Computer Assisted Exercise Environment for Terrorist Attack Consequence Management[1]

Dr. Velizar Mateev Shalamanov
Institute of Parallel Processing - BAS
Sofia 1113, Akad. G. Bonchev Str., Bl. 25 A, IPP-BAS
BULGARIA
Telephone: ++ 359 (2) 9796747, Telefax: ++ 359 (2) 8707273

Shalamanov@acad.bg

(Defense Against Terrorism, Military Exercising, Training and Decision making Support)

ABSTRACT

The paper explores architecture for a Joint Training Simulation and Analysis Center in Civil-Military Emergency Planning / Response (JTSAC-CMEP). The center is developed under NATO's Science for Peace Project, SfP 981149, by the Center of Excellence in Operational Analyses – a network of working groups from the Academy of Science, the Defense Staff College, and the Academy of Interior Ministry. The CAX environment is a synthesis of tools for scenario development, simulation, multi-agency / international C4 network, web-based information sharing / collection / fusion and post-exercise lessons learned analysis. JTSAC-CMEP is based on a model for concept development and experimentation in the area of civil security through CAX. This model is a base for managing the process of transformation of the security sector into an integrated, network enabled organization. The goal of the integrated security sector is to enable the state to face the challenges posed by terrorism and other asymmetric threats.

The JTSAC-CMEP is considered a test-bed for a new decision-making software and information sharing technologies as well as a tool for adding exercise participants in the loop for experimentation of the concepts and acquisition of new knowledge in the area of CMEP. The focus of the environment is on modules for support of exercise (MOSEX), including planning and management, to achieve a higher effectiveness and efficiency of the experimentation and training process.

*The Modelling and Simulation Tool (**MOSEX**) is the main engine of the CAX environment. The MOSEX software is tailored and adapted for the Bulgarian context and will be applied in the "Terrorist Act Consequences Management in South East Europe" exercise (EU TACOM SEE 2006), which is sponsored by the European Union. A limited budget and manpower for the preparation of software is available for the extremely short duration of the exercise. Low cost, standard basic software was selected, which provides the minimum of required functionality of message handling, display capabilities and simulation tools. (MS-Office, MS-Visual Basic, Map Objects / ArcView, PowerSim). The exercise is supported by a set of tools generated with add-ons to MS-Office, some tailoring of existing display software, and quick prototyping. The objective is to demonstrate the possibility to utilize existing low-cost, off-the-shelf software for command and control and to prototype already useful simulation models without great effort.*

The real challenge facing the team is to organize an analysis of the results and to draft the lessons learned. Therefore, result oriented / effect based planning and management of the JTSAC-CMEP and exercises was defined as a priority from the very beginning. This element of the CAX environment is

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considered as important as the conducting of the exercise itself. During the exercise and analysis period, a special package of modelling and simulation tools will be used to acquire knowledge for the emergency management process and for improvement of previously existing models and software.

Although the exercise is currently at the stage of preparation we present the results and lessons learned as an attempt to transform training by new means of communication and the utilization of commercially available products. The JTSAC-CMEP will be fully experimented in the context of the EU TACOM SEE-2006 full-scale exercise, taking place in Sofia, Bulgaria, to include CAX for CPX on national level. The exercise is coordinated by the EU and includes observers from NATO and FX, as well as teams from seven countries. The goal is to further improve the center and integrate it in the network of CoE of the ACT with specialization in CIMIC and CMEP.

