NORTH ATLANTIC TREATY ORGANIZATION

SCIENCE AND TECHNOLOGY ORGANIZATION

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STO TECHNICAL REPORT **TR-MSG-099**

Urban Combat Advanced Training Technology Standards

(Normes de technologie avancée pour l'entraînement au combat urbain)

Final Report of Task Group MSG-099 UCATT Standards.

Published February 2018

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The NATO Science and Technology Organization

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

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

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

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

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

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

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

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List of Acronyms

AAR	After Action Review
AWES	Area Weapon Effect Simulation
BMS	Battle Management System
BPDSP	Balloted Products Development and Support Process
C4I	Command, Control, Communications, Computers and Intelligence
C-BML	Coalition Battle Management Language
CBRN	Chemical, Biological, Radiological, Nuclear
COSIM	C.O.E.L. Simulator (Predecessor organization of RUAG)
CTC	Combat Training Centre
DA	Design Architecture
DIS	Distributed Interactive Simulation
DO	Dynamic Object
EXCOM	Executive Committee
EXCON	Exercise Control
FA	Functional Architecture
FIBUA	Fighting In Built-Up Areas
HLA	High Level Architecture
IEEE	Institute of Electrical and Electronics Engineers
IUC	International User Community
JC3IEDM	Joint Consultation, Command and Control Information Exchange Data Model
LO2020	Land Operations in the Year 2020
LRR	Long Range Radio
M&S	Modelling and Simulation
MILES	Multiple Integrated Laser Engagement System
MOD	Ministry Of Defence
MOUT	Military Operations in Urban Terrain
MSDL	Military Scenario Definition Language
MSG	Modelling and Simulation Group
MSMP	Modelling and Simulation Master Plan
NAAG	NATO Army Armaments Group
NATO	North Atlantic Treaty Organization
NCL	Nouveau Code Laser
NMSG	NATO Modelling and Simulation Group
O/C	Observer Controller
OPFOR	Opposing Forces
ORBAT	Order of Battle
OSAG	Optical interface specification for the German CTC

PDG	Product Development Group
PfP	Partners for Peace
PI	Pulse Interval
PID	Player Identity
PSG	Product Support Group
RTG	Research Task Group
SAC	Standards Activity Committee
SAS	System Analysis and Studies
SISO	Simulation Interoperability Standards Organization
STB	Science and Technology Board
STO	Science and Technology Organization
STOG	Simulation for Training and Operation Group
TES	Tactical Engagement Simulation
TG	Task Group
TSWG	Training and Simulation Working Group
UAV	Unmanned Arial Vehicle
UCATT	Urban Combat Advanced Training Technology
UO2020	Urban Operations in the Year 2020
WG	Working Group

Acknowledgements

The Chairman wishes to thank all members of the Task Group (TG). As it is not self-evident for competitors to work together with the same aim and to discuss technical issues of their products, I like to thank all members for their plain speaking and target oriented work. Also we thank the companies for their sponsoring of the good people that were part of our group.

Also we like to thank the architecture group for their patience. During our long discussions of the simplification of their requirements, forced by limitations of existing technologies, they were always very sympathetic.

We like to send a special thanks to the SISO group that never gave up, no matter how high the unknown formal hurdle appears.

Of course we like to thank each of the participating nations for their hard work and endeavours in delivering this report and also for their contributions, challenge and scrutiny during the life and work of the UCATT-3 RTG.

MSG-099 Membership List

CHAIR

Mr. Ingo WITTWER
Rheinmetall Electronics GmbH
GERMANY
Email: ingo.wittwer@rheinmetall.com

MEMBERS

Mr. Nils Magnus ALEXANDERSSON
SAAB Training Systems AB
SWEDEN
Email: magnus.alexandersson@saabgroup.com

LCDR Pablo ALVAREZ SAN MARTIN
Spanish Navy – Operation Research Center
SPAIN
Email: palvsa2@fn.mde.es

Major Carlos BELINCHON
Ministerio de Defensa de Espana
SPAIN
Email: cbelpin@et.mde.es

Mr. Jesse CAMPOS
PM TRADE Engineering
UNITED STATES
Email: jesse.j.campos2.civ@mail.mil

Mr. Andrew CHAMBERLAIN
UK Ministry of Defence
UNITED KINGDOM
Email: mark.chamberlain484@mod.gov.uk

Mr. Thomas DESFACHELLES
DGA
FRANCE
Email: thomas.desfachelles@dga.defense.gouv.fr

Mr. Philippe DESRUELLES
Airbus Defence and Space
FRANCE
Email: philippe.desruelles@airbus.com

Mr. Joachim GERHARD EISENHAUER
Rheinmetall Electronics GmbH
GERMANY
Email: Joachim.Eisenhauer@rheinmetall.com

Mr. Paul HANDLEY
Cubic Defence New Zealand Ltd
NEW ZEALAND
Email: paul.handley@cubic.com

Prof. Veysi ISLER
Middle East Technical University
TURKEY
Email: isler@ceng.metu.edu.tr

Mr. Jean-Christophe LAMBERT
CASSIDIAN
FRANCE
Email: jean-christophe.lambert@cassidian.com

Mr. Anders Fredrik LINDSTROM
SAAB Training Systems AB
SWEDEN
Email: anders.fr.lindstrom@telia.com

Mr. Bharatkumar PATEL
Dstl – Defence Security & Analysis Division
UNITED KINGDOM
Email: bmpatel@dstl.gov.uk

Ms. Bettina ROSS
DND GmbH
GERMANY
Email: bross@dn-defence.com

Col (ER)Laurent TARD
SOPRA STERIA
FRANCE
Email: laurent.tard@soprasteria.com

Mr. Armin THINNES (Co-Chair)
BWB (Federal Office of Defence and Procurement)
GERMANY
Email: arminthinnes@bundeswehr.org

Mr. Pascal VIROUX
EADS GDI Simulation
FRANCE
Email: pascal.viroux@gdi-simulation.eads.net

Urban Combat Advanced Training Technology Standards

(STO-TR-MSG-099)

Executive Summary

The focus of the MSG-099 Urban Combat Advanced Training Technology (UCATT) Standards Task Group (TG) was to work on the standards, identified and prioritized by the MSG-098 UCATT Architecture group. This enables interoperability of MOUT live training components without inhibiting future research and enhancements.

The Standards group contains industry members of all supporting companies of the live simulation business. This gives the group a powerful basement for sustainable results. Together with the Architecture group UCATT has a unique mixture of military, government and industry people within NATO and PfP, all involved in live simulation. This gives UCATT the capability to discuss live simulation related themes offside the restrictions of a contract situation. The continuation of the UCATT activities within MSG-140 UCATT Live Simulation Standards TG secures not only a vehicle for continued work on standardisation within the live simulation community, but also one to embed and support the goals already achieved.

MSG-099 established very close liaison with MSG-098 UCATT Architecture TG. MSG-098 and MSG-099 together form the UCATT Task Group whose members represent the majority of the SISO UCATT PDG. In conclusion the work of the UCATT TG to date has provided NATO with a usable SISO standard for a laser engagement interface. Two other interfaces (short range and long range radio) have been handed over from the architecture group and the initial discussions for their standardization have been completed.

The recommendations of the UCATT Architecture TG's work are outlined below:

1) Involve new countries and industries and re-engage with countries that have ceased earlier active involvement in the group.
2) Increase the "marketing" activities to create more awareness of the UCATT standard for live simulation systems within the User community.
3) Reactivate the relationship between UCATT TG and the Simulation Training and Operations Group.
4) Establish liaison between the UCATT community and the NATO and SISO efforts enhancing the JC3IEDM, C-BML and MSDL standards.
5) Merge the standardisation and architectural activities together into the follow-up Task Group.
6) Continuation of the SISO membership funding for government members of MSG-140.
7) Consider the translation of the currently used functional architecture into the NATO Architectural Framework (NAF) if applicable and useful.

These recommendations have been recognised by STO and the work of UCATT should continue for four main reasons:

- To continue the standardisation effort;
- To form the basis of SISO PSGs necessary for the maintenance and availability of interface standards;

- To acknowledge the applicability of the UCATT work is beyond just Urban training systems and applies to live simulation systems and Combat Training Centres in general; and
- To accommodate the increased international interest in the interoperability opportunities UCATT can provide and invite other nations and participants.

Normes de technologie avancée pour l'entraînement au combat urbain

(STO-TR-MSG-099)

Synthèse

Le groupe de travail (TG) MSG-099 (Normes de technologie avancée pour l'entraînement au combat urbain) s'est focalisé sur les normes identifiées et hiérarchisées par le TG MSG-098 (Architecture UCATT). Ces normes permettent l'interopérabilité des composants d'entraînement en conditions réelles MOUT, sans freiner les recherches et améliorations futures.

Le TG MSG-099 comporte des participants industriels venant de toutes les entreprises qui travaillent dans la simulation en conditions réelles et apportent leur appui à l'OTAN. Il dispose donc d'une base solide pour obtenir des résultats viables. Avec le TG MSG-098, l'UCATT bénéficie d'un mélange unique de participants militaires, gouvernementaux et industriels au sein de l'OTAN et du PpP, tous impliqués dans la simulation en conditions réelles. L'UCATT a ainsi la capacité de discuter de thèmes liés à la simulation en conditions réelles sans être limité par une situation contractuelle. La poursuite des activités UCATT au sein du TG MSG-140 (Normes de simulation en conditions réelles) est non seulement l'assurance de la continuité des travaux de normalisation au sein de la communauté de simulation en conditions réelles, mais également le moyen d'intégrer et soutenir les buts déjà atteints.

Le MSG-099 a établi une liaison très étroite avec le TG MSG-098 (Architecture UCATT). Le MSG-098 et le MSG-099 forment ensemble le groupe de travail UCATT, dont les membres représentent la majorité du groupe de développement de produit (PDG) UCATT SISO. En conclusion, le travail du TG UCATT a fourni jusqu'à présent à l'OTAN une norme SISO utilisable pour une interface d'engagement laser. Le TG MSG-098 a transmis deux autres interfaces (radio à courte portée et à longue portée) et les discussions initiales visant leur normalisation ont été achevées.

Les recommandations du TG sur l'architecture UCATT sont les suivantes :

1) Impliquer de nouveaux pays et secteurs économiques et réimpliquer les pays qui ont cessé leur implication active dans le groupe.
2) Augmenter les activités de « marketing » pour faire connaître la norme UCATT destinée aux systèmes de simulation en conditions réelles au sein de la communauté des utilisateurs.
3) Réactiver les relations entre le TG UCATT et le Groupe de simulation pour l'entraînement et les opérations.
4) Etablir une liaison entre la communauté UCATT et l'OTAN d'une part, et les travaux de la SISO améliorant les normes JC3IEDM, C-BML et MSDL d'autre part.
5) Fusionner les activités de normalisation et d'architecture au sein du groupe de travail de suivi.
6) Poursuivre le financement de l'adhésion à la SISO des membres gouvernementaux du MSG-140.
7) Envisager la traduction de l'architecture fonctionnelle actuellement utilisée au sein du cadre d'architecture de l'OTAN (NAF) s'il y a lieu.

La STO a pris note de ces recommandations et le travail de l'UCATT devrait se poursuivre dans quatre buts principaux :

- Continuer les travaux de normalisation ;
- Former la base de groupes d'assistance technique des produits (PSG) de la SISO, veillant à la maintenance et la disponibilité des normes d'interface ;
- Reconnaître que les travaux UCATT dépassent le champ des systèmes d'entraînement urbain et s'appliquent aux systèmes de simulation en conditions réelles et aux centres d'entraînement au combat en général ; et
- Tenir compte de l'intérêt international accru porté aux opportunités d'interopérabilité que l'UCATT peut offrir et inviter d'autres pays et participants.

URBAN COMBAT ADVANCED TRAINING TECHNOLOGY STANDARDS

1.0 OVERVIEW

1.1 Introduction

Ground based warfare in an Urban context is perhaps the most deadly and complex type that tends to neutralise much of the technical superiority of modern armies. As such preparedness for operations in such an environment is vital for success. Investments in the first generation of modern combat training centres (with instrumentation for data collection and analysis) with urban training facilities began in the 1990s.

These capabilities are generally bespoke simulation designs to national requirements not lending themselves easily to support training events for contemporary coalition style operations as they have limited ability to achieve standardisation and interoperability.

The NATO structure and objectives make NATO a suitable organisation to seek to harmonise training requirements and move toward common technical architecture and standards for the next generation facilities.

The NATO Modelling and Simulation action / Master Plan (MSMP) cite 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 is the need for a common technical framework to support Live instrumented training among members of the Alliance.

1.2 Background

Two NATO studies are the genesis of the UCATT work:

1) The NATO Research and Technology Organisation (RTO) 1999 Technical Report, Land Operations in the Year 2020 (LO2020); and

2) The 2003 Urban Operations in the Year 2020 (UO2020) report.

LO2020, in particular (as have other studies) concluded that NATO forces would likely have to conduct future operations in urban areas.

In response and in support of the MSMP, a Team of Experts from NATO NAAG completed in 2002 a feasibility study and concluded that a number of potential interoperability areas were worthy of further investigation. As a result the Urban Combat Advanced Training Technology (UCATT) Task Group (TG) was established within the NATO Modelling and Simulation Group (NMSG). Perhaps uniquely from the outset UCATT drew members from both government and industry bodies. UCATT has become the NATO focal point for Urban training technology and data exchange requirements for live training in the land domain. It is well regarded among the military community and industry as the driving force within the live domain.

1.2.1 UCATT-1

In 2003 as MSG-032 TG 023, UCATT (later known as UCATT-1) was tasked to exchange and assess information on Urban facilities and training/simulation systems with a view toward establishing (then) best practice and consider the issues of interoperability, architecture and interfaces to promote and enable interoperability. A technical report was delivered (RTO-TR-MSG-032) and a website (http://www.fibuamoutsite.info[1]) created which was maintained by the NATO Urban Operations TG. The UCATT-1 report became more or less the guideline for urban combat training facilities design.

1.2.2 UCATT-2

In 2007 as MSG-063 TG 040, UCATT-2 was tasked to continue the work of UCATT and also to undertake an international interoperability demonstration to show the potential benefit of interoperability standards and commence a process of defining standards data exchange and communication and audio and visual effects. In addition to delivering a technical report (TR-MSG-063) a successful technical demonstration was held at the Marnehuizen training facility in The Netherlands in 2011 during which a proof-of-concept was presented showing how systems from multiple manufacturers might be integrated into a single training event.

1.2.3 UCATT-3

The availability and subsequent use of a set of standards would generate benefit if adopted. For the military community these include having interoperability across nations and suppliers to enable multinational exercises with a nations own equipment or choice of location leading to better training. For the acquisition community, it opens up the market and provides tools to aide specification and reduce integration costs. For Industry, it offers the potential for a more open and potentially more frequent sales opportunity.

Therefore following the work of MSG-063, in 2011 two UCATT WGs were constituted to undertake the next phase of work: MSG-098 UCATT Architecture Task Group (referred to as the AG) and MSG-099 Standards Task Group (referred to as the SG). During this third period of UCATT, both Task Groups have operated in close concert with joint meetings to aid communication and understanding. This report is that of MSG-099, the Standards Group. It documents the task to review and update the generic functional architecture developed under UCATT-2. Scenarios were developed to derive data exchange requirements for interfaces. Selected data exchange requirements were issued to the Standards Group (MSG-99) for development into standards.

The first truly tangible output (the UCATT Standard Interface for Laser Engagement, to be published by the Simulation Interoperability Standards Organization (SISO)) is in development as a joint MSG-098/MSG-099 activity. A UCATT Product Development Group (PDG) was chartered by SISO in November 2013 and is lead from MSG-098.

The UCATT-3 TGs MSG-098 and MSG-099 are succeeded by MSG-140, UCATT Live Simulation Standards (LSS). The different groups which have been part of the UCATT activity throughout the years are depicted in Figure 1.

[1] This website is now closed and about to be re-launched under a new URL.

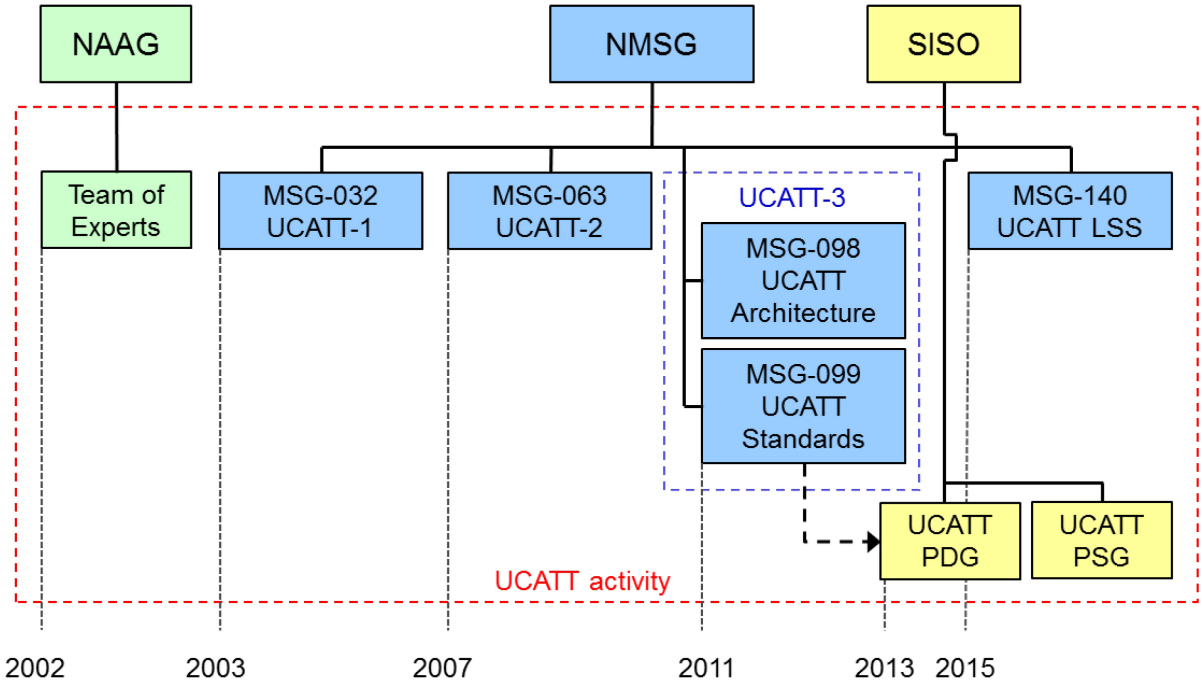

Figure 1: Composition of the UCATT Activity.

1.3 Illustration of the Need for UCATT by Contemporary Example Situations

One of the tasks performed by the Architecture group was the validation of the Use Cases as the UCATT-1 TG formulated them. Those Use Cases have formed the basis of UCATT standardisation efforts ever since, but need validation periodically. It was considered best to validate them by comparing them to current multinational exercising needs and system interconnection efforts. The conclusion of the Architecture group was, and is, that the Use Cases formulated are still valid, so can and must be used for the future. You will find some current day example situations in the report of the Architecture group, which justifies this.

1.4 Working Methodology

This section describes the process followed by the Standards group.

1.4.1 Staged Approach

The starting point for the Standards group was the UCATT-2 report delivered by MSG-063 which recommended work to elaborate on user requirements for urban combat training systems in the live domain and to draft a first series of standards to enable interoperability among different combat training systems.

The Standards group as a new founded group first had to find its working procedures. The members also were new to the UCATT group and had no UCATT-1/2 background. Also we had to build confidence between the competing industry participants.

The first activity was to produce a roadmap, consisting of subjects to investigate and products to deliver during the mandated timeframe of the Standards group. These activities were mapped on the Standards group meeting schedule, which consisted of 3 meetings a year. This schedule is depicted in Figure 2.

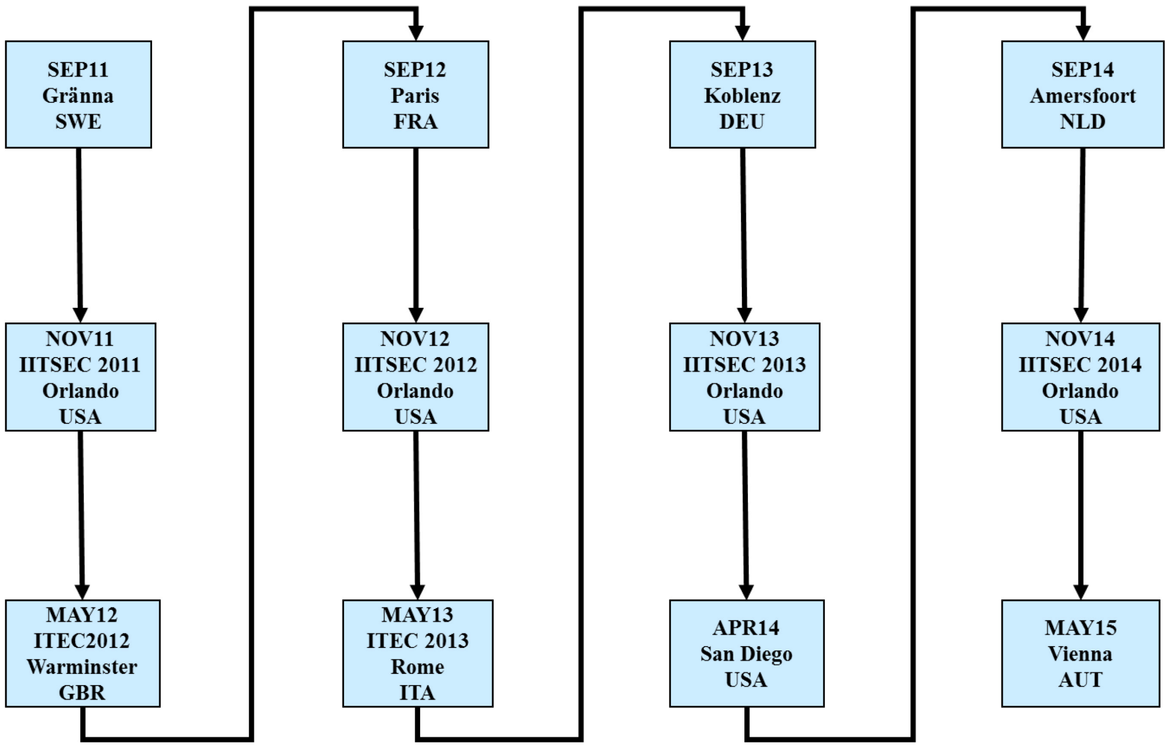

Figure 2: UCATT Meeting Schedule.

During the subsequent meetings this roadmap was checked and updated if required and proved to be a valuable tool for work management to ensure progress towards the end result.

In collaboration with the Architecture group it was decided to first start working on the external interface that enables engagements between live dynamic objects. The Architecture group therefore delivered us a description of the data that has to be transferred (a superset of data elements) for the different types of engagements.

After the handover, we were responsible for the specification of the physical implementation of this interface. We decided not to start from scratch, but to choose an existing code set as baseline, taking the drafted superset of engagement data into account. In order to perform this selection in a transparent and structured way, the two groups adopted a set of voting procedures, based on “Robert’s Rules”. For a definition of Robert’s Rules in the UCATT context see Annex B (UCATT’s Rules of Business). These rules were applied to select the base code set for the first UCATT engagement interface standard. The members of both groups were involved in this voting process. As outcome the OSAG-2 code set was chosen as baseline.

After specifying the dataset for the engagement interface, the Architecture group continued to specify the datasets for the other external interfaces. These external interfaces were identified in the UCATT Functional Architecture (UCATT FA), as designed by the UCATT-1 and UCATT-2 TGs. During this process, the interfaces and the architecture were analysed in more detail. This led to some minor changes to the Functional Architecture (FA) and the identification of a new external interface. The resulting FA and definitions of all external interfaces are described in Section 2.

1.4.2 Use of Existing Standards

The objective of UCATT is to identify and specify interfaces to enable interoperability among different combat training systems. It has been recognised that within NATO and SISO a number of (research) projects have been executed, or even are still progressing, that aim for interoperability among systems and have produced standards. Examples are DIS, HLA, JC3IEDM, MSDL, C-BML, etc. Although initially many of these standards have been created mainly focussing on application in the virtual and/or constructive domain, they can also have value in the live domain.

Looking at the engagement process in a live training, there are a lot of company specific standards that are not interoperable with each other. Therefore we compared the existing standards and proved them on base of the requirements given by the Architecture group. This procedure also shows us a valid way how to proceed for the future.

1.4.3 Interaction with NATO and Other Groups

MSG-099 UCATT Standards TG was very closely linked to MSG-098 UCATT Architecture TG. MSG-098 identified and prioritised candidate interfaces for standardisation through the SISO process. MSG-098 was also the "supplier" of the relevant Use Cases and the datasets for the standardisation process. Questions that arose during our work were brought back to MSG-098 and feedback was given.

In order to introduce a SISO Standard a SISO Product Development Group was established, consisting of members from both groups. This ensured both technical and User aspects were addressed. PDG meetings were scheduled within the UCATT meeting calendar.

During UCATT-1 and UCATT-2 information about User requirements and best practises was exchanged between UCATT and TSWG. During the UCATT-3 phase this useful interaction was disrupted due to change of personnel within UCATT and the transformation of the Training and Simulation Work Group (TSWG) into MSG-116 Simulation Training and Operations Group (STOG).

When applicable, the AG called upon the expertise of other STO TGs, especially those involved with interoperability standards such as that the work of MSG-085 C2SIM which led to a briefing on MSDL, CBML and JC3IEDM to assist the architecture work to assess these as potential candidates for UCATT interface standards.

The Interoperability User Community (IUC) is a SAAB led community of Users of live simulation equipment manufactured by SAAB. The purpose of which is to achieve interoperability between customers and to steer product development for Company and User benefit. A number of UCATT RTG members are also active within the IUC, and this has facilitated the exchange of certain information including ammunition table data and details of the OSAG code. This has been a key relationship.

1.4.4 SISO Related Activities

Even though MSG-099 is a NATO NMSG driven activity, its focus is to define and prioritise interfaces to be standardised through the SISO process.

As the standardisation process has to be driven by a PDG which is formed by live simulation community (military, government and industry), the members of MSG-099 agreed to all join SISO and to subscribe to the UCATT PDG. The same applied to the members of MSG-098. Members of MSG-098 took the positions of SISO PDG chair (Cpt Sander Cruiming) and vice chair (Mr. Staffan Martinsen).

For efficiency, SISO PDG meetings were aligned with the UCATT meetings and time allocated to SISO activities. But much of the development of the SISO Standard documents was done between the UCATT meetings. The SISO portion of the meetings was then used to conduct formal elections and balloting. This method of integrating SISO work into UCATT work has proved to work very effectively and should be continued in the future.

A problem that occurred was that the method of working within the UCATT TGs sometimes conflicted with the very formal procedures of SISO. This delayed the progress a lot and led to the fact, that a balloted UCATT standard could not be finished within the 4 years period of MSG-099.

1.4.5 Benefit and Continued Involvement of Industry, Government and Military

The unique composition of the UCATT group with members from government, military and industry in the spirit of an open minded and cooperative collaborative working method creates a win-win situation for all participating parties. Governments and military users benefit from the experiences and knowledge of their respective counterparts and industry can give guidance on technological possibilities and feasibility. In exchange, the industry members get first-hand information on future User requirements and on government desired standards. The concept of a mixed group has been proved for over 10 years and should be kept for the follow-up activity.

1.5 Recommendations

The recommendations of the MSG-099 and MSG-098 work are outlined below:

1) Involve of new countries and industries and re-engage with countries that have ceased earlier active involvement in the group.

   Rationale: Multinational training is increasingly important for the future with the trend for coalition operations. Technical interoperability of training systems, equipment and devices can assist in improving training effectiveness bringing with it operational benefit. A wider base of contributing nations and industrial entities with UCATT potentially leads to earlier and more widespread adoption.

2) Increase the "marketing" activities to create more awareness of the UCATT standard for live simulation systems within the User community.

   Rationale: To create interest for further national involvement and adoption of UCATT standards by nations and industry awareness must be increased. This could be achieved by articles in magazines, papers, conference presentations, speech, etc.

3) Reactivate the relationship between UCATT TG and STOG.

   Rationale: In order to ensure a correct User perspective is held within UCATT, it is believed necessary to establish and maintain a close working or at least an effective communication between the two bodies.

4) Establish liaison between the UCATT community and the NATO efforts enhancing the JC3IEDM, C-BML and MSDL standards.

   Rationale: UCATT will seek to create a new standard only when no other suitable standard is available. JC3IEDM and C-BML are likely candidates as baseline for E6 and E7, and MSDL for (a large part of) E11. However, these existing standards should also incorporate UCATT specific requirements.

5) Merge the standardisation and architectural activities together into the follow-up task group.

   Rationale: The anticipated benefits of the separation into two different groups did not materialise. Indeed the consequential administrative overhead has proven disadvantageous.

6) Continuation of the SISO membership funding for government members of MSG-140.

   Rationale: Having established a SISO UCATT standard, that standard must be maintained by a SISO Product Support Group (PSG). It is in NATO's interest to ensure a stable community is in place to do that and this can be achieved through this recommendation.

7) Consider the translation of the currently used functional architecture into the NATO Architectural Framework (NAF) if applicable and useful.

   Rationale: This will aid to verify the validity of the architectural approach in relation to physical implementations.

These recommendations have been recognised by STO and that the work of UCATT should continue for four main reasons:

- To continue the standardisation effort.
- To form the basis of SISO PSGs necessary for the maintenance and availability of approved interface standards.
- To acknowledge the applicability of the UCATT work is beyond just Urban training systems and applies to live simulation systems and Combat Training Centres and reflect this in the name of the follow-up activity (UCATT LSS).
- To accommodate the increased international interest in the interoperability opportunities UCATT can provide and invite other nations and participants (three additional nations will contribute to UCATT LSS).

The activity proposal was endorsed by the NMSG during the Business meeting in Oslo June 2014 and was approved by the STB in September 2014 as MSG-140 UCATT Live Simulation Standards (LSS).

It was also determined that the scope of UCATT has been widened up from ‘only’ urban training systems to live simulation systems in general. This is reflected in the name of the follow-up activity UCATT LSS.

The TAP and TOR for UCATT LSS have been created during the working period of MSG-098 and can be found in Annex A.

2.0 TAP AND TOR TASK / FRAMEWORK

2.1 Functional Architecture

2.1.1 Purpose

The capabilities identified in the UCATT-1 Report describe the requirements for a CTC from a user point of view. In order to derive from these capabilities, a generic set of requirements for the development of CTCs, 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 CTC’s on the other hand, an architecture must be created and agreed upon.

Formally, an architecture is “the organizational 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 (FA) 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 (DA) 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 was the purpose of UCATT 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, this product's main focus is on 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 an FA of a CTC. This functional architecture must be representative enough to cover all of the Use Cases intended for a CTC while not touching specific design or implementation issues. The FA captures what the system can or might do, not how it should be implemented (e.g., the requirement, not the implementation such as communication which might actually be by wireless transmission or through a cable). The UCATT FA is illustrated in Figure 3.

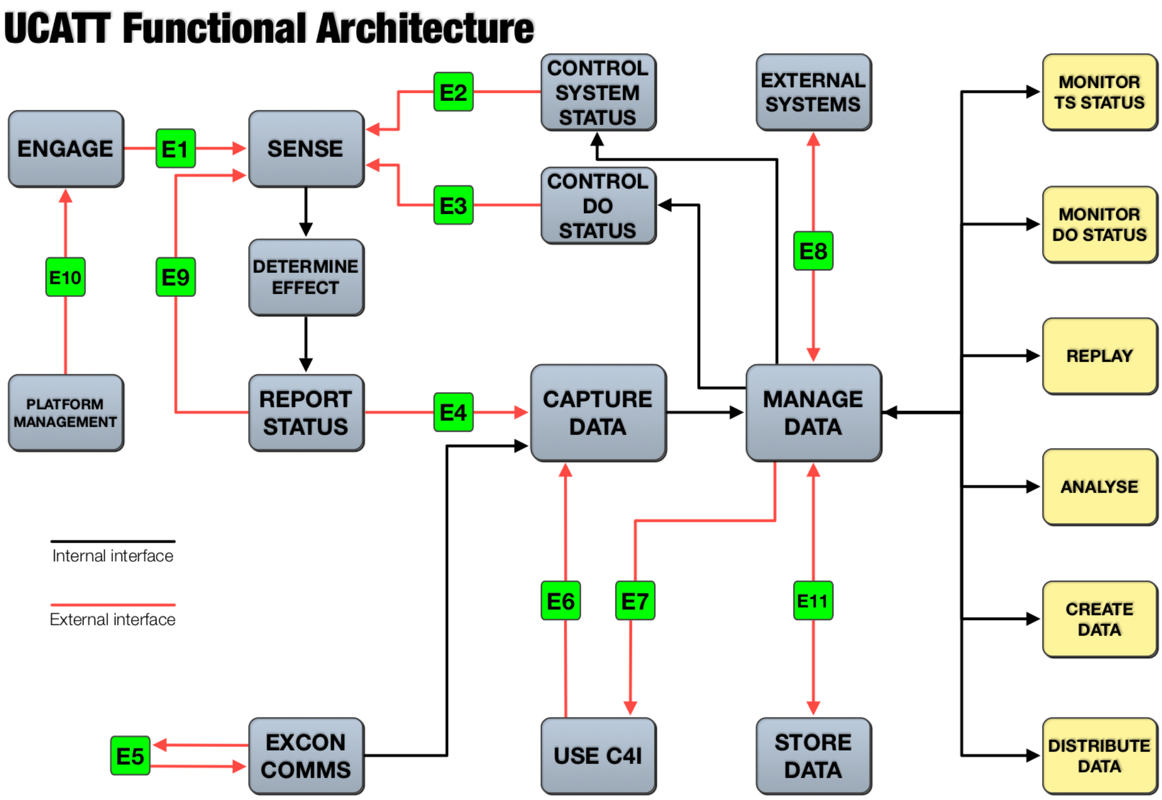

Figure 3: UCATT Functional Architecture.

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.

For details about the functional architecture, see UCATT-1 Report and UCATT-2 Report.

2.1.2 Internal and External Interfaces

In the case of the FA, an interface exists where data is exchanged between functions that reside in the architecture. While the complete FA described and identified all functions and interfaces that can be found in a CTC, it did not definitively identify the interfaces that needed to be standardized to establish interoperability.

In order to do that, a difference was made between internal and external interfaces. Internal interfaces handle data communication that only takes place in the system itself or a designated sub-system, whereas external interfaces communicate to either outside the system or to a system component that can be replaced by a non-proprietary counterpart (e.g., a Personnel Detection Device or Small Arms Transmitter from a different vendor). The internal interfaces where considered proprietary and out of scope for standardization, since they were not mandatory for achieving interoperability.

By identifying the external interfaces, it is made explicit what interfaces need to be standardized to achieve interoperability. The external interfaces where subsequently give the designation "E", followed by an identifying number. From there on, these "E's" formed the basis of all the work done by UCATT, especially during the final delivery phase. A standard definition for each interface can be found in one of the attached annexes to this document.

2.1.3 FA Interface Definitions

This section explains the Functional Architecture interfaces defined in Figure 3 above:

- E1 – DO Engagement (Engage → Sense)

  This interface represents an action of one DO on (one or more) other DO(s), with the purpose to change the status of that other DO(s). The engagement contains only the characteristics of the action, not the resulting status of the affected DO(s), the resulting status has to be determined based on these engagement parameters.

  Examples:

  - Direct or indirect fire from a shooter to a target;
  - The explosion of a mine, possibly affecting the status of DOs in its influence sphere;
  - Medical treatment of a medic on an injured person; and
  - A repair action by a maintenance engineer on a damaged vehicle.

- E2 – Training system status change (Control training system status → Sense)

  This interface controls the technical status of a DO, enabling its functioning in the training environment. Through this interface it is possible that a DO is initialised, reset, calibrated, etc. It also accommodates the distribution of an (altered) terrain representation or damage models for systems that require this data at decentralised nodes, for example in each DO for determination of engagement effects.

  Examples:

  - Initialization of equipment; and
  - Calibration of equipment.

- E3 – DO Status change (Control Dynamic Object status → Sense)

  Through this interface the (simulated) operational status of a DO is set. It contains the new status of the affected DO. This interface implements: A direct action of an O/C, for example a reset; distributing the outcome of an engagement that is centrally evaluated (typically in EXCON). In this case a DO is not provided with the engagement parameters to determine the outcome (that is E1), but only with the resulting status. This interface is required for geo pairing systems and for training systems that centrally simulate engagement areas such as for example artillery areas.

Examples:

- Artillery fire simulation, effecting one or multiple DOs;
- CBRN effects in a certain area; and
- Players are reset when entering a designated area (configuration areas).

- E4 – DO Reporting (Report status → Capture Data)

  A dynamic object reports its (change of) status through this interface to the rest of the world. The status contains for example: Operational status, location, supplies, engaging or being engaged, etc.

  This interface exists in different physical domains, for example:

  - The communication of the status to EXCON (typically radio communication); and
  - The communication of the status to players, including visual presentations (smoke, lights) or sounds (explosion).

  Remark: the interfaces to trigger the physical devices (for example pyrotechnics when shooting or being hit) are considered internal interfaces.

- E5 – EXCON Communication (Use EXCON Communication ↔ Use EXCON communication)

  This interface enables the communication between training staff members of different systems operating in the same exercise. It covers:

  - Voice radio communication; and
  - Exchange of for example electronic notes, pictures and video.

- E6 – Receive C4I Data (Use C4I (capture) → Capture Data)

  This interface transfers data from C4I systems to a UCATT training system. This includes Battlefield Management System functionality such as 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.

  Examples:

  - Capturing reports of enemy dispositions through a Battlefield Management System (BMS); and
  - Capturing overlays, messages, etc.

- E7 – Send C4I Data (Use C4I (manage) ← Manage data)

  This interface transfers data from a training system to C4I systems. For example, 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 (simulated) entities (either "live" dynamic objects or "virtual" players) to the C4I systems.

  Examples:

- Cyber warfare injects (e.g., wrong position data);
- Transfer of overlays from training staff to training audience; and
- "Synthetic wrapping".

- E8 – Event Data exchange (External systems ↔ Manage Data)

  This interface enables the exchange of data between systems, which can influence the course of the training session and generally has a dynamic, time critical character. Examples of event data exchange are (updates of) status of DOs and the creation of a minefield in System A, which is communicated to System B.

  Examples:

  - Connection to a (NATO) distributed training network; and
  - Exporting CTC position data to a virtual UAV.

- E9 – DO Association and pairing (Report Status → Sense)

  This interface enables the logical linking of objects in the training environment, this includes linking of DOs amongst each other (DO association) and linking equipment that is not modelled as a DO with DOs (equipment pairing).

  Examples:

  - Personnel mounting and dismounting vehicles;
  - Personnel or vehicles entering or leaving (parts of) buildings; and
  - Personnel picking up weapons.

- E10 – Exchange platform data (Platform management → Engage)

  This interface enables the exchange of data between the training system and computers (such as the fire control system or platform management system) of the instrumented real systems. This is a bidirectional interface. Data exchange from the platform to the training system is used to enable or influence the behaviour and the engagements of the DO in the training environment. Examples are selected ammunition type, dynamic lead, environmental parameters and relevant vehicle parameters. Data exchange from the training system to the platform is used to influence the behaviour of the real platform, for example providing the platform with target distance information delivered from the training system in case of a laser based training system, visualising tracers and fall of shot in the visual sensors or adding sounds to the communication systems (e.g., explosions, messages for training purposes).

  Examples:

  - Usage of ballistic tables for trajectory calculation;
  - Usage and logging of fire modes used by the gunner;
  - Dynamic lead; and
  - Environmental parameters.

- E11 – Reference data exchange (Store data ↔ Manage Data)

  This interface enables the exchange of data that is generally used for reference purposes, e.g., the transfer from System A to System B of an ORBAT definition, damage model definitions, geospatial (terrain) data such as the layout of a building composed of separate walls, a created scenario or a recorded exercise. It generally contains non-time critical information and is therefore used mostly prior to an exercise, but it can be used during the execution of an exercise.

  Examples:

  - ORBAT definition and input;

- Geospatial data;
- Weather data; and
- Input of the layout of buildings.

2.2 Physical Interfaces

This section presents the most common physical architecture of a combat training center and the relation between functional interfaces and physical interfaces. During the identification process of physical interfaces, it became clear that all companies participating in MSG-099 have a similar architecture for a CTC. The main deviation is related to centralize versus decentralized system design.

Below is a typical implementation of a CTC (by MSG-099 companies), each arrow in the diagram represents a physical interface.

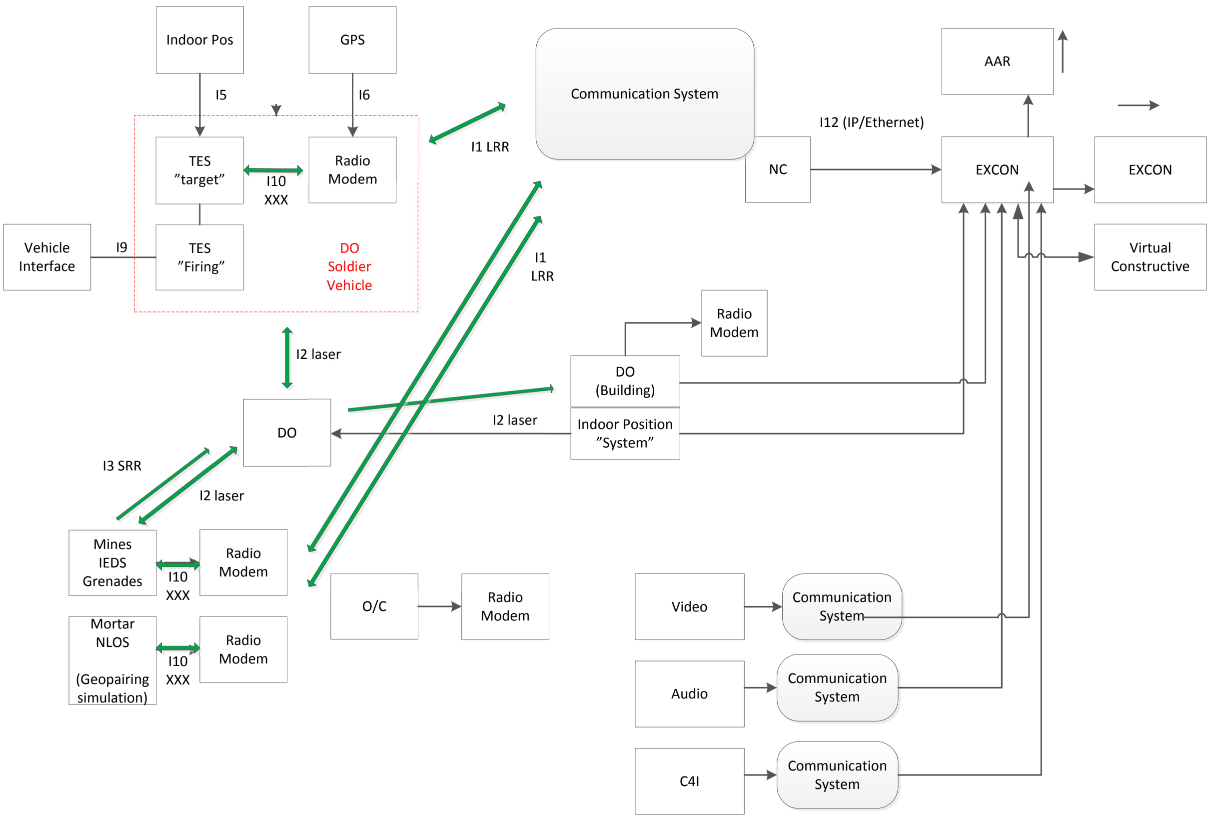

Figure 4: Typical Physical Architecture for a CTC.

The MSG-099 identified the most common physical interfaces, to be used as candidates for standardization. For a list of identified interfaces see section below.

2.3 From Functional to Physical

The FA defines the capabilities in the system; these capabilities are realized through physical interfaces. It is the physical interfaces that are standardized. When going into the physical representation of the interfaces in a system, functional interfaces (E's) are implemented by one or several physical interfaces (I's). The aim of the MSG-099 is to define and standardize a set of physical interface to allow interoperability between systems in the live simulation domain.

When the physical interfaces were (see list below) identified the MSG-099 identified which interface in the FA are today implemented using which interface(s).

Each physical interface has specific characteristic or limitations, for example bandwidth or line-of-sight limitation. These limitations or properties make the different interfaces more or less suitable to be used for implementing an FA interface.

For example; a direct fire engagement simulation (a typical E1 capability) requires a physical interface with very low latency transmission. The simulated engagement information must be transmitted in a similar timeframe as the actual engagement, i.e. within a second.

This characteristics of the capabilities identified in the FA interfaces must be considered when selecting suitable physical interface.

The interfaces in the FA have also a related data model. The data model represents the information that is required/needed to be transmitted in order to be able to fulfill the capabilities identified in the FA interface. The elements in the data model represent various levels of capability fidelity, i.e. the more data that are transmitted the more accurate can the required capability be implemented by the DOs. MSG-098 has defined unique data models for each interface in the FA. The data model remains the same for each physical implementation of the interface.

When MSG-099 identified the most suitable physical interface for realization of the FA interface, we had to consider both the data model and the characteristics of the capabilities that are identified for each FA, and match that with what the physical interfaces can provide.

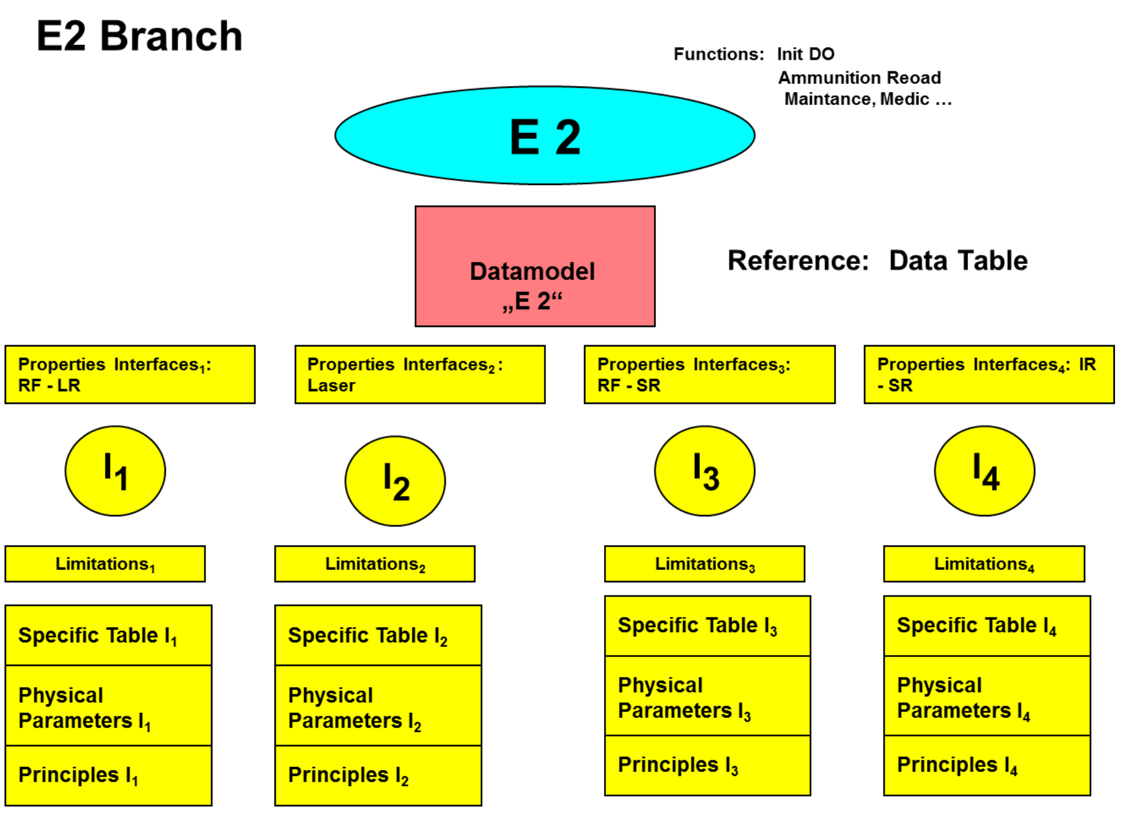

Figure 5: Functional Interface Data Model vs. Physical Interface Properties.

A physical interface may be used to implement several functional interfaces and vice versa.

For example, the laser interface (I2) can be used for direct engagement simulation (E1), DO technical or operational status control by the Observer/Controller using an umpire gun (E2 and E3) and for indoor positioning (E3). MSG-099 must select the most suitable physical interface.

The following existing physical interfaces were identified. For the main interface i.e. the most critical to achieve interoperability, the main characteristics where also identified.

2.3.1 Physical Interface Definitions

- I1 − Long Range Radio (LRR) interface – DO to DO

  The I1 interface is a long range radio interface (generally 0 to 10 km) used to transmit data and command between two dynamics objects in the field without requiring EXCON services. This communication can be broadcast (One DO to multiple DO) or point-to-point (One DO to one DO) communication.

  Examples:

  - This interface can be used to simulate indirect engagement without using EXCON services.
  - In such an engagement the engaging DO needs to know the location and the address of the target DO or the engaging DO transmits, in broadcast, to each DO the position of the projectile in "real time".

- I2 − Optical Laser interface

  The I2 interface is a laser interface used to transmit data and command between two dynamic objects in the field. I2 is mainly used for direct fire simulation (E1), but is also often used for O/C action (E2 and E3) or indoor positioning (E3).

- I3 − Short Range Radio (SRR) interface

  The I3 short-range radio interface can be used to simulate short range (0 to 100 m) area weapon system such as grenades, mines or IED. The short-range radio interface currently implemented on the existing products is either based on radio standards such as Bluetooth, Zigbee or with proprietary radio.

- I4 − Infra Red

  The I4 Infrared interface may be used to communicate data or command between a DO and a peripheral device (e.g., medical treatment PDA).

- I5 − TBD (Indoor Positioning for example)

  To be defined.

- I6 − TBD (Outdoor Positioning − GPS for example)

  To be defined.

- I7 − TBD

  To be defined.

- I8 − EXCON to EXCON

  I8 is the physical interface used to communicate between two EXCONs. In most cases, Ethernet is used for this interface with an application protocol that is often DIS or HLA.

- I9 – TBD (Fire Control Unit Interface)

  Interface between the TES and the firing control unit, enabling exchange of data from or to the actual platform.

  Example:

  - CAN bus, Ethernet, 1553.

- I10 – TES to radio modem interface

  The I10 interface is the link between the TES and the radio modem. It is used to exchange tactical and technical status, commands and events (fire event, target event) between DO and EXCON.

  In the existing products, this interface is usually made with a serial link such as RS232, CAN bus or USB.

- I11 – Long Range Radio – DO and EXCON

  The I11 interface is a Long Range Radio (LRR) interface (generally < 10 km) used to transmit report events (fire event, target event) from DO to EXCON and tactical and operational command from EXCON to DO.

  In the existing CTCs, the interfaces used are for example: TETRA, 4G or more often a proprietary radio system.

- I12 – Network Controller to EXCON

  The I12 interface is the link between the Network Controller and the EXCON.

  In most cases, Ethernet is used for this interface with an application protocol (layer 7 of OSI model) that could be DIS or HLA.

2.4 MSG-099 Prioritization of Physical Interfaces for Standardization

UCATT 3 is the "delivery phase" of UCATT with the primary task for MSG-099; "to deliver one (at least) proposal of interface document to SISO for possible standardization". So far the UCATT standardization efforts work have mainly been focused on the E1 interface, see UCATT 1 and UCATT 2 reports. To start the standardization work with the E1 was natural.

The most mature and interesting existing physical implementation of the E1 interface is the **laser interface** due to the wide usage and therefore vital to provide interoperability, see for example UCATT-2 Report, Marnehuizen demonstration.

Based on recommendation from MSG-098, MSG-099 decided that the first interface to standardize is a laser interface and especially the E1 part of the interface.

The laser interface is a well-established solution for implementing the E1 capabilities, and the laser is used in almost all current Live – CTC implementations worldwide. It would be waste of time and resources to start from "scratch" and not reuse previous knowledge and existing best practice when designing the standard. Therefore to be able to achieve the goal and reuse knowledge, the MSG-099 decides to start the standardization work with an existing standard as baseline.

The second most essential interface for CTC interoperability is the E4 interface.

3.0 LASER STANDARDS – COMPARISON AND CONCLUSIONS

3.1 Hand Over

3.1.1 Introduction

As the MSG-099 group and a lot of participants were new, we started with an analysis of the UCATT architecture and found a common understanding of it. Then, existing interfaces used by the participating companies were listed to get an overview of the possible solutions. The E1 interface (Engage/attack), Laser (I2) was the first interface identified by the Architecture TG MSG-098 to be standardized.

The starting point for the interface discussion was the data table given by the architecture group MSG-098. This database gathered all the expected data for the E1 (Engage) interface. Among this set of data, and due to the laser implementation constraint, (limited time duration), only a few of this data are used for the laser interface.

The Laser interface I2 is mainly used for direct fire simulation (E1), but is also often used for O/C action, system control (E2 and E3) or indoor positioning (E3).

The main properties of the Laser are:

- Limited to line of sight;
- Limited time duration;
- Target separation;
- Real time direct fire;
- No infrastructure; and
- Simplex.

3.2 Approach

The approach of the UCATT group in order to define the laser interface was as follows:

1) Start with an existing interface as baseline (no white paper);
2) Make a selection between the available Laser Codes (MILES, OSAG, NCL, COSIM);
3) Compare the data implemented in the existing laser code with the required data list (engagement data);
4) Filter not needed data for the laser interface (and use case);
5) Define the most important parameters in the laser interface to reach interoperability; and
6) Select a code as a baseline for the UCATT laser code.

3.3 Implementation in Regard of the Requirements

3.3.1 Laser Code Data Survey

For having a first impression MSG-099 analyzed the gap between the required data and the actual used data in legacy systems. The data table presented below was proven with actual codes used by the industry.

Table 1: Laser Code Survey.

