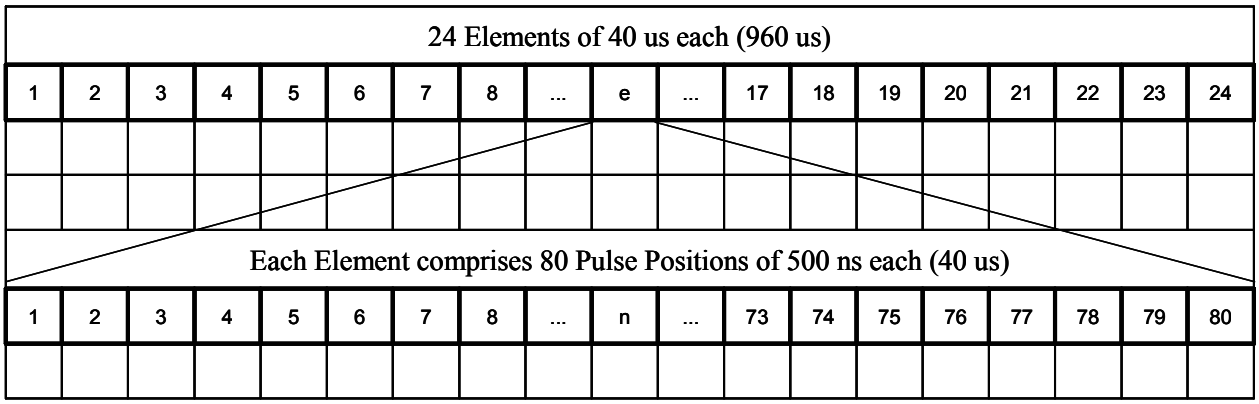
	Element 19	Element 20	Element 21	Element 22	Element 23	Element 24
Number	PID4	PID1	PID3	PID2	Flight T [s]	CheckS
28	14696640	27	181440	2240	27	27
29	15221520	28	187920	2320	28	28
30	15746400	29	194400	2400	29	29
31	16271280	30	200880	2480	30	30
71	37266480	70	460080	5680	660	70
72	37791360	71	466560	5760	720	71
73	38316240	72	473040	5840	780	72
74	38841120	73	479520	5920	840	73
75	39366000	74	486000	6000	900	74
76	39890880	75	492480	6080	960	75
77	40415760	76	498960	6160	1020	76
78	40940640	77	505440	6240	1080	77
79	41465520	78	511920	6320	1140	78
80	41990400	79	518400	6400	1200	79

J2.5 TIMING FOR TIME BASED CODING SYSTEMS (E.G. LASER SIMULATION)

For time based coding systems the following timing can be used to ensure a data transmission that covers the needs of 2020 scenarios. The following values are proposed since they are within the technological capacity of present systems. The timing, if applied with laser simulators, ensures eye safety class one over large distances (more than 6 km depending on technology pull):

- Each Pulse Interval (PI) has a length of 500 ns.
- Each element (80 PI) has a duration of 40 µs.
- 24 elements form one word with a duration of 960 µs.
- Each word is repeated 4 times with a spacing of 1 ms.
- A complete time based transmission therefore requires about 7 ms.
- Short transmission time to ensure code transmission without restrictions on weapon handling.

The timing is depicted in the following graph.



Graph J2-1: Overview of Timing.

In each element up to one Data Position may be occupied. The first Pulse Positions in Elements 1 and 2 are always occupied, resulting in a pulse distance of 40 µs.

In all elements exactly one Pulse Position has to be occupied. This results in 22 elements which are used for information encoding. Together with the two synchronization pulses mentioned before, each Data Word comprises exactly 24 pulses.

Information on which Pulse Position is occupied is defined by the leading edge of the pulse, while the pulse itself as a rule is significantly longer than one Pulse Position.

Appendix J3: POSSIBLE EXTERNAL REPORT MANIFESTATIONS

J3.1 EFFECTS REPRESENTATION (ER) – RELEVANT EVENTS ON THE SIDE OF THE SHOOTER

Table J3-1 shows examples of possible engagement events on a shooter, the kind of representation, a means of representing the effect, an ER example and a blank space for future FIBUA/MOUT WG comment.

