The Need for Interoperability for Urban Training in the Live Environment - The Work of the Urban Combat Advanced Training Technology (UCATT) Group in NATO

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ABSTRACT: *The Urban Combat Advanced Training Technology (UCATT) was established within the NATO Modelling and Simulation Group (NMSG) in 2003 as MSG 032. UCATT was tasked to exchange and assess information on Military Operations in Urban Terrain (MOUT) facilities and training/simulation systems with a view toward establishing best practice. In addition it was required to identify a suitable architecture and a standard set of interfaces that would enable interoperability of MOUT training components that did not inhibit future enhancements and identify limitations and constraints on MOUT development so that areas for future research could be identified. The end product to be a comprehensive report detailing an architectural framework to enable interoperability and future research requirements for MOUT training facilities. The report will be delivered in August 2006. What is unique about the group is that it draws in members from both government and industry. Its industrial partners are particularly important as they ultimately will need to deliver solutions that are interoperable within NATO and Partners for Peace (PfP) countries. This paper covers the work of UCATT from its inception and the work conducted to date which includes the development of a MOUT Website and architectural framework based on use cases and an analysis of the functional components mapped to national requirements for live force-on-force urban training.*

1. Introduction

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

This paper is based on the work of The Urban Combat Advanced Training Technology (UCATT) which was established within the NATO Modelling and Simulation Group (NMSG)[1] in 2003 as MSG 032 Task Group (TG) 023. It was established in order to examine key interoperability issues that had been identified in a feasibility study that was conducted between 2001 and 2002 by a NATO Military Operations in Urban Terrain (MOUT) Team of Experts (TOE). The key aspects of the report are addressed later. Despite Sun-Tzu's warning in relation to besieging walled cities and the weight of historical evidence to show that urban warfare has existed in one form or another for centuries, it had been recognised by NATO that they would have to potentially conduct operations in an urban environment in a report written in 1999 [1]. This had been made evident by events that had taken place in places like Panama City, Kuwait City, Mogadishu, Port-au-Prince, Grozny, Sarajevo and Kinshasa. More recently the battle for An Najaf by the U.S. Army in March 2003 and Fallujah predominantly by the U.S. Marine Corps in October 2004, both in Iraq, has provided more evidence that future military operations are more likely to take

[1] The NMSG is one of seven bodies that conduct Research and Technology activities under the Research Technology Organisation whose headquarters is based in Paris.

place in the urban environment. This is perhaps particularly true with asymmetric warfare waged by terrorists and others who see that the technical advantages of NATO forces can be negated in urban areas. A number of papers in the last decade have made this point and they argue that this is because, 'urban warfare is relatively cheap and low tech making it particularly appealing to non-state actors and unconventional forces' and that '… soldiers are often described as ill-prepared (in equipment, doctrine, training and psychology) for the type of fighting that will occur if an enemy choose to fight in urban terrain'. [2][3].

1.1 Future Operating Environment

Given the evidence it was perhaps not surprising therefore that the NATO Research and Technology Organisation's (RTO)[2] Technical Report Land Operations in the Year 2020 (LO2020) [1] came to the conclusion that NATO forces would potentially have to conduct future operations in urban areas which would be characterised by their physical structures, the presence of non-combatants and both complex well developed infrastructure on one hand and poorer ones in areas like shanty towns on the other (as illustrated in Figures 1.1 and 1.2), and that such operations will pose significant challenges for the Alliance.

Figure 1.1 – Typical urban area.
(Authors Collection)

Figure 1.2 – Patrolling in Kabul
(UK Defence Image Library)

[2] The RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote cooperative research and information exchange.

The Land Operations 2020 Study Group stated that present capabilities for operating in urban areas are essentially those of World War II, which are characterised by massive mechanised confrontations in fairly open terrain, with high levels of casualties and extensive collateral damage. It argued that NATO commanders had very few military options which would avoid serious damage and casualties when dealing with an enemy in urban areas. Such effects were considered unacceptable, particularly at the lower levels of conflict, where NATO forces are more likely to become involved. Therefore, they considered that it was essential that NATO provides its commanders with a range of capabilities for dealing with the varying conditions of operations in urban areas.