	OSAG	MILES	NCL/MK3	COSIM	Remarks
Shooter ID	X	X	X	X	
Position (x, y, z) of the shooter	–	–	–	X	For range limitation and energy reduction of impact
Velocity (vector) of the shooter	–	–	–	–	
Weapon type	–	X	–	X	
Weapon ID	–	–	–	–	
Used weapon mode of shooter	–	–	–	–	
Type of trigger of the event	–	–	–	–	
Direction/angle (vector)	–	–	–	–	
Ammunition type	X	X	X	X	
Target ID	–	–	–	–	
Position (x, y, z)	–	–	–	–	
Velocity (vector) of the target	–	–	–	–	
Target properties	–	–	–	–	
Terrain	–	–	–	–	
Atmospheric data	–	–	–	–	
Time of start	–	–	–	–	
Point of impact	X	–	X	X	2 way only
Direction/angle	–	–	–	–	
Velocity	–	–	–	–	
Hit range	X	–	X	X	2 way only

3.3.2 Selected Data of the Laser Interface

With the rough overview of the expected data content we started in the analysis of the data related to the selected physical interface "Laser" with a direct kinetic engagement understood as "a simple bullet":

- Shooter ID (Laser applicable).
- Position (x, y, z) of the shooter, possibility to go to sub-decimeter, plus indicator of accuracy for each of the elements of the position (Laser applicable).
- Velocity (vector) of the shooter, plus indicator of accuracy (Laser not applicable).
- Weapon type (Laser applicable).
- Weapon ID (e.g., for back-up and/or analysis purposes) (Laser not applicable).
- Used weapon mode of shooter, this includes weapon parameter settings, laser range and used sighting device (e.g., for skills training) (Laser not applicable).
- Type of trigger of the event (e.g., blank or dry fire, e.g., for analysis purposes) (Laser not applicable).
- Direction/angle (vector) of weapon, plus indicator of accuracy (Laser not applicable).

- Ammunition type (Laser applicable).
- Target ID (Laser not applicable).
- Position (x, y, z) of the target, plus indicator of accuracy (Laser not applicable).
- Velocity (vector) of the target, plus indicator of accuracy (Laser not applicable).
- Target properties, e.g. operational status (e.g. wounded), level of protection (e.g., body armor) (this is not part of the transaction) (Laser not applicable).
- Terrain (required for determining result of engagement, but not part of the transaction) (Laser not applicable).
- Atmospheric data (required for settings of the fire control computer of shooter, not part of transaction) (Laser not applicable).
- Time of start (trigger time) and end (impact time) of engagement, plus accuracy to go to microseconds (Laser applicable).
- Point of impact (can be a miss), possibility to make a distinction between the different (body) parts of a DO, possibility to go to sub-decimeter (Laser applicable).
- Direction/angle (vector) of the projectile at the moment of impact (Laser not applicable).
- Velocity (vector) of the projectile at the moment of impact (Laser not applicable).
- Hit range (Laser applicable).

The analyzing of the gap resulted in several data not needed in the laser simulation. Caused by limitations of this interface there are also bandwidth restrictions, so only the absolute necessary information is transmitted. The limited data was discussed with the MSG-098 and we agreed that the gap is acceptable as long as the function behind the missing information is solved in a different way.

During the discussion we also found some other properties that are important for the use of the laser interface:

- Range of transmission must be at least the same as range of weapon;
- Eye safety;
- Receiver Sensitivity and Emitter Power;
- Time on target;
- Robustness (e.g., checksum);
- Penetration (wavelength);
- Ownership;
- Target separation; and
- Growth potential.

3.4 Laser System Comparison

3.4.1 Introduction

To make a decision for the best code, it was necessary to get an overview over the code capabilities and the related systems. Therefore MSG-099 analyzed the common Laser codes and technical systems using the codes to get the important factors for a comparison.

As there are differences between 1-Way and 2-Way systems and there codes, we compared them separately.

3.4.2 1-Way Data

The laser codes have different use cases. To get an overview, we collected the different capabilities and specialties of the codes. It is seen, that the systems have some major differences.

Table 2: 1-Way Data.

	OSAG System	MILES System	NCL System/MK3	COSIM System
Identity Code	0 to 16383	0 to 3700	1000	0 to 64000
Ammunition Code	79 (150)	16	16	40 (1600)
Weapon Code	No	36	No	40 (0)
Admin Code	No	11880	No	No
Umpire Code	74	Yes	Yes	20
Synchronisation	No	Yes	No	No

3.4.3 Physical Characteristics of Existing Systems

For the comparison and to get an impression about the upgradability the physical characteristics of the systems were collected. Also important values related to the systems.

Table 3: Physical Characteristics.

Properties	OSAG System	MILES System	NCL System	COSIM System
System	2-way	1-way (+RF)	2-way	2-way
Wavelength 904 nm	40 ns $\leq$ P $\leq$ 100 ns	20,83 µs ±0,015%	50 – 100 ns	
Clock frequency	15 MHz	48 kHz	15 MHz	
Transmitter Power	ca. 6W			
Detector Sensitivity	24 mW/m^2 4 mW/m^2		8 mW/m^2	4 µW/cm^2
Reflector non ballistics	No	No	No	No
Reflector ballistics Inf/Veh size	Reflectors 22 mm / 60 mm	No	Reflector 0 / > 50 mm	Reflector > 48 mm
Lasershape non ballistics	3 lobe pattern	–	4 shapes	2+2 TDS
Detector Coverage	360°	360°	360°	360°
Reflector/Detector distance	Max. 10 cm	–	Max. 10 cm	Max. 10 cm
Hitzones	8	3	8	n/a
Time Window of Data Transmission	Flight time	< 500 ms	Flight time	< 10 ms
Scanning area			120 x 120 mrad^2	30 x 30 mrad^2
Scanning time	Flight time	1 time	100 ms	

3.4.4 Overall Data Content

In addition to the primary data, MSG-099 collected other data that are also belonging to the systems.

Table 4: Overall Data Content.

	OSAG System	MILES System	NCL System	COSIM System
Identity Code	0 to 16383	0 to 3700	2048	0 to 64000
Ammunition Code	79 (150)	16	136	40 (1600)
Weapon Code	No	36	No	40 (0)
Admin Code	No	11880	No	No
Umpire Code	74	Yes	Yes	20
Synchronisation	No	Yes	No	No
Burst information	No		1 to 15	No
Impact point (resolution)	Yes (10 cm)	Yes (0.25 mrad)	Yes (0.1 mrad)	Yes (3 cm)
Engagement Distance (resolution)	Yes (1 m)		Yes (4 m)	Yes (1 m)
Cant	Yes	No	No	No

3.4.5 Protocol

The protocol is an important issue for comparison.

Table 5: Protocol.

	OSAG System	MILES System	NCL System	COSIM System
Modulation	Pulse Distance	Pulse Code	Pulse Code	Pulse Code
Reliability	Multiple Transmission	Multiple Transmission	Multiple Transmissions	Multiple Transmissions/Checksum
Sync.	Self-synchronizing	Self-synchronizing	Self-synchronizing	Self-synchronizing/Start-Bits
Pulse Interval	80 µs < PI < 160 µs	20.83 µs Sampling frequency	128 µs Sampling frequency	40 µs < PI < 80 µs

3.4.6 Final Comparison

Out of all the different tables of the comparison, MSG-099 filtered the important properties to compare the codes/systems. The conclusion about the detailed comparison was then focused in one table, shown below.

Table 6: Final Comparison.

	OSAG 2.0 Standard	MILES	NCL	COSIM
Availability	Yes	Yes	Yes (to be confirmed)	Yes

	OSAG 2.0 Standard	MILES	NCL	COSIM
Moment of Data Transmission	At impact, trigger for small arms and fire und forget	Trigger	At impact, trigger for small arms and fire und forget	At trigger, impact for guided Missile
Ballistic simulation	Yes	No	Yes	Yes
Laserclass	1	1.3a	1	1
Shooter ID	Nearly 16000	Nearly 16000	0 – 2047	0 – 63999
Position (x, y, z)	No	No	No	Yes
Weapon type	No	Yes	No	40 (0)
Ammunition type	10000	10000	136	40 (1600)
Time of start (trigger time) and end (impact time) of engagement	Yes	No	Yes	No
Point of impact (can be a miss)	0.1 m	No	0.1 mrad	0.03 m
Hit range	No	No	Yes	Yes
Number of countries	High	High	Low	Low

3.4.7 Conclusions on Comparison

- Small arms engagements (non-ballistic) are simulated in a similar way; differences related to:
  - Beam width / number of detectors; and
  - Sensor sensitivity.
- Available time frame for transmission of engagement data is limited (5 – 10 ms), which limits the amount of data to be sent (gun-jump small arms).
- Ballistic simulations principles differ much more between standards /vendors.
- Summary Statement regarding NCL:
  - The NCL code is a Pulse Code Modulation. This kind of modulation is less efficient than pulse period modulation and needs more pulses and so more time to transmit data.
  - The NCL can manage only 2048 players and 256 ammunitions type which is not compliant with the requirements which are up to 15000 players and up to 1000 ammo type.
- Summary Statement regarding MILES:
  - The MILES code system is used to provide tactical training. The input criteria included requirements for ballistic simulation and Class 1 eye-safety.
  - The two requirements of ballistic simulation and Class 1 eye-safety preclude the use of MILES as a baseline system for the UCATT 1.0 laser code.
- Summary Statement regarding COSIM:
  - COSIM has a low number of users. That means a lot of legacy systems has to be updated for the use of COSIM.

4.0 BALLOTING

4.1 Vote Criteria

- E1 − Data set compliancy to architecture group req.
- Technical issues:
  - Code length; and
  - Physical parameters; sensitivity, wavelength, etc.
- System design:
  - Availability;
  - Simulation principle, incl. reliability;
  - Upgrade potential; and
  - Etc...
- Investments:
  - Development of new system; and
  - Transition investments.
- Installed base:
  - Time to operational interoperability between countries; and
  - Possibility to upgrade legacy system to new code.
- Other issues to achieve interoperability:
  - Vulnerability definition;
  - Agreed ammo tables;
  - Impact on other interfaces; SRR, etc.; and
  - Possibility to set up an accreditation service.

4.2 Main Criteria for Balloting

Table 7: Main Criteria.

Code /Properties of the Laser Coding		OSAG 2.0 Standard	MILES	NCL	COSIM
Availibility Code spec		yes	yes	yes (to be confirmed)	yes
Availability of additional information Tech/System spec (to achieve iterop. systems)		yes	yes	yes (to be confirmed)	yes
Moment of Data Transmission		at impact, trigger for small arms and fire und forget	trigger	at impact, trigger for small arms and fire und forget	At trigger, impact for guided Missle
Ballistic simulation		yes	no	yes	yes
Laserclass		1	1,3a	1	1
Number of countrys		high	high	low	low
Upgradeability		Yes	Yes	Yes	Yes
Vendors currently able to deliver systems		2	many	2	1
Code /Properties of the Laser Coding		OSAG 2.0 Standard	MILES	NCL	COSIM
Shooter ID		16383	26400	0 - 2047	0 - 63999
Position (x, y, z) Ballistic		yes	no	yes	yes
Position (x, y, z) None ballistic		Hit range	no	no	yes
Weapon type		Incl. in ammo	34	Incl. in ammo	40 (0)
Ammunition type		3589	8	256	40 (1600)
Time of start (trigger time) and end (impact time) of engagement	Available in the system, but not transferred over E1-I2	no	no	no	no
Point of impact (can be a miss)		0.1 m	no	0.1 mrad	0.03 m

4.3 UCATT Balloting Procedure

For the balloting we gave us the UCATT Rules of order (see Annex B).

4.4 Conclusion

OSAG 2 Standard was selected as the baseline for the UCATT Standard.

5.0 E1/I2 INTERFACE

After the selection of OSAG 2.0 Standard as the baseline for UCATT 1.0 standardization in the Orlando meeting 2012, an extensive task was started in order to achieve a document sufficient and suitable for SISO standardization.

5.1 Creation and Review

The OSAG 2.0 Standard was thoroughly reviewed by MSG-099 during the meeting in Rome 2013. Previous to this meeting, members of the group had made the first drafting in order to create a document in a format suitable for SISO. The OSAG 2.0 Standard document contains a lot of company specific information not needed or desired for a more generic interface document.

During the Rome meeting the technical content of the interface was further analyzed and discussed. A lot of effort was put into questions regarding possible modifications or add-ons to the existing OSAG 2.0 Standard in order to fulfill all parts of the E1 data model as defined by MSG-098. Especially the need for mechanisms to avoid over-range problems (to reach beyond the weapon system's effective range) was subject to discussions. MSG-099 can see possible improvements to the laser interface however it is considered to be a large risk to include new functionality without prototyping and testing, this would require resources and funding which neither MSG-098 nor MSG-099 have. Further development of the E1/I2 interface should be a topic for a future SISO Product Support Group.

At the same meeting the physical parts of the interface was discussed. The following areas could be either specified or emitted:

- Laser detector sensitivity;
- Wavelength;
- Pulse shape;
- Laser output power; and
- Laser beam shape.

MSG-099 considers that laser detector sensitivity must be part of the interface in order to achieve comparable range performance between simulators from different vendors. Laser wave length and pulse characteristics should also be included, while laser output power and beam shape are more defined by requirements for a specific implementation and also by laser safety considerations.

In the 2013 Koblenz meeting the review continued and especially parts of the original OSAG 2.0 Standard document is not belonging to the functional E1 (engage) interface. These are:

- Umpire Control codes (part of functional interfaces E2 and E3); and
- Geographical Positioning codes (part of functional interface E9).

It was decided to keep these parts of the E1/I2 interface document. A general discussion concluded that there will be a number of physical interfaces identified to satisfy the functional interfaces of the UCATT architecture. There are a number of examples where there is no one-to-one connection between a functional and a physical interface. During standardization work for other functional interfaces, there will be a need to again review the E1/I2 document to ensure completeness.

During the meeting in Orlando 2013 a decision was made to exclude possibilities to be partially compliant with the E1/I2 interface in the same way as there is a Basic part of the OSAG 2.0 Standard that will allow interoperability on a lower level. This decision was made since a Basic implementation would not satisfy the data model as defined by MSG-098. Actions were taken to rephrase parts of the E1/I2 document to remove the possibility to implement part of the interface.

A decision was also made regarding the laser detector sensitivity for soldier systems.

After the San Diego meeting in 2014 the review process was considered finalized and the E1/I2 document was released for SISO standardization.

5.2 Ammo Table

The E1/I2 interface must be accompanied by a defined set of ammunition codes to enable interoperability between implementations. The OSAG 2.0 Standard includes an ammo table and it was the opinion of MSG-099 to also use this as reference material in order to create a UCATT E1/I2 ammo table. The OSAG 2.0 ammo table was reviewed by both MSG-098 and MSG-099. The review concluded that the ammunition types listed were sufficient and correct and that it could be used also for UCATT needs.

The OSAG 2.0 ammunition document was rewritten in a format appropriate for SISO usage where also some company and user specific information was removed.

The final E1/I2 ammunition document contains more than 200 NATO and OPFOR ammunition types. The standard allows for national adaptations while still remaining interoperability with other countries. There is also a lot of spare capacity to add more ammunition types when needed.

The E1/I2 ammunition document will be submitted to SISO as a reference document to the E1/I2 interface specification.

5.3 Vulnerability Data

In the process of analyzing laser interfaces to be used for UCATT and SISO standardization there have been discussions in both MSG-098 and MSG-099 regarding the outcome of engagements. What should happen when a vehicle or soldier is hit by a specific ammunition code?

MSG-099 suggested a number of reference target types to be defined:

- Main Battle Tank;
- Infantry Fighting Vehicle;
- Armored Personnel Carrier;
- Light armored vehicle;
- Non armored vehicle; and
- Soldier (with and without protective vest).

The vulnerabilities for these target types could be used either for direct implementation or as reference when creating nation specific vulnerability data (to ensure that the levels are comparable in order to achieve a fair fight).

It was decided together with the architecture group to exclude vulnerabilities from standard. The reason is, that it was stated, that there is knowledge available within each country regarding vulnerabilities for vehicles. If this knowledge is used to create realistic vulnerability data then the balance between forces will be just.

5.4 SISO Process

The Simulation Interoperability Standards Organization (SISO – https://www.sisostds.org/) is dedicated to the promotion of modeling and simulation interoperability and reuse for the benefit of a broad range of M&S communities including developers, procurers, and users. SISO is a kind of an open community forum supporting especially the identification of requirements for M&S standards that facilitate interoperability and reuse and the developing, review, and support of such standards. SISO has three elements:

- The Standards Activity Committee (SAC) is responsible for developing the processes, procedures, and guidelines for standards development.
- The Conference Committee is responsible for developing and presenting Simulation Interoperability Workshops throughout the year.
- The Executive Committee (EXCOM) is responsible for policy and control of the SAC and the Conference Committee.

SISO provides two basic product types: balloted and unballoted products. Products that follow the balloted product track are destined to evolve into either SISO Standards or SISO Guidance Products. Products that fall into the unballoted product track are SISO Reference and Administrative Products. For developing and supporting balloted products SISO has defined a 6-step Balloted Products Development and Support Process that is based on fundamental comprehensive principles. Working groups are an element of the processes:

- Study Groups (SGs) are created to consider specific issues and to provide recommendations concerning proposed courses of action. They are operating under specific Terms of Reference and their working life is limited. SGs can propose a SISO product resulting in a Product Nomination (PN).
- Product Development Groups (PDGs) are created as the result of a Product Nomination. They develop and ballot products. PDGs exist until the product(s) is complete or may be shutdown with due cause.
- Product Support Groups (PSGs) are created to provide support to a product or family of products. They exist until a product is withdrawn.

5.4.1 The 6-Step Balloted Products Development and Support Process

Figure 6 shows the 6-step Balloted Products Development and Support Process (BPDSP). The flow of the 6 steps is initiated with a Product Nomination (PN). During the first step "Activity Approved" the Product Nomination is completed. At the end of this step the final Product Nomination is reviewed by the SISO community and approved by SAC and EXCOM.

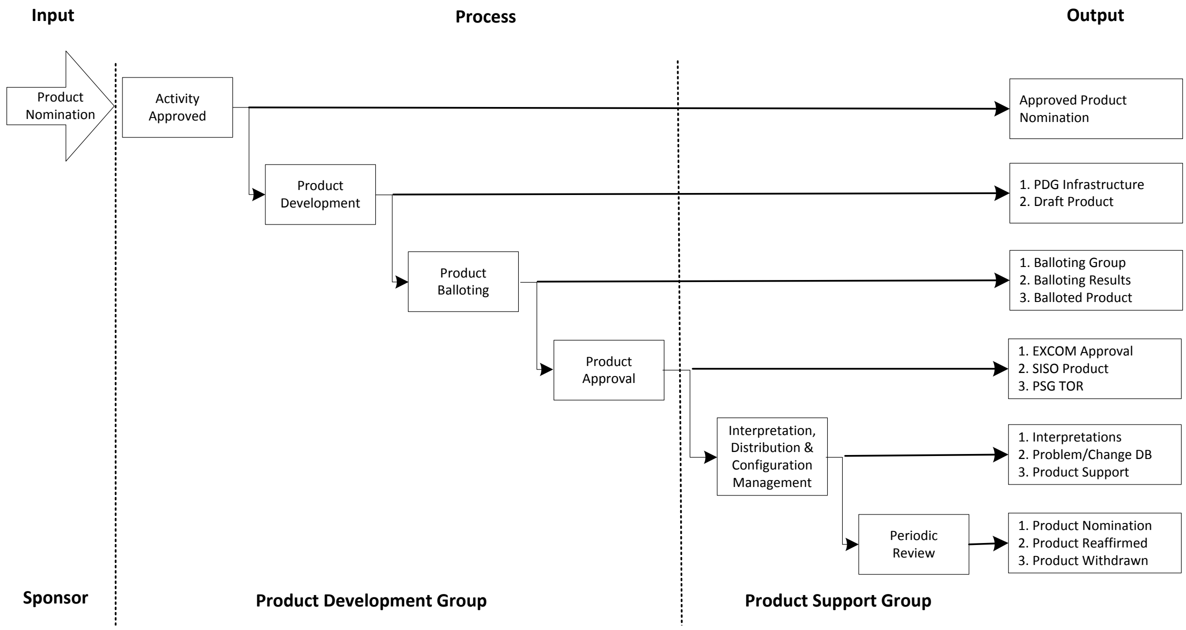

Figure 6: The 6-step Balloted Products Development and Support Process (BPDSP).

Step 2 "Product Development" launches the real product development activities. A PDG has to be created. Chair, Vice-Chair and Secretary are voted by the PDG membership. Only SISO member could join the PDG as a member. Therefor affiliation data have to be provided. The PDG establishes the schedule for development organizes the PDG meetings and creates one or more Drafting Groups. The Drafting Groups are responsible for the generation of the product or product components (e.g., writing of the standard documents).

A main objective is to achieve a broad agreement during the developing process to make the Balloting Process (step 3) easy. Therefore the PDG can hold votings based on fixed rules to resolve issues and open questions.

Finally the PDG submits a circulation package to SAC for "Approval to Ballot".

Reviewing the circulation package is an activity of the SAC in step 3 "Product Balloting". If the package is accepted SAC gives the approval to ballot. The PDG makes a ballot announcement and forms a ballot group. Only SISO members are able to ballot. To create community confidence SISO has defined specific rules to balance a ballot group:

- Members of the ballot group are differentiated into:
  - Representation categories: commercial, government, and academic; and into
  - Interest categories: user, developer, and general interest.
- No representation category shall exceed 75% and each category shall be a minimum of 10% of the ballot group.
- No organization shall exceed 25% of a representation category.
- No interest category shall exceed 50% of the ballot group.

The SAC can direct the PDG to rebalance the ballot group if SAC determines that the balancing is unsatisfactory.

When the ballot group is formed the ballot period is executed. The circulation package is distributed to each member. The ballot period is between 30 and 60 days. The members could submit comments about the product which could be general, editorial or technical comments. Finally, a ballot is only valid:

- If at least 75% of the ballots (including ballots to abstain) are returned; and
- If less than 30% of the ballot returns are abstentions.

A valid ballot for a standard product is successful if at least 75% of the "accept and reject" ballots are accept ballots (For guidance products 65%). If a successful ballot has no comments step 3 is finalized. Otherwise the comments have to be resolved prior. In the case of an unsuccessful ballot the comments are resolved and a re-circulation ballot is done.

With step 4 "Product Approval" the PDG submits the product approval package (balloted product(s) and supporting material) to the SAC. SAC reviews the package for compliance with PDG charter and SISO product development procedures. SAC approves the product(s), recommends disposition, and forwards the package to the EXCOM for approval after accepting. The EXCOM is responsible for the final accepting as a SISO product. The PDG develops terms of reference for Product Support Group (PSG).

After the Product Approval the following steps of the BPDSP are managed by the PSG under direction from the SAC. The step 5 covers the integration, distribution and configuration of a SISO product. The following tasking shall be executed:

- Establish and maintain a process to respond to questions (requests for interpretation).
- Establish and maintain a Help Desk function using the SISO provided discussion board to answer questions and provide support to the community.
- Establish and maintain a Problem/Change Request process to collect problems and change requests from the community. Conduct analysis and refinement of submitted problems and change requests.
- When the PSG is operating in parallel with a PDG developing a revision to a product, forward refined Problem/Change Request to the PDG for use in revision development.
- Maintain liaison with related Conference Forums, related PDGs, related PSGs, and related SGs.
- When allowed by the Terms of Reference, identify, create, and maintain SISO reference products relating to the balloted products being supported.
- Identify and create Product Nominations for additional parts or supplements.
- Conduct periodic review and evaluation of the supported products. Prepare recommendations for reaffirmation, revision, or withdrawal.

The 6-step "Periodic Review" treats the enhancements of a product. The PSG has to review the product every five years (at a minimum) since the date of publication. As a result of this review, one of the following decisions is made for each product:

- Reaffirm:

  A product can be reaffirmed if it is still useful and of value, proposed changes do not justify a full revision, and the product has not been supplemented.

- Revise:

  A product can be revised if it is still useful and of value, if there is interest and support for the revision and the product has obsolete or incorrect parts or it has been supplemented.

- Withdraw:

  A product can be revised if it is no longer useful and of value or if the product is still useful and of value but has significant obsolete or wrong content and is not adequate supported for revision.

5.5 Certification

In the following section MSG-099 describes a proposal for a method to check a valid UCATT-standard-laser code for combat training systems:

The methods are valid for the certification of the following systems:

1) A new laser combat training system, which will be introduced for the army of a NATO member needs to be certified.
2) An old laser combat training system after update (software and/or hardware), already introduced in the army of a NATO member needs to be certified.

The validation is necessary to reach interoperability in between various training systems of different manufactures, when exercising with soldiers of NATO members in a joint training. To reach this interoperability, laser systems must send the correct code from a first system to a second or more systems within the environment or directly to the receiver of the second or more systems.

Furthermore the manufacturer will get a certificate, if his laser combat training system is compliant to the UCATT-standard-code.

The preconditions for this check of interoperability of a laser combat training system is a test equipment, like a laptop with diagnostic software and accessories like tripods equipped with UCATT-standard-code encoder/transmitter and decoder/receiver.

The validation will include the code content e.g., participant number, ammunition, shelves in x- and y-coordinates and test distances (for example 100 m or 400 m or other distances) will be checked. The various parameters are depending of the laser system type to check: one way, two way or real time. This has to be confirmed in the contract.

A qualified test institution (public or private) must fulfil the following requirements:

- General experience in laser simulations;
- Ability of additional laser labor measurements to check the physical laser parameters if necessary (wavelength, energy, etc.);
- Range for the required tests (e.g., test facility WTD91 in Meppen has an air-conditioned 100 m tunnel, a 600 m tunnel and a 2,5 km laser test range. Also higher ranges are possible if required; and
- Certified to ISO 9001.

The concept of the certification has to be developed. It is thinkable, that the manufacturers themselves have the necessary equipment or an independent company is offering the certification to companies and government.

If the tests will be decentralized, the equipment and the test procedures have to be the same, no matter who is doing the work. Otherwise the process is not comparable.

We recommend more than one test equipment, to not rely on one source. Also independency of the testing company should be ensured.

The test procedures shall be standard procedures in accordance to the system to be tested (e.g., compliance with UCATT-standard-code only or also the physical parameters). All involved equipment, parameters and procedures should be given, to make the test reliable.

The certification system and the procedures have to be agreed upon prior to their usage.

Basis for the testing is a standard contract in various languages with the test conditions.

5.6 Other

The MSG-099 TAP and TOR the objective for the MSG-099 is stated:

- One SISO approved UCATT standard; and
- Four draft SISO UCATT standards.

The first objective about the approved UCATT standard is fulfilled by the proposed laser interface standard, see section above.

The other objective is partly covered and fulfilled. The result and status are described in the following sections. The additional interfaces from the UCATT functional architecture that MSG-099 has start working with are; E3, E4.

Additionally MSG-099 has identified that many of the functional interfaces in the architecture have already well-established physical interfaces. The baseline for the E8 interface for example, is already defined by, e.g. DIS or HLA standards. For these interfaces type pf interfaces the MSG-099 will not re-invent something new, but only adopt the exiting standards to the Live Training requirements.

5.6.1 E3 – DO Status Change (Control Dynamic Object Status → Sense)

Through this interface the (simulated) operational status of a DO is set. It contains the new status of the affected DO. This interface implements, e.g., a direct action of an O/C, for example a reset.

The E3 capabilities are in an existing typical physical architecture of a CTC often solved using I1 (long range radio) and I2 (laser) physical interface (see Annex C).

When adopting the OSAG2 laser code as baseline for E1/I2, some E3 related capabilities are already part of the code. During the review process these capabilities were not removed from the laser code. This means that the in the proposed laser code standard, a set of E3 related baseline capabilities are available.

The E4 interface see below, is about reporting to EXCON. The same physical interface will probably also be used also for E3 capabilities, i.e. status changes and EXCON initiated engagement, e.g., AWES (Area Weapon Effect Simulation). The standardization effort for E4, with selection of physical interface also applies to the EXCON part of E3.

5.6.2 E4 – DO Reporting (Report Status → Capture Data)

A dynamic object reports its (change of) status through this interface to the rest of the world. The status contains for example: Operational status, location, supplies, engaging or being engaged, etc.

This interface exists in different physical domains, for example:

- The communication of the status to EXCON (typically radio communication); and
- The communication of the status to players, including visual presentations (smoke, lights) or sounds (explosion).

The MSG-099 has focused on the communication of the status to EXCON. A data set for E4 was received, reviewed and commented. It is notable that the data set states that a distributed simulation model for weapon engagements (through E4) must be part of the future interoperable UCATT training system.

When a DO reports status and events to EXCON in a typical CTC design, several physical interfaces are used. The main question about the E4 is about where to implement the physical interface; I10, I11 or I12, these are all sub-implementation of the I1 physical interface. See figure below.

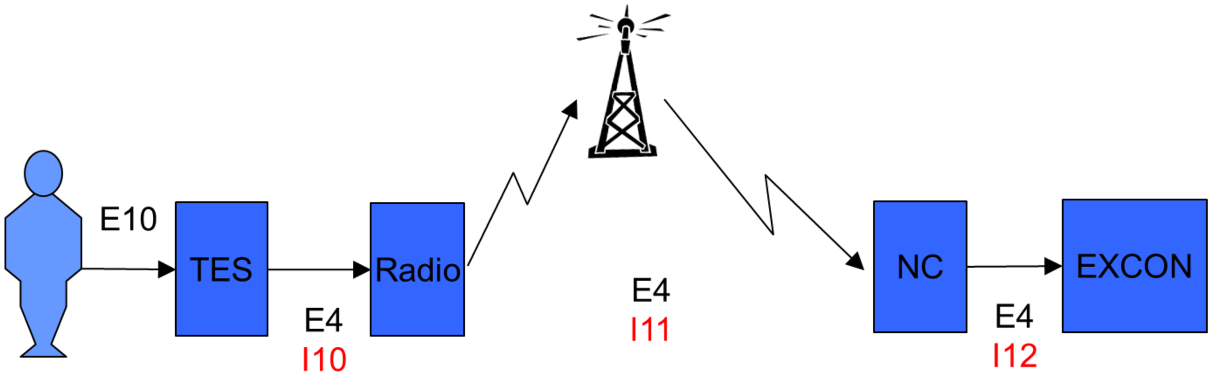

Figure 7: Functional Interface Data Model vs. Physical Interface Properties.

Depending on where the interface is implemented the system receives different characteristics. Even if the data set will be the same, other characteristics will differ, for example:

- If an “air interface” (I11) is selected, usage of radio frequencies and power must be agreed, standardized and harmonized through all nations; and
- If a TES to Radio interface (I10) is selected, nations must provide spare radios for visiting nations’ armies then training together to achieve interoperability.

As the physical implementation have impact on the system characteristics and ability to fulfil operational use cases and not at least have large impact on the implementation cost. The alternatives where discussed within the MSG-099 and also with MSG-098. The following were decided:

- I11 (Air interface):
  - This is the most wanted solution due to flexibility, capability and future growth.
  - The solution will most probably be implemented using commercial LTE/4G technology and relay on commercial networks/suppliers.
  - Possible issues or problems are; Data Safety, Latency, Area coverage, Reliability.
- I10 (TES-Radio interface):
  - I10 is the second best solution, and represent the current situation in most existing CTCs.
  - Require procurement of X-tra radios for visiting troops/equipment.
  - Positioning and “CTC capabilities, e.g., AWES” must be decided to part of the TES or the radio.
- I12 (Com/EXCON) is third.

Based on the pros and cons the decision for future standardization work is the I10 physical interface, for the implementation of E4.

Annex A – UCATT INTERFACE STANDARD FOR LASER ENGAGEMENT

The following document is the actual version. As the standardization process is still ongoing it might not be the final version. This is related to the inputs from SISO.

Simulation Interoperability Standards Organization

www.sisostds.org

SISO-STD-XXX-YYYY

UCATT Interface Standard for Laser Engagement

Version <0.5>

21 May 2015

Prepared by Urban Combat Advanced Training Technology (UCATT) Product Development Group

P.O. Box 781238
Orlando, FL 32878-1238, USA

Revision History

Version	Section	Date (MM/DD/YYYY)	Description
0.1	All	09/05/2013	Pre-released draft version for proofreading only.
0.2	All	11/11/2013	Koblenz meeting review input.
0.3	All	12/19/2013	• Orlando meeting decision input. • Section “Ammunition Number Structure” and “Player Identity Number Structure” were reworked, still without changing any numbering or encoding/decoding logic. • Document section structure was improved.
0.4	All	05/28/2014	The text status “Draft version for proofreading only” removed. Ref. [2] updated.
0.5	All	05/21/2015	Reformatted into SISO template

Participants

At the time this product was submitted to the Standards Activity Committee (SAC) for approval, the UCATT Product Development Group had the following membership and was assigned the following SAC Technical Area Director:

Product Development Group

Capt Sander Cruiming (Chair)
Mr Staffan Martinsen (Vice-Chair)
Mr Joachim Eisenhauer (Secretary)

Mr Grant Bailey (SAC Technical Area Director)

Mr Magnus Alexandersson
Mr Mark Chamberlain
Mr Thomas Defachelles
Dr. Uwe Dobrindt
Maj Johnny Gullstrand
Mr Anders Lindström
Mr Armin Thinnes
Mr Thierry Vinatier
Mr Ingo Wittwer
Mr Jesse Campos
Mr Michelle Coriat
Mr Philippe Desruelles
Mr Rudi Gouweleeuw
Maj Roger Karlsson
LtCol Peter Makowski
Mr Jan Vermeulen
Mr Gary Washam

The Product Development Group would like to especially acknowledge those individuals that significantly contributed to the preparation of this product as follows:

PDG Drafting Group

Mr Anders Lindström (Editor)

Mr Magnus Alexandersson
Mr Jesse Campos
Mr Joachim Eisenhauer
Mr Armin Thinnes
Mr Jan Vermeulen
Mr Thierry Vinatier
Mr Gary Washam
Mr Ingo Wittwer

The following individuals comprised the ballot group for this product.

Ballot Group

Member Name
Member Name
Member Name
…..*<continue with all the other Ballot Group member names and place all in alphabetical order>*

When the Standards Activity Committee approved this product on DD Month YYYY, it had the following membership:

Standards Activity Committee

Member Name (Chair)
Member Name (Vice Chair)
Member Name (Secretary)

Member Name
Member Name
Member Name

…..*<continue with all the other SAC member names and place all in alphabetical order>*

When the Executive Committee approved this product on DD Month YYYY, it had the following membership:

Executive Committee

Member Name (Chair)
Member Name (Vice Chair)
Member Name (Secretary)

Member Name
Member Name
Member Name

…..*<continue with all the other EXXOM member names and place all in alphabetical order>*

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UCATT Interface Standard for Laser Engagement

1. Overview

1.1. Scope

This standard applies to the optical interface primarily used to communicate a simulated weapon engagement from a weapon simulator platform to a target simulator platform. Additionally, the Laser Engagement interface has a secondary use to communicate administrative and other kind of information (i.e. umpire control-gun commands, indoor positioning and player association).In defining this interface the Reference [1] defines a number of key interfaces including capabilities typical of a live ground training system.

This standard primarily defines the optical communication of a simulated weapon engagement. That engagement comprises the period from simulated weapon actuation (firing), through the projectile or missile flight, to the target(s) engagement(s) either as a hit and/or one or several misses (flybys). The subsequent assessment of the simulated effect on the target is not part of this optical interface standard and thus it has to be separately defined. The intent is that the optical communication of a simulated weapon engagement is abstracted from the target simulated effect evaluation; i.e. direct fire optically simulated engagement may be complimented or replaced by another type of communication with the same interface requirements to maintain the coalition interoperability objectives.

This standard does not prescribe maximum simulated engagement ranges, laser transmitter safety classification or similar. The objective is however to replicate the weapon system engagement range performance using primary a Class 1 laser transmitter during optical transmission conditions defined as a standard clear day (i.e. visibility of 23.5km). The vendors and manufacturers are obliged to design the laser transmitter to comply with the weapon performance, given the customer required laser classification, optical transmission conditions and target simulator detector sensitivity specified herein to enable interoperability.

This Laser Engagement standard defines a specific direct fire laser engagement simulation methodology. It does not preclude a non-interfering parallel operation of other laser communication protocols as for example; a simulator system that requires this Laser Engagement optical interface for vehicle engagements and the MILES Communication Code (MCC) optical interface for soldier engagements.

1.2. Purpose

There is a requirement for coalition training of defence forces. Weapons effect simulation has in the past typically evolved with national training requirements resulting in proprietary protocols satisfying specific national needs. This Optical Interface Specification standard primarily details a laser simulated engagement methodology for direct fire weapon simulation used for e.g. gunnery and combat training. The realization of interface standards across coalition platforms enables interoperability in a live ground training environment.

This Optical Interface Specification standard is one of a number of (potential) standards used for weapon effects simulation. This standard will be complimentary to those other standards. Furthermore this optical interface also requires collective implementation of casualty and damage effects resulting from simulated engagements, defined in a separate document.

1.3. Objectives

The primary objective of this optical interface specification is to establish a standard interface for the communication of a laser based simulated weapon engagement in a training environment. The intent is to prescribe the content and engagement methodology for the simulation of a number of classes of direct fire weapon systems. Compliance with these procedures enables interoperability between simulator equipment and systems provided from different vendors and manufacturers.

1.4. Intended Audience (Optional)

A typical weapon simulator is principally built up by two parts, the fire simulator and the target simulator. The weapon simulator may then simulate fire against a target and at the same time receive simulated fire from other weapon simulators.

A weapon simulator may also be made up of only the fire simulator part, as in an antitank weapon, or only the target simulator part as on a truck.

This Laser Engagement specification specifies how the different weapon simulators interact on the exercise area. All simulators on the exercise area have to follow the specification, to ensure that simulators can interoperate properly. The requirements in this specification are specifically important when different weapon simulators from different manufacturers shall interact on the exercise area.

The weapon systems have different price levels and the simulator requirements may differ as for example:

- A tank weapon system is an expensive weapon system and the hit accuracy requirements are usually important
- An antitank weapon system is comparatively less expensive but the simulator might have to consider that it shall simulate a "Fire-and-Forget" weapon system.
- A small arms weapon system is even less expensive but the simulator data transfer from the fire simulator to target simulators can be time critical.

As a consequence different optical encoding methods are used to meet the different simulator requirements.

2. References (Normative)

2.1. SISO References

#	Document Number	Title	Date
1.	SISO-GUIDE-XXX-YYYY	UCATT Live Simulation Standards and Architecture	MM/DD/YYYY
2.	SISO-REF-XXX-YYYY	UCATT Ammunition Table	MM/DD/YYYY

2.2. Other References

#	Document Number	Title	Date
3.			
4.			

3. Definitions, Acronyms, and Abbreviations

English words are used in accordance with their definitions in the latest edition of Webster's New Collegiate Dictionary [ref#] except when special SISO Product-related technical terms are required.

3.1. Definitions

Term	Definition
<Start text here.>	<Start text here.>

3.2. Acronyms and Abbreviations

Acronym or Abbreviation	Meaning
ABM	Air Burst Munitions
AC	Ammunition Code
AmLsd	Ammunition Least Significant Digit
AmNo	Ammunition Number (synonymous with AC)
AP	Armour Piercing
APDS	Armour-Piercing Discarding-Sabot
APFSDS	Armour-Piercing Fin-Stabilized Discarding-Sabot
CA	Cant Angle Code
DI	Distance Info Code
EI	Engagement Info Code
FlgNo	Flag Number
GC	Geographical Command Code
GIC	Geographical Identification Code
HE	High Explosive
HEAT	High Explosive Anti-Tank
HEMP	High Explosive Multi-Purpose
HP	Hit Probability Code
IC	Player Identity Code
IdNo	Player Identity Number
MCC	MILES Communication Code
NC	Null Code
PAC	Player Association Code
PC	Position Code
PI	Pulse Interval
PIU	Pulse Interval Unit
SISO	Simulation Interoperability Standards Organization
SP	Simulated Projectiles
TF	Time-to-Impact for Fire-and-Forget
UC	Umpire Command Code
UCATT	Urban Combat Advanced Training Technology
UIC	Umpire Identification Code

4. UCATT Optical Interface

4.1. Optical Physical Characteristics

This section 4.1 shall be seen as recommendations and not as requirements. The primary intent with the information in this section is to enable a fair and reasonable multinational training interoperability and is not intended to be used as e.g. contractual requirements between vendor and buyer of simulation equipment.

4.1.1. Transmitter and Detector

Wave Length

A laser transmitter is used to transmit:

- All codes with the two exception examples below.

A laser transmitter or infra-red diode transmitter is used to transmit:

- Player Association Code
- Geographical Reference Code

When laser transmitter is used:

Laser pulse wave length	905 nm ± 25 nm

When infra-red diode transmitter is used:

Infra-red diode pulse wave length	930 nm ± 50 nm

The transmitters transmit, using an infra-red diode, at the similar 905nm wavelength as the laser simulator transmitters but the allowed wavelength is 880-980nm to allow cost effective infra-red diodes to be used.

Pulse Length

The pulse length (P) is measured at the half of the pulse height.

Laser transmitter	40 ns ≤ P ≤ 100 ns
Infra-red diode transmitter	40 ns ≤ P ≤ 350 ns

Detector Characteristics

The light detector shall be able to receive information from transmitters simulating a weapon engagement at far distances when the light intensity or luminance is low.

Target simulator laser detector sensitivity	Vehicle	< 4 mW/m²
	Man worn	< 100 mW/m²

The light detector shall be able to receive information also from transmitters at close distances when the light intensity or luminance is high.

Maximum received light intensity (luminance)	< 2.0 kW/m²

4.1.2. Retro Reflector

Retro Reflector Characteristics

For e.g. the "Real-Time Code" the engagement methodology typically requires a laser light reflection from the target to the fire simulator (i.e. two-way simulator). A Retro Detector Unit then comprises both retro reflector(s) and detector(s). The maximum distance from the centre of one retro reflector to the centre of the closest detector is 0,1m. The distance between two Retro Detector Units on a target simulator shall be less than 5m.

The target retro reflector size is designed from two primary maximum range characteristics concerning the fire simulator:

- The ability to receive and detect reflected laser light.
- The ability to transmit engagement information.

To align with typical existing laser fire simulator characteristics and for simulated combat training interoperability a target retro reflector shall have a minimum effective diameter of:

- Vehicle: $d \geq 56$ mm, nominal 60mm
- Man worn: $d \geq 22$ mm

It is possible to design a target simulator replacing a single retro reflector with multiple retro reflectors. In that case the close mounted retro reflectors area sum shall exceed the area of one of the above two defined retro reflectors.

A single retro reflector shall reflect the laser light with at least an accuracy of:

- Vehicle: ± 2 arc seconds
- Man worn: ± 5 arc seconds

Retro Reflector Usage

Target simulator retro reflector(s) are used by the two-way fire simulator primarily for the following reasons:

- Measure the simulated projectile or missile position in relation to the target retro reflector(s).
- Measure distances to target simulator from:
    - Projectile or missile
        - To initiate transmission of engagement info like "Position Code", "Ammunition Code" and "Player Identity Code" when the simulated projectile or missile is close to a target.
        - In case of an air burst engagement the "Detonation Distance" info shall be transmitted.
    - Fire simulator
        - In case of distance dependant engagement lethality the "Engagement Distance" info shall be transmitted.

4.2. Pulse Interval Description

To establish the possibility to simulate fire and to transmit information from the laser fire simulator to the target simulator, one or more laser detectors are mounted on the target simulator. The transmitted information is built up by modulating the laser pulse intervals.

4.2.1. Encoded and Decoded Pulse Interval Item

An optical information code part is built up by pulse intervals (PI). A pulse interval has a start pulse and a stop pulse. The stop pulse can be the start pulse for the next interval.

The pulse interval encoder clock is driven by a frequency of 15 MHz with an accuracy of at least ± 70 ppm.

Two pulses is building a pulse interval (PI) measured in pulse interval units (PIU). A Pulse Interval Unit (PIU) has a resolution of 1 / (15 MHz) or 66+⅔ns. The pulse interval (PI) is the optical code information carrier, used by the firing simulator to transmit information to the target simulator.

A firing laser transmitter transmits several message elements (pulse intervals) to encode each message item. There are several message items building a complete message.

4.2.1.1. Pulse Interval Types

There are three types of transmitted encoded pulse interval message items:

- Fixed
    - Non-alternating
    - Alternating
- Continuously changing

Fixed Non-alternating

This is the most fundamental method of encoding message items, when transmitting fixed values like "Ammunition Code" and "Player Identity Code". A decoded message item is illustrated below.

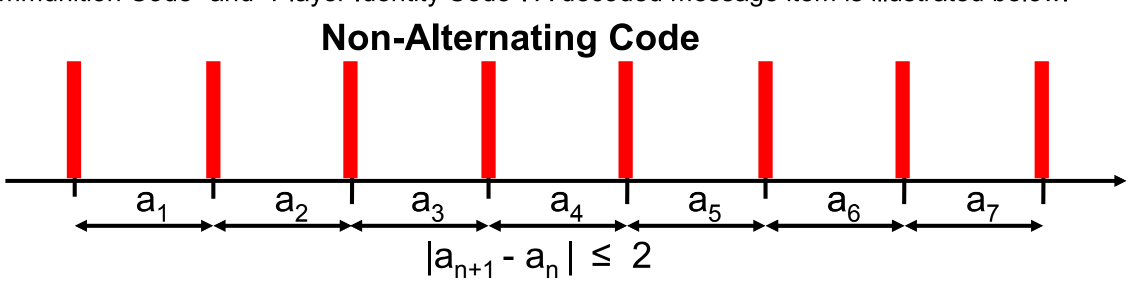

Figure 1. Pulse Interval Description, Fixed Non-alternating Code

Fixed Alternating

This is a more advanced method of encoding message items, when transmitting fixed values like "Ammunition Code" and "Player Identity Code". The pulse intervals "a" and "b" are alternating and both can carry the shortest pulse interval. In the decoded message item illustration below "a" carries the shortest pulse interval.

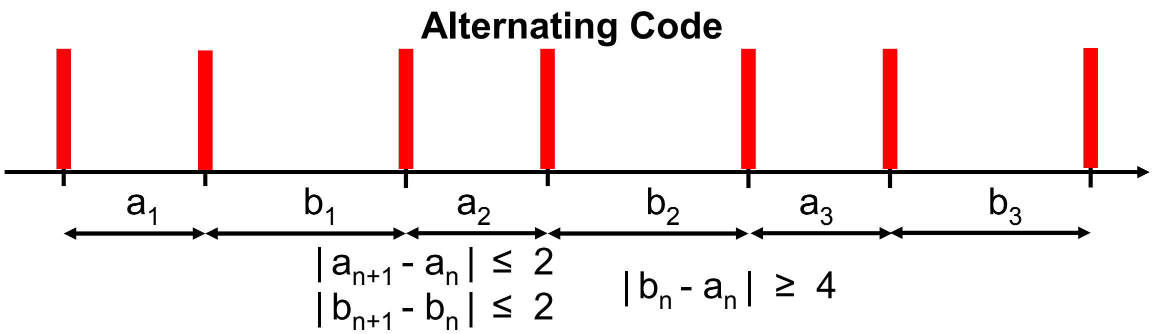

Figure 2. Pulse Interval Description, Fixed Alternating Code

As illustrated above there is a basic decoding rule for alternating pulse interval pairs "a" and "b". To ensure that a fixed alternating message item cannot be decoded and misinterpreted as a fixed non-alternating message item the encoder must use an alternating pair where the difference in encoded pulse intervals "a" and "b" is more or equal to six PIU. The consequence is that the receiver can decode a difference in "a" and "b" equal or more than four PIU and still correctly interpret the message item as alternating.

Continuously Changing

This is the method of encoding the projectile position message item. The pulse interval is continuously changing as the transmitter scans around the simulated projectile, representing a fixed position in space to be read by a single or multiple targets. A decoded message item is illustrated below.

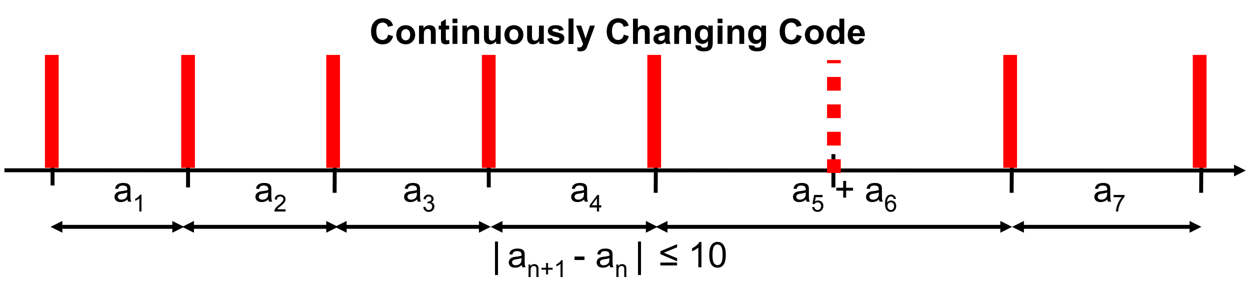

Figure 3. Pulse Interval Description, Continuously Changing Code

As illustrated above the decoded single adjacent pulse interval cannot change more than ten PIU to be decoded as belonging to the same message item. When a single adjacent pulse is missing the decoded pulse interval consequently cannot change more than twenty PIU to belong to the same message item. The consequence is that the transmitter shall not change the adjacent pulse interval more than nine PIU, to assure that the message item is correctly interpreted by the receiver.

To some extent continuously changing encoding has similar characteristics as fixed non-alternating encoding. At the decoder end they differ by the compared characteristics in the next chapter.

4.2.1.2. Basic Message Item Encoding and Decoding Rules

The following pulse interval related definitions in an encoded and decoded message item is used:

Item Definition	Description
a_1 and b_1	First message item pulse interval measured in PIU
a_n, a_k, b_n and b_k	Any message item pulse interval measured in PIU
a_N and b_N	Last message item pulse interval measured in PIU
$1 \leq n \leq N$	Valid indexes on message item pulse intervals
$1 \leq k \leq n$	Valid indexes on message item pulse intervals

Table 1. Pulse Interval Description, Pulse Interval Related Definitions

Encoding rules:

Fixed non-alternating:

$a_{n+1} = a_k$ All pulse intervals are transmitted having the same nominal pulse interval.

Fixed alternating:

$a_{n+1} = a_k$ All "a" pulse intervals are transmitted having the same nominal pulse interval.
$b_{n+1} = b_k$ All "b" pulse intervals are transmitted having the same nominal pulse interval.
$| a_n - b_n | \geq 6$ To ensure that a fixed alternating message item cannot be
$| b_n - a_n | \geq 6$ misinterpreted and decoded as a fixed non-alternating message item.

Continuously changing:

$| a_{n+1} - a_n | \leq 2$ Typical change between adjacent message item pulse intervals.
$| a_{n+1} - a_n | \leq 9$ Maximum allowed change between adjacent message item pulse intervals.

Decoding rules:

Fixed non-alternating:

$| a_{n+1} - a_k | \leq 2$ All received message item pulse intervals does not differ more than two PIU.

Fixed alternating:

$| a_{n+1} - a_k | \leq 2$ All received "a" message item pulse intervals does not differ more than two PIU.
$| b_{n+1} - b_k | \leq 2$ All received "b" message item pulse intervals does not differ more than two PIU.
$| a_n - b_n | \geq 4$ The encoder has ensured that a fixed alternating message item cannot be
$| b_n - a_n | \geq 4$ misinterpreted and decoded as a fixed non-alternating message item.

Continuously changing:

$| a_{n+1} - a_n | \leq 2$ Typical change between adjacent message item pulse intervals.
$| a_{n+1} - a_n | \leq 10$ Maximum allowed change between adjacent message item pulse intervals.

"Continuously changing" is consequently from the above illustrated similarities, sometimes also referred to as "Non-alternating".

4.2.2. Minimum Decodable Pulse Interval Item

The receiver does not need to receive all transmitted pulse intervals to decode a message item. When the fire and target simulators have a distance close to the simulator maximum range performance, more or less pulses in a transmitted sequence are expected to be decoded by the target receiver. To stretch the simulator maximum range performance, minimum decodable pulse interval items are defined. The minimum decodable pulse interval item for each type of pulse interval sequence is illustrated below.

Non-alternating Intervals

The minimum decodable pulse interval items are illustrated below.

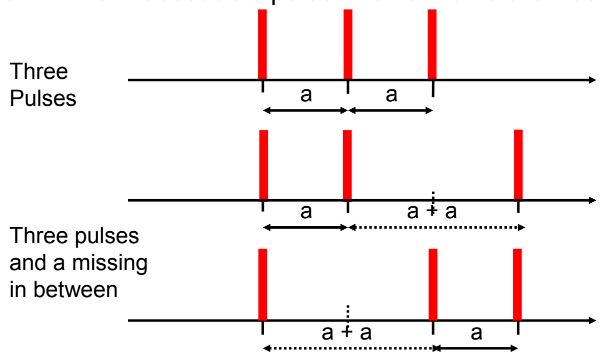

Figure 4. Pulse Interval Description, Minimum Decodable Pulse Interval Item, Non-alternating Code

Alternating Intervals

The interval "a" and "b" is alternating and can both can carry the shortest pulse interval. In the illustration below "a" carries the shortest pulse interval.

As opposed to Non-alternating Intervals, Alternating Intervals is not specified to include a missing pulse in the Minimum Decodable Pulse Interval Item definition. Despite it is not specified it is possible to implement missing pulse decoding as for example illustrated below:

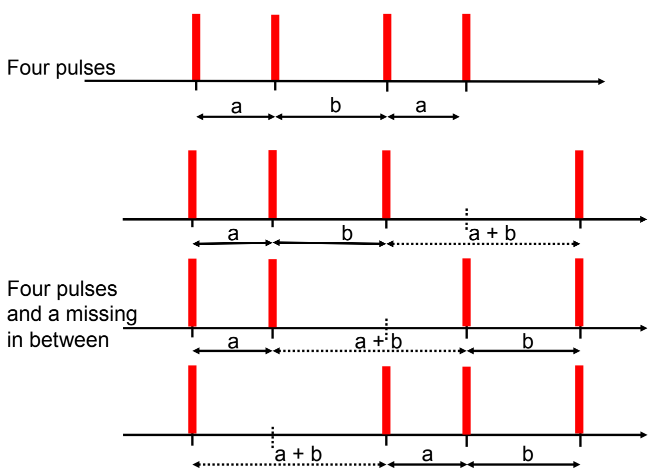

Figure 5. Pulse Interval Description, Minimum Decodable Pulse Interval Item, Alternating Code

4.2.3. Pulse Sequence Identification

When a Minimum Decodable Item is decoded there are rules to connect interval items, as belonging to the same message item. Items are connected by two reasons:

- A single missing pulse is identified, if it is not part of the definition as a minimum pulse interval item
- A "Null Code" (NC1, NC2 or NC3) is identified between the items.