1. INTRODUCTION

The transformation in NATO and national defense organizations is very much dependent on experimentation of new concepts and the training of people to exploit these new concepts with new organization, doctrine, and equipment. In this sense, the use of modeling and simulation (M&S) in transforming training and experimentation is in a way a second level transformation tool.
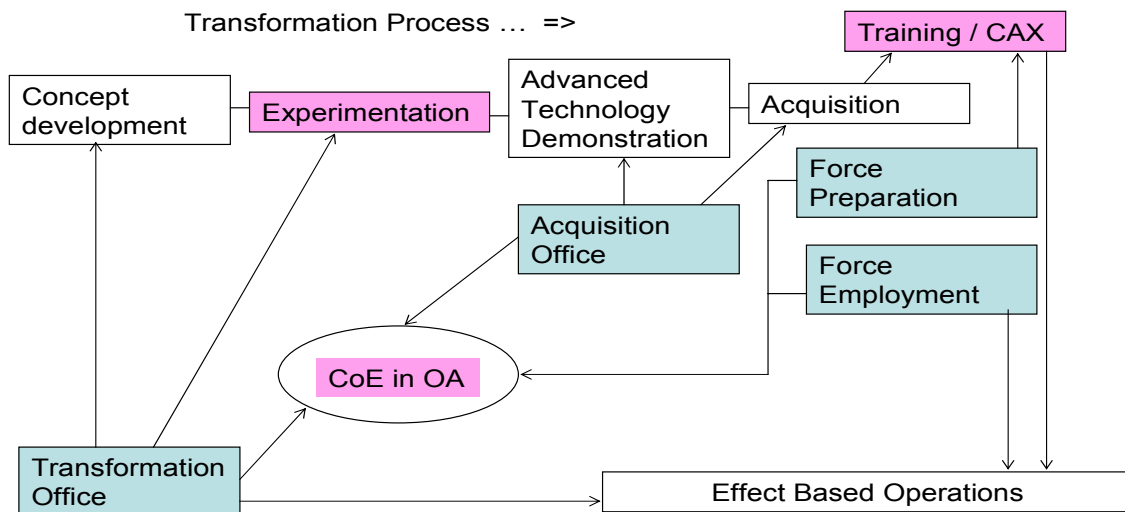

Fig 1. CDE and training process in support of transformation.

Before discussing the transformation of Concept Development and Experimentation (CDE) and Training, a note on the model of transformation process in the security sector at large is in order. As presented in Fig. 1, the final goal is effect-based operations, for which we need effective capabilities, achieved through the integration of new equipment, intensive training, good force structure, and modern doctrines in the context of innovative concepts. In this process Experimentation and Training are two of the key elements for the transformation process. Another crucial element is the development of a Center of Excellence in Operational Analysis (CoE OA, or COA) to support the Office of Transformation, Acquisition Office, Commands of Force Preparation / Training and Force Deployment (Operational Command) with Modeling and Simulation (M&S) Tools [9]. Services provided to all transformation related offices define the type of M&S capabilities required from the CoE-OA.

This paper presents the experience of the team, working on NATO's SfP981149 project [1] to develop capacity in the area of Operational Analyses in support of Transformation and the practical implementation of these capabilities in several national projects in civil protection area as well as its direct involvement in the EU's project for terrorist attack consequence management in SEE (EU TACOM SEE-2006), which took place in Bulgaria, 23-27 July 2006 [3]. To analyze the role of M&S in transforming training and experimentation, the paper considers the following issues:

- Computer Assisted Exercises (CAX) based Model for Concept Development and Experimentation
- Training as a Tool for Change Management in Third Generation of Security Sector Reform
- M&S Capabilities of CAX Environment
- M&S in Planning and Lessons Learned Drafting

The paper's main point is to suggest that Computer Assisted Exercise is a key instrument for transformation because it integrates new concepts with new equipment and doctrines, involving people in the loop and providing very good documentation of the process while providing data for effective lessons learned drafting.

2. CAX BASED MODEL FOR CONCEPT DEVELOPMENT AND EXPERIMENTATION

CAX is considered a tool for transformation, supporting the CDE process [2, 8]. For the purpose of this paper, we consider the development and experimentation of the concept of civil security and, more specifically, the Civil-Military Emergency Planning (CMEP) [10].
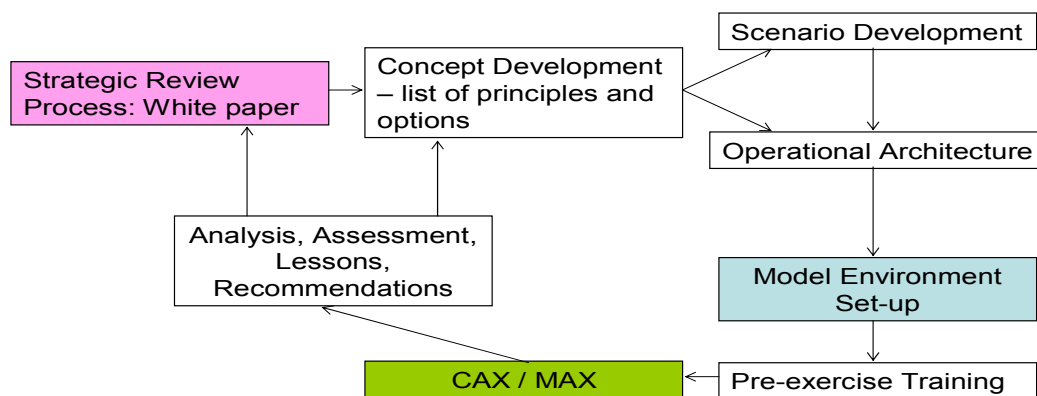

Fig. 2. CAX based Model for Concept Development and Experimentation.