To follow up on these findings, SHAPE established a Military Application Study to examine the need for joint and combined doctrine and concepts for operations in urban areas. Seven NATO nations agreed to provide members for the Study Group, and the Studies, Analyses and Simulation (SAS) panel agreed in May 2000 that the UK should provide the Director. The Study Group examined the requirements of the SAS panel and prepared their Report for further consideration. [4] The results are intended to identify directions for further research and to contribute to the NATO Defence Planning Process, the Defence Capabilities Initiative, and the Concept Development Experimentation Process.

The Study Group report [4] outlined a description of the likely nature of the future urban environment and it "*observed that urban areas will continue to increase in number and size and are likely to become focal points for unrest and conflict. The physical and human complexity of this environment presents unique challenges for a NATO commander which are not adequately addressed by those military capabilities designed for open environments*."

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

Specific training in urban areas is considered the best short-term enhancement available to NATO. While training is the responsibility of individual NATO nations, the lessons learned from training can be shared. Wherever possible, training should be focused upon joint and coalition operations in urban areas, featuring all aspects of the '3 Block

War'[3]*. Specific training/exercises would allow commanders to employ forces with more confidence while taking acceptable risks. However, there is the need for more urban-specific training facilities. There is also a need to combine these training facilities with simulation system(s) to portray more accurately the complexity of the urban battlespace. The training should be able to present the complexity of the urban battlespace at the operational level. The requirement to train and educate commanders in the cultural, political and ethnic background pertaining to the urban area will enhance their capability to deal successfully with such operations if and when they occur.*

The Study Group produced a roadmap which is at Figure 1.3 below:

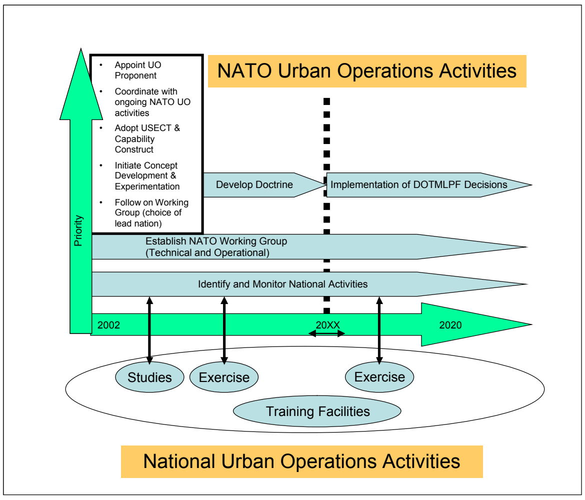

Figure 1.3 – Roadmap for improving capability in conducting Urban Operations [4]

1.2 NATO Military Operations in Urban Terrain (MOUT) Team of Experts (TOE)

In a response to Land Operations 2020 and whilst a study team was examining Urban Operations in 2020 the NATO MOUT/TOE under the direction of the National Army Armaments Group (NAAG) Land Group 8 (LG8) conducted its feasibility study which was presented to LG8 in April 2002 [5]. The aim of the study was to:

To investigate and recommend a generic set of unclassified requirements to be made available for all NATO/PfP[4] *nations to inform requirements and standards for development of instrumented MOUT capability. The generic requirement will specify and detail interface requirements".*

The team identified some key interoperability issues:

- <u>Operational Concepts</u>. The requirement for a User led group that would examine common user requirements for the timeframe 2010 and greater harmonisation of doctrine (Tactics, Training and Procedures (TTPs).
- <u>Battlefield Effects</u>. The achievement of common objectives between nations in the following areas:
  - <u>TES Interoperability</u>. Tactical Engagement Simulations (TES) capability should be a specialist sub-set of Battlefield effects. TES capability should examine Laser Code, class and vulnerability[5] code to ensure interoperability. They envisaged three levels of TES interoperability:
    - To borrow/use existing equipment from other nations i.e. Dutch troops borrowing German equipment when training at German facility;
    - To develop interoperability between existing TES by adapting current equipment. They considered that 2010 would be a realistic date for this to be achieved;
    - Development of common standards and new TES equipment. Which was recognised might not be possible until 2020.
  - <u>Sensory Cueing</u>. Sensory cueing should be as close as possible to reality achieved by visual, audio, shock, Haptic/tactile, pressure, smell, effects of direct and indirect fire, explosives, Non-Lethal weapons and NBC weapon effects.
  - <u>Pyrotechnics</u>. The major issue here was with regards to safety regulations and common representation of effects.
- <u>Exercise Control (EXCON) /After Action Review (AAR).</u> EXCON conducts the following: planning, preparation, conducting an exercise, preparing and providing an interactive AAR (provides feedback, is

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[3] General C.C. Krulak, Commandant US Marine Corps "The Three Block War: Fighting in Urban Areas," presented at National Press Club, Washington, D.C., 10 Oct 1997.