The below figures illustrate how to connect interval items as belonging to the same pulse sequence.

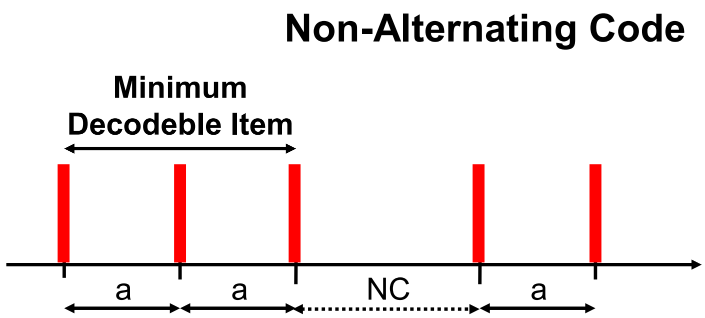

Figure 6. Pulse Interval Description, Pulse Sequence Identification, Non-alternating Code

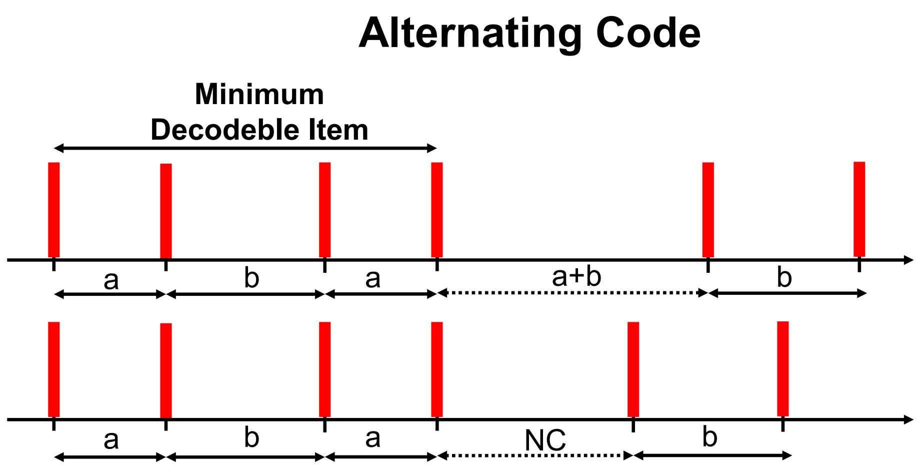

Figure 7. Pulse Interval Description, Pulse Sequence Identification, Alternating Code

4.2.4. Common Decoding Characteristics

The following conditions and abilities are common when decoding all optical code types like "Real-Time Code", "Short-Time Code", etc.

The Target Simulator shall use the following conditions when decoding pulse intervals:

- The Target Simulator does not have to decode more than 50 message elements (pulse intervals) to decode a single message item.
- When the "Ammunition Code", "Player Identity Code", "Detonation Info Code" and similar Fixed Alternating and Fixed Non-alternating Codes are transmitted, the decoded pulse interval **average value** is calculated, when two adjacent pulse intervals does not differ more than two PIU's.
- When the Continuously Changing "Position Code" is transmitted, the decoded pulse interval **average value** is calculated using all pulse intervals, when two adjacent pulse intervals does not differ more than ten PIU's.
- If the player identity number cannot be decoded, the identity value is set to zero. The decoding of the rest of the codes is still done.

The Target Simulator shall have the following abilities when decoding pulse intervals:

- The target simulator must be able to receive codes simultaneously and in parallel received at one single or several detectors and shall consequently be able to decode pulse interval sequences even when they are overlaid.
- The target simulator must be able to decode information when several firing simulators engage the target simulator apparently (i.e. same or multiple detector(s) receive both optical engagement codes) at the same time. As a consequence the target simulator must at least be able to decode engagement information from at least two firing simulators when they are simulating weapon fire trigger at a time distance of 50ms.
- Immunity to optical noise in the ambient environment:
    - All functions of the target simulator must be ensured also if it receives a lot of disturbing noise pulses. The target simulator shall decode "Ammunition Code" and "Player Identity Code" correctly in a test case when a correct transmitted sequence is disturbed by noise pulses evenly distributed around 1000 pulses / second with a 1-sigma value equal to 500 Hz (2ms) and noise pulse amplitude not significantly exceeding the optical coded received pulse.

4.2.5. Encoding and Decoding Notation

In the following optical coding chapters the below mathematical notation is used when encoding and decoding the messages:

- "INT(.../...)" in the formulas means "The truncated integer part of" as a result of the division operation.
- "INT(..%..)" in the formulas means "The remainder part of" as a result of the division operation.
- "INT(...*...)" in the formulas means "The integer part of" as a result of the multiplication operation. The integer result is truncated without using rounding.
- "INT(...+...)" in the formulas means "The integer part of" as a result of the addition operation. The integer result is truncated without using rounding.

The notation is selected and aligned with how embedded computers usually handle basic mathematical operations.

Examples:

INT(8/3)	=	2
INT(-8/3)	=	-2
INT(7/3)	=	2
INT(-7/3)	=	-2
INT(7%3)	=	1
INT(-7%3)	=	-1
INT(7.6*3)	=	22
INT(7.6*4)	=	30
INT(0.3+7.6)	=	7
INT(0.5+7.6)	=	8
INT(0.5+7.6*3)	=	23

Table 2. Pulse Interval Description, Encoding and Decoding Notation Examples

Observe that Microsoft Excel does not define "INT" in the same way as in this specification!
In this specification "INT" corresponds to Microsoft Excel "TRUNC".

4.3. Optical Codes

The simulators and other kind of related laser equipment transmit coded information by using laser light that is received by target simulators.

This optical specification includes the following optical code types and each type consists of the following message items:

Optical Code Type	Message Item Name	Acronym
Short-Time	Ammunition Code	AC3, AC9
	Player Identity Code	IC4a, IC4b, IC5a, IC5b
Real-Time	Ammunition Code	AC1, AC11, AC21
	Player Identity Code	IC1, IC2, IC3, IC11, IC12, IC21, IC22
	Projectile or Missile Position Code	PC1, PC2
	Distance Lethality Code	EI11, DI11
	Cant Angle	CA21
	Null Code	NC1, NC2, NC3
Fire-and-Forget	Ammunition Code	AC5, AC12, AC22
	Player Identity Code	IC1, IC2, IC3, IC11, IC12, IC21, IC22
	Hit Probability Code	HP1
	Time-to-Impact Code	TF1
	Distance Lethality Code	EI11, DI11
	Cant Angle	CA21
	Null Code	NC1, NC2, NC3
Short-Time Scanning	Ammunition Code	AC2, AC11, AC22
	Player Identity Code	IC4a, IC4b, IC5a, IC5b IC11, IC12, IC21, IC22
	Null Code	NC1, NC2, NC3
Umpire Control-Gun	Umpire Identification Code	UIC
	Umpire Command Code	UC1, UC2
	Player Identity Code	IC4a, IC4b, IC5a, IC5b
Geographical Reference	Geographical Identification Code	GIC
	Geographical Command Code	GC1, GC2
Player Association	Player Association Code	PAC

Table 3. Optical Codes, Message Item Names and Acronyms

4.3.1. Pulse Intervals

The pulse intervals can be understood as constructed by using a 15MHz clock.

- A Pulse Interval Unit (PIU) has a resolution of 1/(15 MHz) or 66+⅔ns.
- The pulse interval is defined as the time distance between two pulses, measured at the positive flanks of the two pulses.
- The pulse interval shall not exceed 2399PIU (≈0,16ms) and shall not be less than 1200PIU (0,08ms). The exception is the "Player Association Code" (PAC) where the valid pulse intervals is between 470-490PIU.
- When a single transmitted pulse is missing when received at the target, it is assured it cannot by accident be decoded as any additional valid pulse interval.
- When a single additional (noise) erroneous pulse is received within a valid pulse interval, it is assured that it cannot by accident result in decoding any additional valid pulse interval pair.

The following decodable pulse intervals are used by each message item. The pulse intervals are also illustrated in the Pulse Intervals Map.

Item Acronym	Message Item Description	No.		Alter-nating Pair	PIU	
		Low	High		Low	High
IC1	Player Identity Code Non-alternating	1	20		1505	1564
IC2		0	19		1565	1624
IC3		0	24		1625	1699
IC4a		1	50		1250	1399
IC4b		51	100		1550	1699
IC5a		0	49		1400	1549
IC5b		50	99		1909	2058
			163			2250
			(179)			(2298)
IC11	Player Identity Code Alternating	1	20	IC21	1505	1564
IC12		0	24	IC22	1625	1699
IC21		0	9	IC11	1235	1264
IC22		0	6 (9)	IC12	1205	1234
AC1	Ammunition Code Non-alternating	1	24		1700	1771
AC5		25	25		1772	1774
AC1		26	29		1775	1786
AC5		30	30		1787	1789
AC1		31	46		1790	1837
AC3		47	67		1838	1900
AC3		68	70		2308	2316
AC3		71	76		2371	2388
AC2		77	79		2389	2397
AC9		3	7		1211	1225
AC11	Ammunition Code Alternating	1	20	AC21 AC22	1205	1264
AC12		1	20	AC22	1625	1684
AC21		1	28	AC11	1268	1351
AC22		1	28	AC11 AC12	1355	1438

Item Acronym	Message Item Description	No.		Alter-nating Pair	PIU	
		Low	High		Low	High
EI11	Distance Lethality Code	1	28	DI11 CA21	1268	1351
DI11		1	20	EI11 CA21	1505	1564
CA21	Cant Angle	1	30	EI11 DI11	1355	1444
PC1	Position Code	-97	+97		1911	2105
PC2		-97	+97		2107	2301
HP1	Hit Probability Code	0	100		1999	2101
TF1	Time-to-Impact Code	0	60		2133	2200
UIC	Umpire Identification Code	1	3		2359	2367
UC1	Umpire Command Code	1	64		1912	2103
UC2		1	64		2108	2299
GIC	Geographical Identification Code	1	1		2368	2370
GC1	Geographical Command Code	1	64		1912	2103
GC2		1	64		2108	2299
NC1	Null Code	1	1		2302	2306
NC2		2	2		1902	1906
NC3		3	3		2318	2322
PAC	Player Association Code				470	490

Table 4. Optical Codes, Decodable Pulse Intervals

4.3.2. Pulse Intervals Map

This pulse interval map illustrates pulse interval usage.

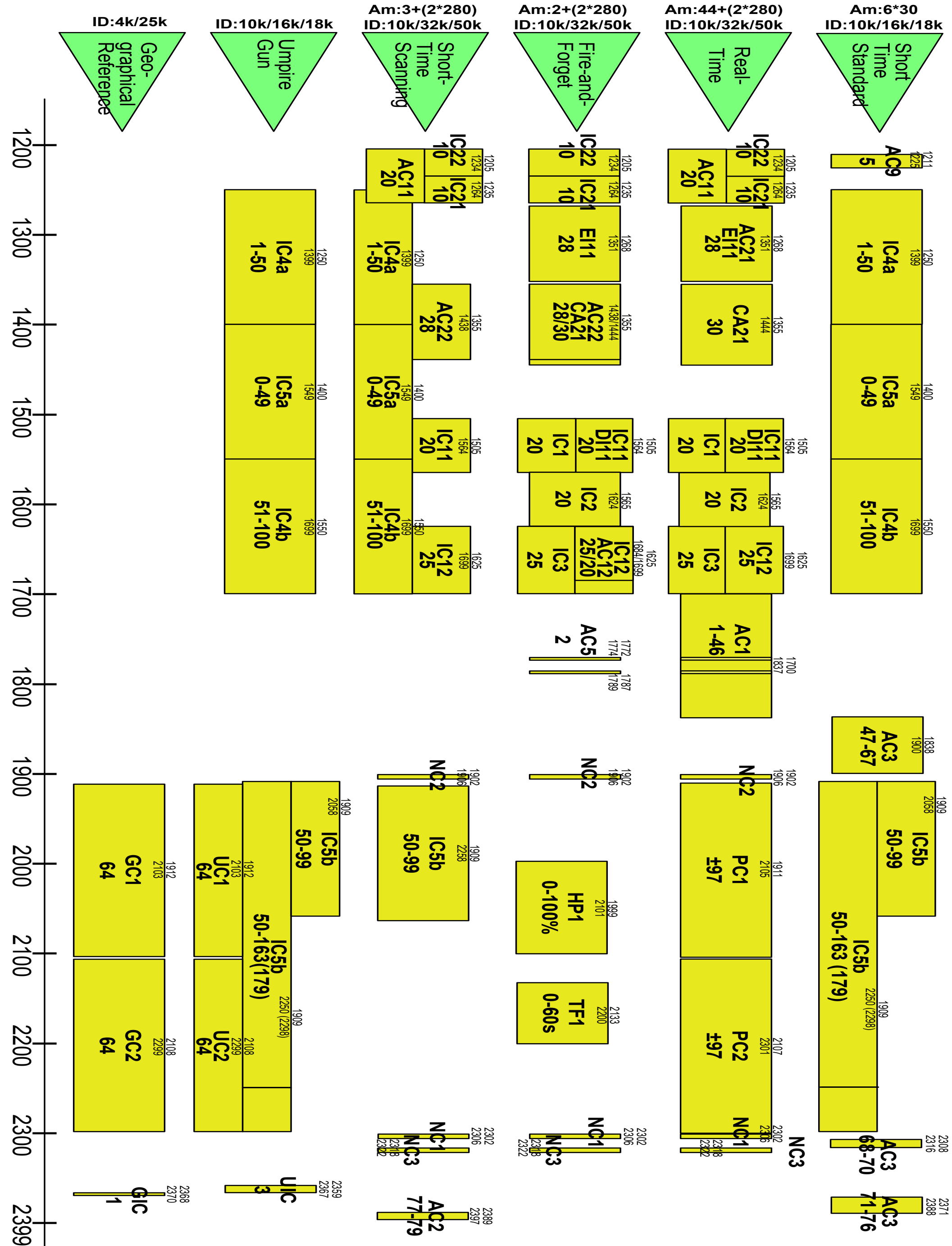

Figure 8. Optical Codes, Pulse Intervals Map

4.3.3. Code Structure

The optical code structure containing message item sequences can be arranged two groups:

- Short-Time Group Structure
- Triplet Group Structure

4.3.3.1. Short-Time Group Structure

The following optical code types are using the Short-Time Group characteristics when transmitting sequences of message items:

- Short-Time Code
- Umpire Control-Gun Code

The "Short-Time Code" use message blocks and sequences of message blocks when transmitting information.

For each simulated projectile the transmitter typically starts with a limited number of hit coded messages followed by a number of near miss coded messages. When hit coded messages are transmitted for a projectile they must precede near miss coded messages. If the receiver can only decode near miss messages, the receiver interprets the engagement as a near miss.

Typical example where the number of blocks B=14, message items I=3 and number of elements E=5:

Block	AC3	Sequence
1-2	Hit	IC4a–IC4a–IC4a–IC4a–IC4a – AC3–AC3–AC3–AC3–AC3 – IC5a–IC5a–IC5a–IC5a–IC5a
2-14	Near Miss	IC4a–IC4a–IC4a–IC4a–IC4a – AC3–AC3–AC3–AC3–AC3 – IC5a–IC5a–IC5a–IC5a–IC5a

Table 5. Optical Codes, Short-Time Group, Block Transmission Illustration 1

To transmit a child ammunition number more than three message items (I >3) are required where AC9 is then transmitted followed by AC3.

Typical example where the number of blocks B=14, message items I=4 and number of elements E=3:

Block	AC3	Sequence
1-2	Hit	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a
2-14	Near Miss	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a

Table 6. Optical Codes, Short-Time Group, Block Transmission Illustration 2

In the two examples above the two first blocks use AC3="Hit" to encode the hit messages and in the following blocks AC3="Near Miss" is used to encode the near miss messages.

A message block delimiter item is defined by the end of a message block and the start of the next message block as illustrated below:

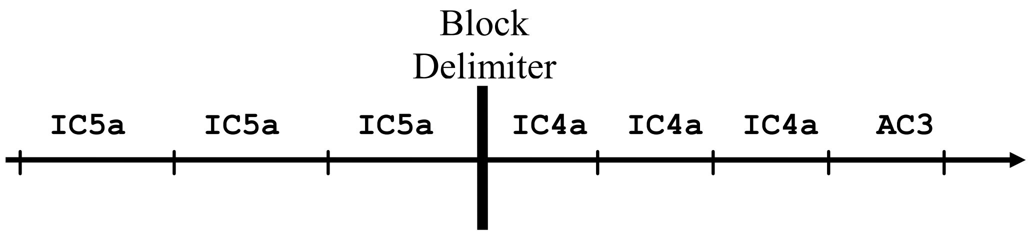

Figure 9. Optical Codes, Short-Time Group, Block Delimiter Example

Block transmission is done in two different ways depending on if IC5a or IC5b is transmitted.

- IC5a is transmitted last in block
- IC5b is transmitted first in block

The "Short-Time Code" is built with message item sequences (blocks) in several combinations with corresponding block delimiter illustrated as follows:

Valid Message Item Sequences (Blocks)	Block Delimiter
IC4a–AC3–IC5a	IC5a–IC4a
IC4a–AC9–AC3–IC5a	
IC4b–AC3–IC5a	IC5a–IC4b
IC4b–AC9–AC3–IC5a	
IC5b–AC3–IC4a	IC4a–IC5b
IC5b–AC9–AC3–IC4a	
IC5b–AC3–IC4b	IC4b–IC5b
IC5b–AC9–AC3–IC4b	

Table 7. Optical Codes, Short-Time Code, Block Delimiters

Note that each message item (IC4a, IC4b, IC5a, IC5b, AC9 and AC3) in the above table consists of three to five message elements.

4.3.3.2. Triplet Group Structure

The following optical code types are using message item triplet sequences and sequences of triplets when transmitting information:

- Real-Time Code
- Fire-and-Forget Code
- Short-Time Scanning Code

There are six message item sequences, build as triplets with acronym names as follows:

- P3ON: Position or "Hit Probability" and "Time-to-Impact". With non-alternating ammo code
- P3OA: Position or "Hit Probability" and "Time-to-Impact". With alternating message item
- I3ON: Player identity. Non-alternating
- I3OA: Player identity and ammo. Alternating
- I3SN: Player identity and ammo. Non-alternating. I3SN is not combined with any other triplet and is exclusively designed for "Short-Time Scanning" simulation.
- I3SA: Player identity and ammo. Alternating. I3SA is not combined with any other triplet and is exclusively designed for "Short-Time Scanning" simulation.

The five most typical triplets are illustrated as follows:

Optical Code Type	Triplet	Sequence			Description of Sequence No. 1 and 3	Description of Sequence No. 2
		1 or 3 No. 1	2 No. 2	1 or 3 No. 3		
Real-Time	P3ON	PC1	AC1	PC2	Projectile Position	Ammo
	I3ON	IC1	IC2	IC3	Player Identity	Player Identity
	P3OA	PC1	EI11 CA21	PC2	Projectile Position	Engagement Info Cant Angle
	I3OA	IC11 IC21	AC11 AC21	IC12 IC22	Player Identity	Ammo
Short-Time Scanning	I3SA	IC11 IC21	AC11 AC22	IC12 IC22	Player Identity	Ammo

Table 8. Optical Codes, Most Typical Used Triplets Illustration

Single and multiple triplets has to be transmitted and combined as illustrated in the below table. Received sequences of triplets builds a minimum decodable sequence combination also illustrated in the below table.

Allowed Encoded Sequence	Minimum Decodable Sequence without firing Player Identity	Minimum Decodable Sequence with firing Player Identity
I3SN		I3SN
I3SA		I3SA
N1*P3ON – M1*I3ON	P3ON	P3ON - I3ON
N2*P3OA – M2*I3OA	Not decodable without I3OA	P3OA - I3OA

Table 9. Optical Codes, Single and Multiple Triplet Combinations

The integers N1, N2, M1 and M2 are selected by the encoder and then typically decoded as follows:

N1, N2	M1,M2	Comment
N1=N2=2	M1=M2=2	Single shot and low rate burst of fire (approx. < 250 rounds/min)
N1=N2=1	M1=M2=1	High rate burst of fire (approximately ≥ 250 rounds/min)

Table 10. Optical Codes, Typical Number of Triplets

In the simulation situations described in the below table comment column, N1, N2, M1 and M2 are extended from the above previous tabled typical values. The decoder shall consequently expect to receive sequences with the following N1, N2, M1, and M2 values:

<table>
<tr><th>N1, N2</th><th>M1, M2</th><th>Comment</th></tr>
<tr><td>1 ≤ N1 ≤ 3
1 ≤ N2 ≤ 3</td><td>1 ≤ M1 ≤ 3
1 ≤ M2 ≤ 3</td><td rowspan="2">Single shot and low rate burst of fire</td></tr>
<tr><td colspan="2">2 ≤ (N1+ M1) ≤ 6
2 ≤ (N2+ M2) ≤ 6</td></tr>
<tr><td>1 ≤ N1 ≤ 2
1 ≤ N2 ≤ 2</td><td>1 ≤ M1 ≤ 2
1 ≤ M2 ≤ 2</td><td rowspan="2">High rate burst of fire</td></tr>
<tr><td colspan="2">2 ≤ (N1+ M1) ≤ 4
2 ≤ (N2+ M2) ≤ 4</td></tr>
</table>

Table 11. Optical Codes, Allowed Number of Triplets

The triplets are illustrated as follows:

<table>
<tr><th rowspan="2">Optical Code Type</th><th rowspan="2">Triplet</th><th colspan="3">Sequence</th><th rowspan="2">Description of Sequence No. 1 and 3</th><th rowspan="2">Description of Sequence No. 2</th></tr>
<tr><th>1 or 3
No. 1</th><th>2
No. 2</th><th>1 or 3
No. 3</th></tr>
<tr><td>Real-Time</td><td rowspan="2">I3ON</td><td rowspan="2">IC1</td><td rowspan="2">IC2</td><td rowspan="2">IC3</td><td rowspan="2">Player Identity</td><td rowspan="2">Player Identity</td></tr>
<tr><td>Fire-and-Forget</td></tr>
<tr><td>Real-Time</td><td>P3ON</td><td>PC1</td><td>AC1</td><td>PC2</td><td>Projectile Position</td><td rowspan="2">Ammo</td></tr>
<tr><td>Fire-and-Forget</td><td>P3ON</td><td>HP1</td><td>AC5</td><td>TF1</td><td>Hit Probability
Time-to-Impact</td></tr>
<tr><td rowspan="4">Short-Time Scanning</td><td rowspan="4">I3SN</td><td>IC4a</td><td rowspan="4">AC2</td><td>IC5a</td><td rowspan="4">Player Identity</td><td rowspan="4">Ammo</td></tr>
<tr><td>IC4b</td><td>IC5a</td></tr>
<tr><td>IC5b</td><td>IC4a</td></tr>
<tr><td>IC5b</td><td>IC4b</td></tr>
<tr><td>Real-Time</td><td rowspan="2">I3OA</td><td rowspan="3">IC11
IC21</td><td>AC11
AC21</td><td rowspan="3">IC12
IC22</td><td rowspan="3">Player Identity</td><td rowspan="3">Ammo</td></tr>
<tr><td>Fire-and-Forget</td><td>AC12
AC22</td></tr>
<tr><td>Short-Time Scanning</td><td>I3SA</td><td>AC11
AC22</td></tr>
<tr><td rowspan="3">Real-Time</td><td rowspan="3">P3OA</td><td rowspan="3">PC1</td><td>EI11
CA21</td><td rowspan="3">PC2</td><td rowspan="3">Projectile Position</td><td>Engagement Info
Cant Angle</td></tr>
<tr><td>DI11
CA21</td><td>Detonation Info
Cant Angle</td></tr>
<tr><td>EI11
DI11</td><td>Engagement Info
Detonation Info</td></tr>
<tr><td rowspan="3">Fire-and-Forget</td><td rowspan="3">P3OA</td><td rowspan="3">HP1</td><td>EI11
CA21</td><td rowspan="3">TF1</td><td rowspan="3">Hit Probability
Time-to-Impact</td><td>Engagement Info
Cant Angle</td></tr>
<tr><td>EI11
DI11</td><td>Engagement Info
Detonation Info</td></tr>
<tr><td>DI11
CA21</td><td>Detonation Info
Cant Angle</td></tr>
</table>

Table 12. Optical Codes, All Used Triplets Illustration

Notes:

- It shall be noted that it is possible to transmit multiple P3OA's referring to the same projectile containing different "Sequence No. 2" information as for example:
    - EI11/CA21 and DI11/CA21

4.4. Ammunition Numbering Structure

The Laser Engagement ammunition table is defined in Reference [2] and includes several hundred ammo numbers.

The ammo numbers are used in two code groups:

- Short-Time Group
- Triplet Group

4.4.1. Short-Time Group Coded

The "Short-Time Group Coded" ammunition codes are typically used by non-scanning transceivers although also scanning transceivers also can use them. The "Short-Time Group Coded" ammunition codes include:

- Short-Time Code
  - 30 grandparent ammo numbers 47-76
  - 5*30 child ammo numbers

The ammo numbering is illustrated with the below table:

Parent-Child Relationship	Short-Time
Grandparent	47-76
Child	1547-1576
Child	1647-1676
Child	1747-1776
Child	1847-1876
Child	1947-1976

Table 13. Ammunition Numbering, Short-Time Group

4.4.2. Triplet Group Coded

The "Triplet Group Coded" ammunition codes are typically used by scanning transceivers although also non-scanning transceivers also can use them. The "Triplet Group Coded" ammunition codes include three types of optical coding.

1. Real-Time Code
   - Ammo numbers 1-24, 26-29 and 31-46.
   - 2*280 ammo numbers.
2. Fire-and-Forget Code
   - Ammo numbers 25 and 30.
   - 2*280 ammo numbers.
3. Short-Time Scanning Code
   - Ammo numbers 77-79.
   - 2*280 ammo numbers.

Depending on how the Real-Time Code ammunition is simulated and detonating, ammo numbers are decoded by the target simulator from detonation types optically transmitted by the fire simulator. The fire simulator encodes some of the detonation types in the "Engagement Info" (EI11) or "Detonation Info" (DI11) optical codes.

- Direct Detonation
- Burst of Fire
- Air Burst
- Unarmed

The ammo numbering is illustrated with the below table:

Parent-Child Relationship	Real-Time			
	Direct Detonation	Burst of Fire	Air Burst	Unarmed
N.A.	1-24 26-29 31-46			
Grandparent	2001-2280			
Parent		4001-4280	6001-6280	8001-8280
Child	3001-3280	5001-5280	7001-7280	9001-9280

Parent-Child Relationship	Fire-and-Forget	Short-Time Scanning
	Direct Detonation	Direct Detonation
N.A.	25, 30	77-79
Parent	12001-12280	22001-22280
Child	13001-13280	23001-23280

Table 14. Ammunition Numbering, Triplet Group

Note 1. There are restrictions in using "Short-Time Scanning" child ammo numbers as they also can be used as part of the "Short-Time Scanning" "Burst of Fire Engagement" simulation mechanism.

4.4.3. Grandparent-Parent-Child Relationship

Grandparent and parent ammo numbers may have one or more related child ammo numbers. Child numbers are free to use as for example for national training purposes, but can be evaluated as its grandparent or parent ammo number at multinational training. See the next chapter for more details. All grandparent ammo numbers and all parent ammo numbers shall have a defined lethality and engagement effect in the target simulators.

It is possible to fine tune the vulnerability data or for specific training purposes alter the grandparent or parent ammo vulnerability data using child ammo numbers. Below are described two examples:

Fine tuning example:
You want to make a difference between 20mm AP and 23mm AP ammunitions. You can then define a child ammo number for the 23mm AP. You shall then select the target simulators where you expect that the child ammo number makes a difference and update the vulnerability description in those target simulators.

Training purpose example:
Your training includes an OPFOR and a BLUEFOR both using the same type of anti-tank weapons. It is then possible to for example decrease the lethality for the OPFOR antitank weapons. You can then define child ammo numbers for the OPFOR anti-tank weapons and then select the target simulators where you expect that the child ammo numbers make a difference and update the vulnerability description in those target simulators.

Missing Child Ammo Vulnerability
When a child ammo number is not noted in a target simulator vulnerability description there is always a grandparent or parent ammo number that is used to evaluate the vulnerability for the child ammo number, as they are assumed having similar vulnerability data.

Missing Parent Ammo Vulnerability
When a parent ammo number is not noted in a target simulator vulnerability description there is always a grandparent ammo number that is used to evaluate the vulnerability for the parent ammo number, as they have associated vulnerability data. In case of e.g. Air Burst or Unarmed engagement you usually cannot expect similarities in inherited vulnerability data. It is up to the target simulator application engineer to carefully define the ammo vulnerability data.

The grandparent-parent-child relationship in the Triplet Group can be illustrated as in the below figure.

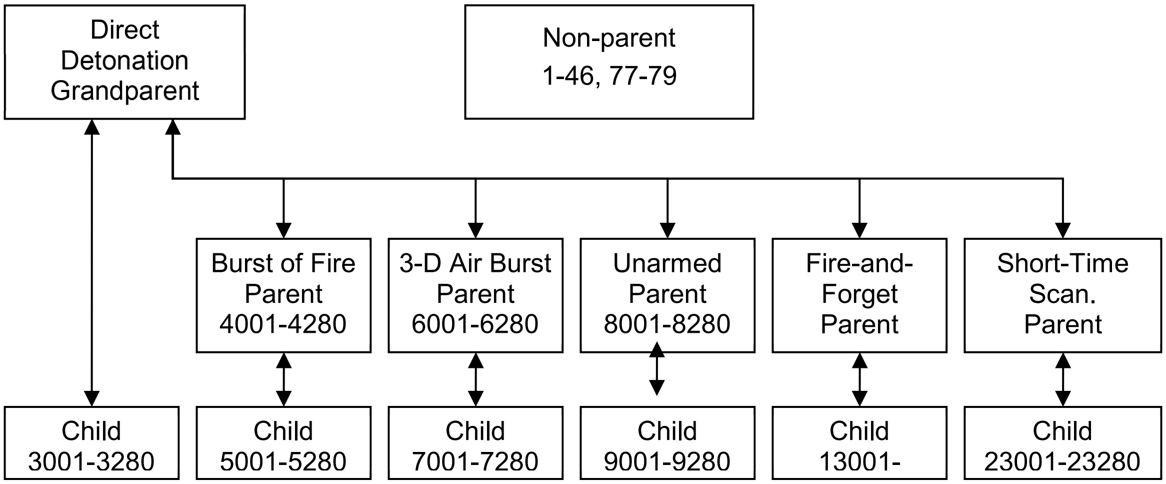

Figure 10. Ammunition Numbering, Grandparent-parent-child Relationship, Triplet Group

The grandparent-child relationship in the "Short-Time Group" can be illustrated as in the below figure.

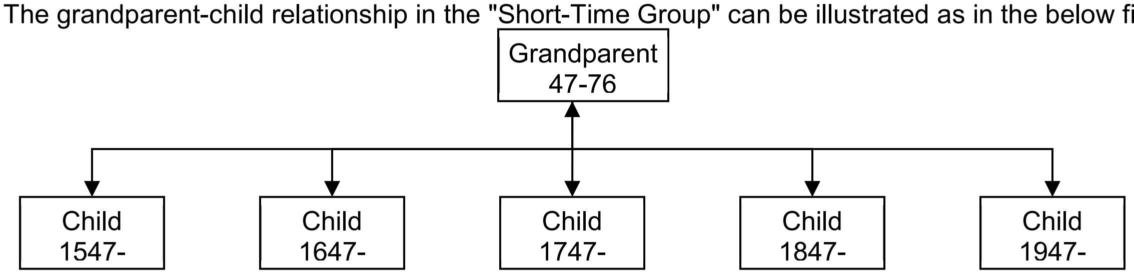

Figure 11. Ammunition Numbering, Grandparent-parent-child Relationship, Short-Time Group

The target simulator decoder and vulnerability functionality handles the grandparent-parent-child relationship as illustrated above.

4.5. Player Identity Numbering Structure

All players on the exercise area shall have a unique "Player Identity" number. The "Player Identity" is normally a permanent number assigned in advance but can in exceptional cases be altered during the exercise. The "Player Identity" number shall be transmitted optically when simulating direct fire.

The player identity numbers are used in two code groups:

- Short-Time Group Coded
- Triplet Group Coded

Observe that the “Short-Time Scanning Code” uses player identities encoded and decoded from both of the above two described groups. However, in both cases the transmission follows the Triplet Group Structure.

4.5.1. Short-Time Group Coded

The "Short-Time Group Coded" player identity codes are typically used by non-scanning transceivers although also scanning transceivers also can use them. The "Short-Time Group Coded" player identity codes include:

- Short-Time Code
- Short-Time Scanning Code
- Umpire Control-Gun Code

Recommendations for the use of "Player Identity" (ID) numbers:

Player ID	Usage
1-16383	Regular Player ID numbers
16384-18000	Spare: Additional future growth Player ID numbers

Table 15. Player ID Numbering, Short-Time Group

4.5.2. Triplet Group Coded

The "Triplet Group Coded" player identity codes are typically used by scanning transceivers although also non-scanning transceivers also can use them. The "Triplet Group Coded" player identity codes include:

- Real-Time Code
- Fire-and-Forget Code
- Short-Time Scanning Code

When the "Player Identity Code" is transmitted alternating, Player ID numbers exceeding 10000 can be used as illustrated in the below table.

Player ID	Use
1-10000	Non-alternating and Alternating Player ID numbers
10001-32767	Additional Alternating Player ID numbers
32768-50000	Spare: Future growth Alternating Player ID numbers

Table 16. Player ID Numbering, Triplet Group

4.6. Engagement Codes

The following optical codes use the laser interface for simulated engagement functions.

- Short-Time Code
- Real-Time Code
- Fire-and-Forget Code
- Short-Time Scanning Code

4.6.1. Short-Time Code

Weapon systems that need to transmit firing data within a short time and/or do not transmit projectile or missile position data may use the "Short-Time Code". Amongst those weapon systems are rifles, guns and sector charged antitank mines. The "Short-Time Code" is also typically used for weapon effects like collateral damage from back blasting weapons, etc.

The "Short-Time Code" does not require a retro-reflection from the target, and as such it is typically referred to as a "one-way" code.

The "Short-Time Code" is identified by the decoder when the ammunition code AC3 is included.

The "Short-Time Code" is built with message item sequences (blocks) in several combinations where the number of encoded message items is I=3 or I=4:

Valid Message Item Sequences (Blocks)	
I=3	I=4
IC4a, AC3, IC5a	IC4a, AC9, AC3, IC5a
IC4b, AC3, IC5a	IC4b, AC9, AC3, IC5a
IC5b, AC3, IC4a	IC5b, AC9, AC3, IC4a
IC5b, AC3, IC4b	IC5b, AC9, AC3, IC4b

Table 17. Short-Time Code, Valid Message Item Sequences

Note that each message item (IC4a, IC4b, IC5a, IC5b, AC9, AC3) in the above table consists of 3-5 message elements.

The following optical codes are used:

- Ammunition Code AC3 and AC9
- Player Identity Code IC4a, IC4b, IC5a and IC5b

4.6.1.1. Additional Code Structure

The simulators using the "Short-Time Code" shall consider the following additional conditions when encoding and decoding pulse intervals:

- The "Short-Time Code" applies only non-alternating pulse intervals
- The "Short-Time Code" transmission rate may replicate the firing rate of the respective weapon.
- The number of different transmitted message items I (IC4a, IC5a, etc., AC3 and AC9) where I is defined as:
- $3 \leq I \leq 4$
- The code is transmitted using a block structure. Each block consists of at least three basic message items (I). Each item consists of a number of elements (E). The basic block consist of player identity and ammunition code and is typically transmitted as for example:
  E*IC4a, E*AC3 and E*IC5a where
  $3 \leq E \leq 5$ (Typically E=5)
  The number of elements (E) is selected depending on the simulated weapon type characteristics. You may want to use as short block transmit time as possible (E=3) when the simulator is using blank ammunition. There might be redundancy aspects to use as many elements as possible (E=5).

Block information example where the number of message items I=3 and number of elements E=3:

Block	Sequence
1	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a

Table 18. Short-Time Code, Block Info Example

Block information example where the number of message items I=4 and number of elements E=3:

Block	Sequence
1	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a

Table 19. Short-Time Code, Block Info Example Including AC9

Block transmission is typically done multiple times. The below table illustrates the timing using an example where three blocks are transmitted and where the number of message items I=3 and number of elements E=3:

Block	I_1			Delay	I_2			Delay	I_3			Delay
B	E_1	E_2	E_3		E_1	E_2	E_3		E_1	E_2	E_3	
1	IC4a	IC4a	IC4a	t1	AC3	AC3	AC3	t1	IC5a	IC5a	IC5a	t2
2	IC4a	IC4a	IC4a	t1	AC3	AC3	AC3	t1	IC5a	IC5a	IC5a	t2
3	IC4a	IC4a	IC4a	t1	AC3	AC3	AC3	t1	IC5a	IC5a	IC5a	t3

Table 20. Short-Time Code, Timing Illustration

The below first definition specification of the transmitted elements E and the time delays t1, t2 and t3 is as follows:

E = 5:t1 = 0 or 1μs < t1 < 300μs; t1 is recommended to be zero, and constant.

0.06ms < t2 < 12ms t1 can change between blocks and inside a block

t3 > 16ms

The above definition shall be regarded as the most typical used and the below second definition can be used in exceptional cases to enhance the encoding performance in time critical situations.

The second definition of the transmitted elements E and the time delays t1, t2 and t3 is as follows:
3 ≤ E ≤ 4 and B ≥ 2:

```
t1 = 0 or 1µs < t1 < 80µs;        t1 is recommended to be zero
t2 = 0 or 1µs < t2 < 80µs;        t2 is recommended to be zero
t3 > 16ms
```

The decoder shall be able to decode sequences from both of the above described definitions of E, t1, t2 and t3.

The time to transmit each element (IC4a, IC4b, AC3, AC9, IC5a and IC5b) is defined as:

```
0.08ms ≤ t4 < 0.16ms
```

A complete transmission containing B blocks (B=3 in the above table example) shall take less than 30ms:

```
B*(t2 + (I-1)*t1 + E*I*t4) + t3 - t2 ≤ 30ms
```

To be compatible with existing sector charged mine simulators, some additional timing rules are added. The added rules are only valid for the sector charged ammunition code. For the sector charged mine, each block can be transmitted up to 12 times within 400ms. The time distance t2 between the blocks then needs to be greater than 0.32ms. All 12 sent blocks within 400ms have the same information and are to be associated with the same round.
Sector charge ammunition code is defined in Reference [2], and the decoder shall interpret the received optical code as a single engagement.

E=5: (12*(t2 + (I-1)*t1 + E*I*t4)) - t2 < 400ms

```
0.32ms < t2 < 12ms;
```

Block sequence example where I=3, E=3, t2=0 and t1=0:

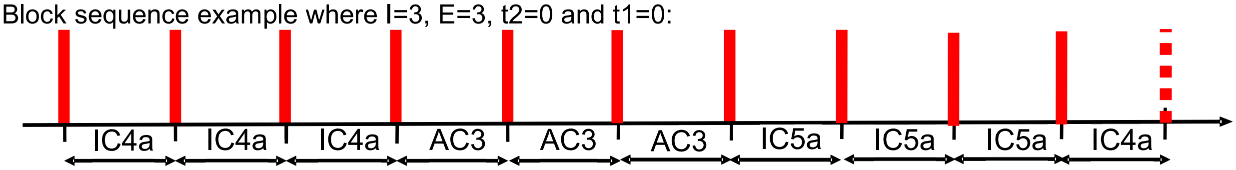

Figure 12. Short-Time Code, Block Sequence 1

Block sequence where t1 is not equal to zero is not recommended but is allowed. Example on part of a block sequence where t1 is not equal to zero and where I=3, E=5:

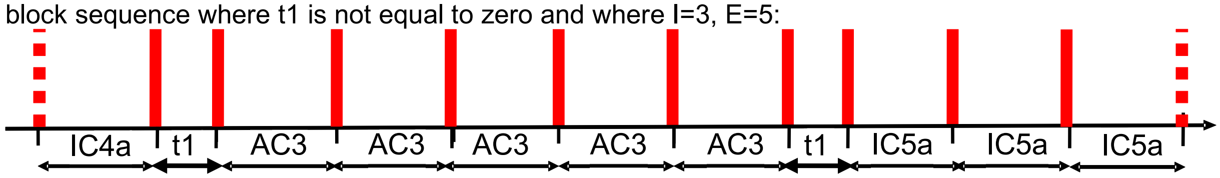

Figure 13. Short-Time Code, Block Sequence 2

Block sequence where t2 is not equal to zero is not recommended but is allowed. Example on part of a block sequence where t2 is not equal to zero and where I=3, E=3 and t1=0:

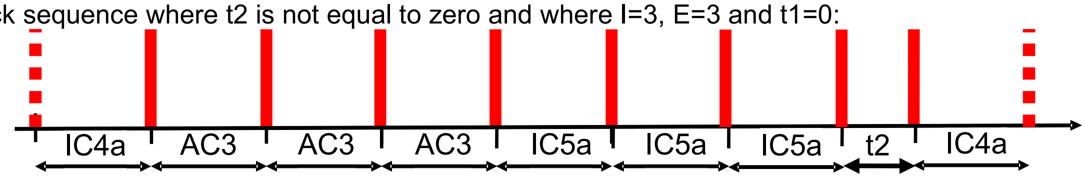

Figure 14. Short-Time Code, Block Sequence 3

4.6.1.2. Ammunition Code

The Ammo Number (AmNo) for the "Short-Time Code" is built from AC3 alone or AC3 followed by AC9. AC9 is used to encode child ammo numbers. You typically transmit ammo numbers as grandparent ammo numbers without using the ammunition code AC9. The ammunition code AC9 is used for transmitting child ammunition numbers.

Example where the number of message items I=3 and number of elements E=3:

Block	Sequence
1	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a
2	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a
3	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a

Table 21. Short-Time Code, Block Transmission Illustration using AC3

There is one Grandparent Ammo Number series. The Ammo Number (AmNo) is encoded and decoded as follows:

Encoding: [AC3 and AmNo are integers]

```
AC9 not transmitted
AC3 = AmNo                    47 ≤ AmNo ≤ 76
PI3 = 1698 + (3*AC3)              47 ≤ AC3  ≤ 67
PI3 = 2105 + (3*AC3)              68 ≤ AC3  ≤ 70
PI3 = 2159 + (3*AC3)              71 ≤ AC3  ≤ 76
```

Decoding: [PI3 is an integer measured in PIU]

```
AC9 transmitted but not received and decoded or
AC9 not transmitted
AC3 = INT((PI3 – 1697) / 3)         1838 ≤ PI3  ≤ 1900
AC3 = INT((PI3 – 2104) / 3)         2308 ≤ PI3  ≤ 2316
AC3 = INT((PI3 – 2158) / 3)         2371 ≤ PI3  ≤ 2388
AmNo = AC3                    47 ≤ AC3  ≤ 76
```

Grandparent ammo number encoding examples:

AmNo	AC3	PI3
47	47	1839
67	67	1899
68	68	2309
76	76	2387

Table 22. Short-Time Code, Grandparent Ammo Number Encoding Examples

When encoding ammunition child codes you shall add AC9 followed by AC3 in the block.
Example where the number of message items I=4 and number of elements E=3:

Block	Sequence
1	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a
2	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a
3	IC4a–IC4a–IC4a – AC9–AC9–AC9 – AC3–AC3–AC3 – IC5a–IC5a–IC5a

Table 23. Short-Time Code, Block Transmission Illustration using AC9 and AC3

There are five Child Ammo Number series. The Ammo Number (AmNo) is encoded and decoded as follows:

Encoding: [AC3, AC9 and AmNo are integers]

```
AC9 = INT((AmNo – 1200) / 100) 1547 ≤ AmNo ≤ 1576
AC9 = INT((AmNo – 1200) / 100) 1647 ≤ AmNo ≤ 1676
AC9 = INT((AmNo – 1200) / 100) 1747 ≤ AmNo ≤ 1776
AC9 = INT((AmNo – 1200) / 100) 1847 ≤ AmNo ≤ 1876
AC9 = INT((AmNo – 1200) / 100) 1947 ≤ AmNo ≤ 1976
PI9 = 1203 + (3*AC9)              3 ≤ AC9  ≤ 7

AC3 = INT((AmNo – 1200) % 100) 1547 ≤ AmNo ≤ 1576
AC3 = INT((AmNo – 1200) % 100) 1647 ≤ AmNo ≤ 1676
AC3 = INT((AmNo – 1200) % 100) 1747 ≤ AmNo ≤ 1776
AC3 = INT((AmNo – 1200) % 100) 1847 ≤ AmNo ≤ 1876
AC3 = INT((AmNo – 1200) % 100) 1947 ≤ AmNo ≤ 1976
PI3 = 1698 + (3*AC3)             47 ≤ AC3  ≤ 67
PI3 = 2105 + (3*AC3)             68 ≤ AC3  ≤ 70
PI3 = 2159 + (3*AC3)             71 ≤ AC3  ≤ 76
```

Decoding: [PI3 and PI9 are integers measured in PIU]

```
AC3 = INT((PI3 – 1697) / 3)          1838 ≤ PI3  ≤ 1900
AC3 = INT((PI3 – 2104) / 3)          2308 ≤ PI3  ≤ 2316
AC3 = INT((PI3 – 2158) / 3)          2371 ≤ PI3  ≤ 2388

AC9 = INT((PI9 - 1202) / 3)          1211 ≤ PI9  ≤ 1225
AmNo = 1200 + (AC9*100) + AC3     47 ≤ AC3  ≤ 76
                              3 ≤ AC9  ≤ 7
```

Child ammo number encoding examples:

AmNo	AC3	AC9	PI3	PI9
1547	47	3	1839	1212
1567	67	3	1899	1212
1668	68	4	2309	1215
1976	76	7	2387	1224

Table 24. Short-Time Code, Child Ammo Number Encoding Examples

The total numbers of available "Short-Time Code" ammo numbers are then:

```
30*6 = 180
```

or 30 Grandparent Ammo Numbers and 5*30=150 Child Ammo Numbers

The Ammunition Table of Reference [2] defines the "Short-Time Code" "Near Miss" ammo numbers. To enhance the decoder capability to identify sequences of "Hit" and "Near Miss" blocks, knowledge about "Near Miss" ammo numbers is useful. The following ammo numbers are "Short-Time Code" "Near Miss" ammo numbers:

	Ammo Numbers
Grandparent	57, 59, 65
Child 1	1557, 1559, 1565
Child 2	1657, 1659, 1665
Child 3	1757, 1759, 1765
Child 4	1857, 1859, 1865
Child 5	1957, 1959, 1965

Table 25. Short-Time Code, Near Miss Ammo Numbers

4.6.1.3. Player Identity Code

Each player has a unique player identity number. The player identity number for players using the "Short-Time Code" is encoded and decoded as described below.

Recommendations for the use of "Player Identity" (ID) numbers:

Player ID	**Usage**
1-16383	Regular Player ID numbers

Table 26. Short-Time Code, Player ID Numbering, Regular

The following "Player Identity" (ID) numbers are reserved for future growth.

Player ID	**Usage**
16384-18000	Spare: Additional future growth Player ID numbers

Table 27. Short-Time Code, Player ID Numbering, Future Growth

The use of IC4a, IC4b, IC5a and IC5b can be illustrated as below:

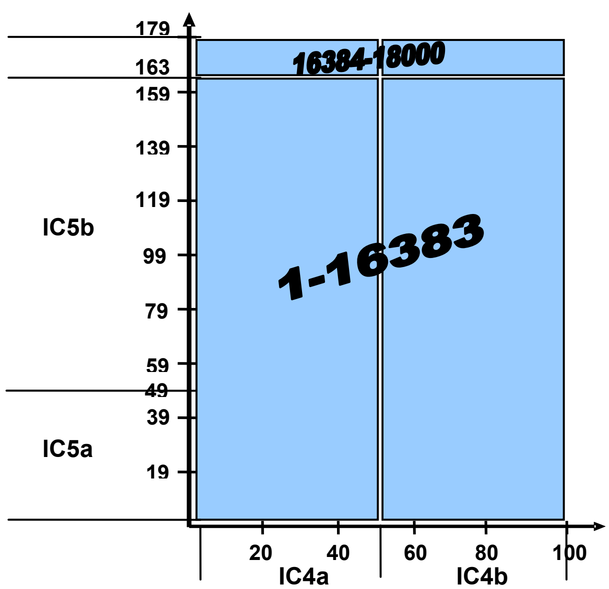

Figure 15. Short-Time Code, Player Identity Code IC4a, IC4b, IC5a and IC5b usage

Block transmission is done in two different ways depending on if IC5a or IC5b is transmitted.

- IC5a is transmitted last in block
- IC5b is transmitted first in block

Block transmission is typically done multiple times.

The below table illustrates an example where three blocks using IC5a are transmitted and where the number of message items I=3 and number of elements E=3:

Block	Sequence
1	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a
2	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a
3	IC4a–IC4a–IC4a – AC3–AC3–AC3 – IC5a–IC5a–IC5a

Table 28. Short-Time Code, Block Transmission Illustration using IC5a

The below table illustrates an example where three blocks using IC5b are transmitted and where the number of message items I=3 and number of elements E=3:

Block	Sequence
1	IC5b–IC5b–IC5b – AC3–AC3–AC3 – IC4a–IC4a–IC4a
2	IC5b–IC5b–IC5b – AC3–AC3–AC3 – IC4a–IC4a–IC4a
3	IC5b–IC5b–IC5b – AC3–AC3–AC3 – IC4a–IC4a–IC4a

Table 29. Short-Time Code, Block Transmission Illustration using IC5b

IC4 represents both IC4a and IC4b and
IC5 represents both IC5a and IC4b in the below formulas.
The "Player Identity Number" (IdNo) is encoded and decoded as follows:

```
Encoding:                          [IdNo, IC4a, IC4b, IC5a and IC5b are integers]
     IC5 =     INT((IdNo-1)/100)           1 ≤ IdNo ≤ 16383(18000 future growth)
     IC4 = 1 + INT((IdNo-1)%100)           1 ≤ IdNo ≤ 16383(18000 future growth)
     PI4 = 1248 + (3*IC4a)              1 ≤ IC4a ≤  50
     PI4 = 1398 + (3*IC4b)             51 ≤ IC4b ≤ 100
     PI5 = 1401 + (3*IC5a)              0 ≤ IC5a ≤  49
     PI5 = 1760 + (3*IC5b)             50 ≤ IC5b ≤ 163(179 future growth)
Decoding:                          [PI4 and PI5 are integers measured in PIU]
     IC4a = INT((PI4 - 1247) / 3)    1250 ≤ PI4 ≤ 1399
     IC4b = INT((PI4 - 1397) / 3)    1550 ≤ PI4 ≤ 1699
     IC5a = INT((PI5 - 1400) / 3)    1400 ≤ PI5 ≤ 1549
     IC5b = INT((PI5 - 1759) / 3)    1909 ≤ PI5 ≤ 2298
     IdNo = IC4 + (100*IC5)                1 ≤ IC4 ≤ 100, 0 ≤ IC5 ≤ 179
```

Encoding examples:

IdNo	IC4	IC5	PI4	PI5
1	1	0	1251	1401
202	2	2	1254	1407
10000	100	99	1698	2057
16383	83	163	1647	2249

Table 30. Short-Time Code, Player ID Encoding Examples

4.6.2. Real-Time Code

Simulators using "Real-Time Code" transmits typically an accurate projectile or missile position, ammunition code and player identity code to a single target simulator or to nearby standing multiple target simulators, when the simulated projectile or missile passes (real-time) the target simulator(s).

The "Real-Time Code" does typically involve reception of retro reflection from the target, and as such it is referred to as a "two-way" code.

The "Real-Time" "Ammunition Code" AC1 or AC11 alternating with AC21 can be used by the target simulators to identify that the simulation is of "Real-Time" type. There are two types of "Real-Time Code"

- Non-alternating AC1 is used
- Alternating AC11 alternating with AC21is used

The following non-alternating optical codes are used:

- Ammunition Code AC1
- Player Identity Code IC1, IC2, IC3
- Projectile or Missile Position Code PC1, PC2
- Null Code NC1, NC2 , NC3

The following alternating optical codes are used:

- Ammunition Code AC11, AC21
- Player Identity Code IC11, IC12, IC21, IC22
- Projectile or Missile Position Code PC1, PC2
- Distance Lethality Code EI11, DI11
- Cant Angle CA21

Messages transmitted by using a "Real-Time Code" consist of three message items building a triplet. The chapter "4.3.3.2 Triplet Group Structure" specifies the triplet encoding and decoding.

4.6.2.1. Additional Code Structure

The following additional conditions are valid for the "Real-Time" optical code type.