Table J3-1: Examples of Engagement Events

Engagement Event Shooter	Kind of Representation	Means of Representing Effect	ER Example	FIBUA/MOUT Comment
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	Acoustical, optical	Pyrotechnics	White flash, loud bang and smoke	
Anti-tank Helicopter fire	Optical	Pyrotechnics (safety?), flashing lights	White flash, smoke/flare (?)	

J3.2 ER-RELEVANT EVENTS ON TARGETS

Table J3-2 shows examples of possible engagement events and their respective representation on the targets.

Table J3-2: Examples of Effects on Targets

Target	Engagement Event	Engagement Result	Kind of Representation	Means of Representing Effect	ER Example	FIBUA/ MOUT Comment
Personnel	Direct/indirect weapon hit	Kill	Acoustical	Electro-acoustic	Long, loud beep	
Personnel	Direct/indirect weapon hit	Degree of wounds < kill	None	–	–	
Vehicle	Direct weapon hit	Total kill	Acoustical, optical	Pyrotechnic, blinking lights	Red flare, loud bang, red smoke, permanent white flashing light	

Target	Engagement Event	Engagement Result	Kind of Representation	Means of Representing Effect	ER Example	FIBUA/ MOUT Comment
Vehicle	Indirect weapon hit (artillery, aircraft bombing)	Total kill	Optical, acoustical	Pyrotechnics, blinking lights	Red flare, loud bang, red smoke, permanent white flashing light, temporary yellow flashing light	
Vehicle	Indirect weapon hit (artillery, aircraft bombing)	Degree of damage < kill	Optical	Blinking lights	Temporary white flashing light, temporary yellow flashing light	
Vehicle	Mine hit	Total kill	Optical, acoustical	Pyrotechnics, blinking lights	Red flare, loud bang, red smoke, permanent white flashlight temporary green flashing light, green smoke	
Vehicle	Mine hit	Degree of damage < kill	Optical	Blinking lights, pyrotechnics	Temporary white flashing light, temporary green flashing light green smoke	
Building	Direct or indirect hit	Total destruction	Optical, acoustical	Blinking lights, electro acoustic, signs, smoke generators	White lightning, loud bang, smoke, sign outside indicating “infrastructure destroyed”	

Target	Engagement Event	Engagement Result	Kind of Representation	Means of Representing Effect	ER Example	FIBUA/ MOUT Comment
Building	Direct or indirect hit	Partial destruction	Optical, acoustical	Blinking lights, electro acoustics, signs, smoke generators	White lightning, loud bang, smoke, sign outside indicating level of destruction/ remaining coverage	
Building	Direct or indirect hit	Hit with no impact on sheltering capability	Optical, acoustical	Blinking lights, electro acoustics, signs, smoke generators	White lightning, loud bang, smoke	

Appendix J4: LEGACY OSAG – CODE ENHANCEMENT OPTIONS

J4.1 INTRODUCTION

The UCATT TG proposes that the code transition phase should be complete by 2020 which is 13 years after the publication of this report. This appendix presents a **conceptual** means of how one of the currently established codes (the OSAG code) can be modified to achieve a level of interoperability that would enable the OSAG-code community to conduct joint training operations in the near term.

J4.2 BACKGROUND

Current users of OSAG compatible laser simulators have different laser code systems, e.g. Austria, Germany, Italy and the Netherlands are using OSAG while Finland and Norway are using a modified OSAG code. The United Kingdom, USA and Sweden among others are using their own code variants. In order to create a common laser code structure that supports both high fidelity and one way simulation one option would be to use the OSAG II laser code. The OSAG II will have approximately 170 ammunition codes available which are 2.5 times more than the present code. In OSAG only every 3rd laser pulse interval is used for an ammunition code. In OSAG II every laser pulse interval within a class can be used.

The OSAG II code would be an open and company independent standard. The OSAG II code is a code that defines the structure of the code itself and its content, i.e. the interpretation, in terms of ammunition type, of the different individual weapons.

J4.3 GUIDING PRINCIPLES

The following are guiding principles on how to achieve a code system that has a defined ammunition code structure and which allows unique user defined ammunitions to be implemented. A brief description would be to say that the OSAG II proposal is an introduction of 38 ammunition classes (categories) as schematically presented in the example at Table J4-1 below.