In order to successfully implement CAX as a tool, it is need to develop the environment to plan, perform and analyze the exercises. At a lower level, CAX can be replaced by a simple Model Assisted Exercise and the environment can be typical for Top Table Exercises (TTE). For an effective CAX, there is a need for effective environment, which we name Joint Training Simulation and Analysis Center in Civil-Military Emergency Planning (JTSAC-CMEP) [3].

JTSAC-CMEP is based on a specially developed model for concept development and experimentation in the area of civil security through CAX. This model is a base for the change management process – transformation of the security sector into an integrated network enabled organization. The integrated security sector is a part of the third generation of security sector reforms enabling the state to address the challenges of terrorism and other asymmetric threats.

JTSAC is an instrument through which CoE-OA extends research, including M&S in crisis management, to support CAX in this area. Especially in the context of the EU TACOM SEE-2006 exercise (EU terrorist attack consequence management in SEE exercise), and in particular its CAX part, the CoE-OA supported (see Fig. 2):

- Strategic review of the civil protection system in Bulgaria and its EU/NATO/regional context;

- Development of Civil Security Concept for Bulgaria;

- Development of General scenario, Operational Architecture and Message Flow for EU TACOM SEE-2006;

- Establishing a model environment based on JTSAC for implementation of the Operational Architecture and Message Flow for EU TACOM SEE-2006;

- Individual and pre-exercise training of the participants in the exercise;

- CAX implementation;

- Currently undergoing process of analysis, assessment and lessons learned drafting from the exercise;

- Currently in the phase of updating the White paper on Civil Protection and Concept for Civil Security,

CAX has a key role in the process of CDE, because it integrates different organizations and technologies as well as involves people in the loop of experimentation. In a sense, CAX itself is motivation and a tool for joint work and well-documented experimentation, providing objective material for analysis and adaptation of the concepts.

3. TRAINING AS A TOOL FOR CHANGE MANAGEMENT IN THIRD GENERATION OF SECURITY SECTOR REFORM

The new security environment at the beginning of 21st century requires a comprehensive model of security and the building of Integrated Security Sector (ISS) as the goal of a third generation of Security Sector Reform (SSR) to provide capabilities in the areas of:

- Defense (Sovereignty, Expeditionary Operations, Territorial defense)

- Public Order and Security);

- Emergency Management / Consequence Management;

- Diplomacy / protection abroad;

- Information operations.

These capabilities have to be implemented in diverse sets of scenarios with the leading role of respective element of the ISS, but with the participation and contribution from all other elements to provide "critical mass" for prevention, reaction or consequence management / mitigation.

It is increasingly becoming a common wisdom that the key pillar of the Integrated Security Sector is Defense Against Terrorism (DAT) and Consequence Management (CnM) / Crisis Management (CM). All these areas require the close cooperation between military and civilian structures, and international cooperation and interoperability. It is not enough to be successful in the classical understanding of SSR, in its first- and second-generation definitions. There is a need for a third generation of SSR, which leads to ISS. This is serious change management (ChM) challenge.

The role of training in change management as the main content of the third generation of SSR leading to ISS, is to bring together people from different organizations – civil and military, governmental and private, national and international – and to make them cognizant of the new concepts of security and crisis management.
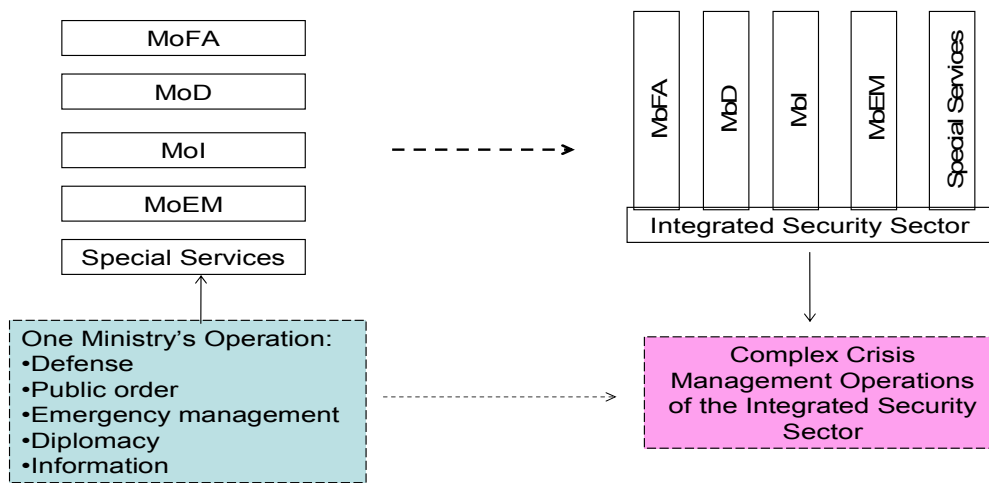