The Target Simulator shall use the following additional conditions to decode pulse intervals as valid pulse intervals:

- The pulse interval decoder shall, as previously described, decode continuously changing, non-alternating as well as alternating pulse intervals.
- When more than one detector at the same time (< 2ms) is receiving, then it is allowed to decode at the detector receiving the most number of position triplets.
- The position triplet can only be transmitted in the following order of occurrences:
  - `PC1–AC1-PC2 or PC2–AC1-PC1`
  - `PC1–XXX-PC2 or PC2–XXX-PC1 XXX` is an alternating pair item
- The player identity triplet can only be transmitted in the following order of occurrences:
  - `IC1-IC2-IC3 or IC3-IC2–IC1`
  - `ICa1-YYY–ICa3 or ICa3-YYY–ICa1` YYY is an alternating pair item

    ICa1 is IC11 alternating with IC21

    ICa3 is IC12 alternating with IC22
- Sometimes as for example in multiple target situations, the fire simulator may transmit a triplet consisting of a combination of info from a position triplet and info from an identity triplet. Such a triplet shall then be ignored by the pulse interval decoder if it cannot identify triplet information from all three message items. Ignored combined info triplet examples:
  - `PC1-AC1–IC3 or IC1-AC1–PC3`
  - `PC1-XXX–ICa3 or ICa1-XXX–PC3`
- The position triplet and the identity triplet can consecutively be transmitted multiple times to a single detector.
- The player identity triplet(s) shall be transmitted following the position triplet(s), when representing a single projectile or missile position.
- The time to transmit three triplets shall not exceed 200ms; otherwise they are interpreted as belonging to multiple target engagements.
- Triplet sequences representing multiple engagements are identified as defined in chapter "4.6.2.8 Burst of Fire Simulation".
- When any of the three message items in a triplet is missing, the triplet is not decoded.
- The time between receiving message items 1-2 and 2-3 within a triplet has to be symmetric within a tolerance of ±5ms. The meaning of 1-2 and 2-3 message items in this sense are:
  - `PC1-AC1 and AC1-PC2` — `AC1` is a non-alternating ammunition code item
  - `PC1-XXX and XXX-PC2` — XXX is an alternating pair item
  - `IC1-IC2 and IC2-IC3`
  - `ICa1-YYY and YYY-ICa3` — YYY is an alternating pair ammunition code item

    ICa1 is IC11 alternating with IC21

    ICa3 is IC12 alternating with IC22

Projectile or missile simulation is done transmitting 2- to 6-fold triplets. Below is an example of two 4-fold message item triplets.

Triplet	Pass 1	Delay	Pass 2	Delay	Pass 3	Delay
1	PC1	t1	AC1	t1	PC2	t2a
2	PC2	t1	AC1	t1	PC1	t2b
3	IC1	t1	IC2	t1	IC3	t2a
4	IC3	t1	IC2	t1	IC1	
1	PC2	t1	AC1	t1	PC1	t2b
2	PC1	t1	AC1	t1	PC2	t2a
3	IC3	t1	IC2	t1	IC1	t2b
4	IC1	t1	IC2	t1	IC3	

Table 31. Real-Time Code, Timing Illustration

Note that each message item (PC1, PC2, IC1, IC2 and IC3) in the above table consists of several (typical eight) message elements.

The length of the decoded time intervals t1, t2a and t2b from the above table:

```
t1  < 30ms   t1 shall be symmetric within a tolerance of ±5ms
t2a < 100ms
t2b < 100ms
```

Two triplets (when followed by at least one triplet) take:

```
4*t1 + t2a + t2b + 2*Pass1 + 2*Pass2 + 2*Pass3 = 120ms ± 10ms
```

As previously described projectile simulation is done using 2- to 6-fold triplets. The fire simulator typically selects between using 2-fold or 4 -fold triplets. Position triplets are transmitted consecutively first, followed by consecutive identity triplets. The number of consecutive position or identity triplets cannot be more than four. The target simulator has to be able to decode 2- to 6-fold triplets, representing a single projectile or missile, as for example for the following reasons:

- The 5 and 6-fold triplets are allowed to be transmitted during exceptional conditions as e.g. for low velocity projectile or missile.
- The 4-fold triplet is used during most normal fire simulations.
- The 3 and 2-fold triplet is used during exceptional fire simulation conditions like high rate burst of fire simulation.

When the pulse interval decoder has received a sequence of triplets, it shall associate the preceding position triplets with identity triplets as belonging to the same round.

See chapter "4.6.2.8 Burst of Fire Simulation" for more info concerning burst of fire simulation.

4.6.2.2. Ammunition Code

The "Real-Time Code" ammo number is encoded and decoded in two ways:

- Non-alternating using AC1
- Alternating using AC11 and AC21

4.6.2.2.1. Non-alternating

You can transmit an ammunition code using non-alternating code.
A laser transmitter typically transmits eight message items when transmitting the "Real-Time Code".

```
AC1 - AC1 - AC1 - AC1 - AC1 - AC1 – AC1 – AC1
```

The ammo number (AmNo) is encoded and decoded as follows:

Encoding: [AmNo and AC1 are integers]

```
AC1 = AmNo                    1 ≤ AmNo ≤ 46
PI1 = 1698 + (3*AC1)
```

Decoding: [PI1 is an integer measured in PIU]

```
AC1 = INT((PI1 – 1697) / 3)          1700 ≤ PI1 ≤ 1837
AmNo = AC1                    1 ≤ AC1 ≤ 46
```

AmNo 25 and 30 are excluded and used for "Fire-and-Forget" simulation

Ammo number encoding examples:

AmNo	AC1	PI1
1	1	1701
2	2	1704
46	46	1836

Table 32. Real-Time Code, Non-alternating Ammo Number Encoding Examples

4.6.2.2.2. Alternating

You can also transmit an "Ammunition Code" using alternating codes AC11 and AC21. A simulator using "Real-Time Code" is typically transmitting four pairs of ammunition code to the target:

```
AC11 – AC21 – AC11 – AC21 – AC11 – AC21 – AC11 – AC21
```

There are grandparent, parent and child Ammo Number (AmNo) series. The ammo numbering depends on three flags (FlgNo) set in "Engagement Info" (EI11) or "Detonation Info" (DI11) as illustrated with the below table.

	Direct Detonation	Burst of Fire	Air Burst	Unarmed
FlgNo	2	4	6	8
Grandparent	2001-2280			
Parent		4001-4280	6001-6280	8001-8280
Child	3001-3280	5001-5280	7001-7280	9001-9280

Table 33. Real-Time Code, Alternating Ammo Numbers

The Ammo Number (AmNo) is encoded and decoded as follows:

Grandparent or Parent Ammo Number: [PI11 and PI21 are integers measured in PIU]

Encoding: [AC11, AC21, AmNo, AmLsd and FlgNo are integers]

```
FlgNo  = INT(AmNo / 1000)
AmLsd = 2000 + INT(AmNo % 1000)
AC11  = 1 + INT((AmLsd – 2001) % 10)  2001 ≤ AmLsd ≤ 2280
AC21  = 1 + INT((AmLsd – 2001) / 10)  2001 ≤ AmLsd ≤ 2280
PI11  = 1203 + (3*AC11)        1 ≤ AC11 ≤ 10
PI21  = 1266 + (3*AC21)        1 ≤ AC21 ≤ 28
```

Decoding:

```
AC11 = INT((PI11 – 1202) / 3)  1205 ≤ PI11 ≤ 1234
AC21 = INT((PI21 - 1265) / 3)  1268 ≤ PI21 ≤ 1351
AmNo = (FlgNo*1000)+((AC21-1)*10)+AC11     1 ≤ AC11 ≤ 10, 1 ≤ AC21 ≤ 28
```

Grandparent and parent ammo number encoding examples:

AmNo	FlgNo	AC11	AC21	PI11	PI21
2001	2	1	1	1206	1269
2010	2	10	1	1233	1269
2032	2	2	4	1209	1278
4280	4	10	28	1233	1350

Table 34. Real-Time Code, Alternating Grandparent/Parent Ammo Number Encoding Examples

Child Ammo Number:

Encoding: [AmNo, AmLsd and FlgNo are integers]

```
FlgNo  = (INT(AmNo / 1000)) - 1
AmLsd = 2000 + INT(AmNo % 1000)
AC11  = 11 + INT((AmLsd – 2001) % 10)      2001 ≤ AmLsd ≤ 2280
AC21  =  1 + INT((AmLsd – 2001) / 10) 2001 ≤ AmLsd ≤ 2280
PI11  = 1203 + (3*AC11)        11 ≤ AC11 ≤ 20
PI21  = 1266 + (3*AC21)         1 ≤ AC21 ≤ 28
```

Decoding: [FlgNo, AC21 and AC11 are integers]

```
AC11 = INT((PI11 – 1202) / 3)  1235 ≤ PI11 ≤ 1264
AC21 = INT((PI21 - 1265) / 3)  1268 ≤ PI21 ≤ 1351
AmNo =((FlgNo+1)*1000)+((AC21-1)*10)+(AC11–10);
                   11 ≤ AC11 ≤ 20, 1 ≤ AC21 ≤ 28
```

Child ammo number encoding examples:

AmNo	FlgNo	AC11	AC21	PI11	PI21
3001	2	11	1	1236	1269
3010	2	20	1	1263	1269
3032	2	12	4	1239	1278
5280	4	20	28	1263	1350

Table 35. Real-Time Code, Alternating Child Ammo Number Encoding Examples

4.6.2.3. Player Identity Code

Each player has a unique player identity number. The player identity number for players using "Real-Time Code" is encoded and decoded as described below.

The "Player Identity Code" is transmitted in two different ways

- Non-alternating "Player Identity" using IC1, IC2 and IC3.
- Alternating "Player Identity" using IC11 alternating with IC21 and IC12 alternating with IC22

When the "Player Identity Code" is transmitted alternating, Player ID numbers exceeding 10000 can be used as illustrated in the below table.

Player ID	Use
1-10000	Non-alternating and Alternating Player ID numbers
10001-32767	Additional Alternating Player ID numbers

Table 36. Player ID Numbering, Regular

The following "Player Identity" (ID) numbers are reserved for future growth..

Player ID	Use
32768-50000	Spare: Future growth Alternating Player ID numbers

Table 37. Player ID Numbering, Future Growth

In the below encoding and decoding formulas the maximum Player ID number equal to 32767 and for future growth (50000) is used.

4.6.2.3.1. Non-alternating Player Identity

Non-alternating "Player Identity Code" transmission sequence is illustrated below:

Triplet	Pass 1	Pass 2	Pass 3
N	IC1	IC2	IC3
N + 1	IC3	IC2	IC1

Table 38. Real-Time Code, Non-alternating Player Identity Triplets Sequence Illustration

Note that each message item (IC1, IC2 and IC3) in the above table consists of several message elements.

The "Player Identity Code" is being transmitted in the order IC1 - IC2 - IC3 or IC3 - IC2 - IC1

The "Player Identity Number" (IdNo) is encoded and decoded as follows:

```
Encoding:                          [IC1, IC2, IC3 and IdNo are integers]
     IC3 =       INT((IdNo-1)/400)       1 ≤ IdNo ≤ 10000
     IC2 =   INT(INT((IdNo-1)%400)/20)         1 ≤ IdNo ≤ 10000
     IC1 = 1+INT(INT((IdNo-1)%400)%20)         1 ≤ IdNo ≤ 10000
     PI1 = 1503 + (3*IC1)                1 ≤ IC1  ≤ 20
     PI2 = 1566 + (3*IC2)                0 ≤ IC2  ≤ 19
     PI3 = 1626 + (3*IC3)                0 ≤ IC3  ≤ 24
Decoding:                          [PI1, PI2, and PI3 are integers measured in PIU]
     IC1 = INT((PI1 - 1502) / 3)            1505 ≤ PI1  ≤ 1564
     IC2 = INT((PI2 - 1565) / 3)            1565 ≤ PI2  ≤ 1624
     IC3 = INT((PI3 - 1625) / 3)            1625 ≤ PI3  ≤ 1699
     IdNo= IC1+(20*IC2)+(400*IC3)    1 ≤ IC1 ≤ 20, 0 ≤ IC2 ≤ 19,
                        0 ≤ IC3 ≤ 24
```

Encoding examples:

IdNo	IC1	IC2	IC3	PI1	PI2	PI3
1	1	0	0	1506	1566	1626
21	1	1	0	1506	1569	1626
421	1	1	1	1506	1569	1629
10000	20	19	24	1563	1623	1698

Table 39. Real-Time Code, Non-alternating Player ID Encoding Examples

4.6.2.3.2. Alternating Player Identity

Alternating "Player Identity Code" transmission sequence is illustrated below:

Triplet	Pass 1	Pass 2	Pass 3
N	ICa3	XXX	ICa1
N+1	ICa1	XXX	ICa3

Table 40. Real-Time Code, Alternating Player Identity Triplets Sequence Illustration

Note that each message item (ICa1 and ICa3) in the above table consists of several message element alternating pairs.

Item Acronym	Message Item Description
ICa1	Message items IC11 alternating with IC21
ICa3	Message items IC12 alternating with IC22
XXX	Other alternating item pairs

Table 41. Real-Time Code, Alternating Message Item Description

The "Player Identity Code" is being transmitted in the order: ICa1 - YYY – ICa3 or ICa3 - YYY – ICa1

The "Player Identity Number" (IdNo) is encoded and decoded as follows:

```
Encoding:                    [IC11, IC21, IC12, IC21 and IdNo are integers]
     IC22 =       INT((IdNo-1)/5000)    1 ≤ IdNo ≤ 32767(50000)
     IC12 =   INT(INT((IdNo-1)%5000)/200)     1 ≤ IdNo ≤ 32767(50000)
     IC21 =   INT(INT((IdNo-1)%5000)%200)/20   1 ≤ IdNo ≤ 32767(50000)
     IC11 = 1+INT(INT((IdNo-1)%5000)%200)%20   1 ≤ IdNo ≤ 32767(50000)
     PI11 = 1503 + (3*IC11)           1 ≤ IC11 ≤ 20
     PI21 = 1236 + (3*IC21)           0 ≤ IC21 ≤ 9
     PI12 = 1626 + (3*IC12)           0 ≤ IC12 ≤ 24
     PI22 = 1206 + (3*IC22)           0 ≤ IC22 ≤ 6(9)
Decoding:                    [PI11, PI21, PI12 and PI22 are integers measured in PIU]
     IC11 = INT((PI11 - 1502) / 3)  1505 ≤ PI11 ≤ 1564
     IC21 = INT((PI21 - 1235) / 3)  1235 ≤ PI21 ≤ 1264
     IC12 = INT((PI12 - 1625) / 3)  1625 ≤ PI12 ≤ 1699
     IC22 = INT((PI22 - 1205) / 3)  1205 ≤ PI22 ≤ 1225(1234)
     IdNo = (IC11+(IC21*20)) + ((IC12+(IC22*25))*200)
                         1 ≤ IC11 ≤ 20, 0 ≤ IC21 ≤ 9
                         0 ≤ IC12 ≤ 24, 0 ≤ IC22 ≤ 6(9)
```

Encoding examples:

IdNo	IC11	IC21	IC12	IC22	PI11	PI21	PI12	PI22
1	1	0	0	0	1506	1236	1626	1206
20	20	0	0	0	1563	1236	1626	1206
21	1	1	0	0	1506	1239	1626	1206
200	20	9	0	0	1563	1263	1626	1206
201	1	0	1	0	1506	1236	1629	1206
5001	1	0	0	1	1506	1236	1626	1209
32767	7	8	13	6	1524	1260	1665	1224
50000	20	9	24	9	1563	1263	1698	1233

Table 42. Real-Time Code, Alternating Player ID Encoding Examples

4.6.2.4. Position Code

The "Position Code" representing the projectile or missile position is transmitted to the target simulators using two codes:

- Position Code 1 (PC1) for vector 1 is positive pointing to the lower right.
- Position Code 2 (PC2) for vector 2 is positive pointing to the lower left.

It may seem unnecessary to think about how to encode using a resolution better than 0.1m as the optical encoding does not have a resolution better than 0.1m. Several position values are transmitted and the receiver calculates an average value resulting in a received position resolution possibly better than 0.1m..

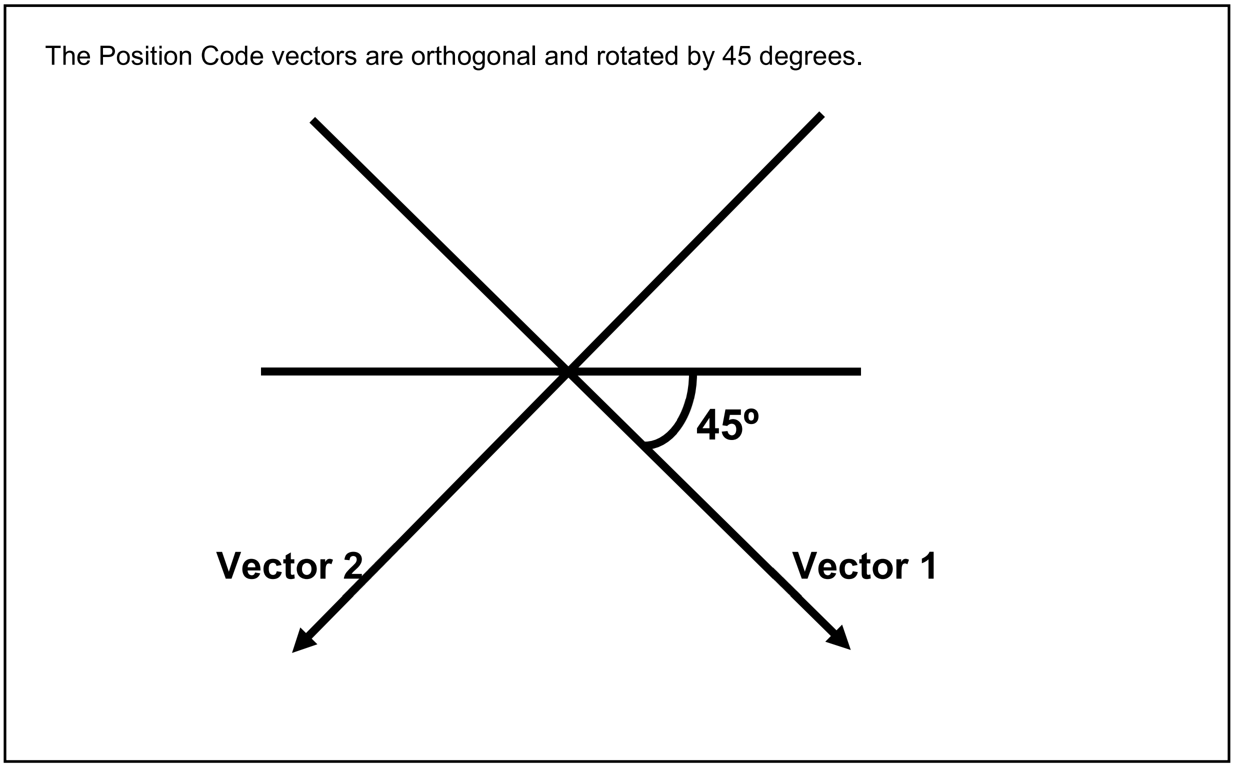

Figure 16. Real-Time Code, Position Code Vectors

The relationship between the position value, position resolution and pulse intervals are shown in the diagrams below.

The position value in the diagrams represents the projectile position relative to the target detector.

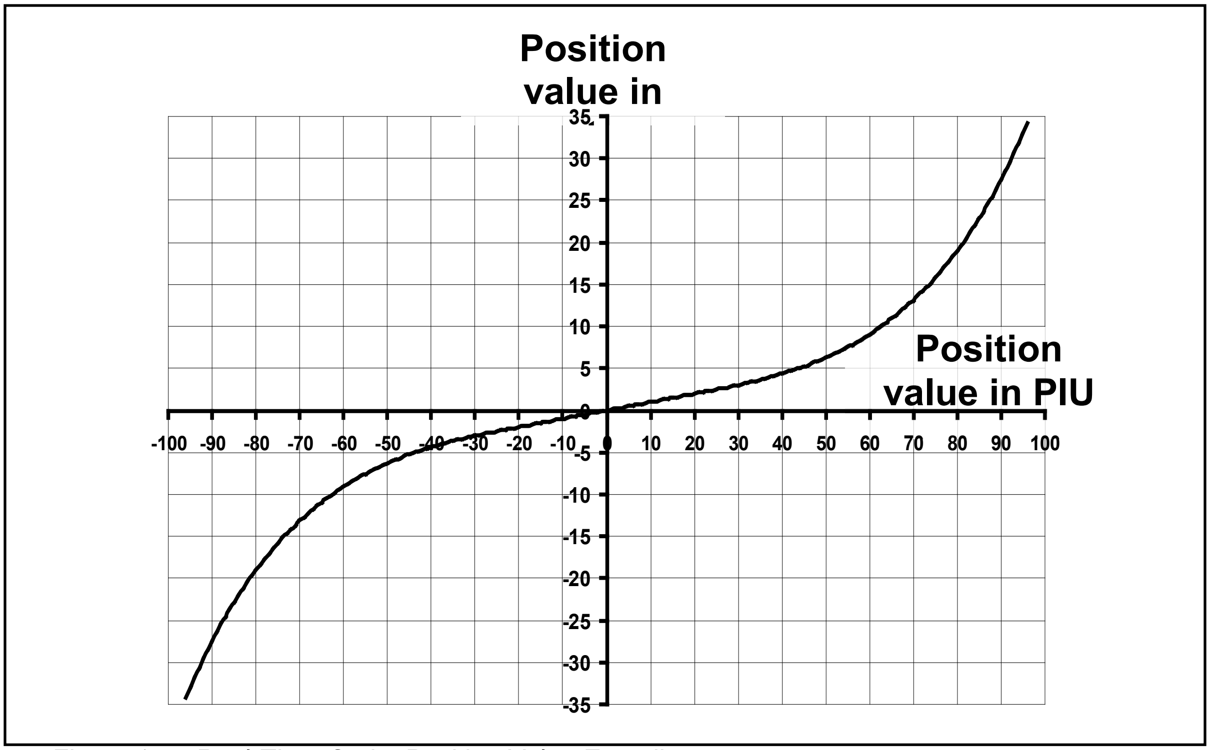

Figure 17. Real-Time Code, Position Value Encoding

The position resolution 0.1m changes for coordinates greater than 2.7 meter from the impact point centre.

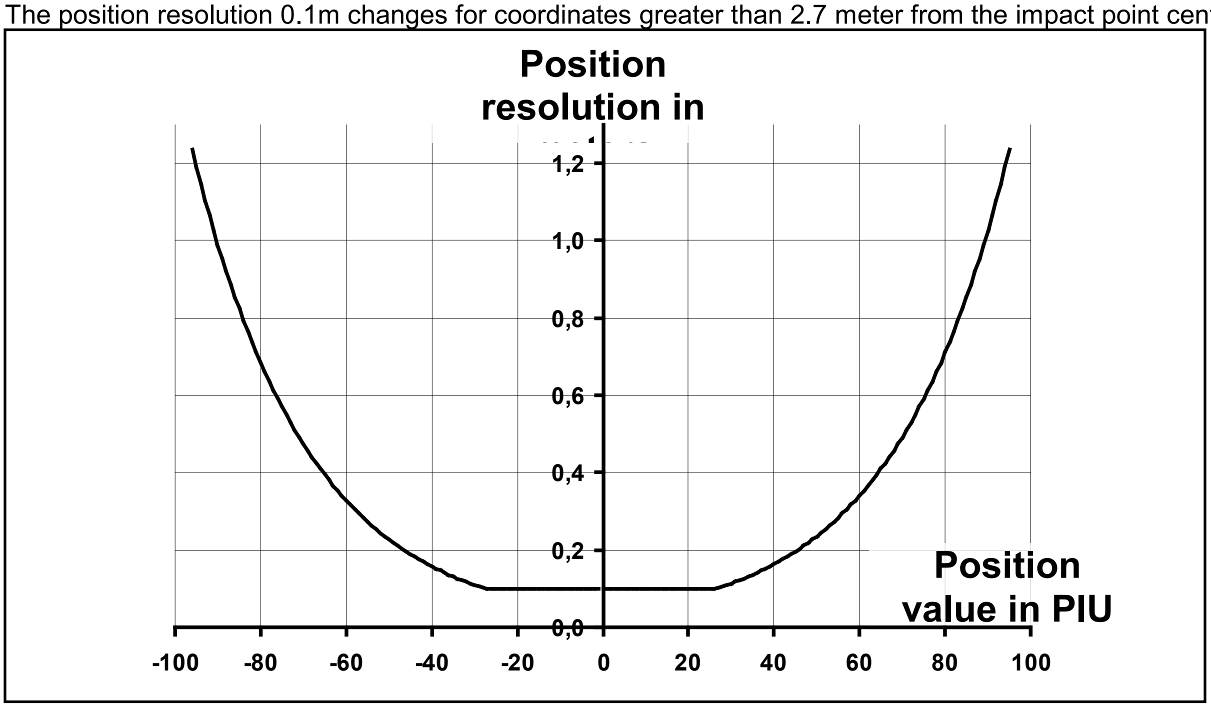

Figure 18. Real-Time Code, Position Value Resolution

The "Position Code" 1 (PC1) is decoded in the range 1911-2105 PIU whereas zero is positioned at 2008 PIU.
The "Position Code" 2 (PC2) is decoded in the range 2107-2301 PIU whereas zero is positioned at 2204 PIU.
The position is encoded from the firing simulator's perspective in relation to the pulse receiving reference module. The encoded position vectors PC1 and PC2 have allowed values between ± 96 PIU thus resulting in decoding values between ± 97 PIU.

PC represents both PC1 and PC2 in the below formulas.
X represents both X1 and X2 in the below formulas.

The decoding of the vector X1 and X2 in meters from PC1 and PC2 is based on the following formulas:
Decoding:

```
PC = 2008-PI1      [PC, PI2 and PI1 are integers measured in PIU]
PC = 2204-PI2
X  = -e^(-PC / 10*e)        -97 ≤ PC < -27
X  =  PC*0,1                -27 ≤ PC ≤  27
X  =  e^( PC / 10*e)         27 < PC ≤  97
```

Observe that the target simulator usually is receiving and decoding multiple X values when a scanning fire simulator is engaging. The final X value is then calculated as the average value of the decoded X values.

The encoding of PI1 and PI2 from the vector length X1 and X2 in meters is based on the following formulas:
Encoding: [X is a decimal value measured in meters]

```
PC  = -10*e*ln(-X))          -34,8 ≤ X < -2,7
PC  =  10*X                  -2,7 ≤ X ≤  2,7
PC  =  10*e*ln(X)             2,7 < X ≤  34,8
PI1 = 2008-PC
PI2 = 2204-PC
```

Embedded computers do not usually include logarithmic formulas or if they do they might be time consuming. A way to solve that problem is to encode and decode using tables. See Appendix C and D at the end of this document for examples on position decoding and encoding tables.

To the above basic encoding formulas is added conventional rounding mathematics:

```
INT(((10*value)+ 5)/10)
```

The resulting encoding of PI1 and PI2 from the vector length X1 and X2 in meters is then written as follows:
Encoding: [X is a decimal value measured in meters]

```
PC  = -INT(((100*e*ln(-X))+5)/10)     -34,8 ≤ X < -2,7
PC  =  INT(((100*X)+5)/10)             -2,7 ≤ X ≤  2,7
PC  =  INT(((100*e*ln( X))+5)/10)       2,7 < X ≤  34,8
PI1 = 2008-PC
PI2 = 2204-PC
```


4.6.2.5. Null Code

The "Null Codes" are codes that do not contain any information to be processed by the targets other than they are "Null Codes". They are only used by the fire simulator for measuring purposes when searching for targets. The "Null Codes" are the most frequent transmitted codes and have to be identified and rejected by the targets when the encoding is done.

The "Null Codes" are defined and encoded and decoded as follows:

Description	Acronym	Encoded	Decoded	
		PIU	Low PIU	High PIU
Null Code 1	NC1	2304	2302	2306
Null Code 2	NC2	1904	1902	1906
Null Code 3	NC3	2320	2318	2322

Table 43. Real-Time Code, Null Code Encoding and Decoding

"Null Codes" may coincide (overlap) in time with other types of codes as e.g. multiple fire simulators may simultaneously engage the same target simulator at the training field. The target simulator must consequently have the ability to reject Null Codes coinciding with codes and at the same time decoding such codes.

4.6.2.6. Distance Lethality Code

The "Distance Lethality Code" is used to enhance the lethality description in the ammunition code sent to target simulators. The "Distance Lethality Code" is then typically transmitted alternating with "Cant Angle Code" (CA21) in a triplet together with the Projectile Position.

The "Distance Lethality Code" is built up by two main components that contain sub components or sub functions:

- Engagement Info Code (EI11)
  - Engagement distance. Distance between the fire simulator and the target simulator.
  - Burst of Fire (multiple projectiles)
- Detonation Info Code (DI11)
  - Detonation distance. Distance between the ammo detonation and the target simulator.
  - Burst of Fire (multiple projectiles)
  - Unarmed

Examples on when and how EI11 and/or DI11 are transmitted:

- When simulating AP type of ammunitions, the "Engagement Info Code" (EI11) encoding engagement distance is typically transmitted alternating with "Cant Angle Code" (CA21).
- When simulating the air burst type of ammunitions, you must transmit "Detonation Distance" in the "Detonation Info" (DI11) to indicate air burst detonation to the target simulator.
- When simulating "Unarmed" ammunition hitting a target, the "Detonation Info Code" (DI11) encoding "Unarmed" engagement is typically transmitted alternating with "Engagement Distance" in (EI11).

Detonation characteristics not handled by the "Distance Lethality Code" is described by the actual ammo number. Such detonation characteristic is for example:

- Delayed Detonation.
  - The simulated warhead is detonating a short time after impact. The ammunition may for example detonate using a Point-Detonation fuse with delay. Compared to the direct at impact detonation the lethality behind the wall or inside the vehicle is considerably increased.
- Proximity Fuze.
  - The simulated warhead is detonating close to the target. The ammunition may detonate using for example short range radar to measure the target distance. Compared to air burst time fuzed detonation for large calibre High Explosive ammo (≥90mm) the lethality for e.g. 40mm proximity fuzed ammo may need different target vulnerability considerations.

The situations the fire simulator can identify and inform the target simulators about are illustrated in the below figure.

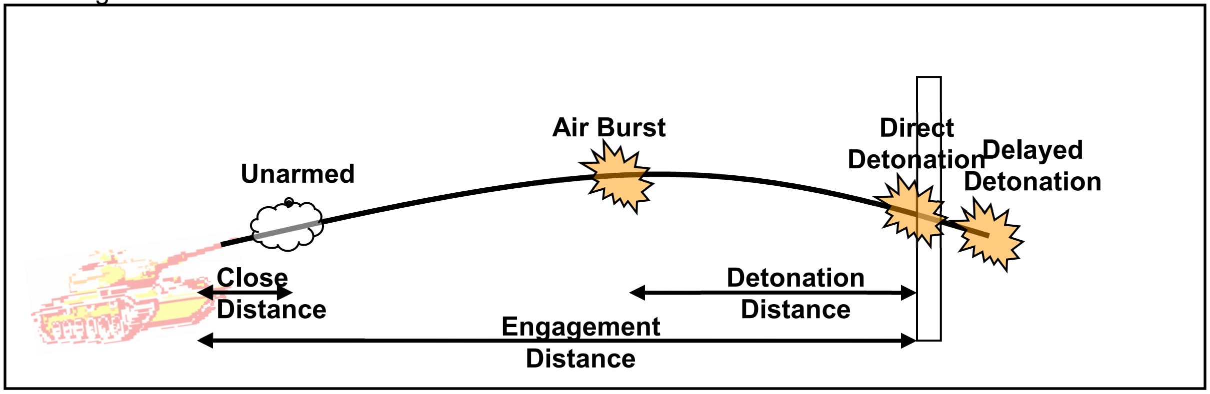

Figure 19. Real-Time Code, Distance Lethality Code Info Illustration

How the fire simulator can inform the target simulators about more details in the engagement using DI11, EI11 and CA21 is described in the following table:

Flag Number FlgNo		Flag Description	Typical Alternating Pair	Significant Distance Lethality Code Usage	"Distance Lethality Code" Description
Real-Time	F-and-F				
2	12	Direct Detonation	EI11/CA21	EI11 Engagement Distance	The distance between the fire simulator and the target.
4	N.A.	Burst of Fire	EI11/DI11	DI11 Burst of Fire	The transmitted projectile position comprises a lethality corresponding to more than one projectile.
6	N.A.	Air Burst	DI11/EI11 DI11/CA21	DI11 Detonation Distance	The warhead is detonating in the air. The distance between the ammo detonation and the target transmitted. Note 1 and 2
8	N.A.	Unarmed	EI11/DI11	DI11 Unarmed	Hitting without detonating. Note 3

Table 44. Real-Time Code, Distance Lethality Codes Details

Note 1. Air burst detonation simulation is indicated by the fire simulator by transmitting "Detonation Distance" in the "Detonation Info" (DI11). Air burst detonation can be simulated for e.g. time fuzed or proximity fuzed type of ammo. Before the detonation the fire simulator can simulate how the projectile passes targets by transmitting an alternating pair not containing "Detonation Distance" as for example "Engagement Distance" and "Cant Angle". The target system shall be able resolve such an engagement simulation and not decode it as a double engagement situation.
Note 2. The lethality of e.g. the Air Burst Munition Kinetic Energy Time Fuze (ABM-KETF) type of ammo depends on both detonation distance and the engagement distance.
Note 3. When for example a missile, is engaging a target before the missile is armed, the missile warhead is usually not detonating and its lethality is considerably reduced. The "Unarmed" flag is set in DI11 and is then typically transmitted alternating with the "Engagement Distance" in EI11.

When transmitting info the fire simulator must select to transmit an alternating pair of "Engagement Info", "Detonation Info" or "Cant Angle". Examples on how DI11 and EI11 can be used for each ammunition type is summarized in the below table.

Ammo Type	**Engagement Info EI11**		**Detonation Info DI11**			**Cant Angle**	**Comment**
	Engage-ment Distance	Burst of Fire	Detonation Distance	Burst of Fire	Unarmed		
Air Burst, Note 1 and Note 2	X					X	Fly-by Simulation
			X			X	Air Burst
	X		X				E.g. ABM-KETF
AP, APDS, APFSDS, HEAT	X					X	
	X			X			
HE, HEMP, Minor calibre Direct Detonation	X					X	
	X			X			
HE, HEMP, Large calibre Direct Detonation	X					X	
Missile	X					X	
	X				X		

Table 45. Real-Time Code, Distance Lethality Code, Usage Examples

Note 1. Example on time fuzed ammo:
The 70mm M255A1 Flechette Warhead rocket design uses standard components such as the M439 Fuze. The M439 Fuze is remotely set from the weapon system with time (range) to the target data. The M439 Fuze initiates the expulsion of the charge at an expected point slightly before and above the target area.

Note 2. Example on proximity fuzed ammo:
The 40 mm L/60 PFHE projectile has a proximity fuze, which operates on the Doppler effect principle to measure the target distance, which is used to initiate the expulsion of the charge against the target area is done.

"Air Burst" in the above table column "Ammo Type" refers to the following examples:

- High Explosive (HE) using a time fuze or proximity fuze detonating in the air.
- Air Burst Munition Kinetic Energy Time Fuze (ABM KETF for CV90)
- Air Burst Munition High Explosive Time Fuze (ABM HETF for CV90)

See Ammunition Table Reference [2] for referred Ammo Types.

4.6.2.6.1. Engagement Info

How the fire simulator can inform the target simulators about more details in the engagement using EI11 is described in the following table:

Engagement Info EI11	Description
Engagement Distance	The distance between the fire simulator and the target simulator is transmitted.
Burst of Fire	The target simulator is informed about that the transmitted projectile position comprises a lethality corresponding to more than one projectile.

Table 46. Real-Time Code, Engagement Info

The engagement info functions and distance are encoded and decoded as follows:

```
Encoding:                              [DED and EED are integers measured in meter]
     PI = 1269                         Burst of Fire
     PI = INT((EED + 50) / 100) + 1272     0m ≤ EED < 7750m
     PI = 1350                         7750m ≤ EED ≤ 12000m
Decoding:                              [PI is an integer measured in PIU]
     Burst of Fire                     1268 ≤ PI ≤ 1270
     DED = 40                          1271 ≤ PI ≤ 1272
     DED = (PI – 1272)* 100                  1273 ≤ PI ≤ 1350
     DED = 7800                        PI = 1351
```

Encoding and decoding engagement functions and distance examples:

Encoded (EED) Engagement Distance or function	Decoded (DED) Engagement Distance or function	PI
m	m	PIU
Not allowed	Burst of Fire	1268
Burst of Fire	Burst of Fire	1269
Not allowed	Burst of Fire	1270
Not allowed	40	1271
0-49	40	1272
50-149	100	1273
150-249	200	1274
Etc.	Etc.	Etc.
7650-7749	7700	1349
≥7750	7800	1350
not allowed	7800	1351

Table 47. Real-Time Code, Engagement Info Encoding and Decoding Examples

Observe that the target simulator may receive and decode multiple DED values when a fire simulator is engaging. The final DED value is then calculated as the average value of the decoded DED values.

4.6.2.6.2. Detonation Info

How the fire simulator can inform the target simulators about more details in the engagement using DI11 is described in the following table:

Detonation Info DI11	Description
Detonation Distance	The warhead is detonating in the air or at impact at another target or on the ground. The ammunition may for example have a time fuze or proximity fuze. The distance between the ammo detonation and the target is transmitted.
Burst of Fire	The target simulator is informed about that the transmitted projectile position comprises a lethality corresponding to more than one projectile.
Unarmed	When for example a missile is engaging a target before the preset arming distance, the missile warhead is usually not detonating and its lethality is considerably reduced.

Table 48. Real-Time Code, Detonation Info

The detonation info functions and distance is encoded and decoded as follows:

```
Encoding:                         [DDD and EDD are integers measured in meter]
     PI = 1506                    Unarmed
     PI = 1509                    Burst of Fire
     PI = 1512                    Future growth
     PI = 1515                      EDD ≤ -155m
     PI = INT((EDD - 5) / 10) + 1531-155m < EDD ≤ -21m
     PI = INT((EDD - 1) /  2) + 1539  -21 < EDD < 0m
     PI = INT((EDD + 1) /  2) + 1539    0m ≤ EDD < 21m
     PI = INT((EDD + 5) / 10) + 1547  21m ≤ EDD < 155m
     PI = 1563                      EDD ≥ 155m
Decoding:                         [PI is an integer measured in PIU]
     Unarmed            1505 ≤ PI ≤ 1507
     Burst of Fire            1508 ≤ PI ≤ 1510
     Future growth            1511 ≤ PI ≤ 1513
     DDD = -20 + (PI − 1529)* 10          1514 ≤ PI ≤ 1528
     DDD = (PI − 1539)   * 2         1529 ≤ PI ≤ 1549
     DDD =  20 + (PI − 1549)* 10          1550 ≤ PI ≤ 1564
```


The sign definition for the "Encoded Detonation Distance" (EDD) and the "Decoded Detonation Distance" (DDD) values is illustrated below:

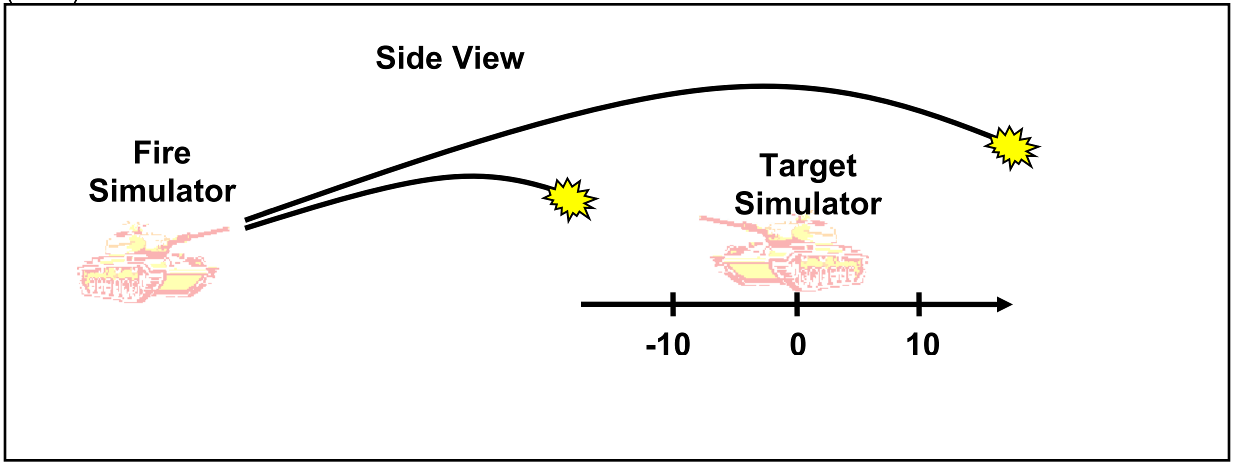

Figure 20. Real-Time Code, Detonation Distance Sign Definition

The three dimensional coordinate definition of the detonation distance and the detonation coordinates is illustrated below. Depending on the level of abstraction the X and Y-axis could have been drawn differently. They could have been drawn as the "Position Code" coordinates rotated 45 degrees relative to ground. As drawn below the X and Y-axis represents how the detonation position normally is presented to e.g. the gunner.

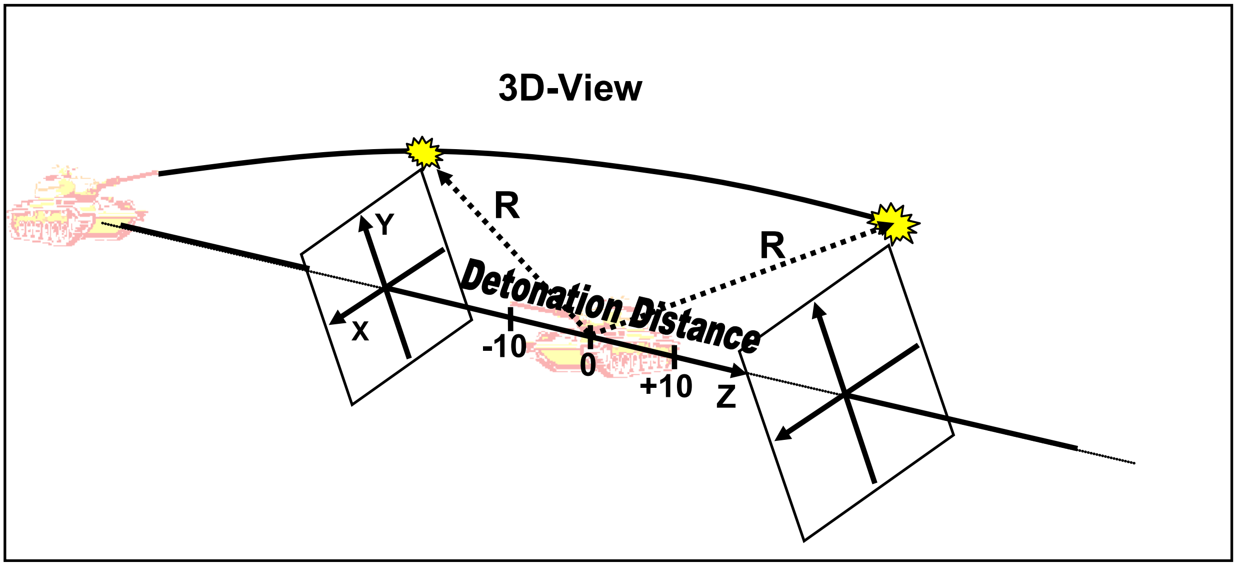

Figure 21. Real-Time Code, Detonation Distance 3D-view

The calculated radius R, dotted in the above illustration, can then be used in the vulnerability evaluation.

Encoding and decoding detonation functions and distance examples:

Encoded (EDD) Detonation Distance or function	Decoded (DDD) Detonation Distance or function	PI
m	m	PIU
Not allowed	Unarmed	1505
Unarmed	Unarmed	1506
Not allowed	Unarmed	1507
Not allowed	Burst of Fire	1508
Burst of Fire	Burst of Fire	1509
Not allowed	Burst of Fire	1510
Not allowed	Future growth	1511
Future Growth	Future growth	1512
Not allowed	Future growth	1513
Not allowed	-170	1514
≤ -155	-160	1515
-154 to -145	-150	1516
Etc.	Etc.	Etc
-34 to -25	-30	1528
-24 to -22	-20	1529
-21 to -19	-20	1529
Etc.	Etc.	Etc.
-4 to -3	-4	1537
-2 to -1	-2	1538
0	0	1539
1 to 2	2	1540
3 to 4	4	1541
Etc.	Etc.	Etc.
19-21	20	1549
22-24	20	1549
25-34	30	1550
Etc.	Etc.	Etc.
145-154	150	1562
≥155	160	1563
Not allowed	170	1564

Table 49. Real-Time Code, Detonation Distance Info, Encoding and Decoding Examples

Observe that the target simulator usually is receiving and decoding multiple DDD values when a fire simulator is engaging. The final DDD value is then calculated as the average value of the decoded DDD values.

4.6.2.7. Cant Angle Code

The Cant Angle Code (CA21) is used to inform the target simulator about how the Projectile Position coordinates are slanted in relation to ground seen from the fire simulator point of view.

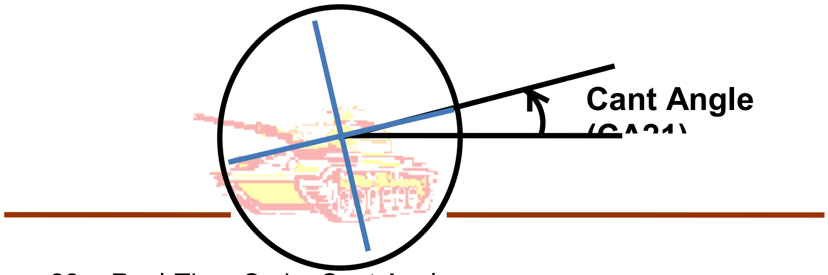

Figure 22. Real-Time Code, Cant Angle

The fire simulators can measure the Cant Angle by using simulator built in sensors or read the Cant Angle from the weapon fire computer system. The Cant Angle value is then transmitted from the fire simulator to the target simulator. The target simulator has then enhanced possibilities to adjust the Projectile Position coordinates transmitted from the fire simulator.

The Cant Angle is measured and regarded positive in the counter clockwise direction as illustrated above. The Cant Angle is encoded and decoded in 2/64 radians increments as follows:

```
Encoding:                           [PI is an integer measured in PIU]
     ECA = ECR * 64                       [ECR measured in radians]
     PI = 1356                            ECA ≤ -83
     PI = INT((ECA-1) / 2) + 1398         -83 < ECA ≤ -1
     PI = 1399                       -1 < ECA <  1
     PI = INT((ECA+1) / 2) + 1400          1 ≤ ECA < 83
     PI = 1442                            ECA ≥ 83
Decoding:                           [DCA is an integer]
     DCA = (PI - 1398)* 2                 1355 ≤ PI ≤ 1397
     DCA = 0                  1398 ≤ PI ≤ 1400
     DCA = (PI – 1400)* 2                 1401 ≤ PI ≤ 1443
     DCR = DCA / 64                       [DCR measured in radians]
```


Encoding and decoding Cant Angle examples:

Encoded (ECA) Cant Angle	Decoded (DCA) Cant Angle	Decoded (DCR) Cant Angle	PI
radians x 64	radians x 64	degrees (approx)	PIU
not encoded	-86	-76.99	1355
ECA≤-83	-84	-75.20	1356
-83<ECA≤-81	-82	-73.41	1357
-5<ECA≤-3	-4	-3.58	1396
-3<ECA≤-1	-2	-1.79	1397
not allowed	0	0	1398
-1<ECA<1	0	0	1399
not allowed	0	0	1400
1≤ECA<3	2	1.79	1401
3≤ECA<5	4	3.58	1402
81≤ECA<83	82	73.41	1441
ECA≥83	84	75.20	1442
not encoded	86	76.99	1443

Table 50. Real-Time Code, Cant Angle Info, Encoding and Decoding Examples

Observe that the target simulator usually is receiving and decoding multiple DCA values when a scanning fire simulator is engaging. The final DCA value is then calculated as the average value of the decoded DCA values.

4.6.2.8. Burst of Fire Simulation

This chapter describes only the "Real-Time" burst of fire simulation. "Short-Time Scanning" burst of fire simulation is described in the "4.6.4.5 Burst of Fire Simulation" chapter.
A laser simulator using "Real-Time Code" transmits information for typically a maximum fire rate of 250 rounds per minute. If the fire rate is greater than that, especially designed burst of fire simulation methods are applied.

1 **Individual Round Simulation.** Each individual round is simulated.
2 **Burst of Fire Simulation.** The target simulator is informed about that the transmitted projectile position comprises a lethality corresponding to more than one projectile.
   2.1 **"Burst of Fire" "Ammunition Code" Simulation**. There are burst of fire coded ammo numbers. This type of functionality is defined for a few non-alternating ammo numbers.
   2.2 **"Distance Lethality Code" "Burst of Fire Flag"**. The fire simulator sets one of the "Burst of Fire" flags in the "Distance Lethality Code".

As previously described the fire simulator typically selects between using 2-fold or 4-fold triplet sequences. The selection can be done for the following reasons:

- The 4-fold triplet is used during most normal fire simulations when the fire rate is <250 rounds per minute. When the fire simulator is selecting the 4-fold triplet the simulation principle typically includes a 2*0.06*v (two 60ms projectile position scans and v = projectile velocity) engagement distance interval where targets are engaged.
- The 2-fold triplet is used during exceptional fire simulation conditions like high fire rate burst of fire simulation when the fire rate is >250 rounds per minute. When the fire simulator is selecting the 2-fold triplet the simulation principle typically includes a 0.06*v (one 60ms projectile position scan and v = projectile velocity) engagement distance interval where targets are engaged.

From the fire simulator point of view you can simulate as follows depending on the simulated fire rate.

Number of Transmitted Triplets	Max. Fire Rate Rounds per Minute	Burst of Fire Simulation Method	Comment
5 or 6	180	1. Individual Round Simulation	In exceptional situations as e.g. for low velocity projectile or missile
4	250	1. Individual Round Simulation	Typical normal simulation
2-3	500	1. Individual Round Simulation	Exceptional high fire rate simulation
2-6	>250	2. Burst of Fire Simulation	The transmitted lethality corresponds to more than one projectile.

Table 51. Real-Time Code, Burst of Fire Simulation

The following triplet definitions are made for the below illustrations:

- P3: Position triplet
  - `P3ON: PC1-AC1-PC2,` Non-alternating ammunition code
  - `P3OA: PC1-XXX-PC2,` XXX is any alternating pair item
- I3: Identity triplet
  - `I3ON: IC1-IC2-IC3` Non-alternating player identity code
  - `I3OA: ICa1-YYY-ICa3,` YYY is an alternating pair ammunition code item

    ICa1 is player identity IC11 alternating with IC21
    ICa3 is player identity IC12 alternating with IC22

A typical 4-fold triplet "Burst of Fire Simulation" including three simulated rounds can be illustrated as:
P3, P3, I3, I3, P3, P3, I3, I3, P3, P3, I3, I3

An exceptional 5-fold triplet "Burst of Fire Simulation" including three simulated rounds can be illustrated as:
P3, P3, P3, I3, I3, P3, P3, I3, I3, I3, P3, P3, P3, I3, I3, I3
Each of the above simulation sequences then comprises two or more simulated projectiles.

Burst of fire simulation triplet sequences are identified as follows:

- Main rules:
    - P3 starts the triplet sequence representing a single projectile
    - When P3ON follows a P3ON triplet, P3ON represents a triplet for **the same** simulation in the triplet sequence.
    - When P3OA follows a P3OA triplet, P3OA represents a triplet for **the same** simulation in the triplet sequence.
    - When P3ON follows an I3ON triplet, P3ON represents a triplet for **the next** simulation in the triplet sequence
    - When P3OA follows an I3OA triplet, P3OA represents a triplet for **the next** simulation in the triplet sequence
    - I3ON represents a triplet for **the same** simulation as the preceding P3ON or I3ON triplet in the triplet sequence.
    - I3OA represents a triplet for **the same** simulation as the preceding P3OA or I3OA triplet in the triplet sequence.
- Additional rules:
    - When the time between two triplets exceeds 230ms, they are not interpreted as belonging to the same simulation.
    - Change in identity code:
        - When I3 follows an I3 triplet, and a change in identity code, compared to the preceding triplet is identified, I3 is not interpreted as belonging to the same simulation.
    - Change in ammunition code
        - When I3OA follows an I3OA triplet, and a change in ammunition code compared to the preceding triplet is identified is identified, I3OA is not interpreted as belonging to the same simulation.
        - When P3ON follows a P3ON triplet, and a change in ammunition code compared to the preceding triplet is identified is identified, P3ON is not interpreted as belonging to the same simulation.

The target simulator is informed about that the transmitted projectile position comprises a lethality corresponding to two or more projectiles. The target simulator can use the burst of fire information in different ways to achieve a realistic engagement outcome:

- Vulnerability data with enhanced vulnerability
- Adjusted target template geometries

4.6.3. Fire-and-Forget Code

The "Fire-and-Forget Code" is implemented on weapon systems not following a ballistic projectile or "Real-Time" guided missile principle. Weapons systems using the "Fire-and-Forget Code" are for example Stinger, PARS LR, Javelin, SPIKE and Gill.

The "Fire-and-Forget Code" does typically involve reception of retro reflection from the target, and as such it is referred to as a "two-way" code.

The "Fire-and-Forget Code" has similar principal structure of the optical code as the "Real-Time Code". For "Fire-and-Forget-Systems", the "Hit Probability" code (HP1) and the "Time-to-Impact" code (TF1) are transmitted instead of the "Position Codes" (PC1 and PC2).

The "Fire-and-Forget" "Ammunition Code" AC5 or AC12 alternating with AC22 can be used by the target simulators to identify that the simulation is of "Fire-and-Forget" type. There are two types of "Fire-and-Forget Code"

- Non-alternating ammunition code. AC5 is used
- Alternating ammunition code. AC12 alternating with AC22is used

The following non-alternating optical codes are used:

- Ammunition Code AC5
- Player Identity Code IC1, IC2, IC3
- Hit Probability Code HP1
- Time-to-Impact Code TF1
- Null Code NC1, NC2 and NC3

The following alternating optical codes are used:

- Ammunition Code AC12, AC22
- Player Identity Code IC11, IC12, IC21, IC22
- Distance Lethality Code EI11, DI11
- Cant Angle CA21

Messages transmitted by using a "Fire-and-Forget Code" consist of three message items building a triplet. The chapter "4.3.3.2 Triplet Group Structure" specifies the triplet encoding and decoding.

4.6.3.1. Additional Code Structure

The "Fire-and-Forget Code" follows the additional conditions also valid for the "Real-Time" optical code type as described in chapter "4.6.2.1 Additional Code Structure".