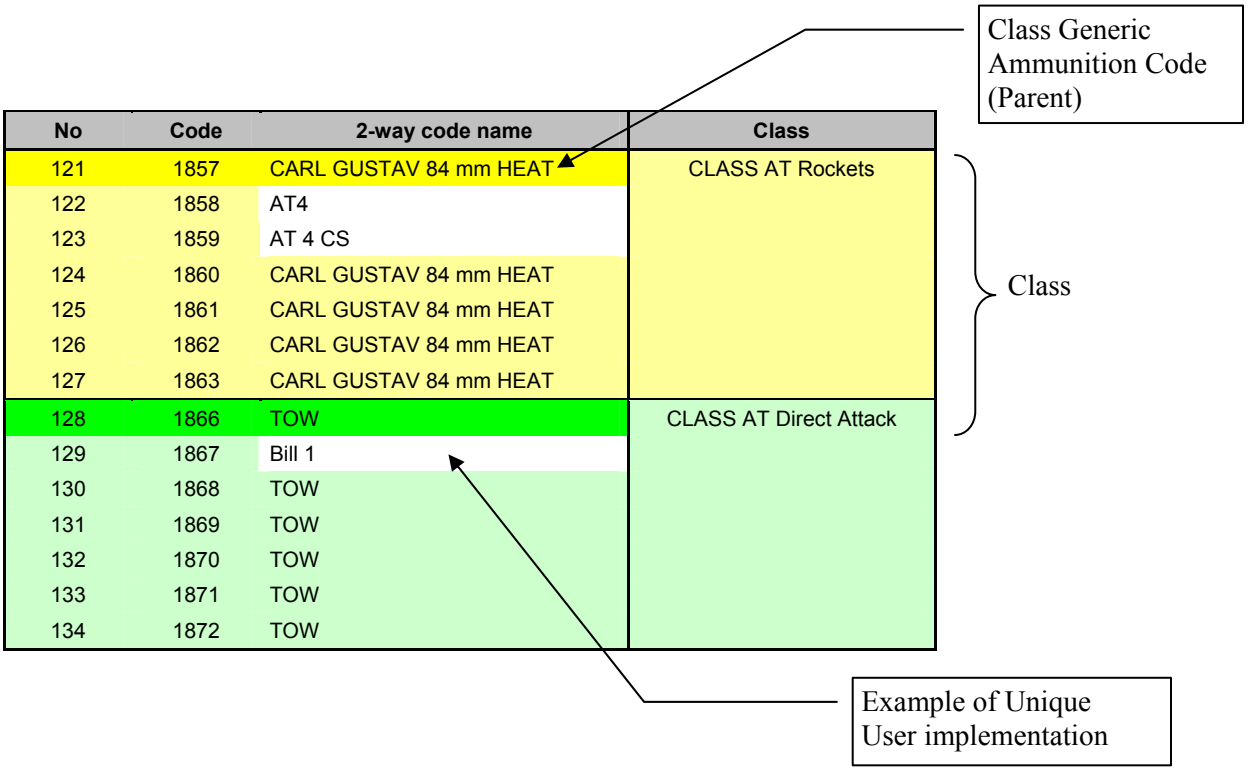
Every single one of these classes is defined by a generic ammunition code and the first ammunition code within the sequence of codes belonging to the applicable class is to be implemented and interpreted in the same way in every system supporting this new approach.

Each user (nation) can then choose and define unique ammunitions within the appropriate class, based on ammunition effect, using the remaining ammunition codes.

During joint training the 38 ammunition classes will be used to determine the effects of an engagement. The more precise, user (nation) specific ammunitions can be used during national (single user) training, enhancing the training fidelity by providing detailed information about the particular ammunition. During national training exercises the proposed concept ensures that all simulators will still be able to interpret the ammunition codes according to the locally defined tailoring with the unique ammunition code implementations that exist today.

During international exercises, the proposal eliminates the problem with undefined codes as all codes, unless identically defined, will be interpreted as the generic ammunition type of applicable class.