Fig. 3. Third Generation SSR for Integrated Security Sector

Fig. 3 illustrates the transition from a traditional security sector to ISS as a consequence of the new security / operational environment and presents the content of the third generation of SSR. The current structure of the security sector includes different institutions with monopoly over the use of force or information operations in support of the use of force. Nowadays, however, the security environment defines the need for complex crisis management operations where interagency, international, joint, and private-public cooperation is essential. This factor drives the integration in the security sector, where different institution, while keeping their functional identity, are also able to form combined, interagency, joint forces for a specific complex operation. The operation requires a different mix of forces depending on the nature or stage of operation.
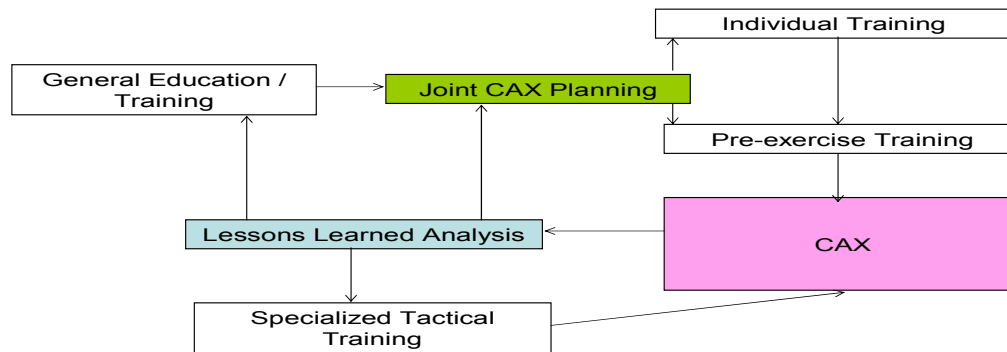
Fig. 4 Training as a Tool for Change Management

The integrated security sector is not an organization, but a concept for organization of institutions participating in this network in order to work together, to support each other, reinforce each other when one institution has a leading role according to the nature the operation or its legal status.

In order to explain our understanding of the role of training as a change management tool on Fig. 4, different types of education and training are presented with CAX as a central instrument in the process. Experimentation of new concepts is a driving force of change. Training has a critical role to play in this process. We see training aspects in all different elements of the knowledge management process for change management:

- General E&T;
- Joint planning for CAX;
- Individual training;
- Pre-exercise group training;
- CAX itself;
- Lessons learned analysis and recommendations drafting;
- And specialized tactical training in parallel or separately of CAX