4.6.3.2. Ammunition Code

The "Fire-and-Forget Code" ammo number is encoded and decoded in two ways:

1. Non-alternating using AC5.
2. Alternating using AC12 and AC22

4.6.3.2.1. Non-alternating

You can transmit an ammunition code using non-alternating code.
A laser transmitter typically transmits eight message elements when transmitting the "Fire-and-Forget Code".

```
AC5 - AC5 - AC5 - AC5 - AC5 - AC5 – AC5 – AC5
```

The Ammo Number (AmNo) is encoded and decoded as follows:
Encoding: [AC5 and AmNo are integers]

```
AC5  = AmNo                AmNo=25, AmNo=30
PI5  = 1698 + (3*AC5)
```

Decoding: [PI5 is an integer measured in PIU]

```
AC5  = INT((PI5 – 1697) / 3)    1772≤PI5≤1774, 1787≤PI5≤1789
AmNo = AC5                 AC5=25, AC5=30
```

Ammo numbers and encoding:

AmNo	AC5	PI5
25	25	1773
30	30	1788

Table 52. Fire-and-Forget Code, Non-alternating Ammo Number Encoding

4.6.3.2.2. Alternating

You can also transmit an ammunition code using alternating codes AC12 and AC22. A simulator using "Fire-and-Forget Code" is then typically transmitting four pairs of ammunition code to the target:

```
AC12 – AC22 – AC12 – AC22 – AC12 – AC22 – AC12 – AC22
```

There are both Parent Ammo Number series and Child Ammo Number series.
The decoded ammo numbering depends on three flags (FlgNo) set in "Engagement Info" (EI11) or "Detonation Info" (DI11) as illustrated with the below table:

	Direct Detonation
FlgNo	12
Parent	12001-12280
Child	13001-13280

Table 53. Fire-and-Forget Code, Alternating Ammo Numbers

Note. "Fire-and-Forget" "Unarmed" ammo numbers are shared with "Real-Time" "Unarmed" ammo numbers.

The Ammo Number (AmNo) is encoded and decoded as follows:

Parent Ammo Number: [PI12 and PI22 are integers measured in PIU]
Encoding: [AC12, AC22, AmLsd, AmNo and FlgNo are integers]

```
FlgNo = INT(AmNo / 1000)
AmLsd= 2000 + INT(AmNo % 1000)
AC22 = 1 + INT((AmLsd – 2001) / 10)   2001 ≤ AmLsd ≤ 2280
AC12 = 1 + INT((AmLsd – 2001) % 10)   2001 ≤ AmLsd ≤ 2280
PI12 = 1623 + (3*AC12)             1 ≤ AC12 ≤ 10
PI22 = 1353 + (3*AC22)             1 ≤ AC22 ≤ 28
```

Decoding:

```
AC12 = INT((PI12 – 1622) / 3)    1625 ≤ PI12 ≤ 1684
AC22 = INT((PI22 - 1352) / 3)    1355 ≤ PI22 ≤ 1438
AmNo = (FlgNo*1000)+((AC22-1)*10)+AC12; 1 ≤ AC12 ≤ 10, 1 ≤ AC22 ≤28
```

Parent ammo number encoding examples:

AmNo	AC12	AC22	PI12	PI22
12001	1	1	1626	1356
12010	10	1	1653	1356
12032	2	4	1629	1365
12280	10	28	1653	1437

Table 54. Fire-and-Forget Code, Alternating Parent Ammo Number Encoding Examples

Child Ammo Number: [PI12 and PI22 are integers measured in PIU]
Encoding: [AC12, AC22, AmNo and FlgNo are integers]

```
FlgNo = (INT(AmNo / 1000)) - 1
AmLsd= 2000 + INT(AmNo % 1000)
AC22 =  1 + INT((AmLsd – 2001) / 10)  2001 ≤ AmLsd ≤ 2280
AC12 = 11 + INT((AmLsd – 2001) % 10)  2001 ≤ AmLsd ≤ 2280
PI12 = 1623 + (3*AC12)             11 ≤ AC12 ≤ 20
PI22 = 1353 + (3*AC22)              1 ≤ AC22 ≤ 28
```

Decoding:

```
AC12 = INT((PI12 – 1622) / 3)    1625 ≤ PI12 ≤ 1684
AC22 = INT((PI22 - 1352) / 3)    1355 ≤ PI22 ≤ 1438
AmNo =((FlgNo+1)*1000)+((AC22-1)*10)+(AC12–10);
                   11 ≤ AC12 ≤ 20, 1 ≤ AC22 ≤ 28
```

Child ammo number encoding examples:

AmNo	AC12	AC22	PI12	PI22
13001	11	1	1656	1356
13010	20	1	1683	1356
13032	12	4	1659	1365
13280	20	28	1683	1437

Table 55. Fire-and-Forget Code, Alternating Child Ammo Number Encoding Examples

4.6.3.3. Player Identity Code

"Player Identity Code" encoding and decoding algorithms identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.3 Player Identity Code".

4.6.3.4. Null Code

"Null Code" encoding and decoding algorithms identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.5 Null Code”

4.6.3.5. Distance Lethality Code

"Distance Lethality Code" encoding and decoding algorithms identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.6 Distance Lethality Code".

4.6.3.6. Cant Angle Code

Cant Angle Code encoding and decoding algorithms identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.7 Cant Angle Code".

4.6.3.7. Burst of Fire Simulation

"Burst of Fire Simulation" principles identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.8 Burst of Fire Simulation".

4.6.3.8. Hit Probability Code

The firing simulator can estimate the probability of hit when engaging the target.
The "Hit Probability" is encoded and decoded using:

- Non-alternating using HP1

The "Hit Probability" (HP) percentage is encoded and decoded as follows:
Encoding: [HP is an integer]

```
PI = HP + 2000              0 ≤ HP ≤ 100
```

The HP is encoded with a resolution of 1% starting at 0%

Decoding: [PI is an integer measured in PIU]

```
HP = 0                      PI = 1999
HP = PI – 2000                  2000 ≤ PI ≤ 2100
HP = 100                    PI = 2101
```

"Hit Probability" encoding and decoding:

HP	Encoding	Decoding
	PI	PI
0%	not allowed	1999
0%	2000	2000
2%	2002	2002
N%	2000+N	2000+N
100%	2100	2100
100%	not allowed	2101

Table 56. Fire-and-Forget Code, Hit Probability Code Encoding and Decoding

Observe that the target simulator usually is receiving and decoding multiple HP values when a "Triplet Group Coded" fire simulator is engaging. The final HP value is then calculated as the average value) of the decoded HP values.

4.6.3.9. Time-to-Impact Code

The "Time-to-Impact" defines the time until impact in target in seconds. When the target receives the info it can wait the time received until the evaluation of the engagement is done.
The "Time-to-Impact Code" is encoded and decoded as follows:

[PI1 is an integer measured in PIU]

Encoding: [K and N are integers]

```
PI1 = 2134 + K          TF1 = K*0.1,  0 ≤ K ≤ 4
PI1 = 2140        TF1 = 0.5
PI1 = 2140 + N          TF1 = N,   1 ≤ N ≤ 59 (N Seconds)
```

Decoding: [TF1 is a decimal value measured in seconds]

```
TF1 = 0       PI1 = 2133
TF1 = 0.1*(PI1 - 2134)    2134 ≤ PI1 ≤ 2139
TF1 = 0.5         PI1 = 2140
TF1 = PI1 - 2140   2141 ≤ PI1 ≤ 2200
```

Observe that the target simulator may receive and decode multiple TF1 values when a fire simulator is engaging. The final TF1 value is then calculated as the average value of the decoded TF1 values.

The "Time-to-Impact Code" encoding and decoding is illustrated as follows:

Encode PI1 PIU	Decode PI1 PIU	Encode TF1 seconds	Decode TF1 seconds
	2133		0
2134	2134	0	0
2135	2135	0.1	0.1
2136	2136	0.2	0.2
2137	2137	0.3	0.3
2138	2138	0.4	0.4
2139	2139		0.5
2140	2140	0.5	0.5
2141	2141	1	1
2140+N	2140+N	1 ≤ N ≤ 59	1 ≤ N ≤ 59
2199	2199	59	59
	2200		60

Table 57. Fire-and-Forget Code, Time-to-Impact Code, Encoding and Decoding

4.6.4. Short-Time Scanning Code

Weapon fire simulators using "Real-Time Code" and "Fire-and-Forget Code" also add "Short-Time Scanning Code", to ensure realistic engagement effects primarily in man worn target simulators but also vehicle target simulators may decode the "Short-Time Scanning Code". Those target simulators may have a solution without retro reflectors or the soldier may temporarily have taken off the retro reflector equipped helmet.

The "Short-Time Scanning Code" does not require a retro-reflection from the target, and as such it is typically referred to as a "one-way" code.

The "Short-Time Scanning" "Ammunition Code" AC2 or AC11 alternating with AC22 is used by the target simulators to identify that the simulation is of "Short-Time Scanning" type. There are two types of "Short-Time Scanning Code".

- Non-alternating
  - AC2 and "Short-Time Code" "Player Identity" encoding is used.
- Alternating
  - AC11 alternating with AC22 and "Real-Time Code" "Player Identity" encoding is used.

The following non-alternating optical codes are used:

- Ammunition Code AC2
- Player Identity Code IC4a, IC4b, IC5a, IC5b
- Null Code NC1, NC2, NC3

The following alternating optical codes are used:

- Ammunition Code AC11, AC22
- Player Identity Code IC11, IC12, IC21, IC22

Messages transmitted by using a "Short-Time Scanning Code" consist of three message items building a triplet. The chapter "4.3.3.2 Triplet Group Structure" specifies the triplet encoding and decoding.

The "Short-Time Scanning Code" is typically transmitted during the real time projectile flight simulation or at an appropriate simulated engagement distance. Depending on type of weapon fire simulator the "Short-Time Scanning Code" shall be transmitted at different occasions:

- At the time when the projectile or missiles leaves the weapon platform.
- Regularly during the real time projectile flight simulation.
- Principally at the engagement distance. If the fire simulator has information about the engagement distance, it may choose to transmit when the projectile reaches the target(s).

The shape and the size of the "Short-Time Scanning" fire engagement area is drawn by the fire simulator laser transmitter. The effective area is adapted by the fire simulator depending on the simulated ammunition lethality. When simulated during the entire real time projectile flight, the effective area can typically be seen, from the gunner’s perspective, to be falling with the projectile drop.

4.6.4.1. Additional Code Structure

The following additional conditions are valid for the "Short-Time Scanning Code". The conditions can to some extent be seen as a subset of the Additional Code Structure for the "Real-Time Code" as described in chapter "4.6.2.1 Additional Code Structure".

The Target Simulator shall use the following additional conditions to decode pulse intervals as valid pulse intervals:

- When more than one detector at the same time (< 2ms) is receiving, then it is allowed to decode at the detector receiving the most number of position triplets.
- The player identity and ammo message item triplets can only be transmitted in the following orders of occurrence:
  - IC4a-AC2-IC5a or IC4b-AC2-IC5a
  - IC5b-AC2-IC4a or IC5b-AC2-IC4b
  - ICa1-ACa-ICa3 or ICa3-ACa-ICa1

    ACa is AC11 alternating with AC22
    ICa1 is IC11 alternating with IC21
    ICa3 is IC12 alternating with IC22
- The triplet can consecutively be transmitted multiple times to a single detector.
- Triplet sequences representing multiple engagements are identified as defined in chapter "4.6.2.8 Burst of Fire Simulation".
- When any of the three message items in a triplet is missing, the triplet is not decoded.

A projectile or missile simulation is done transmitting at least a 1-fold triplet. Below are illustrated simulating two projectiles using a 1-fold and a 3-fold triplet:

Triplet	Pass 1	Delay	Pass 2	Delay	Pass 3	Delay
1	ICa1	t1	ACa	t1	ICa3	t2
2	ICa3	t1	ACa	t1	ICa1	t2
3	ICa1	t1	ACa	t1	ICa3	t3
1	ICa3	t1	ACa	t1	ICa1	

Table 58. Short-Time Scanning Code, Timing Illustration

Note that each message item (ACa, ICa1 and ICa3) in the above table consists of several message elements.

The length of the decoded time intervals t1 and t2 from the above table:

```
t3 ≥ 6s
t2 < 6s
t1 < 30ms    t1 symmetric within a tolerance of ±5ms
```

See following chapters "4.6.4.5 Burst of Fire Simulation" for more info concerning burst of fire simulation.

4.6.4.1.1. Short-Time Scanning Triplet Coded Sequences

Messages transmitted by using a "Short-Time Scanning Code" consist of three message items building a triplet. To accept the information, the target simulator has to receive a complete triplet containing "Ammunition Code" and "Player Identity". The chapter "4.3.3.2 Triplet Group Structure" describe the basics of triplet encoding and decoding. Additional "Short-Time Scanning Code" triplet decoding and encoding rules are specified below.

The following additional acronym definitions are made for the below triplet sequence illustrations:

- ICa1: IC11 alternating with IC21 as player identity item
- ICa3: IC12 alternating with IC22 as player identity item
- ACsp: "Short-Time Scanning Code" AC11 alternating with AC22 as parent ammo code item
- ACsc: "Short-Time Scanning Code" AC11 alternating with AC22 as child ammo code item
- ACs: ACsp or ACsc. "Short-Time Scanning Code" AC11 alternating with AC22
- ACr: "Real-Time Code" AC11 alternating with AC21 as ammo code item
- ACf: "Fire-and-Forget Code" AC12 alternating with AC22 as ammo code item
- Null: Transmitting "Null Code" info searching for targets
- DLY: The time between two triplets exceeds six seconds
- RTa: "Real-Time Code" alternating pair item transmitted together with position code
- FFa: "Fire-and-Forget Code" alternating pair item transmitted together with "Hit Probability" or "Time-to-Impact".

The following "Short-Time Scanning Code" triplet acronym definitions are made for the below descriptions:

- **SPa**3: "**S**hort-Time Scanning Code" **Pa**rent ammo code and player identity triplet
  - `ICa1-ACsp-ICa3`
- **SCh**3: "**S**hort-Time Scanning Code" **Ch**ild ammo code and player identity triplet
  - `ICa1-ACsc-ICa3`
- **SId**3: "**S**hort-Time Scanning Code" ammo code and player identity triplet
  - `ICa1-ACsp-ICa3`
  - `ICa1-ACsc-ICa3`
  - `IC4a-AC2-IC5a`
  - `IC4b-AC2-IC5a`
  - `IC5b-AC2-IC4a`
  - `IC5b-AC2-IC4b`

The following "Real-Time Code" triplet acronym definitions are made for the below descriptions:

- **RPo**3: "**R**eal-Time Code" **Po**sition triplet
  - `PC1-AC1-PC2` Non- alternating ammo code
  - `PC1-RTa-PC2`
- **RId**3: "**R**eal-Time Code" **Id**entity triplet
  - `IC1-IC2-IC3` Non- alternating player identity
  - `ICa1-ACr-ICa3` Alternating message items

The following "Fire-and-Forget Code" triplet acronym definitions are made for the below descriptions.

- **FPo**3: "Fire-and-Forget Code" "Hit Probability" and "Time-to-Impact" triplet
  - `HP1-AC5-TF1` Non- alternating ammo code
  - `HP1-FFa-TF1`
  - `HP1-FFa-TF11`
- **FId**3: "**F**ire-and–Forget" **Id**entity triplet
  - `IC1-IC2-IC3` Non- alternating player identity
  - `ICa1-ACf-ICa3`

There are basic similarities between the "Real-Time Code" and "Fire-and-Forget Code" triplets. In case referring to both triplet types at the same time, the following acronyms are used:

- **Po3** refers to **RPo3** and **FPo3**
- **Id3** refers to **RId3** and **FId3**

An engagement simulation triplet sequence example including one "Real-Time" fire engagement against a single target can then be illustrated as:

`**SId3**,Null,Null,RPo3,RPo3,RId3,RId3,**SId3**,Null,Null`

In the above example the fire simulator has identified that the projectile is passing the target outside the fire template as the "Short-Time Scanning Code" transmission continues after the "Real-Time Code" transmission.

An engagement simulation triplet sequence example including one "Fire-and-Forget" fire engagement against a single target can then be illustrated as:

`RPo3,RPo3,RId3,RId3,**SId3**,**SId3**`

As stated previously weapon fire simulators using "Real-Time Code" and "Fire-and-Forget Code" also use "Short-Time Scanning Code" in the majority of fire engagements. It is up to the man worn target simulators to select between the two simulation types. There are three main situations from which the man worn target simulators shall decode the triplet sequences.

- With retro-reflectors.
    - The target simulator knows that the simulator is equipped with retro-reflectors and the helmet where the retro-reflectors are mounted is taken on.
        - The **SId3** triplets are rejected as the **Po3** and **Id3** triplets probably refers to this target simulator and represents the most realistic simulation.
    - The target simulator knows that the simulator is equipped with retro-reflectors and the helmet where the retro-reflectors are mounted is taken off
        - The **Po3** and **Id3** triplets are rejected independent from the fact that they refer to this target simulator or not. The **SId3** triplets are expected to have stronger lethality, thus expected punishing players having helmet taken off.

- Without retro-reflectors.
    - The target simulator knows that the simulator does not include any retro-reflector.
        - The **Po3** and **Id3** triplets are rejected as they refer to another target simulator. The **SId3** triplets probably represent the most realistic simulation.

- With or without retro-reflectors. Retro-reflectors delivered as add-on kits, thus the simulator does not know whether or not it is currently equipped with them.
    - The target simulator does not know that the simulator is equipped with retro-reflectors.
        - The **Po3** and **Id3** triplets are rejected as they might refer to another target simulator. The **SId3** triplets probably represent the most realistic simulation.

Further explanation of triplet sequence decoding can be read in the "4.6.4.5 Burst of Fire Simulation" chapter.

4.6.4.2. Ammunition Code

The "Short-Time Scanning Code" ammo number is encoded and decoded in two ways:
1. Non-alternating using AC2
2. Alternating using AC11 and AC22

4.6.4.2.1. Non-alternating

The "Ammunition Code" AC2 can be used by the target simulator to identify that the simulation is of "Short-Time Scanning" type.

The laser transmitter transmits three message items each containing typically eight message elements when transmitting the Short-Time Scanning Code. The transmitted ammo code can then be illustrated as:

```
AC2 – AC2 – AC2 – AC2 – AC2 – AC2 – AC2 – AC2
```

The Ammo Number (AmNo) is encoded and decoded as follows:

Encoding: [AC2 and AmNo are integers]

```
AC2 = AmNo                77 ≤ AmNo ≤ 79
PI2 = 2159 + (3*AC2)
```

Decoding: [PI2 is an integer measured in PIU]

```
AC2 = INT((PI2 – 2158) / 3)          2389 ≤ PI2 ≤ 2397
AmNo = AC2                77 ≤ AC2 ≤ 79
```

Ammo number encoding:

Short-Time Scanning		
AmNo	AC2	PI2
77	77	2390
78	78	2393
79	79	2396

Table 59. Short-Time Scanning Code, Non-alternating Ammo Number Encoding

4.6.4.2.2. Alternating

The "Ammunition Code" AC11 alternating with AC22 can be used by the target simulator to identify that the simulation is of "Short-Time Scanning" type.

The laser transmitter transmits three message items each containing typically eight message elements when transmitting the "Short-Time Scanning Code". A simulator using the "Short-Time Scanning Code" is then typically transmitting four pairs of ammunition code to the target:

```
AC11 – AC22 – AC11 – AC22 – AC11 – AC22 – AC11 – AC22
```

There are both a Parent Ammo Number series and a Child Ammo Number series.

Short-Time Scanning	
Parent-Child Relationship	AmNo
Parent	22001-22280
Child	23001-23280

Table 60. Short-Time Scanning Code, Alternating Ammo Numbers

There are restrictions in using "Short-Time Scanning" child ammo codes as they also can be used as part of the "Short-Time Scanning" "Burst of Fire Simulation" mechanism. See the below "4.6.4.5 Burst of Fire Simulation" chapter for more info.

The Parent Ammo Number (AmNo) is encoded and decoded as follows:

Parent Ammo Number: [PI11 and PI22 are integers measured in PIU]

Encoding: [AC11, AC22 and AmNo are integers]

```
AC11 = 1 + INT((AmNo – 22001) % 10)   22001 ≤ AmNo ≤ 22280
```



```
AC22 = 1 + INT((AmNo − 22001) / 10)   22001 ≤ AmNo ≤ 22280
PI11 = 1203 + (3*AC11)               1 ≤ AC11 ≤ 10
PI22 = 1353 + (3*AC22)               1 ≤ AC22 ≤ 28
```

Decoding:

```
AC11 = INT((PI11 − 1202) / 3)   1205 ≤ PI11 ≤ 1264
AC22 = INT((PI22 - 1352) / 3)   1355 ≤ PI22 ≤ 1438
AmNo = 22000+((AC22-1)*10)+AC11 1 ≤ AC11 ≤ 10, 1 ≤ AC22 ≤ 28
```

Parent ammo number encoding examples:

AmNo	AC11	AC22	PI11	PI22
22001	1	1	1206	1356
22010	10	1	1233	1356
22032	2	4	1209	1365
22280	10	28	1233	1437

Table 61. Short-Time Scanning Code, Alternating Parent Ammo Number Encoding Examples

The Child Ammo Number (AmNo) is encoded and decoded as follows:

Child Ammo Number:

Encoding: [AmNo is an integer]

```
AC11 = 11 + INT((AmNo − 23001) % 10)  23001 ≤ AmNo ≤ 23280
AC22 =  1 + INT((AmNo − 23001) / 10)  23001 ≤ AmNo ≤ 23280
PI11 = 1203 + (3*AC11)              11 ≤ AC11 ≤ 20
PI22 = 1353 + (3*AC22)               1 ≤ AC22 ≤ 28
```

Decoding: [AC22 and AC11 are integers]

```
AC11 = INT((PI11 − 1202) / 3)   1205 ≤ PI11 ≤ 1264
AC22 = INT((PI22 - 1352) / 3)   1355 ≤ PI22 ≤ 1438
AmNo =(23000)+((AC22-1)*10)+(AC11−10) 11 ≤ AC11 ≤ 20, 1 ≤ AC22 ≤ 28
```

Child ammo number encoding examples:

AmNo	AC11	AC22	PI11	PI22
23001	11	1	1236	1356
23010	20	1	1263	1356
23032	12	4	1239	1365
23280	20	28	1263	1437

Table 62. Short-Time Scanning Code, Alternating Child Ammo Number Encoding Examples

4.6.4.3. Player Identity Code

Each player has a unique player identity number. The player identity number for players using "Short-Time Scanning Code" is encoded and decoded as described below.

The "Player Identity Code" is transmitted in two different ways

1. Non-alternating "Player Identity" using IC4a, IC4b, IC5a and IC5b.
2. Alternating "Player Identity" using IC11 alternating with IC21 and IC12 alternating with IC22.

4.6.4.3.1. Non-alternating

"Short-Time Scanning" "Player Identity Code" encoding and decoding algorithms identical to those of the "Short-Time Code" shall be used as described in chapter "4.6.1.3 Player Identity Code".

4.6.4.3.2. Alternating

"Short-Time Scanning" "Player Identity Code" encoding and decoding algorithms identical to those of the alternating "Player Identity Code" for "Real-Time Code" shall be used as described in chapter "4.6.2.3.2 Alternating Player Identity".

4.6.4.4. Null Code

"Null Code" encoding and decoding algorithms identical to those of the "Real-Time Code" shall be used as described in chapter "4.6.2.5 Null Code”

4.6.4.5. Burst of Fire Simulation

The "Short-Time Scanning Code" "Burst of Fire Simulation" can be done in two ways:

- Non-alternating
- Alternating

4.6.4.5.1. Non-alternating

A fire simulator using "Short-Time Scanning Code" can use the following burst of fire simulation method:

- **Fire Timing Simulation.** The timing between two triplets is used to identify multiple fire engagements.

Read the previous chapter "4.6.4.1.1 Short-Time Scanning Triplet Coded Sequences" for the explanation of the below acronym definitions.

"Short-Time Scanning Code" simulation triplet sequences are decoded as follows:

- "Real-Time Code" triplets and "Null Code" are ignored when decoding the "Short-Time Scanning Code" triplet sequences. As for example the following triplet sequences are considered as a single continuous sequence:
    - **SId3**, Null, Null, Null, **SId3**
    - RPo3, RPo3, RId3, RId3, **SId3**, **SId3**
    - **SId3**, RPo3, RPo3, RId3, RId3, **SId3**
    - **SId3**, Null, Null, Null, RPo3, RPo3, RId3, RId3, Null, Null, Null, **SId3**
- "Fire-and-Forget Code" triplets are transmitted at time of fire and thus the "Null Code" is not involved in the same way as when using "Real-Time Code". Still for clarification the following triplet sequences are considered as a single continuous sequence:
    - **SId3**, **SId3**
    - FPo3, FPo3, FId3, FId3, **SId3**, **SId3**
    - **SId3**, FPo3, FPo3, FId3, FId3, **SId3**
- A decoded triplet is added to the triplet sequence for **the same** fire engagement when:
    - SId3 follows a SId3 triplet with identical ammo code and player identity
- A decoded triplet is beginning the triplet sequence for **the next** fire engagement when:
    - SId3 follows a SId3 triplet where ammo code or player identity differs
- Additional rules:
    - When the time between two SId3 triplets exceeds six seconds, they are not interpreted as belonging to the same fire engagement.
    - When a change in ammunition code AC1 or AC5, compared to the preceding triplet is identified, the triplets are not interpreted as belonging to the same fire engagement.

The next illustrations show examples on how "Short-Time Scanning Code" typically is transmitted alone without "Real-Time Code", as the "Real-Time" simulation does not find any target simulator retro-reflectors.

Simulation sequence for a single fire engagement:
SId3,Null,Null,Null,**SId3**,Null,Null,Null,**SId3**

Simulation sequence including two fire engagements:
SId3,Null,Null,,Null,Null,**SId3,DLY,SId3**,Null,Null,,Null,Null,**SId3**

The next illustrations show examples on how "Real-Time" and "Short-Time Scanning" simulation typically is combined.
Observe that the RPo3 and RId3 triplets describe projectile coordinates referring to target simulator(s) having retro-reflectors. Still the triplet sequence might be received by target simulator(s) not having any retro-reflector.

Simulation for a single fire engagement can be illustrated as:
SId3,Null,Null,RPo3,RPo3,RId3,RId3,**SId3**,Null,Null,Null,**SId3**
The fire simulator has identified that the projectiles are passing **a target** outside the fire template as the "Short-Time Scanning Code" transmission continues after each "Real-Time Code" transmission.

Simulation sequence for a single fire engagement can be illustrated as:
SId3,Null,Null,RPo3,RPo3,RId3,RId3,**SId3**,Null,Null,RPo3,RPo3,RId3,RId3,**SId3**
The fire simulator has identified that the projectile is passing **targets** as defined by the fire template as the individual projectile simulations continues after the "Real-Time Code" transmissions.

Simulation sequence for multiple fire engagements can be illustrated as:
SId3,Null,Null,RPo3,RPo3,RId3,RId3,**DLY,SId3**,Null,Null,RPo3,RPo3,RId3,RId3

The next illustrations show examples on how "Fire-and-Forget" and "Short-Time Scanning" simulation typically is combined. Observe that the FPo3 and FId3 triplets are transmitted to target simulator(s) having retro-reflectors. Still the triplet sequence might be received by target simulator(s) not having any retro-reflector.

Simulation for a single fire engagement can be illustrated as:
FPo3,FPo3,FId3,FId3,**SId3,SId3**
Simulation sequence including two fire engagements can be illustrated as:
FPo3,FPo3,FId3,FId3,**SId3,SId3,DLY**,FPo3,FPo3,FId3,FId3,**SId3,SId3**

4.6.4.5.2. Alternating

A fire simulator using "Short-Time Scanning" Code can use two different burst of fire simulation methods.

1 **Fire Timing Simulation.** The timing between two triplets is used to identify multiple fire engagements. This method is used to simplify the circumstances for the fire simulators during extraordinary situations. The fire simulators do not always have to remember if a parent or a child ammo code was the latest used ammo code. For example power save and power off situations are then easier to handle for the fire simulators.

1.1 **Individual Round Simulation**. Each individual round is simulated.

1.2 **"Burst of Fire" "Ammunition Code" Simulation**. There are burst of fire coded ammo numbers. The target simulator is informed about that the transmitted ammo number comprises a lethality corresponding to more than one projectile.

2 **"Burst of Fire" Ammo Alternating Simulation**. The alternating between parent and child ammo number is used to identify multiple projectiles. This is the standard mechanism used for "Short-Time Scanning" burst of fire simulation.

2.1 **Individual Round Simulation**. Each individual round is simulated.

2.2 **"Burst of Fire" "Ammunition Code" Simulation**. There are burst of fire coded ammo numbers. The target simulator is informed about that the transmitted ammo number comprises a lethality corresponding to more than one projectile.

Read the previous chapter "4.6.4.1.1 Short-Time Scanning Triplet Coded Sequences" for the explanation of the below acronym definitions.

"Short-Time Scanning Code" simulation triplet sequences are decoded as follows:

- "Real-Time Code" triplets and "Null Code" are ignored when decoding the "Short-Time Scanning Code" triplet sequences. As for example the following triplet sequences are thus considered as a single continuous sequence where "SPa3" follows a "SPa3":
  - **SPa3**, Null, Null, Null, **SPa3**
  - RPo3, RPo3, RId3, RId3, **SPa3**, **SPa3**
  - **SPa3**, RPo3, RPo3, RId3, RId3, **SPa3**
  - **SPa3**, Null, Null, Null, RPo3, RPo3, RId3, RId3, Null, Null, Null, **SPa3**
- "Fire-and-Forget Code" triplets are transmitted at time of fire and thus the "Null Code" is not involved in the same way as when using "Real-Time Code". Still for clarification the following triplet sequences are considered as a single continuous sequence where "SPa3" follows a "SPa3":
  - **SPa3**, **SPa3**
  - FPo3, FPo3, FId3, FId3, **SPa3**, **SPa3**
  - **SPa3**, FPo3, FPo3, FId3, FId3, **SPa3**
- A decoded triplet is added to the triplet sequence for **the same** fire engagement when:
  - SPa3 follows a SPa3 triplet with identical ammo code and player identity
  - SCh3 follows a SCh3 triplet with identical ammo code and player identity
- A decoded triplet is beginning the triplet sequence for **the next** fire engagement when:
  - SPa3 follows a SCh3 triplet
  - SCh3 follows a SPa3 triplet
  - SPa3 follows a SPa3 triplet where ammo code or player identity differs
  - SCh3 follows a SCh3 triplet where ammo code or player identity differs

- Additional rules:
  - When the time between two SPa3 or two SCh3 triplets exceeds six seconds, they are not interpreted as belonging to the same fire engagement.
  - When a change in ammunition code ACr or ACf, compared to the preceding triplet is identified, the triplets are not interpreted as belonging to the same fire engagement.
  - When a change in player identity, compared to in the preceding SPa3 or SCh3 triplet is identified, the triplets are not interpreted as belonging to the same fire engagement.

The next illustrations show examples on how "Short-Time Scanning Code" typically is transmitted alone without "Real-Time Code", as the "Real-Time" simulation does not find any target simulator retro-reflectors.

Simulation sequence using parent ammo code including one fire engagement:
SPa3,Null,Null,Null,**SPa3**,Null,Null,Null,**SPa3**
Similar as above but using child ammo code:
SCh3,Null,Null,Null,**SCh3**,Null,Null,Null,**SCh3**

Fire timing simulation sequence, applied in extraordinary situations, using parent ammo code including two fire engagements:
SPa3,Null,Null,,Null,Null,**SPa3,DLY,SPa3**,Null,Null,,Null,Null,**SPa3**
Similar as above but using child ammo code:
SCh3,Null,Null,,Null,Null,**SCh3,DLY,SCh3**,Null,Null,,Null,Null,**SCh3**

Burst of fire ammo alternating simulation sequence including two fire engagements:
SPa3,Null,Null,Null,**SPa3**,Null,Null,Null,**SCh3**,Null,Null,Null,**SCh3**
The previous triplet sequence shows that there are restrictions in using "Short-Time Scanning" child ammo codes as they also can be used as part of the "Short-Time Scanning" "Burst of Fire Engagement" simulation mechanism.

The next illustrations show examples on how "Real-Time" and "Short-Time Scanning" simulation typically is combined.
Observe that the RPo3 and RId3 triplets describe projectile coordinates referring to target simulator(s) having retro-reflectors. Still the triplet sequence might be received by target simulator(s) not having any retro-reflector.

Simulation sequence including one fire engagement can be illustrated as:
SPa3,Null,Null,RPo3,RPo3,RId3,RId3,**SPa3**,Null,Null,Null,**SPa3**
The fire simulator has identified that the projectiles are passing **a target** outside the fire template as the "Short-Time Scanning Code" transmission continues after each "Real-Time Code" transmission.
Simulation including one fire engagement can be illustrated as:
SPa3,Null,Null,RPo3,RPo3,RId3,RId3,**SPa3**,Null,Null,RPo3,RPo3,RId3,RId3,**SPa3**
The fire simulator has identified that the projectile is passing **targets** as defined by the fire template as the individual projectile simulations continues after the "Real-Time Code" transmissions.

Burst of fire ammo alternating simulation sequence including two fire engagements can be illustrated as:
SPa3,Null,Null,RPo3,RPo3,RId3,RId3,**SCh3**,Null,Null,RPo3,RPo3,RId3,RId3

Similar as above but in a different sequence:
SPa3,Null,Null,RPo3,RPo3,RId3,RId3,RPo3,RPo3,RId3,RId3,**SCh3**
The fire simulator has identified that the projectiles are hitting a target within the fire template as the individual projectile simulations stop after the "Real-Time Code" transmissions.

The next illustrations show examples on how "Fire-and-Forget" and "Short-Time Scanning" simulation typically is combined. Observe that the FPo3 and FId3 triplets are transmitted to target simulator(s) having retro-reflectors. Still the triplet sequence might be received by target simulator(s) not having any retro-reflector.

Simulation sequence including one fire engagement can be illustrated as:
FPo3,FPo3,FId3,FId3,**SPa3,SPa3**

Burst of fire ammo alternating simulation sequence including two fire engagements can be illustrated as:
`FPo3,FPo3,FId3,FId3,`**`SPa3,SPa3`**`,FPo3,FPo3,FId3,FId3,`**`SCh3,SCh3`**

4.7. Auxiliary Codes

The following optical codes use the laser interface for functions other than simulated engagement functions.

- Umpire Control-Gun Code
- Geographical Reference Code
- Player Association Code

4.7.1. Umpire Control-Gun Code

The exercise area umpire, observer/controller or other personnel may have an umpire control-gun transmitter to distantly interfere against the players on the exercise area.

The Umpire Control-Gun Code has similar code structure as defined by the "Short-Time Code".

The Umpire Control-Gun Code is identified by the decoder when the "Umpire Identification Code" UIC is included.
The number of encoded message items in each message is three (I=3) as for example:

- `UC1,  UIC, UC2`

To decode the information, the target simulator has to receive information from all three message items.
The following optical codes are used:

- Umpire Identification Code UIC
- Umpire Command CodeUC1, UC2
- Player Identity Code IC4a, IC4b, IC5a, IC5b

Messages from an umpire control-gun consist of three message items. To accept the information, the target simulator has to receive information from all three message items.

A minimum complete Umpire Command message contains:

- UC1, UIC, UC2

The umpire command message can if required be followed by an Umpire Identity message containing:

- IC4a, UIC, IC5a
- IC4b, UIC, IC5a
- IC5b, UIC, IC4a
- IC5b, UIC, IC4b

4.7.1.1. Additional Code Structure

The simulator systems using Umpire Control-Gun Code shall consider the following additional conditions when encoding and decoding pulse intervals:

- The Umpire Control-Gun Code is only using non-alternating pulse intervals.
- The number of different transmitted message items (I) in a message are three
  `I=3`
- The code is transmitted using a block structure. Each block consists of three message items. The blocks are transmitted as:
  `E*UC1, E*UIC and E*UC2`
  An additional identity sequence can be transmitted as for example:
  `E*IC4a, E*UIC and E*IC5a`
  where E is the number of elements for each message item and
  `E=5`

Block transmission illustration where identity is not transmitted is illustrated below:

Block	I_1					Delay	I_2					Delay	I_3					Delay
	E_1	E_2	E_3	E_4	E_5		E_1	E_2	E_3	E_4	E_5		E_1	E_2	E_3	E_4	E_5	
1	U C 1	U C 1	U C 1	U C 1	U C 1	t1	U I C	U I C	U I C	U I C	U I C	t2	U C 2	U C 2	U C 2	U C 2	U C 2	t4
2	U C 1	U C 1	U C 1	U C 1	U C 1	t1	U I C	U I C	U I C	U I C	U I C	t2	U C 2	U C 2	U C 2	U C 2	U C 2	t4
N	U C 1	U C 1	U C 1	U C 1	U C 1	t1	U I C	U I C	U I C	U I C	U I C	t2	U C 2	U C 2	U C 2	U C 2	U C 2	t4

Table 63. Umpire Control-Gun Code, Timing Illustration

The transmitted time delays are specified as follows:

t1	t2	t4
ms	ms	ms
<30	< 30	50 < t4 < 1000

Table 64. Umpire Control-Gun Code, Time Delays

The time between UC1 and UIC shall also be the same as the time between UC2 and UIC within a tolerance of ±5ms.

$$t1 - 5ms \le t2 \le t1 + 5ms$$

Block transmission illustration when Player Identity is transmitted is illustrated below:

Block	I_1					Delay	I_2					Delay	I_3					Delay
	E_1	E_2	E_3	E_4	E_5		E_1	E_2	E_3	E_4	E_5		E_1	E_2	E_3	E_4	E_5	
1	U C 1	U C 1	U C 1	U C 1	U C 1	t1	U I C	U I C	U I C	U I C	U I C	t2	U C 2	U C 2	U C 2	U C 2	U C 2	t3
2	I C 4a	I C 4a	I C 4a	I C 4a	I C 4a	t1	U I C	U I C	U I C	U I C	U I C	t2	I C 5a	I C 5a	I C 5a	I C 5a	I C 5a	t4
3	U C 1	U C 1	U C 1	U C 1	U C 1	t1	U I C	U I C	U I C	U I C	U I C	t2	U C 2	U C 2	U C 2	U C 2	U C 2	t3
4	I C 4a	I C 4a	I C 4a	I C 4a	I C 4a	t1	U I C	U I C	U I C	U I C	U I C	t2	I C 5a	I C 5a	I C 5a	I C 5a	I C 5a	t4

Table 65. Umpire Control-Gun Code, Timing when Player Identity Code is included

The transmitted time delays when transmitting "Player Identity" are specified as follows:

t1	t2	t3	t4
ms	ms	ms	ms
0	0	4.5 < t3 < 5.5	50 < t4 < 1000

Table 66. Umpire Control-Gun Code, Time Delays when Transmitting Player ID

The time to transmit each item (UC1, UIC, UC2, IC4a, IC4b, IC5a and IC5b) is defined as:

$$0.08ms \le t5 < 0.16ms$$

To achieve easy long distance use of the Umpire Control-Gun without requiring any steady aiming, long transmission times up to one second are allowed. A complete transmission containing N blocks (N=4 in the above table example) shall take less than one second. When N is an even integer it can be described as below:

$$N*(t1 + t2 + t3/2 + t4/2 + E*3*t5) < 1s$$

4.7.1.2. Umpire Identification Code

The "Umpire Identification Code" (UIC) is used to identify the information as coming from an umpire control-gun.

The UIC encoding and decoding is defined as follows:

UIC Encoded	UIC Decoded	PI PIU
not allowed	1	2359
1	1	2360
not allowed	1	2361
not allowed	2	2362
2	2	2363
not allowed	2	2364
not allowed	3	2365
3	3	2366
not allowed	3	2367

Table 67. Umpire Control-Gun Code, Umpire Identification Code Encoding and Decoding

The Umpire Code Types are defined as follows:

UIC	Umpire Code Type	Umpire Code Type Description	Comment
1	UCG	Umpire Control-Gun	Umpire and Observer/Controller
2	*UFG*	*Umpire Future Growth*	*Reserved for future growth*
3	UMF	Umpire Minefield	Defining a mine field area

Table 68. Umpire Control-Gun Code, Umpire Code Types

Note. Optical code UFG written in *italic* is reserved for future growth.

The Umpire Code Types are encoded and decoded from the "Umpire Identification Code" and the "Umpire Command Codes" as defined in the following chapters.

4.7.1.3. Umpire Command Code

The "Umpire Command Codes" (UC1, UC2) are sent in the following order:

UC1, UIC, UC2

The "Umpire Command Code" (UC1, UC2) is encoded and decoded as follows:

Encoding: [PI1 and PI2 measured in PIU]

```
PI1 = 1910 + (3*UC1)      1 ≤ UC1 ≤ 64
PI2 = 2106 + (3*UC2)      1 ≤ UC2 ≤ 64
```

Decoding: [UC1 and UC2 are integers]

```
UC1 = INT((PI1 - 1909)/3) 1912 ≤ PI1 ≤ 2103
UC2 = INT((PI2 - 2105)/3) 2108 ≤ PI2 ≤ 2299
```

The "Umpire Command Number" (UCN) is encoded and decoded from UIC, UC1 and UC2. Valid UCN's are:

Valid Umpire Command Numbers	UIC	Umpire Code Type	Umpire Code Type Description
1 ≤ UCN ≤ 64	1	UCG	Umpire Control-Gun
101 ≤ UCN ≤ 110	3	UMF	Umpire Minefield Area

Table 69. Umpire Control-Gun Code, Umpire Command Code Numbering

The "Umpire Command Numbers" (UCN) can be used when reporting to for example to the Exercise Control Centre.

The use of UC1 and UC2 for UCN encoding is illustrated as below.

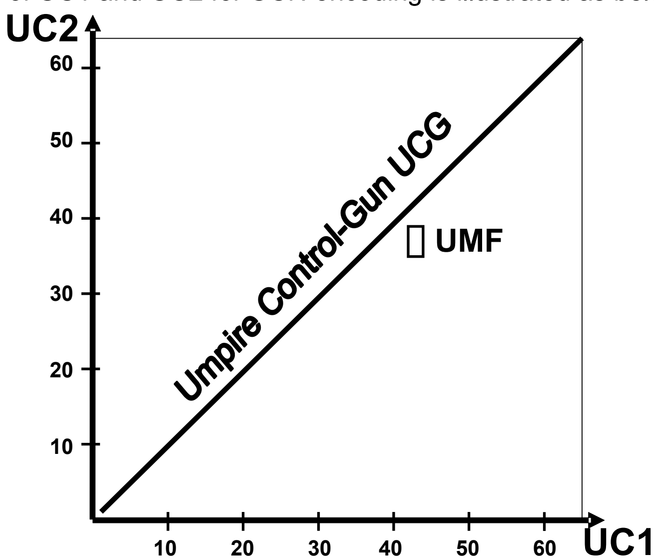

Figure 23. Umpire Control-Gun Code, Umpire Command Numbers (UCN) Encoding Illustration

See Appendix B at the end of this document for decoding and encoding "Umpire Command Number" (UCN).

4.7.2. Geographical Reference Code

An optical transmitter (Room Association Device, RAD) may for example be installed inside a building, sending a reference command number that is related by the target simulators to a geographical position, as part of the indoor positioning system.

The Geographical Reference Code has similar code structure as defined by the "Short-Time Code" and the Umpire Control-Gun Code.

The Geographical Reference Code is identified by the decoder when the "Geographical Identification Code" GIC is included.
The number of encoded message items is three (I=3):

- GC1, GIC, GC2

To decode the information, the target simulator has to receive information from all three message items.

The following optical codes are used:

- Geographical Identification Code GIC
- Geographical Command Code GC1, GC2

4.7.2.1. Additional Code Structure

The simulators using Geographical Reference Code shall consider the following additional conditions when encoding and decoding pulse intervals:

- The Geographical Reference Code applies only non-alternating pulse intervals.
- The number of different transmitted message items (I) are three (GC1, GIC, GC2)
  `I=3`
- The code is transmitted using a block structure. Each block consists of three message items. The blocks are transmitted as:
  `E*GC1, E*GIC and E*GC2`
  where E is the number of elements for each item and
  `E=3`

Block transmission illustration:

Block	I_1			Delay	I_2			Delay	I_3			Delay
	E_1	E_2	E_3		E_1	E_2	E_3		E_1	E_2	E_3	
1	GC1	GC1	GC1	t1	GIC	GIC	GIC	t1	GC2	GC2	GC2	t2
2	GC1	GC1	GC1	t1	GIC	GIC	GIC	t1	GC2	GC2	GC2	t3
3	GC1	GC1	GC1	t1	GIC	GIC	GIC	t1	GC2	GC2	GC2	t2
4	GC1	GC1	GC1	t1	GIC	GIC	GIC	t1	GC2	GC2	GC2	t3

Table 70. Geographical Reference Code, Timing Illustration

The transmitted time delays are specified as follows:

t1	t2	t3
ms	ms	ms
t1=0	$0 \le t2 < 0.08$ or $0.32 \le t2 \le t3$	$t3 \ge 100$

Table 71. Geographical Reference Code, Time Delays

When used against man worn simulators t3 ≥ 500ms is recommended.

4.7.2.2. Geographical Identification Code

The "Geographical Identification Code" (GIC) is used to identify that the optical information contains a reference number to a geographical position on the exercise area.

The GIC encoding and decoding is done as follows:

```
Encoding:                    [PI is an integer measured in PIU]
     PI = 2369
Decoding:                    [GIC is an integer]
     GIC = 1       2368 ≤ PI ≤ 2370
```

4.7.2.3. Geographical Command Code

The "Geographical Command Codes" (GC1, GC2) are encoded from and decoded to the "Geographical Command Number" (GCN) referencing to a geographical position on the exercise area.

The "Geographical Command Codes" (GC1, GC2) are sent in the following order:
GC1, GIC, GC2
The "Geographical Command Number" (GCN) is encoded and decoded as follows:

```
Encoding:                    [GC1, GC2 and GCN are integers]
     GC2 = 1 + INT((GCN-1)/64) 1 ≤ GCN ≤ 4096
     GC1 = 1 + INT((GCN-1)%64) 1 ≤ GCN ≤ 4096
     PI1 = 1910 + (3*GC1)      1 ≤ GC1 ≤ 64
     PI2 = 2106 + (3*GC2)      1 ≤ GC2 ≤ 64
Decoding:                    [PI1 and PI2 is an integer measured in PIU]
     GC1 = INT((PI1 - 1909)/3) 1912 ≤ PI1 ≤ 2103
     GC2 = INT((PI2 - 2105)/3) 2108 ≤ PI2 ≤ 2299
     GCN = GC1 + (64*(GC2-1))  1 ≤ GC1 ≤ 64, 1 ≤ GC2 ≤ 64
```

Encoding examples:

GCN	GC1	GC2	PI1	PI2
1	1	1	1913	2109
1234	18	20	1964	2166
4096	64	64	2102	2298

Table 72. Geographical Reference Code, Command Code, Encoding Examples

4.7.3. Player Association Code

An optical transmitter (Infra-red Beacon Unit, IBU) may be installed inside for example a vehicle. The "Player Association Code" (PAC) is used to inform a man worn target simulator that it should try to associate itself to a vehicle or another kind of player. Geographical position and engagements related to the player may then also be associated to the man worn associated simulator.

The "Player Association Code" (PAC) is transmitted using a block structure as:

- Each block consists of one message item (I=1). The blocks are transmitted as:

  `E*PAC`

  where E is the number of elements for the item and

  `E=3`

The pulse intervals can be understood as constructed by using a 31,25kHz clock. The transmitted nominal pulse interval is then 480PIU. The PAC is encoded and decoded as follows:

Encoding: [PI1 is an integer measured in PIU]

```
PI1 = 480 nominally
475 ≤ PI1 ≤ 485          PAC = 1
```

Decoding: [PAC is an integer]

```
PAC = 1            470 ≤ PI1 ≤ 490
```

It is important to note that this pulse interval is the only allowed interval between 0-1200 PIU and it is used during certain circumstances and only for association purposes. Carefully implemented, it shall not have any substantial impact on the decoder built in error detection and correction capability. 3*(470-490) = 1410-1470PIU and a single pulse interval within 1200-2399PIU is not a minimum decodable item.

Block transmission illustration:

Block	I_1			Delay
	E_1	E_2	E_3	
1	PAC	PAC	PAC	t1
2	PAC	PAC	PAC	t2
3	PAC	PAC	PAC	t1
4	PAC	PAC	PAC	t2

Table 73. Player Association Code, Timing Illustration

The timing values are specified as follows:

t1	t2	t3
s	s	s
0.32 ≤ t1 ≤ t2	1 ≤ t2 ≤ 5	10 ≤ t3 ≤ 20

Table 74. Player Association Code, Timing Values

Decoding of association can be done in the following way:

- At least two of three consecutive PAC elements in each block and two blocks within t3 seconds build a minimum decodable association event.
- Disassociation is done when blocks are not received within t3 seconds.

Appendix A Bibliography (Informative)

Not Applicable.

Appendix B: Umpire Control-Gun Tables (Normative)

There are two "Umpire Command Number" Types tabled separately.

- Umpire Control-Gun
- Umpire Minefield

The "Umpire Command Number" (UCN) is encoded from the "Umpire Identification Code" (UIC) and the "Umpire Command Codes" (UC1 and UC2).

Umpire Control-Gun

The exercise area umpire, observer/controller or other personnel may have an umpire control-gun transmitter to perform actions on players on the exercise area.
UIC=1 corresponding to 2360 PIU and UCN = UC1 = UC2.

Umpire Control-Gun commands are interpreted or neglected as indicated by the text marks in the columns representing the following simulator system types:

- Man Worn. Typically a solider with man worn target system
- Vehicle. Typically a vehicle like a tank or an armoured personnel carrier with a weapon system

There are two Umpire Control-Gun command categories.

- P – Player Control: Changes the tactical status of the simulator system
- C – Configuration Control: Supervises the simulator configuration or functionality

The "Umpire Command Numbers" (UCN) are encoded as follows:

UCN	PI1	PI2	Man worn	Vehicle*	Category	Comments
	PIU	PIU				
1	1913	2109	X	X	C	Test
2	1916	2112	X	X	P	Kill
3	*1919*	*2115*	*X*	*X*	*P*	*Wounded / Damaged medium.* *National unique for the German Army. Not to be used.*
4	1922	2118	X	X	P	Reset. Default ammo quantity given. Clean from contamination
5	1925	2121		X	P	Weapon kill , where the result is a firepower kill applied only to secondary weapons as e.g.: • Remote weapon station damage but not destroy • Main weapon only: Weapon or missile destroy • Main and secondary weapon: Secondary weapon destroy • Tank: Run out of ammo storage
6	1928	2124		X	P	Hit no effect
7	1931	2127		X	P	Weapon kill visual, where the result is firepower kill of the primary weapon as e.g.: • Remote weapon station destroy • Main weapon only: Weapon or missile destroy • Main and secondary weapon: Main weapon destroy • Tank: Main weapon destroy
8	1934	2130	X		P	Medical treatment activated. Wound stable
9	1937	2133	X	X	P	Tampering kill/destroy
10	*1940*	*2136*	*X*		*C*	*Configuration with helmet (man worn target).* *National unique for the German Army. Not to be used*
11	1943	2139		X	P	Mobility kill
12	1946	2142		X	P	Mobility kill visual
13	1949	2145	X	X	P	Exercise pause. All simulator functionality is disabled.

UCN	PI1	PI2	Man worn	Vehicle*	Category	Comments
	PIU	PIU				
						Reset or Reactivate leaves this mode.
14	1952	2148	*X*		*P*	*Wounded slightly. Wounded but can still walk National unique for the German Army. Not to be used*
				X	P	Radio communication destroy
15	*1955*	*2151*	*X*	*X*	*P*	*Wounded seriously / Heavy damage. National unique for the German Army. Not to be used*
16	*1958*	*2154*	*X*		*C*	*Configuration without helmet (man worn target) National unique for the German Army. Not to be used*
17	1961	2157	X		C	*Configuration* with ballistic protective vest on (man worn target).*National unique and not to be used*
18	1964	2160	X	X	P	Reactivate. Remaining ammo quantity given
19	1967	2163	X	X	P	Near miss. Target is under fire without being hit
20	1970	2166	X	X	P	Dug in set. Resulting in increased level of protection.
21	1973	2169	X	X	P	Dug in reset. The target system shall not any longer have the increased level of protection.
22	1976	2172	X		P	Wounded but can still walk
23	1979	2175	X		P	Wounded shall sit or lie down
24	1982	2178	X		P	Wounded shall lie down
25	1985	2181	X		P	Wounded
26	1988	2184	X		P	Medical reset. Healed by medical treatment and ready for combat. Remaining ammo quantity given. Clean from contamination.
27	1991	2187		X	P	Turret stabilization destroy
28	1994	2190		X	C	Selection (toggle) of target simulator characteristics like target application type, protection level and vulnerability level
29	1997	2193		X	P	Sight destroy
30	2000	2196	X	X	P	Contaminate. E.g. nuclear, biological or chemical
31	2003	2199	X	X	P	Clean from contamination
32	2006	2202	X		P	Prisoner Set
33	2009	2205	X		P	Prisoner Reset
34	2012	2208				Spare
35	2015	2211				Spare
36	2018	2214				Spare
37	2021	2217				Spare
38	2024	2220				Spare
39	2027	2223				Spare
40	2030	2226	X	X	C	Log buffer reset; clear event log
41	2033	2229	X	X	P	Time mark / book mark in the event log
42	2036	2232	X	X	C	Controller access. In case locked simulator functionally can be unlocked for controller access.
43	2039	2235	X	X	P	Target lifter down
44	2042	2238	X	X	P	Target lifter up
45	2045	2241	X	X	C	**Stand by**. Power save mode. The Reset commands are then used to leave this power saving mode.
46	2048	2244	X	X		Emergency stop
47	2051	2247	X		C	**Non-active Mode**. Truce mode. The man worn system cannot fire simulated weapons and is unaffected by simulated weapon engagements. Can be used on man worn systems, worn by e.g. observers and spectators instrumented for tracking but not vulnerable to

UCN	PI1	PI2	Man worn	Vehicle*	Category	Comments
	PIU	PIU				
						engagements.
48	2054	2250	X		C	Ballistic protective vest on
49	2057	2253	X		C	Ballistic protective vest off
50	2060	2256	X	X	C	**Simulation Mode:** Blue Force Tracking (simulator configuration)
51	2063	2259	X	X	C	**Simulation Mode:** Exercise Mode (simulator configuration)
52	2066	2262	X	X	C	Reserved**: Player Identity Code Mode:** Regular Player Identity
53	2069	2265	X	X	C	Reserved**: Player Identity Code Mode:** Joint Exercise Player Identity, assigning to a different Player Identity
54	2072	2268	X	X	C	Reserved**: Player Identity Code Mode:** Joint Exercise System Identity
55	2075	2271				Reserved
56	2078	2274				Reserved
57	2081	2277				Reserved
58	2084	2280				Reserved
59	2087	2283			P	NBC Protection on
60	2090	2286			P	NBC Protection off
61	2093	2289				Spare
62	2096	2292				Spare
63	2099	2295				Spare
64	2102	2298				Spare

Table 75. Umpire Control-Gun Code, Encoding Tables

*Note: Umpire commands shall only be implemented on vehicle target simulators where the command characteristics are applicable (i.e. that the target simulator vehicle has weapon(s), sight(s), etc.).