[4] Partners for Peace – countries who are not full members of NATO but participate in certain areas.

[5] Dividing into laser classes is done in different ways in the US and Europe. The US tolerates a 4 times higher figures than Europe.

interactive, objective and flexible). They considered that a possible way ahead was to incorporate a Synthetic Environment (SE) to provide contextual information i.e. platoon in MOUT operates within a company context. They pointed out that integration of training functionality with operational equipment is necessary but there was a need to avoid data contamination between the two domains. Major issues and potential areas for interoperability included:

- The need to minimise training staff particularly Observer Controllers (O/C) in the field;
- The requirement to capture all data[6] to provide situational awareness and statistical analysis;
- The consequent need for smart tools to present the right information at the right time, in the right format.

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

At the conclusion of the feasibility study its key conclusions were:

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

It recommendation was that a NATO MOUT Simulation WG be formed to conduct in depth examination of identified issues.

2. Establishment of UCATT

The report was approved by the NAAG and UCATT was formally established but as a result of a NATO summit in Prague in the autumn of 2002 approximately 30% of the groups where reduced, including LG8. As a result UCATT no longer had a parent organisation within NATO but after negotiations with the NMSG the work of UCATT was brought under their control and held its first meeting in The Hague, The Netherlands in June 2003. UCATT had a number of key objectives [6] which evolved from the work carried out by the MOUT/ TOE:

- Exchange and assess information on MOUT facilities and training/simulation systems;
- Gather military feedback as to the effectiveness of current solutions with a view toward establishing Best Practice;
- Identify a suitable architecture and standard set of interfaces that would enable interoperability of MOUT training components that do not inhibit future research and enhancements;
- Identify limitations and constraints on MOUT development with a view toward identifying areas for future research;
- Provide a report detailing Best Practice for MOUT training facilities;
- Establish a working relationship with industry partners and ensure that industrial participation was worthwhile.

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

Operational Concepts. A comprehensive list of Generic User Requirements needed to be developed working in conjunction with NATO Training Groups and Military Users. In addition a generic set of data for lethality and vulnerability would be is required to enable interoperability of each nation's simulation systems.

System Architecture. It was calculated that there were in excess of 100 national MOUT/FIBUA (Fighting in Built-up Areas) facilities in existence or under construction. These facilities are expensive to construct and operate and most exhibit similar form and functionality but there was no common architecture or interface standards that enable interoperability of one nation's systems in another's MOUT training facility.

Technical Challenges. That significant issues exist regarding frequency spectrum allocation and management, laser safety, laser compatibility, battlefield effects simulations, sensor cueing, NBC simulation, firing through walls, indirect fires,

[6] For example; accurate position of individuals and units, weapon directions, contacts, resulting damage, communication, C4ISR, observation arcs, logistical expenditure, CSS etc.

tracking and position/location in built up areas. It was concluded that many of these challenges could be solved if there was agreement on, and articulation of future NATO training functional requirements. This would enable industry suppliers to better focus their independent research.

2.1 Developing a plan to meet UCATT Objectives

Within the RTO groups are established for either one year to conduct an exploratory study or three years once a valid requirement is established and supported by four nations who have representation on the NMSG. As UCATT had initially been approved by the NAAG as a result of the feasibility study its duration would be three years.