To play the role of Change Management Tool, training has to be based on effective "M&S of the future reality or virtual reality at all" in order to learn from this future. It must be supported by a effective measurement system and adaptation.
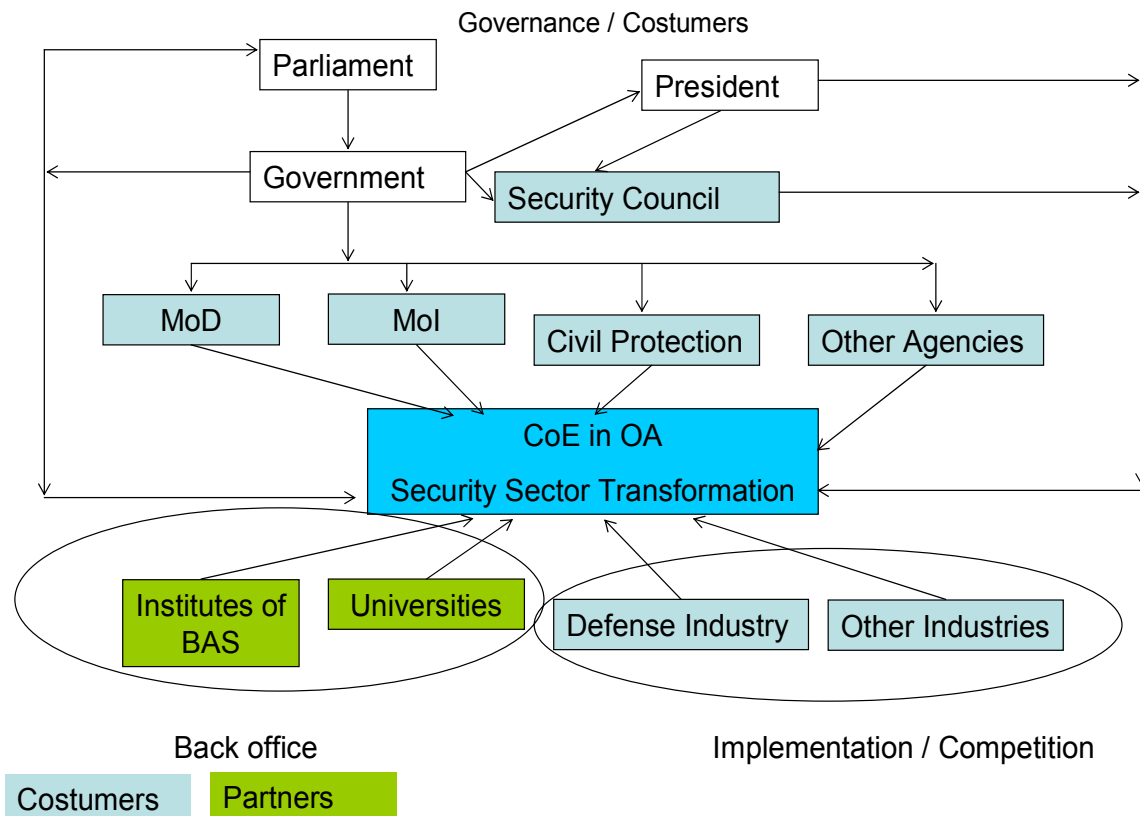
Fig. 5. CoE position among Integrated Security Sector organizations.

In this sense, CAX is only a platform to arrange different types of training with the main focus on experimenting with concepts and promoting the change. The preparation of CAX at the level of ISS is a difficult task that requires a body able to communicate with all the elements of ISS and capable of developing a comprehensive plan for the exercise, from its initial idea to drafting the lessons.

Currently, CoE –OA, established under NATO SfP 981149, is a key instrument for transformation of experimentation and training through M&S by developing JTSAC-CMEP and running activities related to the EU TACOM SEE-2006 and the Feasibility Study on Integrated Emergency Management System in Bulgaria (see Fig. 5). Capabilities for M&S in CoE-OA, through the cooperative environment of JTSAC-CMEP between administration, forces, industry, and academic sector, is providing a great incentive for change. It was proved during the EU TACOM SEE-2006 in Sofia in July CAX.

The existing environment in JTSAC, the network including different institution, and the capacity built around CoE-OA is a solid base for future CAX and training activities and constitutes an element of concept experimentation, technology experimentation and experimentation of innovative training methodologies.

4. M&S CAPABILITIES OF CAX ENVIRONMENT

JTSAC-CMEP, considered to be an integrated environment for CAX, is planned to use M&S in three main elements, covering the following areas:

- *Planning and Analysis Cell* (considered in next chapter)
    - Planning and resource management
    - Assessment of CAX
- *Simulation cell / White Cell*
    - Concept to scenario transition support
    - Simulation of scenario and environment
    - Simulation of Integrated Early Warning System / Notification System
- *Operations Center*
    - Analytical Cell Decision-Making Support (DMS) tools
    - Communications Cell planning and management tolls

The general architecture presented on Fig. 6 includes different cells: planning and analysis; administration and security; briefing cell, VIP cell, Press/PR cell, computer cell; communications cell; operations cell; analytical cell; simulation cell; field C2 cell [7]. During the exercise these elements were divided between different structures of the Operational Architecture, including Operations centers on national and district level, field operations centers, international and ministries' operations centers and, of course, a White Cell to run simulation and information collection for further analysis.