Umpire Minefield Area

The Umpire Minefield Code Type is used to define a minefield area using an umpire control-gun.
Umpire Command Numbers (UCN's) are encoded as follows:

UCN	UC1	UC2	PI1	UIC=3	PI2	Comments
			PIU	PIU	PIU	
101	41	34	2033	2366	2208	Clear all minefield area corners
102	41	35	2033	2366	2211	Finished. All corners are positioned and the minefield area is ready
103	41	36	2033	2366	2214	Minefield area position report from corner 1
104	41	37	2033	2366	2217	Minefield area position report from corner 2
105	41	38	2033	2366	2220	Minefield area position report from corner 3
106	42	34	2036	2366	2208	Minefield area position report from corner 4
107	42	35	2036	2366	2211	Minefield area position report from corner 5
108	42	36	2036	2366	2214	Minefield area position report from corner 6
109	42	37	2036	2366	2217	Minefield area position report from corner 7
110	42	38	2036	2366	2220	Minefield area position report from corner 8

Table 76. Umpire Control-Gun Code, Umpire Minefield Area Encoding Tables

Appendix C: Position Code Decoding Table (Informative)

PI1	PI2	PC1 PC2	X1 X2
PIU	PIU	PIU	m
2008	2204	0	0,00
2007	2203	1	0,10
2006	2202	2	0,20
2005	2201	3	0,30
2004	2200	4	0,40
2003	2199	5	0,50
2002	2198	6	0,60
2001	2197	7	0,70
2000	2196	8	0,80
1999	2195	9	0,90
1998	2194	10	1,00
1997	2193	11	1,10
1996	2192	12	1,20
1995	2191	13	1,30
1994	2190	14	1,40
1993	2189	15	1,50
1992	2188	16	1,60
1991	2187	17	1,70
1990	2186	18	1,80
1989	2185	19	1,90
1988	2184	20	2,00
1987	2183	21	2,10
1986	2182	22	2,20
1985	2181	23	2,30
1984	2180	24	2,40
1983	2179	25	2,50
1982	2178	26	2,60
1981	2177	27	2,70
1980	2176	28	2,80
1979	2175	29	2,91
1978	2174	30	3,02
1977	2173	31	3,13
1976	2172	32	3,25
1975	2171	33	3,37
1974	2170	34	3,49
1973	2169	35	3,62
1972	2168	36	3,76
1971	2167	37	3,90
1970	2166	38	4,05
1969	2165	39	4,20
1968	2164	40	4,36
1967	2163	41	4,52
1966	2162	42	4,69
1965	2161	43	4,86
1964	2160	44	5,05
1963	2159	45	5,24
1962	2158	46	5,43
1961	2157	47	5,64
1960	2156	48	5,85
1959	2155	49	6,07
1958	2154	50	6,29
1957	2153	51	6,53
1956	2152	52	6,77
1955	2151	53	7,03
1954	2150	54	7,29
1953	2149	55	7,56
1952	2148	56	7,85

PI1	PI2	PC1 PC2	X1 X2
PIU	PIU	PIU	m
2008	2204	0	0,00
2009	2205	-1	-0,10
2010	2206	-2	-0,20
2011	2207	-3	-0,30
2012	2208	-4	-0,40
2013	2209	-5	-0,50
2014	2210	-6	-0,60
2015	2211	-7	-0,70
2016	2212	-8	-0,80
2017	2213	-9	-0,90
2018	2214	-10	-1,00
2019	2215	-11	-1,10
2020	2216	-12	-1,20
2021	2217	-13	-1,30
2022	2218	-14	-1,40
2023	2219	-15	-1,50
2024	2220	-16	-1,60
2025	2221	-17	-1,70
2026	2222	-18	-1,80
2027	2223	-19	-1,90
2028	2224	-20	-2,00
2029	2225	-21	-2,10
2030	2226	-22	-2,20
2031	2227	-23	-2,30
2032	2228	-24	-2,40
2033	2229	-25	-2,50
2034	2230	-26	-2,60
2035	2231	-27	-2,70
2036	2232	-28	-2,80
2037	2233	-29	-2,91
2038	2234	-30	-3,02
2039	2235	-31	-3,13
2040	2236	-32	-3,25
2041	2237	-33	-3,37
2042	2238	-34	-3,49
2043	2239	-35	-3,62
2044	2240	-36	-3,76
2045	2241	-37	-3,90
2046	2242	-38	-4,05
2047	2243	-39	-4,20
2048	2244	-40	-4,36
2049	2245	-41	-4,52
2050	2246	-42	-4,69
2051	2247	-43	-4,86
2052	2248	-44	-5,05
2053	2249	-45	-5,24
2054	2250	-46	-5,43
2055	2251	-47	-5,64
2056	2252	-48	-5,85
2057	2253	-49	-6,07
2058	2254	-50	-6,29
2059	2255	-51	-6,53
2060	2256	-52	-6,77
2061	2257	-53	-7,03
2062	2258	-54	-7,29
2063	2259	-55	-7,56
2064	2260	-56	-7,85

PI1	PI2	PC1 PC2	X1 X2
PIU	PIU	PIU	m
1951	2147	57	8,14
1950	2146	58	8,45
1949	2145	59	8,76
1948	2144	60	9,09
1947	2143	61	9,43
1946	2142	62	9,79
1945	2141	63	10,15
1944	2140	64	10,53
1943	2139	65	10,93
1942	2138	66	11,34
1941	2137	67	11,76
1940	2136	68	12,20
1939	2135	69	12,66
1938	2134	70	13,13
1937	2133	71	13,63
1936	2132	72	14,14
1935	2131	73	14,67
1934	2130	74	15,22
1933	2129	75	15,79
1932	2128	76	16,38
1931	2127	77	16,99
1930	2126	78	17,63
1929	2125	79	18,29
1928	2124	80	18,97
1927	2123	81	19,68
1926	2122	82	20,42
1925	2121	83	21,19
1924	2120	84	21,98
1923	2119	85	22,80
1922	2118	86	23,66
1921	2117	87	24,55
1920	2116	88	25,47
1919	2115	89	26,42
1918	2114	90	27,41
1917	2113	91	28,44
1916	2112	92	29,50
1915	2111	93	30,61
1914	2110	94	31,76
1913	2109	95	32,95
1912	2108	96	34,18
1911	2107	97	35,46

PI1	PI2	PC1 PC2	X1 X2
PIU	PIU	PIU	m
2065	2261	-57	-8,14
2066	2262	-58	-8,45
2067	2263	-59	-8,76
2068	2264	-60	-9,09
2069	2265	-61	-9,43
2070	2266	-62	-9,79
2071	2267	-63	-10,15
2072	2268	-64	-10,53
2073	2269	-65	-10,93
2074	2270	-66	-11,34
2075	2271	-67	-11,76
2076	2272	-68	-12,20
2077	2273	-69	-12,66
2078	2274	-70	-13,13
2079	2275	-71	-13,63
2080	2276	-72	-14,14
2081	2277	-73	-14,67
2082	2278	-74	-15,22
2083	2279	-75	-15,79
2084	2280	-76	-16,38
2085	2281	-77	-16,99
2086	2282	-78	-17,63
2087	2283	-79	-18,29
2088	2284	-80	-18,97
2089	2285	-81	-19,68
2090	2286	-82	-20,42
2091	2287	-83	-21,19
2092	2288	-84	-21,98
2093	2289	-85	-22,80
2094	2290	-86	-23,66
2095	2291	-87	-24,55
2096	2292	-88	-25,47
2097	2293	-89	-26,42
2098	2294	-90	-27,41
2099	2295	-91	-28,44
2100	2296	-92	-29,50
2101	2297	-93	-30,61
2102	2298	-94	-31,76
2103	2299	-95	-32,95
2104	2300	-96	-34,18
2105	2301	-97	-35,46

Table 77. Real-Time Code, Position Code Decoding Table

Appendix D: Position Code Encoding Table (Informative)

This is an example of the "positive part" of a position encoding table where the selected resolution is equal to 4cm. The encoder shall consider how the 4cm resolution is achieved before using the below encoding table. For example an incorrect rounding may induce a 2cm table error resulting in a statistical almost 3cm position vector error.

PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m
0	0,00	27	2,72	47	5,72	59	8,72	67	11,72	73	14,72	78	17,72	82	20,72	86	23,72	89	26,72	92	29,72	95	32,72
0	0,04	28	2,76	48	5,76	59	8,76	67	11,76	73	14,76	78	17,76	82	20,76	86	23,76	89	26,76	92	29,76	95	32,76
1	0,08	28	2,80	48	5,80	59	8,80	67	11,80	73	14,80	78	17,80	82	20,80	86	23,80	89	26,80	92	29,80	95	32,80
1	0,12	28	2,84	48	5,84	59	8,84	67	11,84	73	14,84	78	17,84	83	20,84	86	23,84	89	26,84	92	29,84	95	32,84
2	0,16	29	2,88	48	5,88	59	8,88	67	11,88	73	14,88	78	17,88	83	20,88	86	23,88	89	26,88	92	29,88	95	32,88
2	0,20	29	2,92	48	5,92	59	8,92	67	11,92	73	14,92	78	17,92	83	20,92	86	23,92	90	26,92	92	29,92	95	32,92
2	0,24	29	2,96	49	5,96	60	8,96	67	11,96	74	14,96	79	17,96	83	20,96	86	23,96	90	26,96	92	29,96	95	32,96
3	0,28	30	3,00	49	6,00	60	9,00	68	12,00	74	15,00	79	18,00	83	21,00	86	24,00	90	27,00	92	30,00	95	33,00
3	0,32	30	3,04	49	6,04	60	9,04	68	12,04	74	15,04	79	18,04	83	21,04	86	24,04	90	27,04	92	30,04	95	33,04
4	0,36	31	3,08	49	6,08	60	9,08	68	12,08	74	15,08	79	18,08	83	21,08	86	24,08	90	27,08	93	30,08	95	33,08
4	0,40	31	3,12	49	6,12	60	9,12	68	12,12	74	15,12	79	18,12	83	21,12	87	24,12	90	27,12	93	30,12	95	33,12
4	0,44	31	3,16	49	6,16	60	9,16	68	12,16	74	15,16	79	18,16	83	21,16	87	24,16	90	27,16	93	30,16	95	33,16
5	0,48	32	3,20	50	6,20	60	9,20	68	12,20	74	15,20	79	18,20	83	21,20	87	24,20	90	27,20	93	30,20	95	33,20
5	0,52	32	3,24	50	6,24	60	9,24	68	12,24	74	15,24	79	18,24	83	21,24	87	24,24	90	27,24	93	30,24	95	33,24
6	0,56	32	3,28	50	6,28	61	9,28	68	12,28	74	15,28	79	18,28	83	21,28	87	24,28	90	27,28	93	30,28	95	33,28
6	0,60	33	3,32	50	6,32	61	9,32	68	12,32	74	15,32	79	18,32	83	21,32	87	24,32	90	27,32	93	30,32	95	33,32
6	0,64	33	3,36	50	6,36	61	9,36	68	12,36	74	15,36	79	18,36	83	21,36	87	24,36	90	27,36	93	30,36	95	33,36
7	0,68	33	3,40	50	6,40	61	9,40	68	12,40	74	15,40	79	18,40	83	21,40	87	24,40	90	27,40	93	30,40	95	33,40
7	0,72	34	3,44	51	6,44	61	9,44	69	12,44	74	15,44	79	18,44	83	21,44	87	24,44	90	27,44	93	30,44	95	33,44
8	0,76	34	3,48	51	6,48	61	9,48	69	12,48	74	15,48	79	18,48	83	21,48	87	24,48	90	27,48	93	30,48	95	33,48
8	0,80	34	3,52	51	6,52	61	9,52	69	12,52	75	15,52	79	18,52	83	21,52	87	24,52	90	27,52	93	30,52	95	33,52
8	0,84	35	3,56	51	6,56	61	9,56	69	12,56	75	15,56	79	18,56	83	21,56	87	24,56	90	27,56	93	30,56	96	33,56
9	0,88	35	3,60	51	6,60	61	9,60	69	12,60	75	15,60	79	18,60	84	21,60	87	24,60	90	27,60	93	30,60	96	33,60
9	0,92	35	3,64	51	6,64	62	9,64	69	12,64	75	15,64	80	18,64	84	21,64	87	24,64	90	27,64	93	30,64	96	33,64
10	0,96	35	3,68	52	6,68	62	9,68	69	12,68	75	15,68	80	18,68	84	21,68	87	24,68	90	27,68	93	30,68	96	33,68
10	1,00	36	3,72	52	6,72	62	9,72	69	12,72	75	15,72	80	18,72	84	21,72	87	24,72	90	27,72	93	30,72	96	33,72
10	1,04	36	3,76	52	6,76	62	9,76	69	12,76	75	15,76	80	18,76	84	21,76	87	24,76	90	27,76	93	30,76	96	33,76
11	1,08	36	3,80	52	6,80	62	9,80	69	12,80	75	15,80	80	18,80	84	21,80	87	24,80	90	27,80	93	30,80	96	33,80
11	1,12	37	3,84	52	6,84	62	9,84	69	12,84	75	15,84	80	18,84	84	21,84	87	24,84	90	27,84	93	30,84	96	33,84
12	1,16	37	3,88	52	6,88	62	9,88	69	12,88	75	15,88	80	18,88	84	21,88	87	24,88	90	27,88	93	30,88	96	33,88
12	1,20	37	3,92	53	6,92	62	9,92	70	12,92	75	15,92	80	18,92	84	21,92	87	24,92	91	27,92	93	30,92	96	33,92
12	1,24	37	3,96	53	6,96	62	9,96	70	12,96	75	15,96	80	18,96	84	21,96	87	24,96	91	27,96	93	30,96	96	33,96
13	1,28	38	4,00	53	7,00	63	10,00	70	13,00	75	16,00	80	19,00	84	22,00	87	25,00	91	28,00	93	31,00	96	34,00
13	1,32	38	4,04	53	7,04	63	10,04	70	13,04	75	16,04	80	19,04	84	22,04	88	25,04	91	28,04	93	31,04	96	34,04
14	1,36	38	4,08	53	7,08	63	10,08	70	13,08	76	16,08	80	19,08	84	22,08	88	25,08	91	28,08	93	31,08	96	34,08
14	1,40	38	4,12	53	7,12	63	10,12	70	13,12	76	16,12	80	19,12	84	22,12	88	25,12	91	28,12	93	31,12	96	34,12
14	1,44	39	4,16	54	7,16	63	10,16	70	13,16	76	16,16	80	19,16	84	22,16	88	25,16	91	28,16	93	31,16	96	34,16
15	1,48	39	4,20	54	7,20	63	10,20	70	13,20	76	16,20	80	19,20	84	22,20	88	25,20	91	28,20	94	31,20	96	34,20

PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m	PIU	m
15	1,52	39	4,24	54	7,24	63	10,24	70	13,24	76	16,24	80	19,24	84	22,24	88	25,24	91	28,24	94	31,24	96	34,24
16	1,56	40	4,28	54	7,28	63	10,28	70	13,28	76	16,28	80	19,28	84	22,28	88	25,28	91	28,28	94	31,28	96	34,28
16	1,60	40	4,32	54	7,32	63	10,32	70	13,32	76	16,32	80	19,32	84	22,32	88	25,32	91	28,32	94	31,32	96	34,32
16	1,64	40	4,36	54	7,36	64	10,36	70	13,36	76	16,36	81	19,36	84	22,36	88	25,36	91	28,36	94	31,36	96	34,36
17	1,68	40	4,40	54	7,40	64	10,40	71	13,40	76	16,40	81	19,40	85	22,40	88	25,40	91	28,40	94	31,40	96	34,40
17	1,72	41	4,44	55	7,44	64	10,44	71	13,44	76	16,44	81	19,44	85	22,44	88	25,44	91	28,44	94	31,44	96	34,44
18	1,76	41	4,48	55	7,48	64	10,48	71	13,48	76	16,48	81	19,48	85	22,48	88	25,48	91	28,48	94	31,48	96	34,48
18	1,80	41	4,52	55	7,52	64	10,52	71	13,52	76	16,52	81	19,52	85	22,52	88	25,52	91	28,52	94	31,52	96	34,52
18	1,84	41	4,56	55	7,56	64	10,56	71	13,56	76	16,56	81	19,56	85	22,56	88	25,56	91	28,56	94	31,56	96	34,56
19	1,88	41	4,60	55	7,60	64	10,60	71	13,60	76	16,60	81	19,60	85	22,60	88	25,60	91	28,60	94	31,60	96	34,60
19	1,92	42	4,64	55	7,64	64	10,64	71	13,64	76	16,64	81	19,64	85	22,64	88	25,64	91	28,64	94	31,64	96	34,64
20	1,96	42	4,68	55	7,68	64	10,68	71	13,68	76	16,68	81	19,68	85	22,68	88	25,68	91	28,68	94	31,68	96	34,68
20	2,00	42	4,72	56	7,72	64	10,72	71	13,72	77	16,72	81	19,72	85	22,72	88	25,72	91	28,72	94	31,72	96	34,72
20	2,04	42	4,76	56	7,76	65	10,76	71	13,76	77	16,76	81	19,76	85	22,76	88	25,76	91	28,76	94	31,76	96	34,76
21	2,08	43	4,80	56	7,80	65	10,80	71	13,80	77	16,80	81	19,80	85	22,80	88	25,80	91	28,80	94	31,80	96	34,80
21	2,12	43	4,84	56	7,84	65	10,84	71	13,84	77	16,84	81	19,84	85	22,84	88	25,84	91	28,84	94	31,84		
22	2,16	43	4,88	56	7,88	65	10,88	72	13,88	77	16,88	81	19,88	85	22,88	88	25,88	91	28,88	94	31,88		
22	2,20	43	4,92	56	7,92	65	10,92	72	13,92	77	16,92	81	19,92	85	22,92	88	25,92	91	28,92	94	31,92		
22	2,24	44	4,96	56	7,96	65	10,96	72	13,96	77	16,96	81	19,96	85	22,96	89	25,96	91	28,96	94	31,96		
23	2,28	44	5,00	57	8,00	65	11,00	72	14,00	77	17,00	81	20,00	85	23,00	89	26,00	92	29,00	94	32,00		
23	2,32	44	5,04	57	8,04	65	11,04	72	14,04	77	17,04	81	20,04	85	23,04	89	26,04	92	29,04	94	32,04		
24	2,36	44	5,08	57	8,08	65	11,08	72	14,08	77	17,08	82	20,08	85	23,08	89	26,08	92	29,08	94	32,08		
24	2,40	44	5,12	57	8,12	65	11,12	72	14,12	77	17,12	82	20,12	85	23,12	89	26,12	92	29,12	94	32,12		
24	2,44	45	5,16	57	8,16	66	11,16	72	14,16	77	17,16	82	20,16	85	23,16	89	26,16	92	29,16	94	32,16		
25	2,48	45	5,20	57	8,20	66	11,20	72	14,20	77	17,20	82	20,20	85	23,20	89	26,20	92	29,20	94	32,20		
25	2,52	45	5,24	57	8,24	66	11,24	72	14,24	77	17,24	82	20,24	86	23,24	89	26,24	92	29,24	94	32,24		
26	2,56	45	5,28	57	8,28	66	11,28	72	14,28	77	17,28	82	20,28	86	23,28	89	26,28	92	29,28	94	32,28		
26	2,60	45	5,32	58	8,32	66	11,32	72	14,32	78	17,32	82	20,32	86	23,32	89	26,32	92	29,32	94	32,32		
26	2,64	46	5,36	58	8,36	66	11,36	72	14,36	78	17,36	82	20,36	86	23,36	89	26,36	92	29,36	95	32,36		
27	2,68	46	5,40	58	8,40	66	11,40	73	14,40	78	17,40	82	20,40	86	23,40	89	26,40	92	29,40	95	32,40		
		46	5,44	58	8,44	66	11,44	73	14,44	78	17,44	82	20,44	86	23,44	89	26,44	92	29,44	95	32,44		
		46	5,48	58	8,48	66	11,48	73	14,48	78	17,48	82	20,48	86	23,48	89	26,48	92	29,48	95	32,48		
		46	5,52	58	8,52	66	11,52	73	14,52	78	17,52	82	20,52	86	23,52	89	26,52	92	29,52	95	32,52		
		47	5,56	58	8,56	67	11,56	73	14,56	78	17,56	82	20,56	86	23,56	89	26,56	92	29,56	95	32,56		
		47	5,60	58	8,60	67	11,60	73	14,60	78	17,60	82	20,60	86	23,60	89	26,60	92	29,60	95	32,60		
		47	5,64	59	8,64	67	11,64	73	14,64	78	17,64	82	20,64	86	23,64	89	26,64	92	29,64	95	32,64		
		47	5,68	59	8,68	67	11,68	73	14,68	78	17,68	82	20,68	86	23,68	89	26,68	92	29,68	95	32,68		

Table 78. Real-Time Code, Position Code Encoding Table

Annex B – UCATT RULES OF VOTING

The following Rules of Voting were given for balloting processes during the UCATT meetings.

RULES OF BUSINESS

(Original Version 1.0 dated 16 August 2012)
(Revision 1.2 dated 19 September 2012)
(Revision 1.3 dated 26 November 2012)

INTERNATIONAL MODEL NORTH ATLANTIC TREATY ORGANIZATION
adopted for UCATT

PART I. MEETINGS

Meetings of UCATT (Architecture and Standards) will be held at a time and place designated by the Steering Group.

PART II. AGENDA

1. The agenda for regular meetings of UCATT shall be drawn up by the Steering Group and communicated to the members at least two weeks prior to the opening of the meetings.
2. The first item of business for each meeting shall be the approval of the working agenda by a simple majority vote of the members present.
3. Additional items may be placed on the agenda, if the UCATT group so decide by a simple majority vote of the members present.

PART III. REPRESENTATION

1. Each active member shall be allowed one vote. For voting purposes, members become inactive when they fail to attend two consecutive meetings.
2. Representation at each meeting will be certified by the Group Chairperson and/or Group Secretary.
3. Members are requested to participate to all the meetings, when for reasons participation is not possible they should tell (in writing) this ASAP to the Group Chairperson and Group Secretary.

PART V: THE CHAIRPERSON

1. The Group Chairperson shall have the responsibility of ensuring the smooth operation of the meeting through interpretation and enforcement of the Rules. In addition to exercising powers described elsewhere in the Rules, the Chairperson shall declare the opening and closing of each meeting, direct discussions, accord the right to speak and announce decisions. He/she shall rule on points of order and, subject to these Rules, shall have complete control of the proceedings at any meeting. The Chairperson may suspend the rules for the conduct of business when appropriate and for the convenience of the group. All votes on decisions within the group must be managed in accordance with the voting rules which may not be suspended by the Chairperson.
2. The decision of the Chairperson may be appealed by any member. This motion is debatable by one member in favor and one against, after which the motion shall be put to a vote. The Chairperson's decision will stand unless overruled by a two-thirds majority of eligible voting members present.

PART VI: CONDUCT OF BUSINESS

Business processes for UCATT:

1. The Group Chairperson may declare the meeting open if one-third of the members are present. The presence of a majority of voting eligible members is required for a decision to be taken (other than agenda modifications).
2. The Group Secretary will produce a list of all members that are present at the meeting.
3. Committees are sub-elements of the overall Group and will not apply these rules to their activities other than their responsibility to generate draft language and decision proposals.
4. Voting on draft language and decision proposals shall only occur at the Group Level within UCATT.
5. Decision motions (other than agenda modifications) must be developed by the Committees and submitted in writing to the Group Chairperson & Secretary. The Chairperson may take up to twelve (12) hours to review the motion before presenting it to the overall membership for review.
6. Decision motions must be presented to the voting members at least 12 hours before the vote is called to allow review and consultations.
7. Amendments may be proposed by any member during discussion and must be presented to the Group Chairman in writing or through dictation (word for word) during live discussion.
8. The following motions shall be utilized to facilitate decision making during the meeting:

a) Decision Proposal (Motion)
To introduce a new piece of business or propose a new decision or action, a motion must be made by the Committee Chair/Secretary ("I move that......"). A second motion must then also be made (raise your hand and say, "I second it.") After debate & discussion the group then votes on the motion. Administrative motions regarding business proceedings or deliberations regarding a pending decision or action may be made by any active member. A second motion may be required as appropriate along with additional discussion. All administrative motions must be resolved prior to voting on affected decision or action motions.

Note: If more than one motion is proposed, the most recent takes precedence over the ones preceding it.

b) Point of Order
During the discussion of any matter, a member may raise a Point of Order, and the point of order shall be immediately decided by the Chairperson in accordance with the Rules of Procedure. A Point of Order may relate to the maintenance of order, the observance of Rules, or the way in which the presiding officers exercise the powers conferred upon them. An argument for or against the pending question shall not be recognized as a valid point of order. ***A point of order is the only circumstance under which a speaker may be interrupted***. The Chairperson may refuse to recognize points of order if it is his/her judgment that the member has not maintained the restraint and decorum which should govern the use of such a right, or if in his/her judgment the point is clearly dilatory in nature.

c) Point of Information
A Point of Information is raised to the Chairperson if a member wishes to obtain a clarification of procedure or a statement of the matters before the body. Members may not interrupt a speaker on a Point of Information.

d) Point of Inquiry
A member requesting clarification or additional information will raise a Point of Inquiry. A Point of Inquiry may be used to question a speaker only after he/she has finished his/her remarks and may not interrupt any speaker. A questioner will address the Point of Inquiry to the Chairperson, who will then ask the speaker if he/she *wishes to yield*.

e) To suspend the meeting
During the discussion of a matter, a member may move for the Suspension of the meeting. Should the Chairperson entertain it, it shall immediately be put to a vote. The suspension of a meeting requires a simple majority of the members present and voting.

f) To adjourn the meeting
At the conclusion of business defined in the approved agenda, a member may move for the Adjournment of the meeting until the next scheduled date. This motion is only in order for the full membership and requires a second and a two-thirds majority.

g) To suspend debate on the item under discussion
During the discussion of any matter, a member may move to Suspend debate on the item under discussion. Two representatives may speak in favor of the motion and two against the motion, after which the motion shall immediately be put to a vote. This motion requires a two-thirds majority to pass.

h) To close debate on the item under discussion
A member may move for Closure of debate on the item under discussion; whether or not any other member has signified his/her desire to speak. Two members may speak in favor of the motion and two against, after which time the motion shall be put to an immediate vote. This motion requires a two-thirds majority vote to pass.

i) To postpone indefinitely
This tactic is used to kill a motion. When passed, the motion cannot be reintroduced at that meeting. It may be brought up again at a later date. This is made as a motion ("I move to postpone indefinitely..."). A second is required. A majority vote is required to postpone the motion under consideration.

j) To Change the Order of Consideration of Agenda Items
Agenda items will be considered in the order in which they appear on the agenda, unless that order is altered by the passage of a motion To Change the Order of Consideration of Agenda Items. This motion is only in order during the first session of the conference. Once the agenda has been set, it may not be changed unless the group is tasked with a crisis by the Steering Committee. A majority vote is needed for passage.

k) To limit debate on the item under discussion
When discussing an item on the agenda, a member may move to Limit Debate. The purpose of this motion is to focus the committee's attention on the topic or individual draft resolution or amendment. Once this motion has passed, debate is limited to introducing and discussing any draft language under that topic. A member may also limit debate to draft language or a amendment, meaning all discussion must be relevant to the document at hand. Once limited, debate on a topic or document can be suspended or closed. This motion requires a second and a simple majority.

l) To Divide the Question
In the group, a member may move to Divide the Question, so that parts of draft language or an amendment could be voted on separately. If objection is made to the request for division, the motion shall be voted upon, requiring a simple majority to pass. Permission to speak on the motion shall be accorded to two speakers in favor and two against. If the motion for division is carried, those parts of the proposal shall then be put to a vote as a whole. If all operative parts of the proposal or of the amendment have been rejected, the proposal or the amendment shall be considered to have been rejected as a whole.

m) To amend the item under discussion
An Amendment is that which adds to, deletes, or alters part of the Draft Language. Amendments must be submitted in writing (or dictated word for word during live forum) to the Chairperson during the discussion of a Draft Language and must receive his/her approval. The Chairperson may, at his/her discretion, limit the number of amendments or request members to combine similar amendments. Amendments shall be numbered in the order in which they are received. Once the Amendment is introduced, all sponsors of the draft language to which the Amendment pertains must be asked if the Amendment is Friendly or Unfriendly. If the Amendment is deemed Friendly by all Sponsors, then it is automatically adopted into the Draft Language. If the Amendment is deemed Unfriendly by any of the Sponsors, then it is dismissed and voted upon by the Group. The Group may limit debate to any dismissed Amendment and at the closure of debate on the Amendment, the Amendment will be voted upon by the Group. Regardless of limitation, *all* dismissed Amendments must be voted upon by the Group after the closure of debate on relevant draft language.

This is the process used to change a motion under consideration. Perhaps you like the idea proposed but not exactly as offered. Raise your hand and make the following motion: "I move to amend the motion on the floor." This also requires a second. After the motion to amend is seconded, a majority vote is needed to decide whether the amendment is accepted. Then a vote is taken on the amended motion. In some organizations, a "friendly amendment" is made. If the person who made the original motion agrees with the suggested changes, the amended motion may be voted on without a separate vote to approve the amendment.

n) To reconsider

When a proposal has been adopted or rejected it may not be considered at the same session but may be introduced at the next meeting and must be approved by a two-thirds majority. Permission to speak on a Motion to Reconsider will be accorded to speakers opposing and favoring the motion.

o) Right of Reply

The Chairperson may accord a Right of Reply in the case of grave personal insult and injury. The offense to which the member is responding must occur within formal debate. The right of reply must be submitted in writing to the Chairperson. Upon the Chairperson's approval, the member may move for a right of reply. The time granted for a right of reply is at the Chairperson's discretion. There may not be a right of reply in response to another member's right of reply.

p) Call the Question

To end a debate immediately, any member, when mandatory debate has been completed regarding a specific draft language or decision proposal, may Call the Question which when seconded serves to direct the Chairperson to discontinue discussion and poll the voting membership for a vote on the issue at hand. A two-thirds vote is required for passage. If it is passed, the motion on the floor is voted on immediately.

q) Commit

This is used to place a motion in committee. It requires a second. A majority vote must rule to carry it. At the next meeting the committee is required to prepare a report on the motion committed. If an appropriate committee exists, the motion goes to that committee. If not, a new committee is established.

r) Table

To Table a discussion is to lay aside the business at hand in such a manner that it will be considered later in the meeting or at another time ("I make a motion to table this discussion until the next meeting. In the meantime, we will get more information so we can better discuss the issue.") A second is needed and a majority vote required to table the item being discussed.

PART VII: VOTING

1. Each active member within UCATT shall be accorded one vote in the Group.
2. Voting must be either in person or by proxy. If by proxy, the voting member must designate to the Chairperson & Secretary their proxy from the list of existing eligible UCATT voting members. The proxy vote may be cast only on decision motions formally announced in a previous UCATT meeting.
3. All decision proposals of the Group must be approved by a simple majority of all voting members present, but with the realization that unanimous consent is desirable.
4. Administrative motions shall be voted on in accordance with the relevant parts of the Rules.
5. Immediately prior to a vote, the Chairperson shall describe to the body the item to be voted on, and shall explain the consequences of a "yes" or a "no" vote. Voting shall begin upon the Chairperson's declaration "**the question has been called**," and end when the results of the vote are announced. Once in voting procedure, no member shall interrupt the voting except on a point of order concerning the actual conduct of the vote. Following Closure of Debate, and prior to entering voting procedure, the Chairperson shall pause briefly to allow members the opportunity to make any relevant motions.

6. Voting shall normally be carried out by raising of hands, unless a representative requests a **Roll Call Vote** where individual voters are called by name and respond with "Aye" or "No" verbally.
7. If hands are not raised indicating a **No** vote, then the Group Secretary shall record the vote as unanimous in the affirmative.
8. The term No with rights may be used by members wishing to explain their vote after voting has concluded. This right may be limited by the Chairperson.
9. A member may record a formal Reservation if a particular part of a proposal is partially unacceptable to him/her. This reservation is raised at the time of voting and will be formally recorded on the proposal in question.

PART VIII: GENERAL

1. The official language of the sessions is English.
2. Members are expected to dress in UCATT casual for the duration of the meetings.
3. The NATO UCATT Working Group Chair with the lower assigned MSG # will act as the overall Group Chairperson when multiple working groups are collaborating on the UCATT program.
4. The UCATT Group will consist of any and all NATO level Working Groups chartered to address the interoperability of instrumentation and operating with the UCATT name.

Voted on an unanimously approved by the UCATT membership in attendance – 19 September 2012.

Armin Thinnes
Chairman
NATO UCATT MSG-98

Annex C – GUIDANCE DOCUMENT

The Guidance Document is the overarching architecture of the UCATT Interface Standard for Laser Engagement. It shows the structure of the UCATT physical interfaces.

Simulation Interoperability Standards Organization
"Simulation Interoperability & Reuse through Standards"

SISO-GUIDE-XXX-YYYY

UCATT Live Simulation Standards and Architecture

Guidance Document
Version 1.0

[MONTH] 2015

Prepared by
Urban Combat Advanced Training Technology (UCATT) Product Development Group

P.O. Box 781238
Orlando, FL 32878-1238, USA

Revision History

Version	Section	Date (DD/MM/YYYY)	Description
0.1	All	27/03/2014	First draft released for internal proofreading
0.2	All	06/05/2014	Overall editing after review by PDG
1.0	All	30/02/2015	Final draft

Participants

At the time this product was submitted to the Standards Activity Committee (SAC) for approval, the UCATT Product Development Group had the following membership and was assigned the following SAC Technical Area Director:

Product Development Group

Capt Sander Cruiming (Chair)
Mr Staffan Martinsen (Vice-Chair)
Mr Joachim Eisenhauer (Secretary)

Mr Grant Bailey (SAC Technical Area Director)

Mr Magnus Alexandersson
Mr Mark Chamberlain
Mr Thomas Defachelles
Dr. Uwe Dobrindt
Maj Johnny Gullstrand
Mr Anders Lindström
Mr Armin Thinnes
Mr Thierry Vinatier
Mr Ingo Wittwer
Mr Jesse Campos
Mr Michelle Coriat
Mr Philippe Desruelles
Mr Rudi Gouweleeuw
Maj Roger Karlsson
LtCol Peter Makowski
Mr Jan Vermeulen
Mr Gary Washam

The Product Development Group would like to especially acknowledge those individuals that significantly contributed to the preparation of this product as follows:

PDG Drafting Group for E1/I2 Laser standard

Mr Anders Lindström (Editor)

Mr Magnus Alexandersson
Mr Jesse Campos
Mr Joachim Eisenhauer
Mr Armin Thinnes
Mr Jan Vermeulen
Mr Thierry Vinatier
Mr Gary Washam
Mr Ingo Wittwer

The following individuals comprised the ballot group for this product.

Ballot Group

Member Name
Member Name
Member Name
…..*<continue with all the other Ballot Group member names and place all in alphabetical order>*

When the Standards Activity Committee approved this product on DD Month YYYY, it had the following membership:

Standards Activity Committee

Member Name (Chair)
Member Name (Vice Chair)
Member Name (Secretary)

Member Name
Member Name
Member Name

…..<continue with all the other SAC member names and place all in alphabetical order>

When the Executive Committee approved this product on DD Month YYYY, it had the following membership:

Executive Committee

Member Name (Chair)
Member Name (Vice Chair)
Member Name (Secretary)

Member Name
Member Name
Member Name

…..<continue with all the other EXXOM member names and place all in alphabetical order>

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1 Introduction

1.1 Purpose

The purpose of this product is to provide context for the Urban Combat Advanced Training Technology (UCATT) family of standards and architecture in order to;

- Enable data exchange between (legacy) live simulation systems from different suppliers and end-users;
- Enable data exchange between sub-systems of live simulation systems from different manufacturers and end-users;
- Support the design, development and construction of live simulation systems;
- Give guidance to the definition of future live simulation system requirements to support interoperability.

1.2 Scope

The UCATT Live Simulation Standards and Architecture are aimed at providing joint and combined military training through the ability to interconnect live simulation training systems, otherwise known as CTC's (Combat Training Centers). CTC's contain a multitude of interfaces over which data is sent and received before, during and after an exercise. UCATT has identified some of those interfaces to be internal (only of interest to the system itself) and some to be external interfaces (data sent to outside of the system).
To achieve full interoperability, all or most interfaces will need to be standardized. Up to this date 11 external interfaces have been identified and considered standardization candidates. The UCATT standard is therefore considered a family of standards, even though each individual standard can also be used on its own. This, and the fact that 15 years of study and analysis have taken place prior to its publication, makes the UCATT family of standards quite complex compared to other existing (SISO) standards.
Therefore, the UCATT PDG developed this guidance document.

Although the initial scope of the various Working Groups (MSG-032, MSG-063, MSG-098/099 and the SISO UCATT PDG) was directed at Urban Operations training, as the UCATT acronym suggests, systems using individual UCATT standards will have no limitations in deploying in environments elsewhere. Indeed the standards have benefitted from the considerations required due to the urban environment and the unique challenges, complexity and context that describes.

This document was intended to grow and develop over time, based on community requirements and future standard development.

1.3 Objective

The objective of this guidance document is to:

- Provide context and understanding for the related UCATT standards;
- Provide a functional architecture which show UCATT standard interrelationship;
- Give historical context to the development of the UCATT standards;
- Give guidance to UCATT standard implementation and system design;
- Serve as a knowledgebase for future standard development;

1.4 Intended Audience

The primary audience for this document is the Modelling & Simulation community. Even though developed with live simulation systems in mind, other communities are encouraged to leverage this standard for use within their own community.
Within the M&S community this document in primarily intended for (industry) system engineers, procurement agency personnel and (military) end-users.

1.5 Structure

This document starts with providing historical background to the development of the UCATT family of standards, which has started over fifteen years ago and went from study and analysis to delivering its first standard to the community. After that an explanation is given about the basis of all UCATT work to date: the operational use cases, Capability Requirement Matrix, the functional architecture, together with the benefits of the standard and study approach. The following chapters explain each individual functional and physical interface, giving guidance on system design. UCATT based its technical interoperability work on the OSI 7-layer model, which is explained in the final chapter.

1.6 Acknowledgements

This document was created as a community effort by the NATO UCATT working group (MSG-032/063/098/099) and the Urban Combat Advanced Training Technology Product Development Group (UCATT PDG). The PDG was chartered by SISO in November 2013.
This product would not have been possible without the hard work and dedication of the following individuals:

<u>MSG-098/099 UCATT members (if not already listed as PDG members):</u>

Mr Steve Blahnik
Mr Max Fenner
LtCol Rolf Lerch

2 References

2.1 SISO References

Document number	Title	Date
SISO-STD-007-2008	Standard for: Military Scenario Definition Language (MSDL)	Oct 14, 2008
SISO-REF-042-2013	UCATT Study Group Final Report	Jan 8, 2013
SISO-ADM-001-2011	Policy for Numbering of SISO Products	June 13, 2011
SISO-ADM-02-2011	SISO Policies & Procedures	April, 2011
SISO-ADM-03-2011	SISO Balloted Products Development and Support Process (BPDSP)	Nov 14, 2011
SISO-ADM-05-2011	Policy for: The Style and Format of SISO documents	June 13, 2011
SISO-PN-008-2014	Product nomination for Standardization of UCATT architecture external interfaces for live simulation instrumented training interoperability	April 16, 2014
SISO-STD-01102014	Standard for Coalition Battle Management	April 14, 2014

	Language (C-BML)	

2.2 Other references

Document number	Title	Date
STANAG 2019, edition 6	NATO Joint Military Symbology App-6(C), May 2011	May, 2011
AC/323(MSG-032)TP/293	MSG-032 UCATT Final Report	April, 2010
	MSG-063 UCATT Final Report	To be released
ISO/IEC 7498-1	Information Technology – Open Systems Interconnection – Basic Reference Model: the Basic Model	
RTO-TR-8/AC323(SAS)/TP-5	Land Operations in the year 2020	March, 1999
RTO-TR-071/AC323(SAS030) TP/35	Urban Operations in the year 2020	April, 2003
STANAG 5525	Joint C3 Information Exchange Data Model	June 26, 2007

3 Definitions

The following definitions are given for clarity only, not as guidelines.

Term	Definition
After Action Review	Providing interactive and objective feedback to the training audience regarding its exercise performance.
Architecture	The structure of components in a program/system, their relationships and the principles and guidelines governing their design and evolution over time.
Combat Training Centre	A Combat training centre is an instrumented range, urban operations training village or exercise area. It can also be a mobile system capable of instrumenting a training area.
Dynamic Object	A live, virtual or constructive element in the training environment that 1) has a presence in the environment and either 2) has a valid status, or 3) can influence the status of other DOs (execute engagements) or possesses both of these characteristics. Ad 1. Presence: a DO can be seen, observed or detected in the training environment. For example, a vehicle can be seen by the naked eye, observed in infra-red, detected by radar and be tracked by C4I systems. But even a CBRN area can be detected with specific sensors. Associated with its presence is its position. During an exercise the position of a DO can be dynamic (e.g. a soldier can move around) or static (e.g. a wall generally stays on the same position during an exercise). Ad 2. Status indicates the (level of) capabilities of a DO. It can be very basic (such as for example dead/alive for human beings, or operational/destroyed for weapon systems and infrastructure), or it can be more complex, distinguishing between more levels of degraded performance. The status of a DO can be changed during and exercise, either by engagements from other DOs or by

(interventions from) the training system. Although it could be required that a DO has a fixed status that cannot be changed, thus rendering it untouchable or indestructible in an exercise. A typical example of such a DO is an O/C, its status cannot be changed, but it can engage other DOs.
Ad 3. Engagement. Generally a DO can influence the status of other DOs, especially in the context of urban combat. For example, a soldier can fire an anti-tank weapon at a vehicle or at a building, a wall could be destroyed and with its debris it can engage DOs in its vicinity, and a CBRN area can affect unprotected DOs that enter it.
However, examples of DOs that cannot engage are a pop-up target or an unarmed UAV, which is just a sensor platform.

Exercise Control The ability to conduct the following functions: exercise planning, exercise preparation, conducting an exercise, preparing and providing After Action Review.

Facility Control The capability to represent the static environment (infrastructure, buildings, roads, etc) This can either be fixed or mobile (e.g. containers)

Interoperability The ability of a model or simulation to provide services to and accept services from other models and simulations, and to use these exchanged services to operate effectively together.

Live Simulation A simulation involving real people operating real systems.

Model A physical, mathematical or otherwise logical representation of a system, entity, phenomenon or process.

Modelling & Simulation The discipline that comprises the development and/or use of models and simulations.

MOUT facility A building, or number of buildings, dedicated to training military units to operate in the urban environment.

Observer/Controller The capability to analyse the results of an exercise and provide feedback to the training audience.

Simulation A method for implementing a model over time.

System A group of related hardware units or programs or both, especially when dedicated to a single application.

System Control The capability to monitor and control the training system itself, necessary to support the training exercise.

4 Acronyms and abbreviations

AAR	After Action Review
AG	Architecture Group
AGDUS	Ausbildungsgerät Duellsimulator / Duel Simulator in German Language
BMS	Battlefield Management System
C4I	Command, Control, Communications, Computers and Intelligence

CBRNe	Chemical Biological Radiological Nuclear explosives
C-BML	Coalition Battle Management Language
CNR	Combat Net Radio
CRM	Capability Requirements Matrix
CTC	Combat Training Centre
DA	Design Architecture
DIS	Distributed Interactive Simulation
DO	Dynamic Object
EU	European Union
EXCON	Exercise Control
FA	Functional Architecture
FIBUA	Fighting in Built-Up Areas
HICON	Higher Control
HLA	High Level Architecture
IED	Improvised Explosive Device
IEEE	Institute of Electrical and Electronics Engineers
JC3IEDM	Joint Consultation, Command and Control Information Exchange Data Model
LG/8	Land Group 8 (Group under NAAG)
LO2020	Land Operations in the Year 2020
LVC	Live Virtual Constructive
MILSTD	Military Standard
MIP	Multinational Interoperability Programme
MOD	Ministry of Defence
MOOTW	Military Operations Other Than War
MOUT	Military Operations in Urban Terrain
M&S	Modelling and Simulation
MSMP	Modelling and Simulation Master Plan
NAAG	NATO Army Armaments Group
NATO	North Atlantic Treaty Organisation
NMSG	NATO Modelling and Simulation Group
O/C	Observer Controller
ORBAT	Order of Battle
OSAG	Optische Schnittstellen für AGDUS und Gefechts Űbungszentrum Heer
PDD	Personal Detection Device
PDG	Product Development Group
PfP	Partnership for Peace
PID	Player Identity
PSO	Peace Support Operation
R&D	Research and Development
RTO	Research and Technology Organisation
SAS	Studies, Analyses and Simulation
SAT	Small Arms Transmitter
SE	Synthetic Environment
SG	Standards Group
SHAPE	Supreme Headquarters Allied Powers Europe
SISO	Simulation Interoperability Standards Organization
STANAG	Standardization Agreement
STO	Science and Technology Organisation
STOG	Simulation, Training and Operations Group
TES	Tactical Engagement Simulation
TAP	Technical Activity Proposal
TG	Task Group
TOE	Team of Experts

TOR	Terms of Reference
TSWG	Training and Simulation Working Group
TTP	Tactics, Techniques and Procedures
UAV	Unmanned Aerial Vehicle
UCATT	Urban Combat Advanced Training Technology
UN	United Nations
UO	Urban Operations
UO2020	Urban Operations in the Year 2020
WES	Weapon Effects Simulator
WG	Working Group

5 Urban Combat Advanced Training Technology (UCATT)

5.1 Background

5.1.1 Team of Experts (TOE)

Two NATO studies have been fundamental to taking the work of the UCATT WG forward: the NATO Research and Technology Organisation (RTO) 1999 Technical Report, Land Operations in the Year 2020 (LO2020) and the 2003 Urban Operations in the Year 2020 (UO2020) report. LO2020 concluded that NATO forces would likely have to conduct future operations in urban areas.

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 and CTC’s.

The NATO Modelling and Simulation Action/Master Plan (MSMP) identifies 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.

In 2002, a Team of Experts from NATO NAAG completed a feasibility study in order to investigate the need for a generic set of requirements for NATO/PfP countries in relation to live instrumented training. The conclusion was that a number of potential interoperability areas were identified and assessed to be worthy of further investigation.

5.1.2 MSG-032 UCATT-1

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 MOUT facilities and training/simulation systems with a view toward establishing best practice. In addition it was required to identify interoperability requirements, 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.

UCATT has become the NATO focal point for MOUT training technology and exchanging information with the military community and is well regarded among industry as a driving force within the live domain.

Over a three-year period the UCATT TG held 12 meetings in various NATO and PfP countries.

Although in its Terms of Reference it was required to liaise with a number of groups both within Supreme Headquarters Allied Powers Europe (SHAPE) and outside of NATO, which included the STOG (formerly

TSWG), Topical Group 3 from the NAAG and SISO, the main contact group was the NATO Urban Operations TG (formerly FIBUA/MOUT WG).
Besides a technical report, TG 032 delivered a website where all main NATO/PfP MOUT sites are registered (http://www.fibuamoutsite.info). This site is still maintained and supervised by the NATO Urban Operations TG.

5.1.3 MSG-063 UCATT-2

The UCATT-2 WG was the successor of the first UCATT WG within NMSG and was chartered in 2007 as MSG 063 TG 040. The UCATT-2 WG was tasked to continue the work of the previous UCATT WG; to exchange and assess information on MOUT facilities and training/simulation systems with a view toward establishing best practice. In addition it was required to organize an interoperability demonstration to prove standards and start the process of defining standards for laser-, and data communication and audio & visual effects.
It did just that, which resulted in a successful technical demonstration in 2011, held at the Marnehuizen MOUT training facility in The Netherlands. During this demonstration a proof-of-concept was presented, showing systems from multiple manufacturers exchanging information and simulated battlefield effects.

5.1.4 MSG-098/099 UCATT-3

The success of the UCATT-2 technical demonstration led to the institution of two new WG's: the MSG-098 UCATT Architecture Group (AG) and the MSG-099 Standards Group (SG). Since UCATT had now reached the "delivery phase", the decision was made to split up into two WG's to bring focus to the work at hand.
Both WGs operated in close cooperation with joint meetings to aid communication and reduce delay.

The AG was tasked to revise and develop requirements for each individual interface (see Functional Architecture, Ch 7). It then handed over those requirements to the SG, which was tasked with standardizing, based on those requirements.
In accordance with SISO policy, a UCATT PDG was instated. This occurred at the end of 2013. The work done in all the UCATT WGs, the SISO SG and PDG have resulted in this standard.

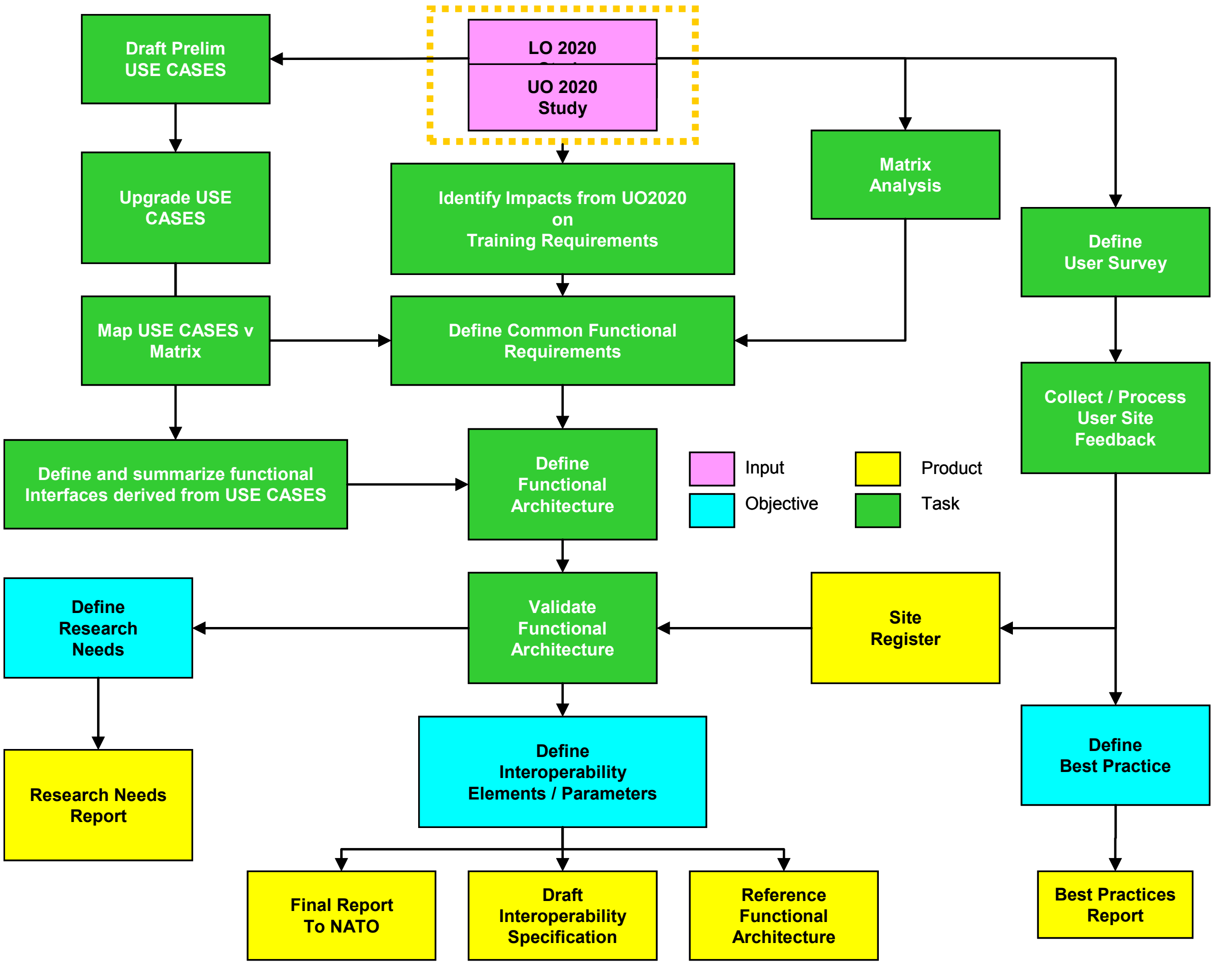

Fig 1 UCATT 1 and 2 study approach

5.2 Military benefit

The military end-user benefits greatly from having interoperability between live simulation systems. Since countries are looking to partner with other countries within different alliances more and more (NATO, EU, PfP, etc), multinational exercises have become more rule than exception.
Having the ability to use their own live simulation equipment during those exercises brings about a higher quality of training, together with an increased sense of “fair play”.
Using the UCATT standard also opens up many more (urban) training facilities to the different nations than before. This again, gives more variety to training and therefore a higher level of readiness.

5.3 Procurement benefit

From a governmental procurement perspective, there are also benefits to be found. Since this product is aimed at interoperability at a modular level, procurement no longer has to follow the “whole system” approach. This decreases vendor lock-in and gives more flexibility to the procurement process . High cost and often bespoke efforts needed to make systems interoperable with specific other vendors or CTC’s (stove pipe couplings) will no longer be necessary in the future if this Standard is widely adopted.

5.4 Industry benefit

Industry partners were invited to work within the UCATT WG's. The benefit that they gained while providing their expertise was that those members of industry were able to form a close relationship with those nations participating and their urban simulation experts. This has enabled industry to understand the user needs and help to direct their own R&D work.
Having an interoperability standard also provides the possibility for industry to enter markets that are now closed due to "vendor lock-in" and give more focus to their areas of expertise.
Industry involvement helps greatly to establish a solid user base for the UCATT standard as it is more likely to be implemented in future products.