Table J4-1: Example of Code Structure



No	Code	2-way code name	Class
121	1857	CARL GUSTAV 84 mm HEAT	CLASS AT Rockets
122	1858	AT4	
123	1859	AT 4 CS	
124	1860	CARL GUSTAV 84 mm HEAT	
125	1861	CARL GUSTAV 84 mm HEAT	
126	1862	CARL GUSTAV 84 mm HEAT	
127	1863	CARL GUSTAV 84 mm HEAT	
128	1866	TOW	CLASS AT Direct Attack
129	1867	Bill 1	
130	1868	TOW	
131	1869	TOW	
132	1870	TOW	
133	1871	TOW	
134	1872	TOW	

J4.4 EXAMPLE OF IMPLEMENTATION

In the following, a brief example will be given with a selection of codes implemented for User A and B respectively.

Table J4-2: Example of Implementation for User A

No	Code	2-Way Code Name	Class
121	1857	CARL GUSTAV 84 mm HEAT	CLASS AT Rockets
122	1858	AT4	
123	1859	AT 4 CS	
124	1860	CARL GUSTAV 84 mm HEAT	
125	1861	CARL GUSTAV 84 mm HEAT	
126	1862	CARL GUSTAV 84 mm HEAT	
127	1863	CARL GUSTAV 84 mm HEAT	
128	1866	TOW	CLASS AT Direct Attack
129	1867	Bill 1	
130	1868	TOW	
131	1869	TOW	
132	1870	TOW	
133	1871	TOW	
134	1872	TOW	

Table J4-3: Example of Implementation for User B

No	Code	2-Way Code Name	Class
121	1857	CARL GUSTAV 84 mm HEAT	CLASS AT Rockets
122	1858	PZF 3	
123	1859	CARL GUSTAV 84 mm HEAT	
124	1860	CARL GUSTAV 84 mm HEAT	
125	1861	CARL GUSTAV 84 mm HEAT	
126	1862	CARL GUSTAV 84 mm HEAT	
127	1863	CARL GUSTAV 84 mm HEAT	
128	1866	TOW	CLASS AT Direct Attack
129	1867	MILAN	
130	1868	TOW	
131	1869	TOW	
132	1870	TOW	
133	1871	TOW	
134	1872	TOW	

As seen from Table J4-2 and Table J4-3 above the following would apply:

Fire Code by Country A	Interpretation by User A	Interpretation by User B
121	Generic Code Carl Gustav Heat	Generic Code Carl Gustav Heat
122	AT4	PzF3
123	AT4 CS	Generic Code Carl Gustav Heat
128	Generic Code TOW	Generic Code TOW
129	Bill 1	Milan

As seen by the example, the introduced classes would assure that the interpretation of the different codes would be valid in terms of similarity between the different weapon platforms introduced in the different categories. A certain code would not be interpreted as a completely different weapon type.

If the penetration characteristics, ranges and effects of the specific ammunitions are not identical enough, the interpretation will be set to the generic ammunition code only, e.g. the interpretation of Codes 121 through 127 in the example above would always be 121 (generic Carl Gustav 84 mm Heat).

J4.5 CONCEPTUAL OSAG II AMMUNITION CODE TABLES

The following paragraphs presents conceptual ammunition tables, thus not to be read as finalized versions. To further clarify the intent and purpose, the tables shall be read with the following statements in mind:

- The ammunition tables are all default; no user adaptations in terms of unique ammunitions are included.
- The ammunition codes listed define the type of effect in the target.
- The first ammunition code (the generic ammunition code) of each class as well as generic Codes 211 through 219, shall remain intact in each user implementation.

- All ammunition codes represent single shots unless otherwise specifically stated.
- Please note that the pulse code intervals related to positional information (i.e. hit co-ordinates) and transmitting of player identities as well as control gun codes has not been included in this description.
- The "Code" in the tables below refers to the information coding defined by the time difference between successive laser pulses. This interval is permitted to be between 1200 and 2400 * 66.7 ns.