One of the challenges of establishing working groups such as UCATT is that it relies on participation by NATO members and partners who must be prepared to fund their representatives and carry out assigned tasks from within national resources. In the case of UCATT it also sought to have participation by members of industry and they had to believe that they would benefit. In the case of the latter this was made easier as they had been involved in the MOUT/TOE work and were prepared to continue. Although 8 nations signed up to participate and 12 industrial partners this was reduced to 7 nations (Finland, Germany, The Netherlands, Sweden, Switzerland, United Kingdom and United States of America) who have attended the majority of meetings and one attending once so far (Greece) and 11 industrial partners have attended the meetings held to date (which have included representatives from Anteon, COEL, COMET/Diehl, CUBIC, Defcon, EADS, OSCMAR, RUAG, SAAB Training Systems (STS) and Thales). The chairman was provided by The Netherlands and the secretary by Finland.

It was recognised that the group would need to establish a relationship with user groups and other bodies that included SHAPE, the Training and Simulation Working Group, the FIBUA/MOUT Working Group within NATO and the Simulation Interoperability Standards Organisation (SISO). In the end the major group was the FIBUA/MOUT Working Group who received briefs on the work of UCATT at each of their meetings and assisted by validating requirements from nations represented in their group.

It was agreed that there would be three meetings per year, one to coincide with ITEC in London or Amsterdam, the second in Europe and the third in the USA to coincide with I/ITSEC. This resulted in the following work plan (Figure 2.1).

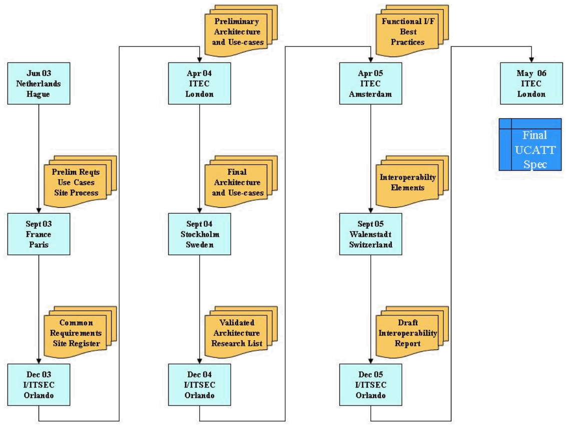

Figure 2.1 – UCATT Work Plan

By the third meeting it was clear that the group needed to determine more clearly its output and a matrix was produced to help identify the inputs, objectives and outputs that needed to be achieved. This is shown at Figure 2.2.

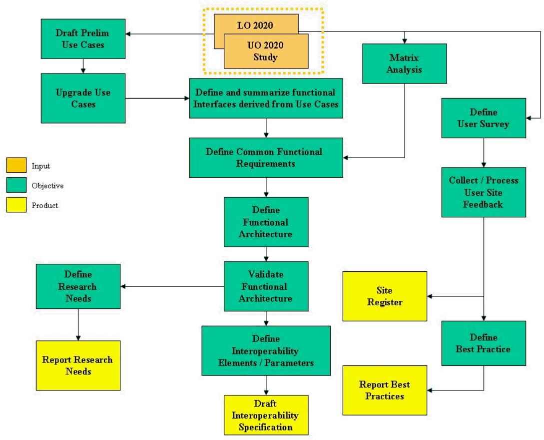

Figure 2.2 – Inputs, Objectives and Outputs for UCATT

2.2. Initial Tasks

To assist in ensuring that the work progressed a small executive sub-group was formed and it met prior to each meeting. The initial meeting in The Hague provided representatives with their first tasks which would be reported on at the next and subsequent meetings dependent on the time needed to complete the task. Members were divided into sub groups to conduct the tasks as follows:

- Requirements Matrix Sub Group. The USA had developed a requirements matrix and this was used as the means to establish national requirements and then develop a common set. It was emphasized that nations should objectively fill in all the columns. It was agreed that the NATO MOUT/FIBUA Working Group's involvement in this activity would be invaluable and avoid duplication of effort and could be done in parallel with work by UCATT members. The initial Matrix contained requirements for the live force on force training requirement.

- USE CASES Sub Group. The group would be in close contact with the NATO Training Simulation Working Group, which is mainly concentrated on the user aspect of TES and other simulators. The group will try to focus on the three main categories of simulation; live, virtual and constructive and how they relate to the objectives for UCATT.