5.5 Use Cases

5.5.1 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 requirements. It also provided an opportunity for starting the process of cooperation with the Urban Operations (UO) TG, which was asked to validate the Use Cases and answer a set of generic questions for each one.

The UO 2020 report describes 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 like at that time. Based on the report, presentations and thoughts of each of the national representatives, the UCATT WG developed a set of Use Cases and supporting scenarios, which not only describe the current situation but also accommodate 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 (joint, combined and inter-agency).
The results of the work were five Use Cases and supporting scenarios that were thought would help to both visualize 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 UO TG. This also helped in capturing the training needs of the different nations.
An overview of the Use Cases can be found in the figure below. Further explanation is available in the different UCATT RTO Technical Reports.

USE CASE 0	National training on National site
USE CASE 1	Live MOUT training Multinational 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

Table 1 Overview of the identified use cases

6 Capability Requirements Matrix (CRM)

6.1 Introduction

It was recognized in 2003 that doctrine published by individual NATO/PfP countries did not support or identify joint or combined requirements for conducting effective military operations in an urbanized environment. Very few training exercises were conducted at the joint or combined level in an urban training environment. Countries had different requirements for the level of live training conducted from squad (4-8 personnel) through to Brigade level.
As late as 2006 urban training was not mandated by many of NATO and PfP countries. The UCATT WG, 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.

6.2 Purpose

The purpose of the capability requirements matrix was to identify those components needed to support training at all levels from Squad to Brigade, including non-military (MOOTW) 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 7, through the definition of a common set of functional training requirements. More information and the complete Capability Requirements Matrix can be found in Annex F of the MSG-032 RTO Technical Report.

7 Functional architecture

7.1 Purpose

The capabilities identified in the CRM describe the requirements for a CTC from a user point of view. In order to derive from these capabilities, a generic set of requirements for the development of CTC's, 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 CTC's on the other hand, an architecture must be created and agreed upon.

Formally, an architecture is "the organizational 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 (FA) 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 (DA) 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 was the purpose of UCATT 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, this product's main focus is on 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 an FA of a CTC. This functional architecture must be representative enough to cover all of the Use Cases defined in Chapter 5 and the requirements from the CRM, while not touching specific design or implementation issues. The FA captures what the system can or might do, not how it does or should do it (e.g. the requirement, not the implementation such as communication which might actually be by wireless transmission or through a cable). The UCATT FA is illustrated in Figure 2
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.

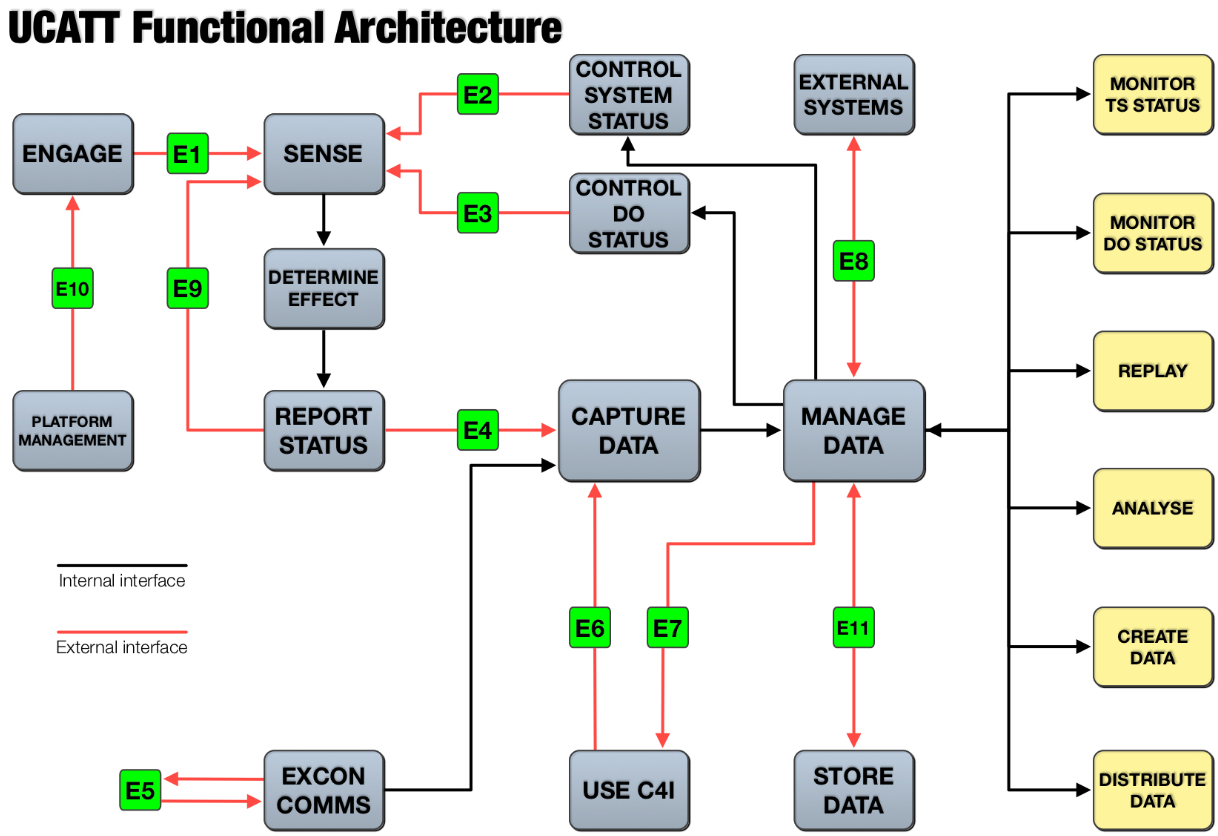

Fig 2 UCATT Functional Architecture

7.2 Internal and external interfaces

In the case of the FA, an interface exists where data is exchanged between functions that reside in the architecture. While the complete FA described and identified all functions and interfaces that can be found in a CTC, it did not definitively identify the interfaces that needed to be standardized to establish interoperability.
In order to do that, a difference was made between internal and external interfaces.
Internal interfaces handle data communication that only takes place in the system itself or a designated sub-system, whereas external interfaces communicate to either outside the system or to a system component that can be replaced by a non-proprietary counterpart (eg. a PDD or SAT from a different vendor). The internal interfaces where considered proprietary and out of scope for standardization, since they were not mandatory for achieving interoperability.
By identifying the external interfaces, it is made explicit what interfaces need to be standardized to achieve interoperability. The external interfaces where subsequently give the designation “E”, followed by an identifying number. From there on, these “E’s” formed the basis of all the work done by UCATT, especially during the final delivery phase. A standard definition for each interface can be found in one of the attached annexes to this document.

7.3 Interface definitions

7.3.1 E1 – DO Engagement (Engage → Sense)

This interface represents an action of one DO on (one or more) other DO(s), with the purpose to change the status of that other DO(s). The engagement contains only the characteristics of the action, not the resulting status of the affected DO(s), the resulting status has to be determined based on these engagement parameters.

Examples:
- Direct or indirect fire from a shooter to a target;
- The explosion of a mine, possibly affecting the status of DOs in its influence sphere;
- Medical treatment of a medic on an injured person;
- A repair action by a maintenance engineer on a damaged vehicle.

7.3.2 E2 – Training system status change (Control training system status → Sense)

This interface controls the technical status of a DO, enabling its functioning in the training environment. Through this interface it is possible that a DO is initialised, reset, calibrated, etc. It also accommodates the distribution of an (altered) terrain representation or damage models for systems that require this data at decentralised nodes, for example in each DO for determination of engagement effects.

Examples:
- Initialization of equipment;
- Calibration of equipment.

7.3.3 E3 – DO Status change (Control Dynamic Object status → Sense)

Through this interface the (simulated) operational status of a DO is set. It contains the new status of the affected DO. This interface implements:
- A direct action of an O/C, for example a reset;
- Distributing the outcome of an engagement that is centrally evaluated (typically in EXCON). In this case a DO is not provided with the engagement parameters to determine the outcome (that is E1), but only with the resulting status. This interface is required for geo pairing systems and for training systems that centrally simulate engagement areas such as for example artillery areas.

Examples:
- Artillery fire simulation, effecting one or multiple DO's.
- CBRNe effects in a certain area.
- Players are reset when entering a designated area (configuration area's).

7.3.4 E4 – DO Reporting (Report status → Capture Data)

A dynamic object reports its (change of) status through this interface to the rest of the world. The status contains for example:
- Operational status, location, supplies, engaging or being engaged, etc;

This interface exists in different physical domains, for example:
- The communication of the status to EXCON (typically radio communication);
- the communication of the status to players, including visual presentations (smoke, lights) or sounds (explosion).

Remark: the interfaces to trigger the physical devices (for example pyrotechnics when shooting or being hit) are considered internal interfaces.

7.3.5 E5 – EXCON Communication (Use EXCON Communication ↔ Use EXCON communication)

This interface enables the communication between training staff members of different systems operating in the same exercise. It covers:

- Voice radio communication;
- Exchange of for example electronic notes, pictures, video.

7.3.6 E6 – Receive C4I Data (Use C4I (capture) → Capture Data)

This interface transfers data from C4I systems to a UCATT training system. This includes Battlefield Management System functionality such as 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.

Examples:

- Capturing reports of enemy dispositions through a Battlefield Management System (BMS).
- Capturing overlays, messages, etc..

7.3.7 E7 – Send C4I Data (Use C4I (manage) ← Manage data)

This interface transfers data from a training system to C4I systems.
For example, 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 (simulated) entities (either “live” dynamic objects or “virtual” players) to the C4I systems.

Examples:

- Cyber warfare injects (eg wrong position data);
- Transfer of overlays from training staff to training audience;
- “Synthetic wrapping”

7.3.8 E8 – Event Data exchange (External systems ↔ Manage Data)

This interface enables the exchange of data between systems, which can influence the course of the training session and generally has a dynamic, time critical character. Examples of event data exchange are (updates of) status of DOs and the creation of a minefield in System A, which is communicated to System B.

Examples:

- Connection to a (NATO) distributed training network;
- Exporting CTC position data to a virtual UAV.

7.3.9 E9 – DO Association and pairing (Report Status → Sense)

This interface enables the logical linking of objects in the training environment, this includes linking of DOs amongst each other (DO association) and linking equipment that is not modelled as a DO with DOs (equipment pairing).

Examples:

- Personnel mounting and dismounting vehicles;
- Personnel or vehicles entering or leaving (parts of) buildings;
- Personnel picking up weapons.

7.3.10 E10 – Exchange platform data (Platform management → Engage)

This interface enables the exchange of data between the training system and computers (such as the fire control system or platform management system) of the instrumented real systems. This is a bidirectional interface. Data exchange from the platform to the training system is used to enable or influence the behaviour and the engagements of the DO in the training environment. Examples are selected ammunition type, dynamic lead, environmental parameters and relevant vehicle parameters.
Data exchange from the training system to the platform is used to influence the behaviour of the real platform, for example providing the platform with target distance information delivered from the training system in case of a laser based training system, visualising tracers and fall of shot in the visual sensors or adding sounds to the communication systems (e.g. explosions, messages for training purposes).

Examples:
- Usage of ballistic tables for trajectory calculation;
- Usage and logging of fire modes used by the gunner;
- Dynamic lead;
- Environmental parameters.

7.3.11 E11 – Reference data exchange (Store data ↔ Manage Data)

This interface enables the exchange of data that is generally used for reference purposes, e.g. the transfer from System A to System B of an ORBAT definition, damage model definitions, geospatial (terrain) data such as the layout of a building composed of separate walls, a created scenario or a recorded exercise. It generally contains non-time critical information and is therefore used mostly prior to an exercise, but it can be used during the execution of an exercise.

Examples:
- ORBAT definition and input;
- Geospatial data;
- Weather data;
- Input of the layout of buildings.

7.4 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.
- Centralized 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.

8 Physical interfaces

This chapter presents the most common physical architecture of a combat training centre and the relation between functional interfaces and physical interfaces.

The physical architecture that is presented here is just an example of implementation. Each arrow in the diagram represents a physical interface.

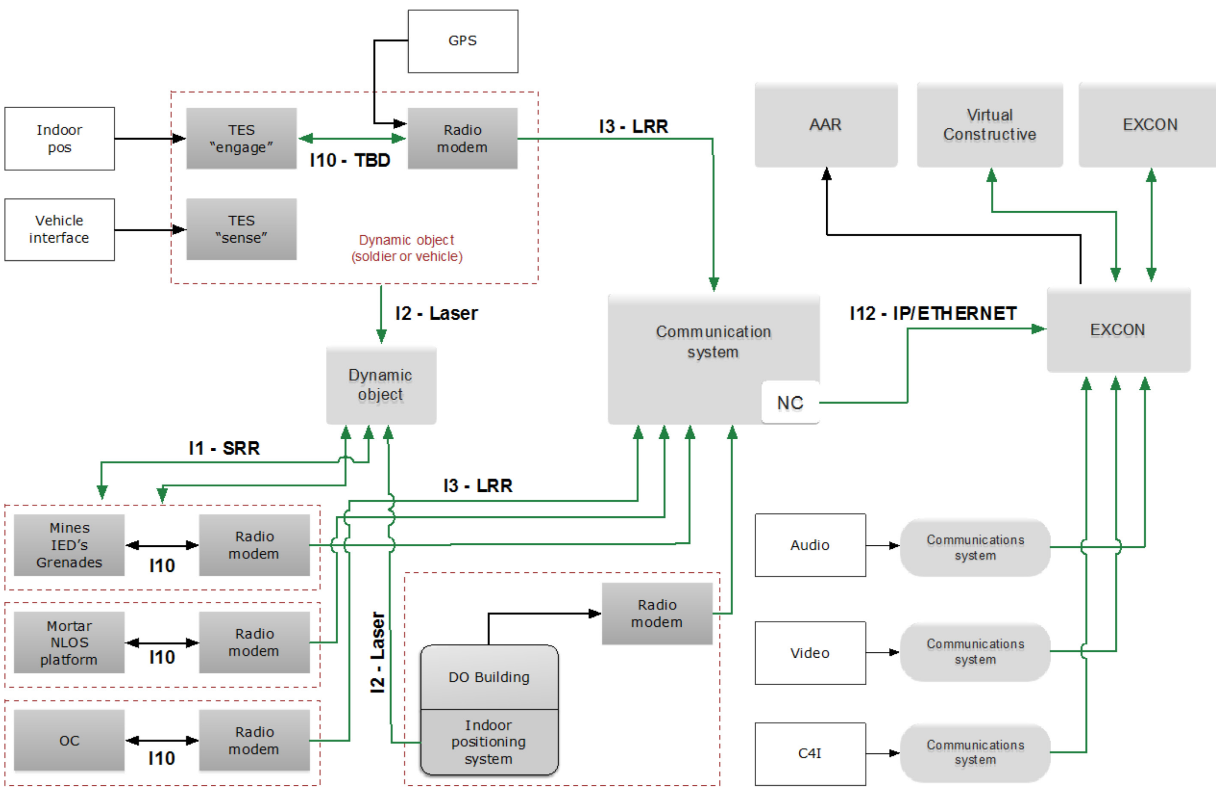

Fig 3 Physical Architecture

8.1 From functional to physical

When going into the physical layar of interfaces in a system, functional interfaces (E's) are implemented by physical interfaces (I's). The aim of the UCATT group is to define and standardize a set of physical interface to allow interoperability between systems in the live simulation domain.

The links between functional and physical interfaces are summarized in the following matrix.

A physical interface may be found in several functional interfaces. For example, the laser interface (I2) is used for direct engagement simulation (E1), DO technical or operational status control by the Observer/Controller using an umpire gun (E2 and E3) and for indoor positioning (E3).

		E 1	E 2	E 3	E 4	E 5	E 6	E 7	E 8	E 9	E10	E11	E12
I1	Long range radio DO to DO	x											
I2	Laser	x	x	x									
I3	Short range radio	x											
I4	IR- Short Range												
I5	TBD												
I6	TBD												
I7	TBD												
I8	TBD								x				
I9	TBD												
I10	Serial interface between TES and Radio modem		x	x	x								
I11	Long Range Radio – DO / EXCON		x	x	x								
I12	Ethernet – NC to EXCON				x								

Table 2 Functional to physical matrix

8.1.1 I1 - Long Range Radio (LRR) interface – DO to DO

The I1 interface is a long range radio interface (generally 0 to 10 km) used to transmit data and command between two dynamics objects in the field without requiring EXCON services.

This communication can be broadcast (One DO to multiple DO) or point-to-point (One DO to one DO) communication.

Examples:
This interface can be used to simulate indirect engagement without using EXCON services.
In such an engagement the engaging DO needs to know the location and the address of the target DO or the engaging DO transmits, in broadcast, to each DO the position of the projectile in "real time".

8.1.2 I2 – Optical Laser interface

The I2 interface is a laser interface used to transmit data and command between two dynamic objects in the field.
I2 is mainly used for direct fire simulation (E1), but is also often used for O/C action (E2 and E3) or indoor positioning (E3).

8.1.3 I3 - Short range radio (SRR) interface

The I3 short-range radio interface can be used to simulate short range (0 to 100 m) area weapon system such as grenades, mines or IED.

The short-range radio interface currently implemented on the existing products is either based on radio standards such as Bluetooth, Zigbee or with proprietary radio.

8.1.4 I4 - Infra Red

The I4 Infra red interface may be used to communicate data or command between a DO and a peripheral device (e.g. medical treatment PDA).

8.1.5 I5 - TBD (Indoor Positioning for example)

To be defined

8.1.6 I6 - TBD (Outdoor Positioning – GPS for example)

To be defined

8.1.7 I7 – TBD

To be defined

8.1.8 I8 - EXCON to EXCON

I8 is the physical interface used to communicate between two EXCONs. In most cases, Ethernet is used for this interface with an application protocol that is often DIS or HLA.

8.1.9 I9 - TBD (Fire Control Unit Interface)

Interface between the TES and the firing control unit, enabling exchange of data from or to the actual platform.

Example:

- CAN bus , Ethernet, 1553

8.1.10 I10 - TES to radio modem interface

The I10 interface is the link between the TES and the radio modem. It is used to exchange tactical and technical status, commands and events (fire event, target event) between DO and EXCON.

In the existing products, this interface is usually made with a serial link such as RS232, CAN bus or USB.

8.1.11 I11 - Long Range Radio – DO & EXCON

The I8 interface is a long range radio (LRR) interface (generally < 10 km) used to transmit report events (fire event, target event) from DO to EXCON and tactical and operational command from EXCON to DO.

In the existing CTC's, the interfaces used are for example: TETRA, 4G or more often a proprietary radio system.

8.1.12 I12 - Network Controller to EXCON

The I12 interface is the link between the Network Controller and the EXCON.

In most cases, Ethernet is used for this interface with an application protocol (layer 7 of OSI model) that could be DIS or HLA.

8.2 OSI 7 layer model

The OSI (Open System Interconnection) model defines a networking framework to implement protocols in seven layers. Control is passed from one layer to the next, starting at the application layer in one station, and proceeding to the bottom layer, over the channel to the next station and back up the hierarchy.

The OSI model is a conceptual framework made to understand complex interactions that are happening. The OSI model takes the task of internetworking and divides that up into what is referred to as a vertical stack that consists of the seven following layers:

8.2.1 Physical (Layer 1)

This layer conveys the bit stream - electrical impulse, light or radio signal -- through the network at the electrical and mechanical level. It provides the hardware means of sending and receiving data on a carrier, including defining cables, cards and physical aspects. Ethernet, RS232,
and USB are protocols with physical layer components.

Layer 1 Physical examples include Ethernet, FDDI, B8ZS, V.35, V.24, RJ45.

8.2.2 Data Link (Layer 2)

At this layer, data packets are encoded and decoded into bits. It furnishes transmission protocol knowledge and management and handles errors in the physical layer, flow control and frame synchronization. The data link layer is divided into two sub layers: The Media Access Control (MAC) layer and the Logical Link Control (LLC) layer. The MAC sub layer controls how a computer on the network gains access to the data and permission to transmit it. The LLC layer controls frame synchronization, flow control and error checking.

Layer 2 Data Link examples include PPP, FDDI, ATM, IEEE 802.5/ 802.2, IEEE 802.3/802.2, HDLC, Frame Relay,

8.2.3 Network (Layer 3)

This layer provides switching and routing technologies, creating logical paths, known as virtual circuits, for transmitting data from node to node. Routing and forwarding are functions of this layer, as well as addressing, internetworking, error handling, congestion control and packet sequencing.

Layer 3 Network examples include AppleTalk DDP, IP, IPX.

8.2.4 Transport (Layer 4)

This layer provides transparent transfer of data between end systems, or hosts, and is responsible for end-to-end error recovery and flow control. It ensures complete data transfer.

Layer 4 Transport examples include SPX, TCP, UDP.

8.2.5 Session (Layer 5)

This layer establishes, manages and terminates connections between applications. The session layer sets up, coordinates, and terminates conversations, exchanges, and dialogues between the applications at each end. It deals with session and connection coordination.

Layer 5 Session examples include NFS, NetBios names, RPC, SQL.

8.2.6 Presentation (Layer 6)

This layer provides independence from differences in data representation (e.g., encryption) by translating from application to network format, and vice versa. The presentation layer works to transform data into the form that the application layer can accept. This layer formats and encrypts data to be sent across a network, providing freedom from compatibility problems. It is sometimes called the syntax layer.

Layer 6 Presentation examples include encryption, ASCII, EBCDIC, TIFF, GIF, PICT, JPEG, MPEG, MIDI.

8.2.7 Application (Layer 7)

This layer supports application and end-user processes. Communication partners are identified, quality of service is identified, user authentication and privacy are considered, and any constraints on data syntax are identified. Everything at this layer is application-specific. This layer provides application services for file transfers, e-mail, and other network software services. Telnet and FTP are applications that exist entirely in the application level. Tiered application architectures are part of this layer.

Layer 7 Application examples include WWW browsers, NFS, SNMP, Telnet, HTTP, FTP

Group	#	Layer Name	Key Responsibilities	Data Type Handled	Scope	Common Protocols and Technologie s
Lower Layers	1	**Physical**	Encoding and Signaling; Physical Data Transmission; Hardware Specifications; Topology and Design	Bits	Electrical or light signals sent between local devices	USB, Etherent, RS 232, CAN
	2	**Data Link**	Logical Link Control; Media Access Control; Data Framing; Addressing; Error	Frames	Low-level data messages between local devices	IEEE 802.2 LLC, Ethernet Family; Token Ring;

			Detection and Handling; Defining Requirements of Physical Layer			FDDI and CDDI; IEEE 802.11 (WLAN, Wi-Fi); HomePNA; HomeRF; ATM; SLIP and PPP
	3	**Network**	Logical Addressing; Routing; Datagram Encapsulation; Fragmentation and Reassembly; Error Handling and Diagnostics	Datagrams / Packets	Messages between local or remote devices	IP; IPv6; IP NAT; IPsec; Mobile IP; ICMP; IPX; DLC; PLP; Routing protocols such as RIP and BGP
	4	**Transport**	Process-Level Addressing; Multiplexing/Demultiplexing; Connections; Segmentation and Reassembly; Acknowledgments and Retransmissions; Flow Control	Datagrams / Segments	Communication between software processes	TCP and UDP; SPX; NetBEUI/NBF
Upper Layers	**5**	**Session**	Session Establishment, Management and Termination	Sessions	Sessions between local or remote devices	NetBIOS, Sockets, Named Pipes, RPC
	6	**Presentation**	Data Translation; Compression and Encryption	Encoded User Data	Application data representations	SSL; Shells and Redirectors; MIME
	7	**Application**	User Application Services	User Data	Application data	DNS; NFS; BOOTP; DHCP; SNMP; RMON; FTP; TFTP; SMTP; POP3; IMAP; NNTP; HTTP; Telnet

Table 3 OSI 7 layar model

Annex D – AMMO TABLES

The Ammo Tables are an Appendix Document of the Standard.

Simulation Interoperability Standards Organization
www.sisostds.org

SISO-REF-XXX-YYYY

UCATT Ammunition Table

Version <0.3>

21 May 2015

Prepared by
Urban Combat Advanced Training Technology (UCATT) Product Development Group

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Version	Section	Date (MM/DD/YYYY)	Description
0.1	All	12/19/2013	Pre-released draft version for proofreading only.
0.2		05/28/2014	The text status “Draft version for proofreading only” removed. Ref. [2] updated.
0.3	All	05/21/2015	Reformatted into SISO template

Participants

At the time this product was submitted to the Standards Activity Committee (SAC) for approval, the UCATT Product Development Group had the following membership and was assigned the following SAC Technical Area Director:

Product Development Group

Capt Sander Cruiming (Chair)
Mr Staffan Martinsen (Vice-Chair)
Mr Joachim Eisenhauer (Secretary)

Mr Grant Bailey (SAC Technical Area Director)

Mr Magnus Alexandersson
Mr Mark Chamberlain
Mr Thomas Defachelles
Dr. Uwe Dobrindt
Maj Johnny Gullstrand
Mr Anders Lindström
Mr Armin Thinnes
Mr Thierry Vinatier
Mr Ingo Wittwer
Mr Jesse Campos
Mr Michelle Coriat
Mr Philippe Desruelles
Mr Rudi Gouweleeuw
Maj Roger Karlsson
LtCol Peter Makowski
Mr Jan Vermeulen
Mr Gary Washam

The Product Development Group would like to especially acknowledge those individuals that significantly contributed to the preparation of this product as follows:

PDG Drafting Group

Mr Anders Lindström (Editor)

Mr Magnus Alexandersson
Mr Jesse Campos
Mr Joachim Eisenhauer
Mr Armin Thinnes
Mr Jan Vermeulen
Mr Thierry Vinatier
Mr Gary Washam
Mr Ingo Wittwer

When the Standards Activity Committee approved this product on DD Month YYYY, it had the following membership:

Standards Activity Committee

Member Name (Chair)
Member Name (Vice Chair)
Member Name (Secretary)

Member Name
Member Name
Member Name

…..<continue with all the other SAC member names and place all in alphabetical order>

When the Executive Committee approved this product on DD Month YYYY, it had the following membership:

Executive Committee

Member Name (Chair)
Member Name (Vice Chair)
Member Name (Secretary)

Member Name
Member Name
Member Name

…..<continue with all the other EXXOM member names and place all in alphabetical order>

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Not applicable

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Standard for <Title>

1. Overview

1.1. Scope

The UCATT Ammunition Table primarily applies to the UCATT Interface Standard for Laser Engagement, describing how to communicate a simulated weapon engagement from a weapon simulator platform to a target simulator platform.

The UCATT Ammunition Table defines the type of ammunition used in primarily optical communication of a simulated weapon engagement. The subsequent assessment of the simulated effect on the target is not part of this Ammunition Table and thus it has to be separately defined. The intent is that the ammunition type of a simulated weapon engagement is abstracted from the target simulated effect evaluation; i.e. direct fire optically simulated engagement may be complimented or replaced by another type of communication with the same interface requirements to maintain the coalition interoperability objectives.

1.2. Purpose

There is a requirement for coalition training of defense forces. Weapons effect simulation has in the past typically evolved with national training requirements resulting in proprietary specifications satisfying specific national needs. The Ammunition Table primarily refers to a laser simulated engagement methodology for direct fire weapon simulation used for e.g. gunnery and combat training. The realization of training specifications across coalition platforms enables interoperability in a live ground training environment.

1.3. Objectives

The primary objective of the UCATT Ammunition Table is to establish a specification for the communication of a laser based simulated weapon engagement in a training environment. The intent is to prescribe the use of a number of classes of ammunition types for simulating direct fire weapon systems.

The UCATT Interface Standard for Laser Engagement specifies how the different weapon simulators interact on the exercise area. All simulators on the exercise area have to follow the specification, to ensure that simulators can interoperate properly. The requirements in the UCATT Interface Standard for Laser Engagement and the UCATT Ammunition Table are specifically important when different weapon simulators from different manufacturers shall interact on the exercise area.

2. References (Normative)

2.1. SISO References

#	Document Number	Title	Date
1.	SISO-STD-XXX-YYYY	UCATT Interface Standard for Laser Engagement	
2.			

2.2. Other References

#	Document Number	Title	Date
3.			
4.			

3. Definitions, Acronyms, and Abbreviations

English words are used in accordance with their definitions in the latest edition of Webster's New Collegiate Dictionary [ref#] except when special SISO Product-related technical terms are required.

3.1. Definitions

Term	Definition
<Start text here.>	<Start text here.>

3.2. Acronyms and Abbreviations

Acronym or Abbreviation	Meaning	Note
AP	Armour Piercing	
APC	Armoured Personnel Carrier	
API	Armour Piercing Incendiary	
*APimp	Armour-Piercing, Improved	More lethality than an AP. See Note APimp.
*APtop	Armour-Piercing, Top Attack	
DPICM	Dual-Purpose Improved Conventional Munitions	
ERA	Explosive Reactive Armour	
GL	Grenade Launcher	
HE	High Explosive	
*HEair	High Explosive Air Burst	Exploding in the air. See Note HEair.
*HEimp	High Explosive, Improved	More lethality than HE. See Notes APimp.
HEAT	High Explosive Anti-tank	
*HEBB	High Explosive Bunker Buster	
*HEcani	High Explosive Canister	The canister cartridge provides a short range anti-personnel capability
HEDP	High Explosive Dual Purpose	
HE-FRAG	High Explosive Fragmentation	Can be considered as APERS
HEI	High Explosive Incendiary	
HEMP	High Explosive Multi-Purpose	
*HEMPair	High Explosive Multi-Purpose, Air Burst	Exploding in the air. See Note HEair.
*HEMPdd	High Explosive Multi-Purpose with Delayed Detonation	HEMP with delayed detonation. See Note HEMPdd.
*HEMPimp	High Explosive Multi-Purpose, Improved	More lethality than HEMP. See Note APimp.
*HEMPimpair	HEMPimp, Air Burst	Exploding in the air. See Notes APimp and HEair
*HEORT	High Explosive Obstacle Reduction Tank	
HEP	High-Explosive Plastic	US acronym for HESH
HESH	High Explosive Squash Head	See Note HESH
HVAP	High Velocity Armour Piercing	Similar to APCR
HVAPDS	High or Hyper Velocity APDS	
IFV	Infantry Fighting Vehicle	
IUC	Interoperability User Community	
ITKK	Ilmatorjuntakonekivääri	Heavy 12.7mm Machine Gun in

Acronym or Abbreviation	Meaning	Note
		Finland
*KETF	Kinetic Energy Time Fuse	ABM-KETF in direct hit role.
*KETFair	Kinetic Energy Time Fuse Air Burst	ABM-KETF detonating in the air.
KVKK	Kevyt Konekivääri	Light Machine Gun in Finland
MPI	Multi-Purpose Incendiary	See Note MPI
MRM-CE	Mid-Range Munition, Chemical-Energy	
MRM-KE	Mid-Range Munition, Kinetic-Energy	
NMISS	Near Miss	
NLETH	Non-lethal	
PKM	Pulemjot Kalašnikova Modernizirovannyi	Heavy 7.62mm Machine Gun in Finland
PPHE	Programmable Pre-fragmented HE	
RCL	Recoilless Rifle	
RHA	Rolled Homogeneous Armour	
RPG	Rocket Propelled Grenade	Russian language: Reaktivnyy/Ruchnoy Protivotankovyy Granatomyot. Hand held anti-tank grenade launcher
SABOT	A carrier designed to centre a smaller calibre projectile in a larger gun barrel.	When the SABOT round is fired, it is normally discarded after leaving the muzzle.
SISO	Simulation Interoperability Standards Organization	
SLAP	Saboted Light Armour Penetrator	Small arms APDS
STAFF	Smart Target Activated Fire-and-Forget	
THBAR	Thermobaric	See Note Thermobaric
TNT equivalent	Trinitrotoluene equivalent	The explosive yield of TNT is considered a standard measure of strength of bombs and other explosives.
TPDS	Training-Practice, Discarding-Sabot	
UCATT	Urban Combat Advanced Training Technology	
WB	Wall Breaker	
3P	Programmable, Pre-fragmented and Proximity	As in KSGR40 3P

Note *. Ammunition Table acronym only.

Note APimp. APimp stands for “AP improved” and is used in categories in which the effect spectrum generated by the different calibres and weapon platforms is too wide for one AP code only. APimp has a higher lethality than an AP, a result of longer barrel or modified propellant and/or heavier or stronger penetrator.

Note HEair. The HEair (HE Air Burst) acronym is used for fused HE ammunitions, set to detonate in air.

Note HEMPdd. The acronym is used for HEMP ammunitions with delayed detonation, i.e. detonation not at but after impact. It can be achieved by use of, for instance, point-detonation fuse with delay.

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

Note MPI. This cartridge is effective against airborne and light surface threats at ranges up to 2,000 meters. The Multipurpose Concept projectile with delayed reaction carries the effectiveness inside the threat with large fragments and incendiary effects.

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

4. UCATT Ammunition Table

4.1. Introduction

A typical weapon simulator is principally built up by two parts, the fire simulator and the target simulator. The weapon simulator may then simulate fire against a target and at the same time receive simulated fire from other weapon simulators.

A weapon simulator may also be made up of only the fire simulator part, as in an anti-tank weapon, or only the target simulator part as on a truck.

The weapon systems have different price levels and the simulator requirements may differ as for example:

- A tank weapon system is an expensive weapon system and the hit accuracy requirements are usually important.
- An anti-tank weapon system is comparatively less expensive but the simulator might have to consider that it shall simulate a "Fire-and-Forget" weapon system.
- A small arms weapon system is even less expensive but the simulator data transfer from the fire simulator to target simulators can be time critical.
- Similar or even equal ammunition type is used in different weapon systems (e.g. 7.62mm coax and machine gun) where the simulator systems requirements still differ.

As a consequence the Ammunition Table has to support different optical encoding methods used to meet the different laser simulator requirements.

4.1.1. Optical Coding Structure

There are four basic optical codes defined in the UCATT Interface Standard for Laser Engagement. The optical codes with related ammunition number series can briefly be described as follows:

The below Table 1 summarizes the optical codes characteristics.

Optical Code	Simulation Principle	Typically a scanning transmitter	Comment
Real-Time	Two-Way	Yes	Ballistic projectiles and guided missiles
Fire-and-Forget	Two-Way	Yes	Fire-and-Forget weapons
Short-Time Scanning	One-Way	Yes	Against soldiers without retro-reflectors
Short-Time	One-Way	No	Small arms weapons

Table 1. Optical Code Characteristics Summary

4.1.2. Ammunition Type Grouping

To reduce the number of ammunition types and the resulting number of ammunition numbers, the ammunition types with similar lethality are grouped as illustrated in the example Table 2 below:

UCATT Ammunition Type	Real Ammunition Type
AP	AP
	APCR
	APDS
	APFSDS
	APFSDS-DU
	APSE
	APEP
	HVAP
	HVAPDS
HEAT	HEAT
	HESH
	HEP

UCATT Ammunition Type	Real Ammunition Type
HE	APAM
	APERS
	DPICM
	HE
	HE-FRAG
	HEI
HEMP	HEDP
	HEMP

Table 2. Ammunition Type Grouping Examples

4.2. Ammunition Numbering Summary

The Table 4 and Table 5 in this section summarize the ammunition numbering that come with the UCATT Ammunition Table and to what simulation characteristics they apply.

The ammunition numbering of the UCATT Ammunition Table is divided into two sections.

- Section 1:
    - Ammunition numbers 1 through 79.
    - Non-alternating coded ammunition numbers.
- Section 2:
    - Ammunition types 2001 through 2280 with a vast number of related ammunition numbers.
    - Alternating coded ammunition numbers.

This document referred child ammunition numbers are supplemental numbers providing further simulation potential. Each grandparent or parent ammunition number has one or more related child ammunition numbers. It is possible to fine tune the lethality or for specific training purposes alter the grandparent or parent ammunition lethality using child ammunition numbers. Child ammunition numbers are free to use as for example for national training purposes, but are at least target simulator evaluated as its grandparent ammunition number vulnerability when in multinational training.

Another typical simulation characteristics example is that a top attack engaging missile can detonate with a simulated projectile position above the target and still the target simulator realistically simulates the engagement result.

The Table 4 and Table 5 summary tables include Real-Time Code simulation characteristics that can briefly be described as follows:

Simulation Characteristics	Abbrevi-ation	*Target simulator(s) typical measured engagement position	Number of fire simulator simulated projectiles or missiles for each optical engagement simulation.
Burst of Fire	RB	Surface impact x-y coordinate	Two. The target simulator(s) compen-sate(s) with raised vulnerability
Direct Impact	RD	Surface impact x-y coordinate	One
Unarmed	RU	Surface impact x-y coordinate. Impact	

Simulation Characteristics	Abbreviation	*Target simulator(s) typical measured engagement position	Number of fire simulator simulated projectiles or missiles for each optical engagement simulation.
		before arming distance (without explosives detonation)	
Top Attack	RT	Detonation above or surface impact x-y coordinate	
Air Burst 2D	RA	Two dimensional (2D) x-y coordinate.	
Air Burst 3D	RA	Three dimensional (3D) x-y-z coordinate used for calculating engagement distance	

Table 3. Real-Time Ammunition Numbering Simulation Characteristics

Note *: Target simulators also simulate fly-by and ground hit engagement positions.

4.2.1. Numbering Summary Section 1

The UCATT Interface Standard for Laser Engagement includes non-alternating coded ammunition numbers 1 through 79 and contains additional Short-Time coded child ammunition numbers. Each of the Short-Time ammunition numbers 47-76 has five related child ammunition numbers as illustrated by the below Table 4.

As for example fused HE ammunition is simulated and optically communicated to the targets to recognize that the engagement was detonating as an air burst. The air burst engagement effect is simulated with a basis of a two dimensional (x-y) measured engagement position.

The following Table 4 summarizes the numbering summary section 1 ammunition numbering and how the numbering supports simulation characteristics:

Simulation Character-istics	*Parent-Child Relation-ship	Optical Code						
		Real-Time				Short-Time	Fire-and-Forget	Short-Time Scanning
		Section 1a				Section 1c	Section 1b	Section 1d
		Direct Impact	Top Attack	Burst of Fire	Air Burst 2D			
Abbreviation / Ammo Type		RD	RT	RB	RA	N.A.	FF	N.A.
1-79	None	1-24, 26-29, 31-46				N.A.	25, 30	77-79
	Grand-parent	N.A.				47-76	N.A.	N.A.
	Child	N.A.				1547-1576 1647-1676 1747-1776 1847-1876 1947-1976	N.A.	N.A.

Table 4. Ammunition Numbering for Ammunition Table Section 1

4.2.2. Numbering Summary Section 2

To the ammunition numbers in section 1 are in section 2 added several hundreds more alternating coded ammunition numbers allowing simulation of numerous weapon platforms and ammunition types. In addition to growth potential, these ammunition numbers also allow the users to as for example:

- Achieve interoperability between coalition forces
- Separate between weapon systems in the battlefield
- Support training against simulated OPFOR weapons.

Together with the ammunition numbers in section 2 there is also an additional support of enhanced simulation principles as for example:

- Three dimension air burst
- Engagement distance dependent lethality
- Weapon arming distance dependent lethality
- More accurate target simulator measurement of projectile or missile engagement position as fire simulator weapon cant angle can be transferred to target simulator.

As illustrated in the below Table 5, the basic number series 1 through 280 is repeated with different digit(s) prefixes. The number series 2001 through 2280 represents the basic ammunition types and the ammunition number prefixes reflect the Ammunition Table support of the UCATT Interface Standard for Laser Engagement multiple optical codes and other simulation characteristics.

As for example HE ammunition, can be simulated and optically communicated to the targets to recognize that the engagement was a direct hit, ground hit, a fly-by or that it was fused and thus detonating as an air burst. The air burst engagement effect is simulated with a basis of a three dimensional (x-y-z) measured engagement position then calculated as an engagement distance.

Another functionality example is interaction with simulator systems without retro-reflectors. The Real-Time two-way simulated ammunitions, requiring target retro-reflectors, are also supplemented with a corresponding ammunition number for Short-Time Scanning one-way simulation requiring no retro-reflectors.

The following Table 5 summarizes the numbering summary section 2 ammunition numbering and how the numbering supports simulation characteristics:

Simulation Character-istics	*Parent-Child Relation-ship	Optical Code						
		Real-Time					Fire-and-Forget	Short-Time Scanning
		Direct Impact	Top Attack	Burst of Fire	Air Burst 3D	Unarmed		
Abbrevia-tion / Ammo Type		RD	RT	RB	RA	RU	FF	SS
2001-2280	Grand-parent	2001-2280		N.A.				
	Parent	N.A.		4001-4280	6001-6280	8001-8280	12001-12280	22001-22280
	Child	3001-3280		5001-5280	7001-7280	9001-9280	13001-13280	23001-23280

Table 5. Ammunition Numbering for Ammunition Table Section 2

4.3. Ammunition Tables

The UCATT Ammunition Table presents ammunition type numbers with related ammunition numbers, caliber/weapon and ammunition type. In case the “Real Ammo Type” is equal to the “UCATT Interface Standard for Laser Engagement Ammo Type” it is for matter of brevity not always written.

4.3.1. Section 1

Section 1 contains four sections related to fire simulator used optical code.

- 1a. Real-Time
- 1b. Fire-and-Forget
- 1c. Short-Time
- 1d. Short-Time Scanning

4.3.1.1. Section 1a

This section contains ammunition numbers related to the Real-Time optical code.

Ammo No.	Simulation Characteristics					Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
	RD	RT	RB	RA	FF				
1	RD					AP 120mm <2500m	AP		
2	RD					AP 120mm >2500m	AP		
3	RD					HE 120mm	HE		
4	RD					HE 120mm delayed detonation	HE	Detonation behind the wall	
5	RD					AP 105mm	AP		
6	RD					HE 70-90mm	HE		
7	RD					HEAT 105mm	HEAT		
8	RD					HE 105mm	HE		
9	RD					AP 35mm Cannon	AP		
10	RD					AP 20mm Cannon	AP		
11			RB			Ball 5.56mm MG vehicle, burst of fire	Ball	COAX	
12	RD					HOT, anti-tank helicopter	HEAT		
13	RD					MELLS, GILL, Spike, Bill 2, - direct hit	HEAT		
14	RD					TOW, Bill 1 direct hit	HEAT		
15	RD					MILAN	HEAT		
16	RD					HEAT PzF3	HEAT	CG84 HEAT 551, HL PAR 66/79	
17	RD					ABM 30mm direct hit	HE		
18	RD					HEI 20mm Cannon	HEMP		HEI
19	RD					Non-Lethal Weapon, vehicle	Ball		
20	RD					Ammunition without effect	NLETH	Non-lethal ammo, rubber projectiles	
21			RB			AP 20mm Cannon, burst of fire	AP		
22			RB			HE 20mm Cannon, burst of fire	HEMP		
23			RB			Ball 7.62mm MG vehicle, burst of fire	Ball	COAX	
24	RD					HEI PzF3 heavy	HE		HEI
25					FF			See section 1b	
26	RD					HEAT 40mm, AGL	HEAT		
27	RD					HEI 40mm, AGL	HEMP		HEI
28	RD					HEI 35mm Cannon	HEMP		HEI
29	RD					HEMP 12.7mm / HMG / BMG	HEMP		
30					FF			See section 1b	
31	RD					HEAT PzF3 heavy tandem	HEAT	CG84 HEAT 751	
32	RD					PzF Bunkerfaust	HE BB	Bunker buster, CG84 HE 441 direct hit, PAR 66/79 direct hit	
33				RA		ABM 35mm time fuzed	HEair		ABM
34		RT				Bill 1 Top attack	HEAT		
35		RT				Bill 2 Top attack	HEAT		
36				RA		PzF middle air burst	HEair	CG84 HE 441 air burst, PAR 66/79 Hoch	HE
37	RD					AP 12.7mm / HMG / BMG	AP		
38	RD					Bill 2 soft target	HEAT		
39	RD					HEAT PzF light	HEAT	RGW60	
40				RA		ABM 30mm time fuzed	HEair		HE
41				RA		AGL ABM 40mm time fuzed	HEair		HE
42				RA		ABM 120mm time fuzed	HEair		HE
43	RD					Ball 12.7mm HMG / BMG	Ball		

Ammo No.	Simulation Characteristics					Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
	RD	RT	RB	RA	FF				
44	RD					AP 30mm	AP		
45	RD					PzF middle	HEAT	CG84 HEAT 651, L-HL PAR 66/79, Ammo with tracer	
46	N.A.					Not yet used	NLETH	Spare	

Table 6. Ammunition Table Section 1a

4.3.1.2. Section 1b

This section contains ammunition numbers related to the Fire-and-Forget optical code.

Ammo No.	Caliber or Weapon	UCATT Ammo Type	Description
25	Fire-and-Forget middle, 70mm helicopter rocket	HEAT	
30	PARS LR, MELLS, GILL, Spike, (F&F heavy)	HEAT	TRIGAT LR

Table 7. Ammunition Table Section 1b

4.3.1.3. Section 1c

This section contains ammunition type numbers related to the Short-Time optical code. The ammunition type numbers are then related to ammunition numbers as further described in section "4.2.1 Numbering Summary Section 1".

Ammo Type No.	Corre-sponding Near Miss No.	Caliber or Weapon	UCATT Ammo Type	Description
47		Not yet used	NLETH	Spare
48	59	IED light, TNT < 5kg, remote range	HE	HEW Mine Hit, Remote range M19 Anti-Personnel Note M19
49	65	IED middle, TNT 5 - 20kg, remote range	HE	HEW Mine Hit, Remote range M100 Anti-Personnel Note M100
50	59	HEMP Hand Grenade	HE	
51	57	Ball 5.56mm MG	Ball	Machine Gun MG4, C7, C8, Minimi, HK416
52	65	Truck bomb TNT >100kg	HE	Truck bomb
53	59	Grenade-thrower	HE	Grenade thrower
54	65	HEMP 12.7mm HMG	HEMP	Heavy Machine Gun MP, Sniper MP
55	57	Non-Lethal Weapon, tear gas	NLW	Tear gas
56	57	Ball 5.56 / 7.62mm Assault weapon	Ball	Assault rifle 5.56: G36, StG 77 7.62: G3, AG-3, HK417
57	57	Near Miss – light hand held weapon	NMISS	Light Small Arms Weapon Near Miss StG, C7, C8, Minimi
58	59	Ball 7.62mm MG	Ball	Machine Gun MG3, MG74, MAG Inf, KVKK (Light MG), PKM (HMG), Chain gun
59	59	Near Miss – middle hand held weapon	NMISS	Middle Small Arms Weapon Near Miss SSG, MG74, MAG Inf.
60	65	HEW Off Route Anti-tank Kill, short range	HEMP	HEW Vehicle Kill DM-12 PARM, 125mm HEAT

Ammo Type No.	Corre-sponding Near Miss No.	Caliber or Weapon	UCATT Ammo Type	Description
61	65	HEW Off Route Anti-tank Hit, remote range	HEMP	HEW Soldier Kill
62	59	Indirect kill, against transported personnel	Kill	Indirect Kill e.g. inside the vehicle
63	59	Indirect kill, back blast	Kill	Backfire from a recoilless weapon AT4 back-blast
64	65	Ball 12.7 mm HMG / Long range rifle	Ball	ÜsMG, Browning .50, ITKK
65	65	Near miss heavy hand held weapon	NMISS	Heavy Small Arms Weapon Near Miss ÜsMG, Browning .50, Accuracy 8.6mm
66	59	HEMP Hand Grenade	HE	
67	67	Non-Lethal Weapon, rubber projectile, concussion grenade	NLW	
68	59	IED light, TNT < 5kg, short range	HE	HEW Mine Kill, Short range M19 Anti-armour Note M19
69	65	IED middle , TNT 5 - 20kg, short range	HE	HEW Mine Kill, Short range M100 Anti-armour Note M100
70	65	IED heavy, TNT 20 - 100kg	HE	
71	65	AP 12.7mm HMG / Long range rifle	AP	G82, ITKK APS, APS
72	59	AP 7.62mm / 8.6mm Sniper	AP	Sniper 7.62mm: G22, SSG69, NM-149 8.6mm: Accuracy, TAK
73	59	HEAT 40mm Grenade Pistol, AG36	HEAT	Grenade Pistol/Rifle
74	59	HEMP 40mm Grenade Pistol, AG36	HE	Grenade Pistol/Rifle
75	57	Ball 4.6mm Machine Pistol, MP7	Ball	Sub-Machine Gun
76	57	Ball 9mm Machine Pistol MP5, Pistol P8	Ball	Pistol, Sub-Machine Gun MP5, Glock 17

Table 8. Ammunition Table Section 1c

4.3.1.4. Section 1d

This section contains ammunition numbers related to the Short-Time Scanning optical code.

Ammo No.	Caliber or Weapon	UCATT Ammo Type	Description
77	Vehicle HE	HE	
78	Vehicle MG	Ball	COAX
79	Anti-tank HE	HE	

Table 9. Ammunition Table Section 1d

4.3.2. Section 2

This section contains ammunition type numbers related to the Real-Time, Fire-and-Forget or Short-Time Scanning optical codes. The ammunition number is given by the below tabled basic ammunition type number and ammunition number digit(s) prefixes. The ammunition number digit(s) prefixes selects optical code as well as other characteristics to the simulation as further described in section “4.2.2 Numbering Summary Section 2”.