J4.5.1 2-Way Ammunition Codes

2-Way Codes			
No	Code	Name	Comment
1	1701	120 mm APFSDS <1000 m	
2	1702	120 mm APFSDS <1000 m	
3	1703	120 mm APFSDS <1000 m	
4	1704	120 mm APFSDS <1000 m	
5	1705	120 mm APFSDS <1000 m	
6	1706	120 mm APFSDS <1000 m	
7	1707	120 mm APFSDS <1000 m	***Class 120 mm KE Tank***
8	1708	120 mm APFSDS <1000 m	
9	1709	120 mm APFSDS <1000 m	
10	1710	120 mm APFSDS <1000 m	
11	1711	120 mm APFSDS <1000 m	
12	1712	120 mm APFSDS <1000 m	
13	1713	120 mm APFSDS <1000 m	
14	1716	120 mm HE <1000 m	
15	1717	120 mm HE <1000 m	
16	1718	120 mm HE <1000 m	
17	1719	120 mm HE <1000 m	
18	1720	120 mm HE <1000 m	
19	1721	120 mm HE <1000 m	
20	1722	120 mm HE <1000 m	
21	1723	120 mm HE <1000 m	
22	1724	120 mm HE <1000 m	
23	1725	120 mm HE <1000 m	***Class 120 mm HE Tank***
24	1726	120 mm HE <1000 m	
25	1727	120 mm HE <1000 m	
26	1728	120 mm HE <1000 m	
27	1731	105 mm APFSDS <1000 m	
28	1732	105 mm APFSDS <1000 m	***Class 105 mm KE Tank***
29	1733	105 mm APFSDS <1000 m	
30	1734	105 mm APFSDS <1000 m	

2-Way Codes			
No	Code	Name	Comment
31	1735	105 mm APFSDS <1000 m	***Class 105 mm KE Tank (cont'd)***
32	1736	105 mm APFSDS <1000 m	
33	1737	105 mm APFSDS <1000 m	
34	1738	105 mm APFSDS <1000 m	
35	1739	105 mm APFSDS <1000 m	
36	1740	105 mm APFSDS <1000 m	
37	1741	105 mm APFSDS <1000 m	
38	1742	105 mm APFSDS <1000 m	
39	1743	105 mm APFSDS <1000 m	
40	1746	105 mm HE <1000 m	***Class 105 mm HE Tank***
41	1747	105 mm HE <1000 m	
42	1748	105 mm HE <1000 m	
43	1749	105 mm HE <1000 m	
44	1750	105 mm HE <1000 m	
45	1751	105 mm HE <1000 m	
46	1752	105 mm HE <1000 m	
47	1753	105 mm HE <1000 m	
48	1754	105 mm HE <1000 m	
49	1755	105 mm HE <1000 m	
50	1756	105 mm HE <1000 m	
51	1757	105 mm HE <1000 m	
52	1758	105 mm HE <1000 m	
53	1761	73 mm AP	***Class 73 mm KE***
54	1762	73 mm AP	
55	1763	73 mm AP	
56	1764	73 mm AP	
57	1767	73 mm HE	***Class 73 mm HE***
58	1768	73 mm HE	
59	1769	73 mm HE	
60	1770	73 mm HE	
61	1773	40 mm APFSDS	***Class 40 mm KE***
62	1774	40 mm APFSDS	
63	1775	40 mm APFSDS	
64	1776	40 mm APFSDS	
65	1777	40 mm APFSDS	
66	1778	40 mm APFSDS	
67	1779	40 mm APFSDS	
68	1782	40 mm HE	***Class 40 mm HE***

2-Way Codes			
No	Code	Name	Comment
69	1783	40 mm HE	***Class 40 mm HE (cont'd)***
70	1784	40 mm HE	
71	1785	40 mm HE	
72	1786	40 mm HE	
73	1787	40 mm HE	
74	1788	40 mm HE	
75	1791	30 mm APSFSDS	***Class 30 mm KE***
76	1792	30 mm APSFSDS	
77	1793	30 mm APSFSDS	
78	1794	30 mm APSFSDS	
79	1795	30 mm APSFSDS	
80	1796	30 mm APSFSDS	
81	1797	30 mm APSFSDS	
82	1800	30 mm HE	***Class 30 mm HE***
83	1801	30 mm HE	
84	1802	30 mm HE	
85	1803	30 mm HE	
86	1804	30 mm HE	
87	1805	30 mm HE	
88	1806	30 mm HE	
89	1809	20 mm AP Single	***Class 20 mm KE Single***
90	1810	20 mm AP Single	
91	1811	20 mm AP Single	
92	1812	20 mm AP Single	
93	1815	20 mm AP Burst	***Class 20 mm KE Burst***
94	1816	20 mm AP Burst	
95	1817	20 mm AP Burst	
96	1818	20 mm AP Burst	
97	1821	20 mm HE Single	***Class 20 mm HE Single***
98	1822	20 mm HE Single	
99	1823	20 mm HE Single	
100	1824	20 mm HE Single	
101	1827	20 mm HE Burst	***Class 20 mm HE Burst***
102	1828	20 mm HE Burst	
103	1829	20 mm HE Burst	
104	1830	20 mm HE Burst	
105	1833	12.7 mm AP Single	***Class Heavy Machine Gun Single***
106	1834	12.7 mm AP Single	