The main dividing line is between emulation of Integrated Emergency Management System (IEMS) and White cell.
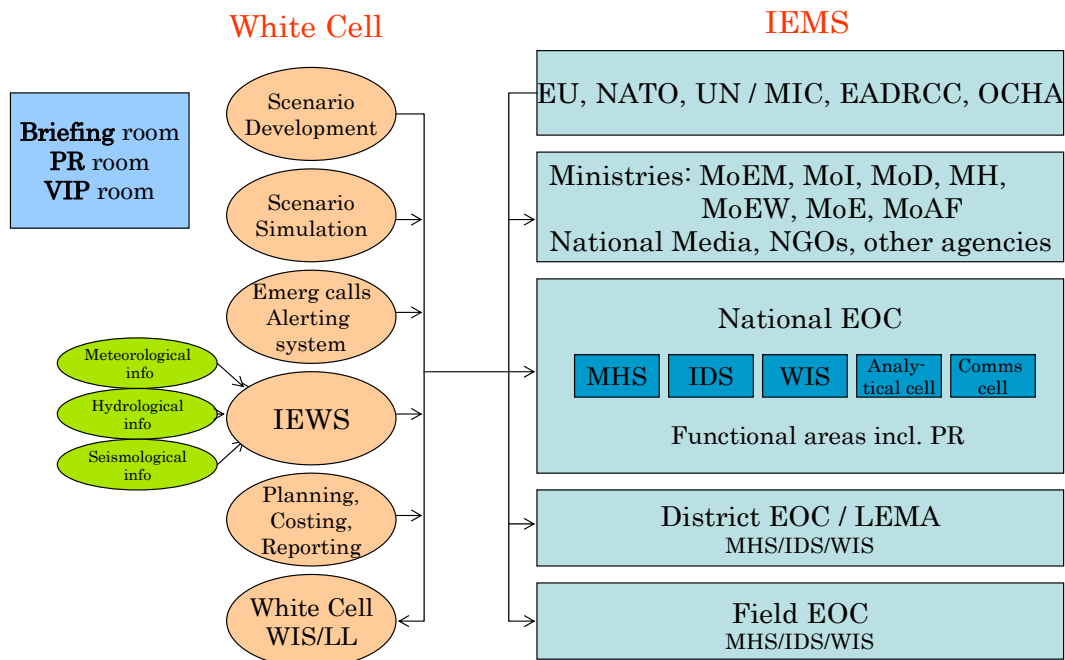

Fig. 6. Architecture of JTSAC-CMEP

The JTSAC-CMEP is considered a test-bed for a new decision-making software and information sharing technologies as well as a tool for adding exercise participants in the loop for experimentation of the concepts and acquisition of new knowledge in the area of CMEP [3]. Therefore, the focus of the environment is on modules for support of the exercise (MOSEX), including planning and management, to achieve a higher effectiveness and efficiency of the experimentation and training process.

The Modelling and Simulation Tool, MOSEX, is the main engine of the CAX environment [5]. The MOSEX software is tailored and adapted for the Bulgarian context and was applied in the "Terrorist Act Consequences Management in South East Europe" exercise (EU TACOM SEE 2006) sponsored by the European Union.

A limited budget and manpower for the preparation of software is available for the extremely short duration of the exercise. Low cost, standard basic software was selected, which provides the minimum of required functionality of message handling, display capabilities and simulation tools. (MS-Office, MS-Visual Basic, Map Objects / ArcView, PowerSim).

The exercise was supported by a set of tools generated with add-ons to MS-Office, some tailoring of existing display software, and quick prototyping. The objective is to demonstrate the possibility to utilize existing low-cost, off-the-shelf software for command and control and to prototype already useful simulation models without great effort.

For the JTSAC-CMEP, there is another architectural model, depicted in Fig. 7, oriented to the services provided for CAX [6]. The main elements provide:

• Modeling of scenario in order to select the right operational architecture and message flow;
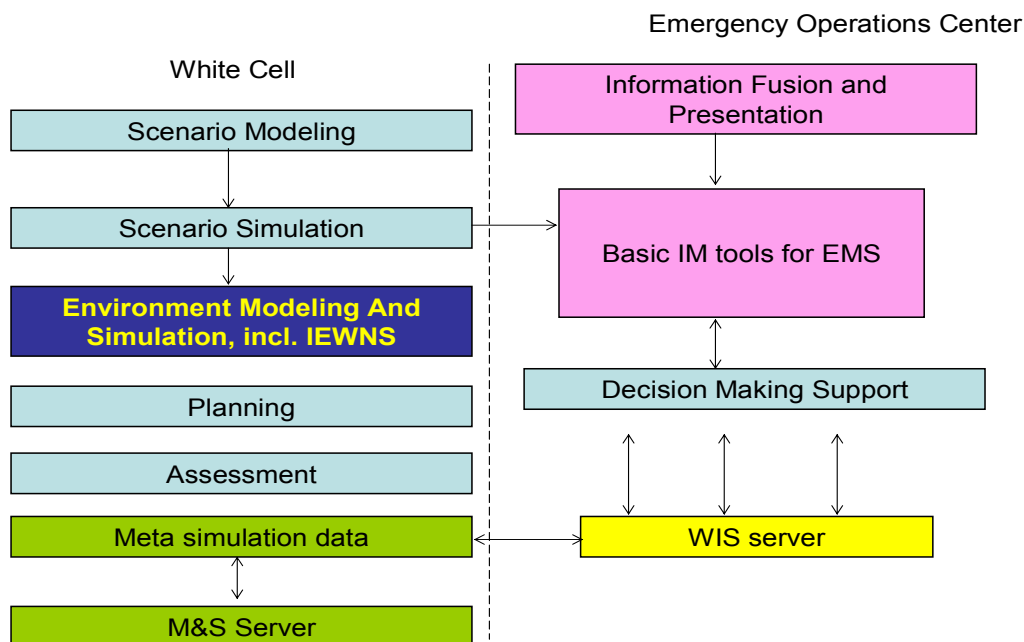
• Simulation of message flow and events;

Fig. 7. M&S in JTSAC Service Oriented Architecture

- Modeling and simulation of "white" systems not included in the main program for the exercise including notification, hydro-meteorological early warning and forecast, seismological monitoring, development of the "objective processes" – physical, chemical, psychological, etc…

- Information management (IM) in the operations centers, including message handling system (MHS), web information system (WIS), databases, comms, etc.

- Information fusion and display in the operations centers, including integrated display system (IDS).

- M&S to support decision making process for the participants in the operations centers.

- Planning support and reporting, including financial management.

- Assessment support and analysis

There are three main areas where M&S plays critical role in CMEP related elements of JTSAC considered in next subchapter:

- Scenario development

- Environment simulation

- Decision making support

4.1. CMEP Related M&S elements in JTSAC Architecture

A special M&S product, SCIP (scenario computer interface program), was developed for the EU TACOM SEE-2006 to provide analysis of the scenarios. The program supports the definition of an entity-relationship model of the scenario elements and analysis of mutual influence in order to provide support for decision on which elements and relationships to be included in the operational architecture for the scenario [4, 11]. The dynamics of the scenario is modeled through PowerSim to identify important event and message flow for the exercise. Adaptation of MOSEX was used to provide such M&S functionality.

The Institute of Geophysics, Institute of Hydrology and Meteorology, Space Research Institute and Smart Media Ltd. provide different products for the environment simulation. These software modules were used to mostly provide visual information and data for decision-makers about the environment in which the terrorist attack consequence management is taking place.

The Institute of Geophysics feeds JTSAC with seismology activity data as well as information of ionization activity and possible distribution of chemicals.

The Institute of Hydrology and Meteorology provides weather forecast and plume movement model after a dirty bomb explosion. Dam monitoring system demonstrated by the Electron Progress SHC is added to the hydrological monitoring and forecast data.

The Space Research Institute provides remote sensing data from Aviotehnika SHC UAV and Eurosense-Bulgaria Ltd. airplane as well as video surveillance. In addition, Telesys Ltd, provided the integration of information coming from all sources and data presentation on a data wall as well as the sharing of information and VTC.

For the decision-making support, a number of models were developed by the Institute of Mathematics and Informatics. Most of the models are based on the use of PowerSim and proprietary software to cover the issues of:

- Evacuation of population;

- Distribution of critical resources and medicine;

- Search and rescue planning;

- Analysis of critical infrastructure – power and water supply;

- Operational calculations on the decontamination process.

Electron Progress SHC, Telesys Ltd., and National Computer Virology laboratory provided General Information Management (IM) support and network management.

The network behavior was modeled by OpNet after its definition with System Architect in order to manage communications in JTSAC-CMEP and adjacent elements in different ministries and districts according to realistic expectations about such a complex system. Message flow is simulated based on two related models – first, the organizational structure and procedures, and second, the communications network supporting this structure and procedures.