Ammo Type No.	Simulation Characteristics							Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
	RD	RT	RB	RA	RU	FF	SS				
								5.45-6.5mm Assault Rifle Machine Gun		5.56mm Cal. 0.223	
2001	RD		RB					5.45x39mm	AP		AP
								5.56x45mm		M995 AP	
2002	RD		RB					5.45x39mm	Ball	5,45mm M74 (USSR/Russia)	Ball
								5.56x45mm		Similar as ammo no 56 AK5, Ksp90	
								5.56mm		.223 Remington / 5,56 NATO (USA) M855 NATO Ball, M193 Ball	
								6.8-8.6mm Assault Rifle Machine Gun		6.8mm Cal. 0.27 7.62mm Cal. 0.30	
2003	RD		RB					7.62x39mm	AP		AP
								7.62x51mm			
2004	RD		RB					6.8x43mm	Ball	Similar as ammo no 58 6.8x43mm SPC (Spec. Purpose Cartridge)	Ball
								7.62x39mm			
								7.62x51mm		AK4, Ksp58, Psg90, Ksp m/39, Ksp94	
								7.62mm		M59, M61, M64, M80 Ball	
								5.45-8.6mm Sniper		5.56mm Cal. 0.223 7.62mm Cal. 0.30	
2005	RD							7.62X51mm	AP	Psg90	AP/SLAP
								7.62X54Rmm			
								8.6X70mm			
2006	RD							5.56x45mm	Ball	Mk 262 Sniper	Ball
								7.62X51mm		M118 Long Range	
								7.62X54Rmm			
								8.6X70mm			
								5.56mm Coax Main Gun		5.56mm Cal. 0.223 Tank, IFV, and APC coaxial gun IFV and APC main gun	
2007	RD		RB					5.56mm	AP		AP
2008	RD		RB					5.56mm	Ball	Vehicle MG	Ball
								6.8-8.6mm Coax Main Gun HMG		7.62mm Cal. 0.30 Tank, IFV, and APC coaxial gun IFV and APC main gun Heavy Machine Gun	
2009	RD		RB					7.62mm	AP		AP
2010	RD		RB					7.62mm	Ball	Small Arms (M16, M60, Coax), Vehicle Mounted Vehicle coaxial Vehicle MG, Turret MG, Ksp58C, Ksp m/39, Ksp94	Ball
							SS			Against one-way targets Vehicle coaxial 7.62mm	
								12.7-14.5mm Sniper Rifle Anti-Material Rifle		12.7mm Cal. 0.50	
2011	RD							12.7x99mm	AP	Ag90	AP
								12.7x107mm			
2012	RD							14.5x114mm	AP		AP

Ammo Type No.	Simulation Characteristics							Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
	RD	RT	RB	RA	RU	FF	SS				
2013	RD							12.7x99mm	Ball	Ag90	Ball
								12.7x107mm			
								14.5x114mm			
2014	RD							12.7x99mm	HEMP	Ag90	MP
								12.7x107mm			
								14.5x114mm			
								12.7mm Coax Main Gun HMG		12.7mm, Cal 0.50 Tank, IFV, and APC coaxial gun IFV and APC main gun Heavy Machine Gun	
2015	RD		RB					12.7x99mm	AP	M2, M8, M20	AP
								12.7mm		sMG, BMG, üsMG, XA-203 OWS, ITKK	
										M903 SLAP, M962 SLAPT	SLAP
								12.7x107mm			AP
2016	RD		RB					12.7x99mm	APS		APS
2017	RD		RB					12.7x99mm	Ball	Heavy MG M2, M85, M82, M95 Barrett sMG, BMG, üsMG (weich) KSP (Tksp)	Ball
								12.7x107mm			
								12.7mm		XM1022	
							SS			Against one-way targets Vehicle coaxial 12.7mm	
2018	RD		RB					12.7x99mm	HEMP	Mk 211 MP sMG, BMG, üsMG KSP (Tksp)	MP
								12.7x107mm			
								14.5mm Coax Main Gun HMG		Tank, IFV, and APC coaxial gun IFV and APC main gun Heavy Machine Gun	
2019	RD		RB					14.5x114mm	AP		AP
2020	RD		RB					14.5x114mm	Ball	BTR-80, RSKK RSKK: Raskas konekivääri	Ball
2021	RD		RB					14.5x114mm	HEMP		HEMP
								20-50mm Grenade Rifle		20, 25, 30, 35, 40, 43mm	
2022	RD							40x46	APERS		HE
								40mm	HE	M406	
				RA					APERS	M576 Using the 3D detonation model, detonating when directly leaving the gun muzzle	Buckshot
2023	RD							40mm	HEMP	M433	HEDP
										M430 40x46 MEI Hellhound	
										M79	
								Shotgun		10-, 12-, 16-, 20-, 28-, 67-Gauge	
2024	RD							Shotgun	APERS		Buckshot
				RA						Using the 3D detonation model, detonating when directly leaving the gun muzzle	
2025	RD							Shotgun	HEMP		Buckshot
				RA						Using the 3D detonation model, detonating when directly leaving the gun muzzle	
								AGL ≤35mm		AGL: Automatic Grenade Launcher 20, 30mm	
2026	RD			RA				20, 25mm	HE		HE
				RA					HEair	XM1018, XM1019	
2027	RD							20, 25mm	HEcani		APERS
				RA						Using the 3D detonation model, detonating when directly leaving the gun muzzle	
2028	RD							20, 25mm	HEMP		HEDP
2029	RD							20, 25mm	HEAT		HEAT
								AGL >35mm		AGL: Automatic Grenade Launcher	

Ammo Type No.	Simulation Characteristics RD	RT	RB	RA	RU	FF	SS	Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
										40, 43mm	
2030	RD			RA				40x53	HE	AGL HE	HE
2031	RD							40mm	HEcani	MK19 with M1001 Canister	APERS
				RA						Using the 3D detonation model detonating when directly leaving the gun muzzle	
2032	RD							40mm	HEMP	MK19 with M430	HEDP
										XM320	
										AGL with HEI or HEDP ONTSIRP	HEI HEDP
										Extended Range Low Pressure" (ERLP) 40×51mm	HEDP
2033	RD							40mm	HEAT	AGL with shaped charge ammo	HEAT
								<25mm Cannon		Fast-firing, automatic guns	
2034	RD		RB					20mm	AP	Opfor 20-23mm	APDS
2035	RD		RB					20mm	APimp	On-board mounted MG Mk 149 CIWS, Mk 244 CIWS	APDS
										PGU-2/B SAPHE	APHE
										PGU-28A/B SAPHEI	APHEI
										M53 API, M601 API-T, M775 API-T	API
								23mm		ZSU 23-4 ZSU 23-4, SABOT	API SABOT
2036	RD		RB	RA				20mm	HEMP	On-board mounted MG 20/41 Slbrhpgr 95 (Pbv302, Ptgb203)	HE, HEI, HEMP
										M56 HEI, M56A3 HE/I	HEI
										M210 HEI, M242 HEI-T	HEI
										M940 MPT-SD	MPI
								23mm		SIRP ZSU 23-4, HEAT	HEMP, HEAT
								25-29mm Cannon		Fast-firing, automatic guns	
2037	RD		RB					25mm	AP	Opfor 25-29mm	APDS
2038	RD		RB					25mm	APimp	YPR AP YPR AP 163-3	AP
										XM1049	
										M791 APDS-T, M919 APDS-T	APDS
										PGU-20/U API	APHEI
2039	RD			RA				25mm	KETF	ABM-KETF direct detonation, fly by or air burst	ABM-KETF
2040	RD		RB	RA				25mm	HEMP		HEMP
										M792 HEI-T, MK210 HEI-T	HEI
										PGU-22 HE-I, PGU-25 HE-I,	HEI
										PGU-32/U, SAPHEI, PGU-38/U HE-I	HEI
								30-34mm Cannon		Fast-firing, automatic guns	
2041	RD		RB					30mm	AP	BMP-2 PS Opfor APC 2 AP	APDS APFSDS APEP
										PGU-14/B API	API
2042	RD		RB					30mm	APimp	Ulan KE CV9030 APFSDS-T Bluefor APEP and APDS	APDS APFSDS APEP
2043	RD			RA				30mm	KETF	ABM-KETF direct detonation, fly by or air burst	ABM-KETF
2044	RD		RB	RA				30mm	HEMP	BMP-2 SIRP Opfor APC HE	HEMP
2045	RD		RB	RA				30mm	HEMPimp	Ulan MZ CV9030 MPLD-T and MP-T Bluefor HE	HE MP MPLD
								35-39mm Cannon		Fast-firing, automatic guns	
2046	RD							35mm	AP	On-board mounted MG ALIK	AP
2047	RD			RA				35mm	KETF	ABM-KETF direct detonation, fly by or air burst	ABM-KETF
2048	RD			RA				35mm	HEMP	On-board mounted MG	HEI,

Ammo Type No.	Simulation Characteristics RD	RT	RB	RA	RU	FF	SS	Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
										SIRP	HEMP
2049	RD							35mm	HEMPdd	Delayed detonation	HEMP
								40mm Cannon		Fast-firing, automatic guns	
2050	RD							40mm	AP	CV90	AP
2051	RD			RA				40mm	KETF	ABM-KETF direct detonation, fly by or air burst	ABM-KETF
2052	RD							40mm	HEAT	PSGR	HEAT
2053	RD							40mm	HEMP	CV90 SGR	HE
								40x46mm		M406HE , M381HE, M386HE, M441HE	
								40x53mm		M383 HE, M384 HE	
				RA				40mm	HEMPair	Air burst CV90 KSGR CV90 KSGR 3P	HEMP
										M397 Air burst , M397A1 Air burst	
										MK285	PPHE
										XM1060 Thermobaric Round	THBAR
2054									HEMPdd	Delayed detonation	HEMP
								<76mm AT Gun RPG, RCL		RPG: Rocket Propelled Grenade RCL: Recoilless Rifle	
2055	RD			RA				40mm	HE	RPG-7 with OG-7V	HE
								73mm		OPFOR APC HE	
								75mm		Type 69	
2056	RD				RU			66mm	HEAT	M72 LAW	HEAT
								64mm		RPG-18	
								73mm		RPG-22, RPG-26	
										OPFOR APC 73mm HEAT	
								77-94mm AT Gun RPG, RCL		RPG: Rocket Propelled Grenade RCL: Recoilless Rifle	
2057	RD							84mm RPG, RCL	HE	84mm Carl Gustaf direct impact CG84 with HE441B and HE441D HE PAR 66/79 AUF	HE
								92mm		Type 69	HE-FRAG
				RA				84mm RPG, RCL	HEair	84mm Carl Gustaf air burst CG84 with HE441B and HE441D PAR 66/79 HOCH SGR 84 time fuzed Also as ammo no. 36	HE
2058	RD				RU			84mm	HEAT 1	84mm Carl Gustaf CG84 with HEAT 551C CG84 with HEDP 502 (HEAT role) PzF3 LGS, HL PAR 66/79 84/48 SLPSGR 75, Psk84 Also as ammo no. 31	HEAT
								83mm		SMAW HEAA Rockeye, SMAW	
								84mm		AT4, M136 AT4 HEAT, AT4CS	
								85mm		RPG-7 with PG7V	
								85mm		Type 69-1	
								90mm		Matador (PZF-90) MP HEAT Role Matador (PZF-90) MP HESH Role	
								90mm RPG, RCL		M371E1 HEAT	
								94mm RPG, RCL		LAW80	
								94mm		Type 69-II, Type 69-III (RPG)	
2059	RD				RU			84mm	HEAT 2	CG84 HEAT 751	HEAT
								93mm		RPG-7 with PG7VL	
							SS			Against one-way targets	
2060	RD			RA				84mm	ADM	CG84 ADM 401 (Area Defence Munition)	ADM
2061	RD							84mm	HEMP	Tandem warhead CG84 MT 756 (Multi Target, behind wall) AT4 AST (delayed detonation)	AST
2062	RD							84mm	HEMP	CG84 HEDP 502 (delayed detonation) AT4 AST (mouse hole role)	AST
								90mm		Matador (PZF-90) WB (Wall Breaching)	

Ammo Type No.	Simulation Characteristics RD	RT	RB	RA	RU	FF	SS	Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
										PzF90 (delayed detonation)	
2063	RD							84mm	HEMP	CG84 ASM 509 (Anti-Structure Munition) Direct impact role	ASM
								90mm		Matador (PZF-90) AS (Anti-Structure Munition) Direct impact role	
2064	RD							84mm	HEMPdd	CG84 ASM 509 (Anti-Structure Munition) Delayed detonation role	ASM
								90mm		Matador (PZF-90) AS (Anti-Structure Munition) Delayed detonation role	
								95-109mm AT Gun RPG, RCL		RPG: Rocket Propelled Grenade RCL: Recoilless Rifle	
2065	RD			RA				105mm	HE		HE
								107mm		OF-883A	HE-FRAG
2066	RD				RU			105mm	HEAT	RPG-7 with PG-7VR	HEAT
										RPG-27	
										RPG-29 with PG-29V	
								107mm		BK-883	
2067	RD							105mm	HEMP	Multi-Purpose Munition	HEMP
2068	RD							105mm	HE BB	RPG-7 with TBG-7V RPG-29 with TBG-29V	THBAR
										RPG-27 with RShG-1	
								≥110mm AT Gun RPG, RCL		RPG: Rocket Propelled Grenade RCL: Recoilless Rifle	
2069	RD			RA				110mm	HE	PzF3 HE and HEI	HE HEI
2070	RD				RU			110-112mm	HEAT	PzF3 shaped charge PzF3 HEAT 112mm APILAS, RSKSKO	HEAT
2071	RD							110mm	HEMP	Multi-Purpose Munition	HEMP
2072	RD							110mm	HE BB	PzF3 Bunker Buster (delayed detonation)	HE
								≤76mm Gun Tank, IFV and APC		57, 73, 76mm IFV: Infantry Fighting Vehicle APC: Armoured Personnel Carrier	
2073	RD							73mm	AP		AP APC APFSDS
2074	RD							73mm	HE		HE
2075	RD							73mm	HEAT		HEAT
								77-94mm Gun Tank, IFV and APC		82, 84, 85, 90mm	
2076	RD							90mm	AP	M77 AP-T, M318 AP-T, M318A1 AP-T	AP
										M332A1 HVAP-T	HVAP-T
										M82 APC-T	APC-T
										M690 APFSDS	APFSDS
2077	RD			RA				90mm	HE	M71 HE, M71A1 HE-T	HE
2078	RD							90mm	HEAT	M348A1 HEAT, M431 HEAT-T	HEAT
										M691 HESH-T, M692 HESH-TP	HESH
2079	RD							90mm	HEMP		HEMP
								95-103mm Gun Tank, IFV and APC		100mm	
2080	RD							100mm	AP	3UBM10	APFSDS
										UBR-412B , BR-412B, JPSV, PSV	APHE
										UBM-2, UBM-8	APFSDS
										UBM-6	HVAPDS
2081	RD			RA				100mm	HE	Opfor APC HE	HE
										3UOF10, 3UOF11	HE-FRAG
										UOF-3, UOF-412, UO-415	
2082	RD							100mm	HEAT	3BK-5M, 3UBK9, 3BK16M, 3BK17M	HEAT
										BK3, BK5, JPRSV, M69	
										Type 73, UBK-412R	HEAT-T
										UBK-2, UBK-4, UBK-4M, UBK-9M	HEAT
								104-109mm Gun Tank, IFV and APC		105, 106	

Ammo Type No.	Simulation Characteristics							Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
	RD	RT	RB	RA	RU	FF	SS				
2083	RD							105mm	AP	M724A1	TPDS
										M392 APDS-T, M728 APDS-T	APDS
										JaPzK APFSDS APDS-T	
2084	RD							105mm	APimp	APFSDS-T	APFSDS
										M735 APFSDS-T, M774 APFSDS-T	
										M833 APFSDS-T, M900 APFSDS-T	
										FP105, Olin 105	
2085	RD							105mm	HE	M494 APERS-T	HE
										M393A3, M546	
				RA					HEair	APAM	
2086	RD							105mm	HEcani	M1040 Canister	Canister
				RA						Using the 3D detonation model, detonating when directly leaving the gun muzzle	
2087	RD							105mm	HEMPdd	Delayed detonation	HEMP
2088	RD							105mm	HEAT	JaPzK L-HL Leopard 1 HEAT-T	HEAT
										Leopard 1 HEP-T	HEP-T
										M456 HEAT-T , M662 HEAT-T	HEAT-T
										XM815 HEAT-MP	HEAT-MP
										M393A2	HEP
										MRM	MRM-CE
2089	RD							105mm	HEMP		HEMP
								110-116mm Tank, IFV and APC		115mm	
2090	RD							115mm	AP	OPFOR MBT FSAPDS	APDS
										UBM-3, UBM-9	APFSDS-T
										UBM-5	HV APFSDS-T
2091	RD			RA				115mm	HE	OPFOR, MBT HE	HE
										3UOF-37, UOF-37, UOF-6	HE-FRAG
2092	RD							115mm	HEAT	OPFOR MBT HEAT	HEAT
										UBK-3, UBK-3M	HEAT-T
								117-122mm Tank, IFV and APC		120, 122mm	
2093	RD							120mm	AP	Leopard 1APDS Strv 121 AP	APDS
2094	RD							120mm	APimp	M829A1/A2/E3 APFSDS-T Leopard 2 APFSDS-T Challenger APFSDS Strv122 AP	APFSDS
										DM63A1KE, DM53A1KE	
										DM43A1KE, DM33A1KE	
										Advanced Tungsten KE Cartridge	
2095		RT						120mm	APtop	XM943 STAFF, top attack	STAFF
2096	RD							120mm	HEcani	M1028	Canister
				RA						M1028 Using the 3D detonation model detonating when directly leaving the gun muzzle	
2097	RD							120mm	HE	Leopard HE AMOS Strv 121 and Sgr	HE
										M908	HEORT
										M933, M934	HEMO
										DM12A2MP, M337	HEMP
				RA					HEair	Air burst	ABM
							SS		HE	Vehicles HE	HE
2098	RD							120mm	HEMPdd	Delayed detonation	HEMP
2099	RD							120mm	HEAT	M830A1 HEAT Leopard 2 HEAT	HEAT
										Challenger HESH	HESH

Ammo Type No.	Simulation Characteristics RD	RT	RB	RA	RU	FF	SS	Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
										MRM	MRM-CE
2100	RD							120mm	HEMP	Leopard HEMP	HEMP
								≥125mm Tank, IFV and APC		125mm	
2101	RD							125mm	AP	T-90 APFSDS OPFOR MBT 125mm FSAPDS	APDS
										BR-471B	APHE
										VBR-472	APC-T
2102		RT						125mm	APtop	Top attack	AP
2103	RD							125mm	HE	T-90 HE OPFOR MBT 125mm HE	HE
										Type 83	DPICM
										OF-1, M76, Type 54	HE-FRAG
										OF-56, OF-56-1, Type 462	
										OF-462, OF-471N, OF-472	
				RA					HEair	Air burst	HE
2104	RD							125mm	HEAT	OPFOR MBT HEAT	HEAT
										BK-9, BP-463	
										BK-6M, BK-13, BK463UM, 3UBK-9	HEAT-FS
								≤94mm Mortar, Field Gun and Art.Rockets		50, 51, 52, 70, 76, 60, 81, 82, 88mm	
2105	RD							70mm	HE	Type 71	HE
										Artillery Rocket FZ LAU-97: FZ-71	HE-FRAG
										Artillery Rocket FZ LAU-97: FZ-85	PFHE
										Artillery Rocket Hydra 70: M151	
								80mm		SGR80, GA	HE
								105mm		M915, 105mm	DPICM
										M916, 105mm	
				RA				70mm	HEair		HE
										Artillery Rocket FZ LAU-97: FZ-100	Cargo
										Artillery Rocket Hydra 70: M151 - time fuzed	HE
										Art. Rocket Hydra70: M261 - remote fuzed	MPSM HE
										Art. Rocket Hydra 70: M255 - remote fuzed	HE
2106	RD							70mm	HEAT		HEAT
										Artillery Rocket FZ LAU-97: FZ-49	AP
										Artillery Rocket FZ LAU-97: FZ-58	HEAP
								73mm		73mm 2.75inch Rocket	HEAT
								95-149mm Artillery, Mortar, Field Gun, Artillery Rocket		100, 105, 107, 120, 122, 130mm	
2107	RD							100mm	HE	Type 71	HE
								105mm		M915, M916	DPICM
								107mm		Type 63 rocket	HE
								122mm		122mm ARTY DF	
								120mm		AMOS SGR120/GA 120mm (GRK)	
								120mm		OGR 120 PR	DPICM
								122mm		Firos 25/30 rocket	HE
								130mm		M46	APHE
								130mm		BR-482B	APHE-T
								130mm		Type 59, M79, OF33	HE
								130mm		OF-482M	HE-FRAG
								130mm		HE-482M	HE
				RA				122mm	HEair	Air burst	HE
2108	RD							120mm	HEAT	Psgr 120mm STRIX (GRK)	HEAT
								122mm		Firos 25/30 rocket	
2109	RD							130mm	THBAR	M79BB	THBAR

Ammo Type No.	Simulation Characteristics							Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
	RD	RT	RB	RA	RU	FF	SS				
								≥150mm Artillery, Mortar, Field Gun		152, 155, 160, 165, 175, 180, 203, 240, 305mm	
2110	RD							152, 155mm	HE	152mm 155mm	HE
								155mm		M483A1, M864, Type 66	DPICM
										M107, M549A1, M795, M795E1, M864	HE
										SIRP SGR 155A (Haubits 77)	
								160mm		F-853A, F-853U	
								180mm		G-572	
								203mm		G-620	
								240mm		F864	
								280mm		675	
								305mm		724	
				RA				155mm	HEair	SGR 155Z (Haubits77)	
2111	RD								THBAR		THBAR
								Anti-tank Missile, Russia			
2112	RD				RU			AT-4, Spigot 9M111, “Fagot”	HEAT	BMP, BMD, BRDM, manpack mounts; can be fired from AT-5 launchers	HEAT
								AT-5, Spandrel 9M113, “Konkurs”		9M113, BMP, BMD, BRDM, manpack mounts; can be fired from AT-4 launchers BMP-2, PST082 OPFOR APC ATGW	
2113	RD				RU			AT-9, Spiral-2 9M120, "Ataka"	HE BB		HE BB
2114	RD				RU			AT-8, Songsterd 9M112, "Ataka"	HEAT	125mm gun launched; T-64B and early T-80	HEAT
								AT-9, Spiral-2 9M120, "Ataka"		HAVOC, HOKUM, HIND E/F launchers	
2115	RD				RU			AT-10, Stabber 9M117, “Bastion”	HEAT	100 and 115mm gun launched; T-55, T-62, MT-12, and BMP-3	HEAT
								AT-10, Stabber 9M117M, “Kan”		100 and 115mm gun launched; T-55, T-62, MT-12, and BMP-3	
								AT-10, Stabber 9M117M1, “Arkan”		100 and 115mm gun launched; T-55, T-62, MT-12, and BMP-3 OPFOR APC ATGW	
2116	RD				RU			AT-11, Sniper 9M119, “Svir” 9M119M, “Refleks”	HEAT	125mm gun launched; T-72, T-80, T-84, T-90 OPFOR MBT ATGW	HEAT
2117	RD				RU			AT-12 9M117	HEAT	Uses the same missile as the AT-10 115mm gun launched; T-62	HEAT
								AT-12, Swinger 9M117M, “Sheksna”		Uses the same missile as the AT-10 115mm gun launched; T-62	
								AT-12, Swinger 9M117M1, “Sheksna”		Uses the same missile as the AT-10 115mm gun launched; T-62 OPFOR MBT ATGW	
2118	RD				RU			AT-13, Saxhorn-2 9M131, "Metis-M"	HEAT	METIS-M: 9K115-2	HEAT
								AT-14, Spriggan 9M133, "Kornet"		152mm. Tripod or vehicle-mounted; thermal viewer effective to 3500m	
								AT-15, Springer 9M123, "Kriz-antema"		150mm	
2119	RD				RU			AT-13, Saxhorn-2 9M131F, "Metis-M"	HE BB		HE BB
								AT-14, Spriggan 9M133F, "Kornet"			
								AT-15, Springer 9M123F, "Kriz-antema"			
								AT-16, Scallion, "Vikhr"		Air to ground system	
2120	RD				RU			AT-16, Scallion, "Vikhr"	HEAT	Air to ground system	HEAT
2121	RD				RU			AT-16	HE		HE
				RA					HEair	Time fuzed direct detonation	
2122	RD							SA-14, Gremlin 9M36, “Strela-3”	HE		HE

Ammo Type No.	Simulation Characteristics RD	RT	RB	RA	RU	FF	SS	Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
								SA-16, Gimlet 9M313, “Igla-1”			
								SA-18, Grouse 9M39, “Igla-M”			
2123	RD							SA-24, Grinch 9M342, “Igla-S”	HE		HE
								Anti-tank Missile, US			
2124	RD							AGM-65	HEAT	Maverick, 57 kg hollow charge with contact fuze	HEAT
										135 kg high explosive	
2125	RD				RU			AGM-114K	HEAT	Hellfire II US, Swedish, NATO, and Israeli use	HEAT
								AGM-114N		Metal augmented charge	HEAT MAC
2126	RD				RU			AGM-114KII	HE	External blast frag sleeve	HEMP
								AGM-114M		Blast fragmentation	HE-FRAG
								AGM-114L		Longbow Hellfire	HE
2127	RD				RU			AGM-BGM-XYZ	HEAT	Joint Air to Ground Missile (JAGM)	HEAT
2128	RD				RU			AGM-BGM-XYZ	HE	Joint Air to Ground Missile (JAGM)	HE-FRAG
2129	RD				RU		SS	TOW	HEAT		HEAT
								BGM-71D		TOW 2	
								BGM-71A		Basic TOW	
								BGM-71C		ITOW	
								Predator		Direct attack	
								Troophan 2		Copy of TOW	
								HJ-8E		Red Arrow 8 Copy of TOW, China	
								Baktar-Shikan,Pakistan		License production of HJ-8	
								KAM9/ TYPE 79		Similar to TOW, Japan	
2130	RD				RU			TOW 2A	HEAT	RB55C	HEAT
								M220/ BGM-71E			
2131	RD				RU			TOW 2A, M220/ BGM-71H	HE BB	TOW 2A Bunker Buster	HE BB
								Predator, FGM-172B SRAW-MPV		Predator. Multi-purpose variant (MPV) blast fragmentation warhead, which will convert the system into a direct attack urban assault weapon, effective against buildings and bunkers.	
2132		RT			RU			TOW 2B , M220/ BGM-71F	HEAT	TOW 2B top attack. RB55E	HEAT
								Predator FGM-172A		Top attack. UK Kestrel	
2133	RD				RU			TOW 2B air launched	HEAT	TOW 2B Aero TOW 2B RF	HEAT
2134	RD				RU			LOSAT	HEAT	Fire-and-Forget weapon system Line-Of-Sight Anti-tank weapon using Kinetic Energy Missile (KEM)	HEAT
2135	RD				RU			M47 Dragon	HEAT	Dragon, Saudi, Yugoslav, Swiss, Moroccan, Jordanian and other users	HEAT
2136	RD				RU	FF		Javelin	HEAT	Fire-and-Forget weapon system Javelin direct attack	HEAT
2137		RT			RU	FF		Javelin	HEAT	Javelin top attack. Imaging Infrared (I2R)	HEAT
2138	RD							Stinger (Fire-and-Forget) Ground to Air	HE	Stinger, GILL	HE
								Type 87		Stinger copy from Japan	
						FF				Also as ammo no. 25 Stinger, GILL	
								Anti-tank Missile, Europe			
2139	RD				RU			HOT 1	HEAT	HOT 1, HOT Ground Several missile versions; anti-reactive armour capability	HEAT
								HOT 2			
								HOT 3			

Ammo Type No.	Simulation Characteristics							Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
	RD	RT	RB	RA	RU	FF	SS				
2140	RD				RU			HOT air launched	HEAT	HOT PAH	HEAT
2141	RD				RU			MILAN 2	HEAT	Ground and vehicle mounts	HEAT
2142	RD				RU			MILAN 2T	HEAT	Tandem warhead	HEAT
								MILAN 3			
								MILAN ER			
2143	RD				RU			TRIGAT MR	HEAT	PARS 3 MR	HEAT
2144	RD				RU			TRIGAT LR, MELLS	HEAT	Direct attack MELLS - direct	HEAT
2145		RT			RU			TRIGAT LR, MELLS	HEAT	Top attack	HEAT
						FF			HEAT	Also as ammo no.30 PARS LR, MELLS	
2146	RD				RU			NLAW	HEAT	Fire-and-Forget weapon system NLAW direct attack RB57 direct attack, origin Sweden ShoRats, NBTPsk, Pskott2000	HEAT
2147		RT			RU			NLAW	HEAT	NLAW top attack RB57 top attack, origin Sweden ShoRats, NBTPsk, Pskott2000	HEAT
2148	RD				RU			ERYX	HEAT	Origin France HE Calibre 137mm SM-137	HEAT
2149	RD				RU			Brimstone	HEAT	Single and multiple launch, origin UK	HEAT
2150	RD				RU			Bill 1. Direct attack	HEAT		HEAT
2151		RT			RU			Bill 1. Top attack	HEAT	Proximity and top attack mode. Also as ammo no. 34. Origin Sweden	HEAT
2152	RD				RU			Bill 2. Direct attack	HEAT		HEAT
2153		RT			RU			Bill 2. Top attack	HEAT	Also as ammo no. 35. Origin Sweden	HEAT
2154	RD				RU			Bill 1 and Bill 2. Soft Target	HEAT	Also as ammo no. 38. Origin Sweden	HEAT
2155	RD							RBS-70	HE	RBS-70 MK0. Origin Sweden	HE
										RBS-70 MK1. Origin Sweden	
2156	RD				RU			RBS-70	HEAT	RB90 MK2. Origin Sweden	HEAT
2157	RD				RU			RBS-70	HEAT	Direct attack BOLIDE ITO2005. Origin Sweden	HEAT
2158		RT			RU			RBS-70	HEAT	Top attack BOLIDE. Origin Sweden	HEAT
								Anti-tank Missile, International			
2159	RD				RU			SPIKE-SR Direct attack	HEAT	Short Range	HEAT
2160	RD				RU	FF		SPIKE-MR Low Trajectory	HEAT	Medium Range GILL Low Trajectory	HEAT
2161	RD				RU	FF		SPIKE-MR High Trajectory	HEAT	Medium Range GILL High Trajectory	HEAT
2162	RD				RU			SPIKE-LR Direct attack	HEAT	Long Range Also as ammo no. 13	HEAT
2163		RT			RU			SPIKE-LR Top attack	HEAT	Long Range	HEAT
						FF			HEAT	Also as ammo no. 30	
2164	RD				RU			SPIKE-ER	HEAT	Extra Long Range. NTD Dandy	HEAT
2165	RD							Mokopa	HEAT	Origin S.Africa	HEAT
								Ingwe		Origin S.Africa	
								Non-Lethal Less Lethal		As for example tear gas shells, bean bags, stun rounds and rubber projectiles.	
2166	RD							Ammo with no effect	NLETH	Ammo with no effect	NLETH
2167	RD							≤76mm	NLETH		NLETH
								40mm Grenade		M385, M918, M203, Mk19, XM320	
								40mm		M1006 Sponge Round (Point), M651 CS	
								40mm		M1029 Crowd Dispersal Cartridge	
2168	RD							77-109mm	NLETH	Stun Cartridge	NLETH
								105mm			
2169	RD							≥110mm	NLETH	Stun Cartridge	NLETH
								120mm			

Ammo Type No.	Simulation Characteristics							Caliber or Weapon	UCATT Ammo Type	Description	Real Ammo Type
	RD	RT	RB	RA	RU	FF	SS				
								Horizontal Effects Weapon Improvised Explosive Device			
2170	RD							IED light TNT <5kg	HE	As for example improvised shrapnel packed together with a number of dynamite cartridges.	HE
								Booby-trap			
								Suicide Bomber			
				RA				IED light TNT <5kg		Using the 3D detonation model	
2171	RD							IED medium, TNT 5-20kg	HE	E.g. 120mm HE shells armed as an IED	HE
				RA						Using the 3D detonation model	
2172	RD							IED heavy, TNT 20-100kg	HE		HE
				RA						Using the 3D detonation model	
2173	RD							Truck bomb, TNT >100kg	HE		HE
				RA						Using the 3D detonation model	
2174	RD							HEW Off-Route Anti-tank	HEAT	DM-12 PARM M24 mine	HEAT
								Handgrenade			
2175	RD							100g TNT equivalent	HE	Fragmentation grenade	FRAG
								M67			
								F1		USSR Limonka	
				RA				100g TNT equivalent		Using the 3D detonation model	
2176	RD							250g TNT equivalent	APERS	Concussion grenade	Concussion
								MK3A2		MK3A2	
				RA				250g TNT equivalent		Using the 3D detonation model	
2177	RD							M84	NLETH	Stun grenade	Stun
								Engagement Alert		To inform the target about an engagement	
2178	RD							Laser Range Fire	NLETH	A LRF is made against the target	
2179	RD							Laser Designator	NLETH	A Laser designation is done against the target	
2180	RD							Laser Beam Rider	NLETH	A Laser beam riding missile is engaging the target	
2181	RD							IFF A	NLETH	Identification Friend or Foe. IFF is done by A (Bluefor)	
2182	RD							IFF B	NLETH	IFF is done against the target by B (Opfor)	
	RD							IFF answer		Answer to a friendly IFF Not simulated	
2183	RD							Munition Flame	NLETH	Simulate the fact that the target may visually recognize that a weapon is fired against the target	
								Short-Time Scanning		Primary dedicated Short-Time Scanning simulation. May still be used also in Real-Time simulation	
2184	RD						SS	Near Miss ≤8.6mm	NMISS	5.56, 7.62mm Cal 0.223, 0.30	
2185	RD						SS	Near Miss >8.6mm	NMISS	12.7, 14.5, 20, 30, 35, 40mm	
2186	RD						SS	Universal Kill	Kill	Universal Kill	
2187	RD						SS	Helmet off Kill	Kill	Punishing soldiers with helmet taken off	
								Additional		Additional Simulated Functions	
2188	RD							RF SAM	HE	RF Surface to Air Missile	HE
2189	RD							Secondary Effects Kill	Kill	As for example shrapnel from a tank hit	
2190	RD							Flame-thrower	Kill		
								Main Gun Danger Zones			
2191	RD							Short Range Main Gun Danger Zone	Kill	As for example lethality caused by petals or gun overpressure when standing typically up to 200m in front of a tank gun	
				RA						Using the 3D detonation model	
2192	RD							Remote Range Main Gun Danger Zone	Kill	As for example lethality caused by petals when standing typically 200-1000m in front of a tank gun	
								Spare ammo numbers			
2193 to 2280	N.A.							Spare ammo types			

Table 10. Ammunition Table Section 2

Note M19. Although M19 is an anti-tank mine, for simulation purposes a specific long range anti-personnel code is required to give the possibility of adjusting the Laser effect radius and vulnerability. Used on its own, it simulates a larger type of anti-personnel mine.

Note M100. Although M100 is an anti-tank mine, for simulation purposes a specific long range anti-personnel code is required to give the possibility of adjusting the Laser effect radius and vulnerability. Used on its own, it simulates a larger type of anti-personnel mine.

Annex E – PRODUCT NOMINATION

The following document shows the Product Nomination to SISO.

SISO-PN-008-2015

Product Nomination for

Standardization of Urban Combat Advanced Training Technologies (UCATT) Architecture External Interfaces for Live Simulation Instrumented Training Interoperability

Version 3.0

February 27, 2015

SAC Approved: 03/17/2015 **EXCOM Approved: 04/13/2015**

Revision History

Version	Section	Date (MM/DD/YYYY)	Description
V1.0	All	07/30/2013	Original version
V2.0	9	04/16/2014	Front cover, header, footer, copyright, Sec 9 Schedule
V3.0	All	02/27/2015	Added guidance and reference products. Revised timeline and roadmap.

Table of Contents

SISO Product Nomination for
Standardization of Urban Combat Advanced Training Technologies (UCATT) Architecture External Interfaces for Live Simulation Instrumented Training Interoperability

SISO-PN-008-DRAFT

1. Product title *

Standardization of UCATT Architecture External Interfaces for Live Simulation Instrumented Training Interoperability

2. Proponent name(s) and contact information

First name: Armin **Last name:** Thinnes
Affiliation: German Federal Office of Defence Technology and Procurement
Street Address: Ferdinand-Sauerbruch-Str. 1
City: Koblenz **State:** Germany **Zip:** 56073
Phone #: +49 2614006813 **Fax #:**
Email: arminthinnes@bundeswehr.org

Additional proponents:

Name	Organization	Email Address	Phone Numbers
Mark Chamberlain	UK MOD	deslejbtse-lve-atl@mod.uk	
Gary Washam	Cubic	gary.washam@cubic.com	
Joachim Eisenhauer	Rheinmetall	joachim.eisenhauer@rheinmetall.com	00491752275754
Niclas Von Rothstein	FMV	niclas.von.rothstein@fmv.se	
J. Campos	US Army PeoSTRI	jesse.j.campos@us.army.mil	
M. Coriat	THALES	michel.coriat@thalesgroup.com	
S. Cruiming	Min.Def NL	ba.cruiming@mindef.nl	
T. Desfachelles	FR DGA	thomas.desfachelles@dga.defense.gouv.fr	
P. Desruelles	Cassidian	philippe.desruelles@cassidian.com	
Max Fenner	RUAG	max.fenner@bluewin.ch	
R. Gouweleeuw	TNO	rudi.gouweleeuw@tno.nl	
J. Gullstrand	SE MIL	johnny.gullstrand@mil.se	
R. Lerch	CH MIL	Rolf.Lerch@vtg.admin.ch	
P. Makowski	GE MIL	PeterMakowski@bundeswehr.org	
R.Karlson	SE MIL	roger.1.karlsson@mil.se	
I. Wittwer	RUAG	ingo.wittwer@ruag.com	
T. Vinatier	GDI Simulation	Thierry.Vinatier@gdi-simulation.eads.net	
A. Lindstroem	Saab	anders.y.lindstrom@saabgroup.com	
M Alexandersson	Saab	magnus.alexandersson@saabgroup.com	
S. Blahnik	Cubic	steve.blahnik@cubic.com	
P. Handley	Cubic	Paul.Handley@cubic.com	

List of proponents can change during the process.

3. Type of product(s) *(*Balloted Products)*

X	Standard*
X	Guidance*
X	Reference
	Administrative

4. Product description

- A guidance document that describes the overall UCATT "family of products" standardization philosophy and functional architecture. It furthermore contains use cases, best practices and implementation guidelines.

- Interface specification standards as identified in the UCATT functional architecture, allowing technical interoperability between live simulation systems. Together these standards specifications will form the UCATT family of standards.

- Reference products supporting the developed standards. Some examples are the ammunition table supporting the laser interface standard, or an injury database to ensure fair-play during combined exercises.

5. Identification of the community to which product applies

This product is primarily intended to serve the military live simulation community, but should have equal applicability to other communities that engage in live training, such as emergency management / emergency response personnel. Furthermore, UCATT will encourage other communities including those in the virtual and constructive domain to leverage the developed standards when and where applicable.

6. Problem(s) and/or issue(s) that the proposed product addresses

There is currently a large demand for joint and combined military operations world wide and this demand drives the military training requirements for combined training. Up to the time of this proposal there have been no official standards regulating interoperability of live instrumented simulation systems. Several national and/or proprietary solutions are currently in use world wide but there is no or little interoperability between the different solutions. The current situation is such that it precludes combined simulation training using the original country's simulation equipment and demand presently cannot be met by the existing training technology due to the lack of common standards. Joint live training using mixed equipment is currently effectively impossible.

This proposed family of standards, and further subsequent proposals, are intended to overcome this deficiency by providing a common definition of interoperability and physical interfaces for live simulation instrumentation architectures.

a) Provide details on the specific need or requirement for this product in the community.

The inability to perform combined live simulation exercises has been identified and discussed by the military user and several NATO Working Groups (FIBUA/MOUT, TSWG, etc). As a direct result of these discussions the UCATT working group (NMSG WG 063 TG 040) was created to address the matter.

b) Provide details on the discussion of the need for this product in the community.

The UCATT group has been studying and analysing live training standardization since its formation in 2003 and it is now ready to initiate and manage the development of a SISO approved family of standards beginning with this proposal.

c) Have you investigated similar products in the community to ensure no overlap exists?

UCATT has studied the NATO instrumentation needs for live simulation training and concluded that there is a requirement for an open international standard of a set of multiple interfaces (currently defined as eleven external interfaces, E1 to E11, of the functional architecture). It has determined that that there are no similar products in existence.

Within the set of interfaces identified as required by UCATT, there are three that are candidates for leveraging SISO existing or under development standards:

- UCATT external interface (E6), designed to provide input interoperability from tactical C4I systems, would be a candidate for using C-BML.
- UCATT external interface (E7) designed to provide simulation outputs to the C4I system would also be a candidate for using C-BML.
- UCATT external interface (E8), designed to enable communications between independent simulation systems connected to support a combined live training exercise, would be a candidate for using IEEE 1516 (High Level Architecture for Modeling and Simulation). HLA was effectively used to implement the UCATT multi-national simulation interoperability demonstration held in 2010 in Marnehuizen, Netherlands.

The remaining external interfaces for instrumentation currently defined in the UCATT Functional Architecture for Live Simulation, E1 to E5 and E9 to E11, are low-level interfaces between physical components unique to live simulation and will require separate fresh efforts to create them as new members of the family of UCATT specifications.

7. Indication of the maturity of the product

a) Detailed description on HOW the problem/issue will be solved (approach)

UCATT has been analysing the user requirements, use cases and technology relevant to providing interoperability for live simulations for over 10 years and has developed a functional architecture with clear definitions for specific interfaces that it believes should be standardized.

The approach for standardizing the proposed UCATT interfaces is to implement the SISO Balloted Products Development and Support Process (BPDSP) and generate a single UCATT/SISO Guidance Product with multiple standards with reference products as required. This will be done in an iterative manner as a family of related standards where each member of the family addresses a particular interface.

The UCATT group reports to the NATO CSO (CSO-TR-MSG-032, MSG-63, MSG-98, MSG-99, MSG-140), which will provide the baseline for the first comment round. The intent is to reach out to and engage other groups and bodies that have an interest in interoperability standards for live simulation training and follow the SISO process to ensure widest possible community acceptance of the final standard.

The UCATT functional architecture for military live simulation defines a number of interfaces (E1 - 11). Each of these interfaces can be implemented using one or several physical interfaces (I1 – I12). It is also the case that each physical interface (Ix) can be used to implement more than one functional interface (Ex).

The overarching guide that will be submitted to SISO for approval will specify all physical interfaces incrementally. Each physical interface will be a separate standard supported by any required reference products.

Figure 1. Diagram showing the projected UCATT family of standard, guidance and reference products

The UCATT guidance product will:

- Explain the generic information related to the functional architecture

Each UCATT standard will:

- Define the functional interface, and
- Define which physical interface shall be used to implement each functional interface.

Each UCATT reference document will:

- Support a specific UCATT standard or set of standards. For example, the ammunition table reference document supports the functional E1 “engage” interface and can be used for three physical interfaces (E1/I1, E1/I2 and E1/I3), as shown in figure 1.

The SISO PDG will start to define the overall UCATT guidance and standards products. The idea is to submit and approve each standard (Ex-Ix) separately beginning with the guidance product. The UCATT guidance product will, if needed, be updated for each new release of a standard.

The timeline / development plan is as follows. The first standard developed is the E1/I2 Optical laser interface specification standard, as this is the most mature document and well agreed upon across the UCATT community. The first reference document to be delivered is the ammunition table, supporting the optical laser interface standard. Both are expected to be delivered to the SISO community in 2015 (see ch. 9).

Further planned UCATT standards and reference and guidance products, as shown and explained in Section 7 and Figure 1, will be developed in an incremental way. Since each interface demands a study in itself and its maturity investigated, it is at this point not possible to give a specific timeline for each and every UCATT PDG product. However, a prioritization has been made within the projected family of products to develop standards for the functional E1, E4 and E8 interfaces first. This will provide the live simulation community with a basic form of system-to-system interoperability. With the development of each standard, guidance) products will be reviewed and updated accordingly.

b) Brief discussion on the maturity of the proposed product.

Elements of the proposed UCATT guidance are based on existing technology specifications and products already fielded. One example is the laser engagement data and physical interface called Optische Schnittstelle AGDUS GÜZ-2 (OSAG-2) developed originally for the German Combat Training Center and enhanced by Saab Training Systems and users.

Additional proprietary interface implementations are already fielded for standalone live simulation training and would be evaluated as candidates for becoming an element of the final UCATT standard to satisfy one of the eight defined interfaces.

c) Brief discussion on alternative approaches to the proposed product

Because the community has an established need for this product, the only viable alternative would be to standardize the product outside of SISO. Since SISO is the principal standards organization for simulation interoperability and has been endorsed by NATO (the UCATT parent organization), selecting an alternative approach is not appropriate or desirable.

d) Provide examples of prototypes of the proposed product or reasons why this product will not be prototyped.

Over the past 35 years multiple instrumentation architectures have been developed and fielded by different industry members for various countries with unique capabilities and proprietary interfaces based on isolated program requirements. UCATT proposes to leverage its common functional architecture developed over the past 10 years to implement a set of standards for the multiple interface elements that address these essential boundaries for interoperability.

The instrumentation systems implemented at Combat Training Centers and Urban Training Centers over the past three decades are essentially prototypes of the UCATT architecture but with variations dictated by unique customer demands and without attention to joint interoperability. Also, the proof-of-concept demonstration of UCATT in Marnehuizen MOUT village (The Netherlands) in 2011 was prototyped according to the UCATT functional architecture design.

UCATT does not wish to impose system design but the common functional architecture can be used as a reference and to ensure interoperability, while still allowing flexibility.

e) What impact will the proposed product have on the M&S community?

The product will for the first time provide a standard that can be used by the live training community to ensure interoperability between live training systems of different origin. From a more military point of view, the product will provide the standard required to govern the technology employed in joint live training exercises.

f) What impact will this proposed product have on the SISO community?

SISO is all about simulation interoperability, and the UCATT standard is to define the core processes for live simulation interoperability. This standard will be the first to fully address the live simulation segment of training and will enhance the credibility of SISO across all three domains of training – virtual, constructive and live.

g) What is the impact to the community on the LACK of this proposed product?

If this set of standards are not developed the possibilities to achieve cost effective and high quality multi national joint and combined live training exercises will be limited. In its final consequence the required military readiness for "today's and tomorrow's" military missions is at stake.

h) What are the domain implications for this proposed product?

This proposed product will permit combined simulation training using the country's existing simulation equipment.

i) State which SIW conference track(s) takes an active interest in the development of this proposed product?

None to date but the Acquisition Lifecycle and Technology Transfer (ACQ) Track should take interest in this work.

8. Planned compliance testing

The UCATT PDG intends to develop a plan for how to achieve an independent certification process for the proposed standard. The plan will describe how to reach a certification process, along with draft associated test procedures and tools needed for compliance testing.

9. Schedule of product development milestones including reviews and reports

Jul 2013	Submit the PN to SISO
Aug 2013	SISO approve PN
Dec 2013	PDG Kick-off Meeting. Select officers, and discuss scope of effort and proposed schedule.
May 2014	Release of the Draft E1/I2 Specification; first part of the set of standards stated above. Open a discussion forum/ thread on the SISO web.
Sep 2014	PDG / UCATT Meeting. Update Draft E1/I2 Specification and UCATT guidance document based on document review comments.
Nov 2014	PDG / UCATT Meeting. Release of an updated E1/I2 Specification, if necessary including certification plan.
March 2015	Submit revised PN for SISO approval. Build circulation package for UCATT guidance product and another for the E1/I2 optical laser interface specification standard.
April 2015	Approval of revised PN by SISO SAC
May 2015	UCATT/PDG meeting. Final review of E1/I2 standard, ammunition table reference product and UCATT guidance product circulation packages. Start balloting process for the guidance and standard products.
Q3/Q4 2015	SISO Product Approval; limited to E1/I2interface specification standard and UCATT guidance product.

This schedule will be extended, in order to represent further live Simulation Instrumentation Interfaces as part of the family of products. This schedule will consider these new interfaces when they achieve a proper mature level.

Note: E1/I2 refers to the UCATT E1 interface implemented using laser technology (I2).

10. Candidate volunteers for the product development effort

Name	Organization	Email Address
A. Thinnes	BWB	arminthinnes@bwb.org
G. Washam	Cubic	gary.washam@cubic.com
J. Vermeulen	Min.Def NL	ja.vermeulen@mindef.nl
N. von Rothstein	FMV	niclas.von.rothstein@fmv.se
J. Campos	US Army PeoSTRI	jesse.j.campos@us.army.mil
M. Chamberlain	UK MOD	deslejbtse-lve-atl@mod.uk
M. Coriat	THALES	michel.coriat@thalesgroup.com
S. Cruiming	Min.Def NL	ba.cruiming@mindef.nl
T. Desfachelles	FR DGA	thomas.desfachelles@dga.defense.gouv.fr
P. Desruelles	Cassidian	philippe.desruelles@cassidian.com
Max Fenner	RUAG	max.fenner@bluewin.ch
R. Gouweleeuw	TNO	rudi.gouweleeuw@tno.nl
J. Gullstrand	SE MIL	johnny.gullstrand@mil.se
R. Lerch	CH MIL	Rolf.Lerch@vtg.admin.ch
P. Makowski	BWB	PeterMakowski@bundeswehr.org
R.Karlson	SE MIL	roger.1.karlsson@mil.se
J. Eisenhauer	Rheinmetall	joachim.eisenhauer@rheinmetall.com
I. Wittwer	RUAG	ingo.wittwer@ruag.com
T. Vinatier	GDI Simulation	Thierry.Vinatier@gdi-simulation.eads.net
A. Lindstrom	Saab	anders.y.lindstrom@saabgroup.com
M Alexandersson	Saab	magnus.alexandersson@saabgroup.com
S. Blahnik	Cubic	steve.blahnik@cubic.com
P. Handley	Cubic	Paul.Handley@cubic.com
B. Ross	Chemring	bettina.ross@chemringdefence.com

11. Suggested product periodic review cycle (timeline)

Formal periodic reviews of each published balloted product should be conducted and documented IAW SISO-ADM-002 and SISO-ADM-003. Informal reviews of published products should be conducted as new information becomes available, technology changes, etc.

Annex F – MSG-099 WORK FLOW

The steps from the functional architecture to a standard are shown in Figure F-1. The figure also shows that prior to the interface standardization, physical interfaces had to be created and voting rules had to be established to make a decision.

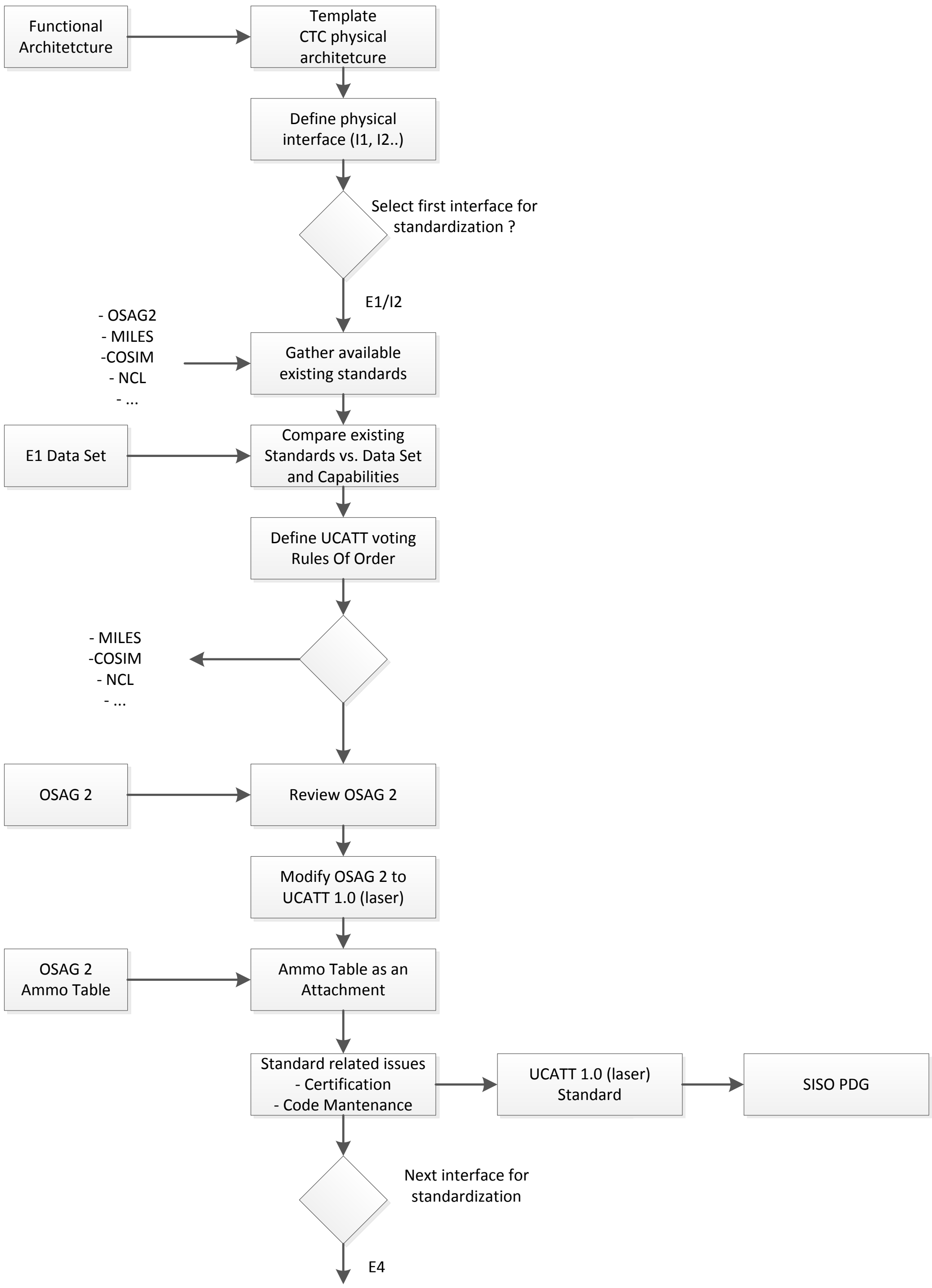

Figure F-1: Flow of Work MSG-099.

Annex G – TERMS OF REFERENCE

G.1 BACKGROUND AND JUSTIFICATION

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

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

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

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

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

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

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

G.2 OBJECTIVE(S)

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

G.3 TOPIC TO BE COVERED

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

G.4 DELIVERABLE

Technical Report.

G.5 TECHNICAL TEAM LEADER AND LEAD NATION

Chair: Holger Boettcher Germany (RUAG COEL Gmbh).

Deputy Chair: Armin Thinnes, Germany.

Lead Nation: Germany.

G.6 NATIONS WILLING/INVITED TO PARTICIPATE (GOV, IND)

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

G.7 NATIONAL AND/OR NATO RESOURCES NEEDED

Travel funding for national participation in meetings.

G.8 RTA RESOURCES NEEDED

MSCO support to TG.

Publication.

Additional Information

Limited Participation Technical Team: No.

Annex H – TASK GROUP INFORMATION

H.1 PARTICIPATING NATIONS

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

- France FRA
- Germany DEU
- New Zealand NZL
- Sweden SWE
- Turkey TUR
- United States of America USA

H.2 STEERING GROUP MEMBERS

Chairman: Ingo Wittwer, RUAG Defence Deutschland GmbH, DEU (12)*.

Secretary: Mr. Anders Lindström, Saab Training Systems, SWE (10).

Other Steering Group Members: Mr. Gary Washam, CUBIC, USA (7), Mr. Armin Thinnes, GOV, DEU (12).

H.3 PARTICIPANTS

Participants of MSG-099 are listed in the table below.

Table H-1: UCATT-3 MSG-099 Participants.

Nation	Rank/Title	Name	Department/Company	Timeframe
SWE	Mr.	Alexanderson, Magnus	SAAB Training System	2011 – 2015 (9)
TUR	Mr.	Colakoglu, Cagatayhan	Aselsan	2011 (1)
DEU	Dr.	Dobrindt, Uwe	Rheinmetall Defence Electronics GmbH	2014 – 2015 (3)
DEU	Mr.	Eisenhauer, Joachim	Rheinmetall Defence Electronics GmbH	2011 – 2015 (8)
DEU	Mr.	Neugebauer, Holger	WTD91, German Armed Forces	2014 – 2015 (3)
SWE	Mr.	Nyfelt, Leif	NSC	2011 (1)
NZL	Mr.	Paul, Handley	CUBIC Global Defense	2012 – 2015 (3)
DEU	Mrs.	Ross, Bettina	Drew Defense (formerly Chemring Deutschland)	2012 (2)
USA	Mr.	Steve, Blahnik	CUBIC Global Defense	2011 – 2015 (8)
FRA	Mr.	Vinatier, Thierry	Airbus Group GDI Simulation	2011 –2015 (12)
TUR	Mr.	Yahsi, Zafer	Aselsan	2011 (1)

* Number of Meetings attended shown in brackets.

H.4 MEETING LOCATIONS

Table H-2: UCATT MSG-099 Meeting Locations.

2011	2012	2013	2014	2015
	Warminster (GBR)	Rome (ITA)	San Diego (USA)	Vienna (AUT)
Gränna (SWE)	Paris (FRA)	Koblenz (DEU)	Amersfoort (NLD)	
Orlando (1) (USA)	Orlando (2) (USA)	Orlando (3) (USA)	Orlando (4) (USA)	

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North Atlantic Treaty Organization
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14. Abstract

The Urban Combat Advanced Training Technology (UCATT) Standards Task Group (TG) was established within the NATO Modelling and Simulation Group (NMSG) in 2011 as MSG-099 TG. Simultaneously UCATT Architecture TG was established as MSG-098. Together they form the UCATT TG.

The UCATT Standards TG is tasked to standardize interfaces that has been prioritized and handed over by the MSG-098 UCATT Architecture TG. An important task was to analyse the given datasets traveling through these interfaces and to select an appropriate interface solution. The group evaluates the applicability of existing standards as potential candidates for the realisation of UCATT interfaces and discuss and decides limitations with the MSG-098.

The SISO standardisation activities of the UCATT Standards TG are supported by all members of the UCATT Architecture TG who form together the SISO UCATT PDG.

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Management of Scientific & Technological Research for Defence, National STO Coordinator
Royal Military Academy – Campus Renaissance
Renaissancelaan 30, 1000 Bruxelles

BULGARIE
Ministry of Defence
Defence Institute "Prof. Tsvetan Lazarov"
"Tsvetan Lazarov" bul no.2
1592 Sofia

CANADA
DGSIST 2
Recherche et développement pour la défense Canada
60 Moodie Drive (7N-1-F20)
Ottawa, Ontario K1A 0K2

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

ESPAGNE
Área de Cooperación Internacional en I+D
SDGPLATIN (DGAM)
C/ Arturo Soria 289
28033 Madrid

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

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

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

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

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

ITALIE
Ten Col Renato NARO
Capo servizio Gestione della Conoscenza
F. Baracca Military Airport "Comparto A"
Via di Centocelle, 301
00175, Rome

LUXEMBOURG
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"Tsvetan Lazarov" bul no.2
1592 Sofia

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