2-Way Codes			
No	Code	Name	Comment
107	1835	12.7 mm AP Single	***Class Heavy Machine Gun Single (cont'd)***
108	1836	12.7 mm AP Single	
109	1839	12.7 mm AP Burst	***Class Heavy Machine Gun Burst***
110	1840	12.7 mm AP Burst	
111	1841	12.7 mm AP Burst	
112	1842	12.7 mm AP Burst	
113	1845	7.62 mm Single	***Class Coax Machine Gun Single***
114	1846	7.62 mm Single	
115	1847	7.62 mm Single	
116	1848	7.62 mm Single	
117	1851	7.62 mm Burst	***Class Coax Machine Gun Burst***
118	1852	7.62 mm Burst	
119	1853	7.62 mm Burst	
120	1854	7.62 mm Burst	
121	1857	CarlGustav 84 mm HEAT	***Class AT Rockets***
122	1858	CarlGustav 84 mm HEAT	
123	1859	CarlGustav 84 mm HEAT	
124	1860	CarlGustav 84 mm HEAT	
125	1861	CarlGustav 84 mm HEAT	
126	1862	CarlGustav 84 mm HEAT	
127	1863	CarlGustav 84 mm HEAT	
128	1866	TOW	***Class AT Direct Attack***
129	1867	TOW	
130	1868	TOW	
131	1869	TOW	
132	1870	TOW	
133	1871	TOW	
134	1872	TOW	
135	1875	TOW 2A	***Class AT Direct Tandem***
136	1876	TOW2A	
137	1877	TOW2A	
138	1878	TOW2A	
139	1879	TOW2A	
140	1880	TOW2A	
141	1881	TOW2A	
142	1884	TOW2B	***Class AT Top Attack***
143	1885	TOW2B	
144	1886	TOW2B	
145	1887	TOW2B	

2-Way Codes			
No	Code	Name	Comment
146	1890	Hellfire	***Class Designated Missiles***
147	1891	Hellfire	
148	1892	Hellfire	
149	1893	Hellfire	
150	1896	Javelin SAM	***Class Guided SAM Missiles***
151	1897	Javelin SAM	
152	1898	Javelin SAM	
153	1899	Javelin SAM	
154	2325	To be defined	***Class Fire&Forget Direct***
155	2326	To be defined	
156	2327	To be defined	
157	2328	To be defined	
158	2331	Spike Direct Mode	***Class Fire&Forget Direct Tandem***
159	2332	Spike Direct Mode	
160	2333	Spike Direct Mode	
161	2334	Spike Direct Mode	
162	2337	Javelin	***Class Fire&Forget Top Attack***
163	2338	Javelin	
164	2339	Javelin	
165	2340	Javelin	
166	2343	Stinger	***Class Fire&Forget SAM***
167	2344	Stinger	
168	2345	Stinger	
169	2346	Stinger	

J4.5.2 1-Way Ammunition Codes

1-Way Codes			
No	Code	Name	Comment
180	1203	5.56 mm Full Metal Jacket	***Class 5.56 mm***
181	1206	5.56 mm Full Metal Jacket	
182	1209	5.56 mm Full Metal Jacket	
183	1212	5.56 mm Full Metal Jacket	
184	1215	7.62 mm Full Metal Jacket	***Class 7.62 mm***
185	1218	7.62 mm Full Metal Jacket	
186	1221	7.62 mm Full Metal Jacket	
187	1224	7.62 mm Full Metal Jacket	