- Survey Sub Group. Main task of the group would be to develop a MOUT/FIBUA site register data template which would be developed as a tool for NATO and partner countries to use in planning MOUT/FIBUA training. The register would contain: Country, MOUT/FIBUA facility established or planned, size of facility, number of buildings, specification, kind of training conducted within the facility, training equipment used, co- use of the facility and need for interoperability.

2.3 Requirements Matrix

The Requirements Matrix Sub-Group having analysed the matrix found that it broadly supported the listed Operational Capability Requirements found in the Urban Operations 2020 study report [4] although there were some unmapped capabilities. There was however a potential conflict between the training capability issues and the operational capability issues deriving from the manoeuvre approach to urban operations in 2020 as the concept was set at the operational level. They believed however that the issues can/or would be solved through the use of constructive and/or virtual simulations in this timeframe. The requirements would however be impacted by future, as yet unknown, material acquisitions which will have a potentially large impact on a future training strategy. As work on the Matrix continued requirements to support constructive and virtual simulations were also identified.

2.4 USE CASES

By using requirements extracted originally from the Requirements Matrix List provided by the USA the Study sub group got a broad overview of what was needed. It was felt however that these were fitted to needs of today and one of the objectives of UCATT was to develop an interoperable solution for urban operations in 2020. It was therefore necessary to develop scenarios that fitted into that timeframe and it was decided to utilize the scenarios developed to support Urban Operations 2020 [4]. The USE CASES were developed by UCATT and were then verified in conjunction with the FIBUA/MOUT Working Group. As a result of this joint effort the following USE CASES were identified:

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

Having established a set of USE CASES the FIBUA/MOUT Working Group were then asked to complete a questionnaire for each USE CASE. It contained the following questions:

- What objective(s) do you think the commander would like to train?
- What kind of risks does the training eliminate?
- What type of actions/situations would you like to train?
- What are the most important training aspects for the individual soldiers/units?
- Make a time schedule of this exercise; Planning, Preparation, Exercise, AAR?
- Do you think it is necessary to train together as a taskforce?
- Do you think that this USE CASE is or will be a realistic scenario?
- Could you describe the training system that you would like to have for this training?
- Make a list of interoperability aspects?
- Make a list of the legal aspects?

The importance of the USE CASES was to identify the key interoperability aspects for live training in an open environment. Also by using USE CASES and the answers to the questions posed it was possible to check if there were any additional requirements on top of those that had already been identified in the Requirements Matrix. In addition they were used to develop the Functional Architecture.

2.5 Site Survey

Work on this task was initially centred on gathering data and entering results into a spreadsheet. The work has been carried on throughout the life of UCATT to date and has resulted in the development of a website accessible to NATO members and partners. To date 20 sites have been added to the register. The site in the short term will be owned by the FIBUA MOUT Working Group and is currently being administered by Sweden whose representative sits on both UCATT and the FIBUA MOUT Working Group. Figure 2.3 illustrates the front end access to the website which is password protected.

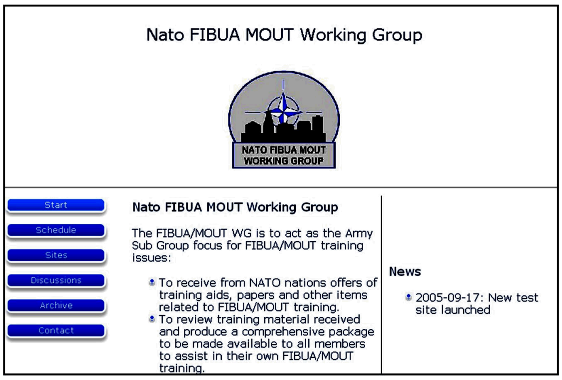

Figure 2.3 – FIBUA MOUT Working Group Website Front End

3 Functional Architecture

Having developed a robust set of USE CASES the next step was to determine the type of architecture that UCATT would deliver.

3.1 Selecting an Architecture

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

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

Formally, an architecture is "the 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** is "an arrangement of functions and their sub-functions and interfaces (internal and external) that defines the execution sequencing, conditions for control or data flow, and the performance requirements to satisfy the requirements baseline".

- A **design architecture** is "an arrangement of design elements that provides the design solution for a product or life cycle process intended to satisfy the functional architecture and the requirements baseline" (IEEE 1220).