1-Way Codes			
No	Code	Name	Comment
188	1227	9 mm Full Metal Jacket	***Class 9 mm***
189	1230	9 mm Full Metal Jacket	
190	1233	9 mm Full Metal Jacket	
191	1236	12.7 mm Full Metal Jacket	***Class 12.7 mm***
192	1239	12.7 mm Full Metal Jacket	
193	1242	12.7 mm Full Metal Jacket	
194	1245	12.7 mm Full Metal Jacket	
195	1248	ShotGun	***Class ShotGun***
196	1251	ShotGun	
197	1254	ShotGun	
198	1257	Small AP Mine	***Class AP Mines and Hand Grenades***
199	1260	Small AP Mine	
200	1263	Small AP Mine	
201	1266	Small AP Mine	
202	1269	Small AT Mine	***Class AT Mines***
203	1272	Small AT Mine	
204	1275	Small AT Mine	
205	1278	Small AT Mine	
206	1281	40 mm HE	***Class 20 – 40 mm***
207	1284	40 mm HE	
208	1287	40 mm HE	
209	1290	40 mm HE	
210	1293	40 mm HE	
211	1296	Laser Range Finder	***Class Special***
212	1299	Laser Designator	
213	1302	Indirect Hit Troop Transport	
214	1305	Indirect Hit Back Blast	
215	1307	Near Miss (Fine Calibre)	
216	1310	Near Miss Heavy (Medium Calibre)	
217	2349	HE Vehicle	***Class 2-Way Fragments***
218	2352	7.62 – 12.7 mm	
219	2355	HE ATW	

Annex K – NEW TERMS OF REFERENCE AND TECHNICAL ACTIVITY PROGRAMME

TERMS OF REFERENCE

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 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 were not completely covered or needed more investigation also a number of areas are new. Those new areas are in the constructive and the virtual domain. Also there is a need to further develop standards in laser and data communication, audio and visual effects.

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.

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.

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

B. Military Benefit

Operational Concepts: A comprehensive list of Generic User Requirements will be developed working in conjunction with NATO Training Groups and Military Users on the virtual and the constructive domain.

Standardization of frequency spectrum allocation and management, laser compatibility, battlefield 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: Ing. Jan VERMEULEN, Netherlands.

B. Nations Really Participating

Canada, Czech Republic, Finland, France, Germany, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States.

IV. SECURITY LEVEL

The security level will be Unclassified/Unlimited.

V. PARTICIPATION BY PARTNER NATIONS AND OTHER NATIONS

This activity is open to PfP.

VI. LIAISON

VII. REFERENCE

TECHNICAL ACTIVITY PROGRAMME

<table>
<tr><td colspan="2">ACTIVITY</td><td>MSG-063</td><td colspan="11" rowspan="2">Urban Combat Advanced Training Technology – UCATT 2</td><td colspan="3">2007</td></tr>
<tr><td colspan="2">Activity REF. Number</td><td>RTG-040</td><td colspan="3">June 2007 IS</td></tr>
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<tr><td colspan="3">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>
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<tr><td colspan="3"></td><td colspan="4">Interoperability</td><td colspan="4">Training</td><td colspan="5"></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 battlefield in the 21st century.

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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.

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.

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

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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. TOPICS TO BE COVERED

Operational Concepts: A comprehensive list of Generic User Requirements will be developed working in conjunction with NATO Training Groups and Military Users on the virtual and the constructive domain.

Standardization of frequency spectrum allocation and management, laser compatibility, battlefield 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.

IV. DELIVERABLE

Technical Report.

V. TECHNICAL TEAM LEADER AND LEAD NATION

Chair: Ing. Jan VERMEULEN, Netherlands.

Lead Nation: Netherlands.

VI. NATIONS WILLING/INVITED TO PARTICIPATE

Canada, Czech Republic, Finland, France, Germany, the Netherlands, Sweden, Switzerland, the United Kingdom and the 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.

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13. Keywords/Descriptors

Combat Training Centre (CTC)
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14. Abstract

The Urban Combat Advanced Training Technology (UCATT) Task Group (TG) was established within the NATO Modelling and Simulation Group (NMSG) in 2003 as MSG-032 TG-023. The UCATT TG was tasked 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 identify a suitable architecture and a standard set of interfaces that would enable interoperability of MOUT training components without inhibiting future enhancements, and pinpoint limitations and constraints on MOUT development so that areas for future research could be identified. The end product of this TG is this comprehensive report detailing an architectural framework to enable interoperability and future research requirements for MOUT training facilities. This report covers the work of UCATT from its inception and the work conducted to date which includes the development of a MOUT website and architectural framework based on USE CASES and an analysis of the functional components mapped to national requirements for live force-on-force urban training.

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