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

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

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

3.2 Functional Components

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

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

The USE CASES were used to identify functional components as illustrated in Figures 3.1 and 3.2.

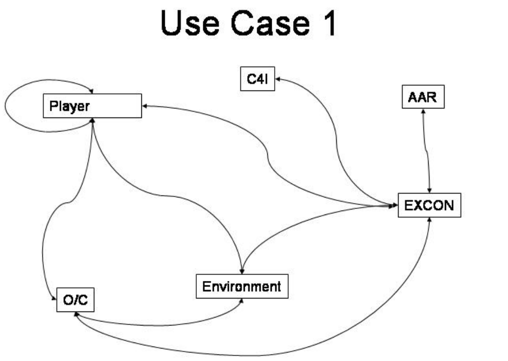

Figure 3.1 – USE CASE 1 and Functional Components

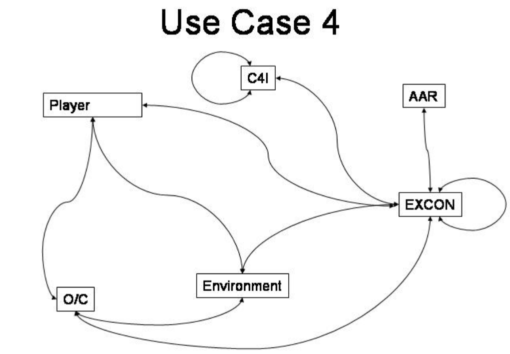

Figure 3.2 – USE CASE 4 and Functional Components

Through this process the UCATT Task Group identified 6 main functional components of a FIBUA/MOUT training system:

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

O/C might seem a logical part of EXCON and both components share a lot of functionality. However our analysis highlighted that the O/C capability also had other functionality that clearly distinguished it from EXCON and therefore it was felt justified to consider the O/C as a separate component.

Figure 3.3 shows the breakdown for each functional component and Table 3.1 the interaction between each object identified.

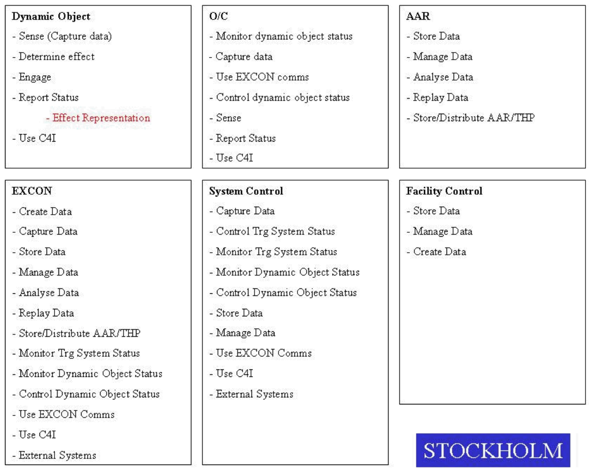

Figure 3.3 – Breakdown of Function Components

From	To	Description
Engage	Sense	Provides the characteristics of an engagement of a dynamic object.
Sense	Determine effect	Provides the characteristics of an engagement in order to determine the effects of that engagement.
Determine effect	Report status	Provides the (change of) operational status of a dynamic object.
Report status	Capture data	Provides the current status of a dynamic object, both operational status and technical status.
Control training system status	Sense	Provides the (change of) technical status of a dynamic object.
Control dynamic object status	Sense	Provides the (change of) operational status of a dynamic object.
Use ExCon communication	Capture data	Provides data on the ExCon communication network that has to be logged.
Use ExCon communication	Use ExCon communication	Provides to communication between ExCon members of different training systems.
Use C4I	Capture data	Provides C4I data to the training system.
Capture data	Manage data	Provides real-time data that has to be processed and/or stored.
Manage data	Monitor dynamic object status	Provides data to monitor the operational status of dynamic objects.
Manage data	Monitor training system status	Provides data to monitor the technical status of the training system components.
Manage data	Control dynamic object status	Provides data to set the operational status of dynamic objects.
Manage data	Control training system status	Provides data to set the technical status of training system components.
Manage data	Store data	Provides processed data to be stored.
Store data	Manage data	Provides stored data to be (re)processed.
Manage data	Create data	Provides information about the resources and capabilities of the training system in order to create scenarios.
Create data	Manage data	Provides scenario data to be stored. It includes initialisation data for all systems involved (e.g. training system, C4I systems).
Manage data	Replay	Provides data to replay a recorded exercise.
Manage data	Analyse	Provides data to evaluate.
Manage data	Store and distribute AAR/THP	Provides data to create/modify AAR/THP.
Store and distribute AAR/THP	Manage data	Provides AAR/THP data to be stored.
Manage data	Use C4I	Provides data from the training system to C4I systems.
Interface with external systems	Manage data	Provides external system data to the training system.
Manage data	Interface with external systems	Provides training system data to external systems.

Table 3.1 – Interaction between Objects

3.3 System functions

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

Figure 3.4 contains the overview of all identified system functions in a FIBUA/MOUT training site that were identified at the meeting in Stockholm.

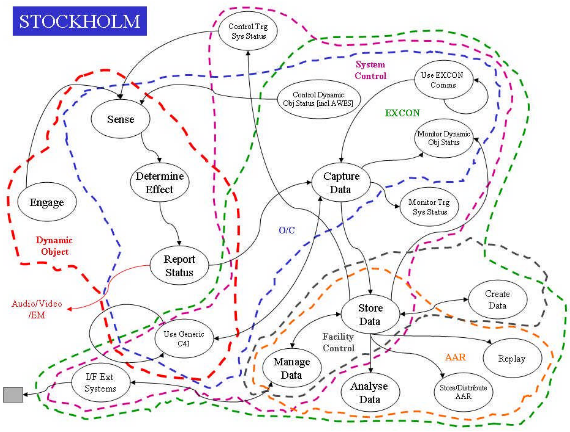

Figure 3.4 – System Functions

3.4 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;

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

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

3.5 Internal and External Interfaces

In the context of our functional architecture, an interface is a connection between system functions over which data is exchanged. Those interfaces must be identified and the (type of) data which is transferred over those interfaces must be specified, as part of the guidelines for interoperability.

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

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

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

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

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

Based on the analyses of the USE CASES, a number of external interfaces were identified as shown in Figure 3.5.

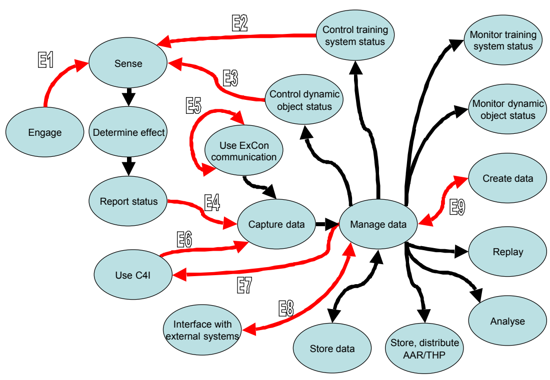

Figure 3.5 – External Interfaces

3.6 Summary

Based on the USES CASES and the capability matrix the Task Group defined a functional architecture, which provides the context to define requirements for interoperability.

The functional architecture reflects the capabilities that a FIBUA/MOUT site must possess, finding a balance between applicability and complexity, without addressing implementation issues.

4 Interoperability

There were a number of issues relating to interoperability not least being to define what was meant by the term. The following was accepted:

Interoperability is the ability of a system or a product to work with other systems or products without special effort on the part of the customer. Products achieve interoperability with other products using either or both of two approaches:

- *By adhering to published interface standards;*

- *By making use of a "broker" of services that can convert one product's interface into another product's interface "on the fly".*

A good example of the first approach is the set of standards that have been developed for the World Wide Web. These standards include TCP/IP, Hypertext Transfer Protocol, and HTML. The second kind of interoperability approach is exemplified by the Common Object Request Broker Architecture (CORBA) and its Object Request Broker (ORB). [7]

A number of interoperability models were examined and the OSI 7-layer model was considered to be an appropriate approach to the technical interoperability but there was a belief that there were layers above this that were necessary in order to identify the total interoperability requirements. USE CASES and the Functional Architecture Components were two additional layers but it was decided that although a robust set of USE CASES had been described and these had been successfully used to define the functional components it was necessary to look at what information was needed to be exchanged/or effects created in a training event. This would bridge the gap between our USE CASES and the Functional Components. This is illustrated in diagram form at Figure 4.1.

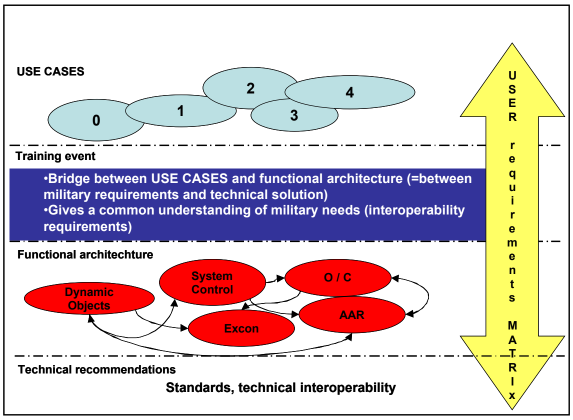

Figure 4.1 – UCATT Interoperability Model

To explain what members would be tasked to populate in order to further identify functional requirements, an example model was used and from this a series of tables populated. This model is shown in Figure 4.2.

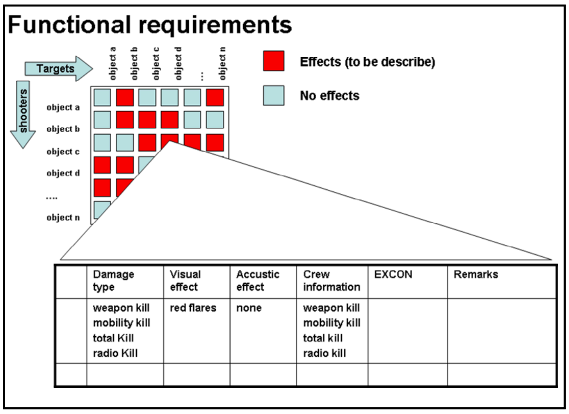

Figure 4.2 – Functional Requirements

This prompted considerable discussion and work in this area is still being completed and for each of the identified external interfaces, the final report will describe categories of data transfer between functional components, distinguishing between trigger events, outgoing events and effects. The latter are further divided into internal and external effects. It is clear from the work so far that this will lead to a requirement for nations to harmonize both their procedures and display of effects so that the meaning is understood by all. e.g. orange smoke and green flags have different meanings in different countries.

More importantly the industrial partners in UCATT have recognised that in order to have interoperability between the different equipments operated by each nation that they will have to develop a standard set of laser codes. The final report will provide a roadmap for achieving this and it may be an area that is potentially developed as a standard by SISO before being agreed as a NATO STANAG.

5 Conclusion

In conclusion the work to date has provided NATO with a scaleable functional architecture based on USE CASES agreed by the military user community in NATO and partner nations. A web-based register of FIBUA/MOUT sites has been successfully developed and interoperability issues are being addressed. The final report is scheduled for delivery to the RTO in August/September 2006. Indications so far would suggest there is still more to be done particularly in developing the standards and more needs to be done to address the other two simulation domains of constructive and virtual simulation in support to urban training. One of the reports recommendations will be for UCATT to continue either for a further 12 months to ensure progress on developing a standard for laser codes and other visual and audio effects or move into a further programme of work for three years to examine outstanding issues. There is no doubt that with government and industry working in tandem that this has been a major reason for the progress so far. In future industry should be able to compete on quality of service and not on propriety codes that have hampered interoperability to a certain degree.

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RUDI GOUWELEEUW graduated in 1989 from the Free University of Amsterdam with a Master's degree in Computer Science. After accomplishing his military service, he joined the Netherlands Organisation for Applied Scientific Research TNO. He has been involved in many projects in the field of tactical training and simulation, with a focus on improving the effectiveness and efficiency of training through the application of information technology. At present he is advisor to the Royal Netherlands Army for the procurement of a tactical indoor simulation system. In 2003 he was assigned as an operational analyst to the Headquarters of the 1st German/Netherlands Corps in Kabul, Afghanistan. He still is attached to that unit as a reserve officer. Currently he is programme manager of research projects on small units operations and is point of contact within TNO regarding Urban Operations.