The goal is to integrate different models:

- Organizational and procedural model;

- Communications network model;

- Environment model (weather, terrain, time);

- Events model (accidents like explosions, other manmade incidents; disasters);

- Decision support model;

- White cell simulation of virtual participants such as higher command, rescue teams, media;

- Expected rational behavior model of participants (to check and assess their activity against a "normative" one)

Key challenge in such an environment is to balance and integrate the model of real C2 system with computer simulated data.

4.2. Integration between scenario M&S and C2 system

There are three critical elements in a CAX architecture – simulation cell, operations cell and analytical cell – that need conceptual, information, hardware and software integration in order to support the realistic flow of the training process.

The real challenge is to integrate commercial, off-the-shelf IM systems with commercial Emergency management tools and to add them to all specific M&S tools in order to support experimentation and training. CAX requires integration of traditional C2 system with M&S tools to provide real test–bed for new concepts and new technologies including the key element – people in the loop.

The model used for general integration on functional level of M&S and C2 system is based on static and dynamic technological diagrams with distributed nodes in three cells – analytical, operations and simulation. The the EU TACOM SEE-2006, the main approach was to integrate different subsystems on data level through open operational web server. Work is under way to add to this data proxy server to "translate information" to and from the third component - M&S server that works over "meta simulation data".

In typical C2 system all nodes will "sit" in the operations and analytical cell with tendency to have as much as possible of them in the analytical cell providing scientific best solution for problems arising during crisis management scenario. In exercise, the simulation cell has to cover all nodes that is impossible to be covered by operations and analytical cells. At one end is a system with participants in the exercise who are only looking at closed simulation run by simulation cell, without any input from operations or analytical cells. Next, there are some nodes implemented in analytical or operations cell. At the other end, there is a full C2 system where there are no elements in simulation cell – all of the nodes are implemented in operations and analytical cells.

Static technological diagram is used to organize access to different functions at every work-station through easy used menu system. This static diagram is designed according to the functional account of the workstation.

Dynamic technological diagram is covering the event / message flow in the system as a whole and it is a representation of the scenario, where events and messages are linked with work stations or other physical elements of the operational architecture.

Open operational web server is used to integrate all the messages exchanged and through IDS provides a display at the work station or on data wall / collective screens of different types of information (including geographic information) associated with the message.

Meta simulation data is a service under development to provide data required by models from the operational web server and to send as a message to the web server results of the simulation.

5. PLANNING AND LESSONS LEARNED DRAFTING RELATED M&S ELEMENTS IN JTSAC ARCHITECTURE

In addition to kernel of exercise, related to CMEP procedures and personnel as an object of management, CAX has its larger life cycle and typical resource management / effectiveness assessment elements. There are specific aspects of using M&S in support of the process of life cycle management – especially planning, implementation and assessment of the results. Specific aspect of CAX management is related to the model of public-private partnership to provide the best use of resources and to maximize the result for different end-users from investments coming from different sources. An integrated package for planning and analysis of the EU TACOM SEE-2006 is under development and testing in the University of National and World Economy and Imbility Ltd.

5.1. Life Cycle of CAX

CAX's life cycle starts with the initial idea to organize an exercise and includes general planning, scenario development, architecture development, costing, definition of measurement, indicators of effectiveness assessment, implementation (to include budgeting, procurement, public-private partnership arrangements, environment set-up, training, certification), analysis and assessment, reporting to end-users and financing organizations.

Some of the key elements of this life cycle related to resource management are depicted in Fig. 8.

In the process of CAX planning there are several M&S tools used to improve experimentation and training. First, System Architect was used for EU TACOM SEE-2006 to develop operational and system / technical architecture for CAX environment. OpNet was used for M&S of the network to support IM in the wide area network to include several emergency operations centers in Bulgaria and abroad. In order to select different options for the CAX environment, Expert Choice and its Bulgarian analog, Multichoice 2,

were used for final approval of CAX architecture as well as to select subcontractors for different elements of the architecture.

MS-Project and MS-Excel Activity Based Costing model were used for the development of budget and deliverables' timetable. Finally, QPR Balance Score Card system is under development for precise analysis of the results and strategic management of the exercise as well as transformation of the emergency management system at large.

Even simple table / chart based models in MS-Excel proved to be very effective for improving the process of experimentation of Civil Security Concept and for adapting of the training of diverse personnel to the realities of CAX.

This package for M&S in support of CAX planning will be very useful in preparation of more training session in the future and better utilization of JTSAC-CMEP as a facility.
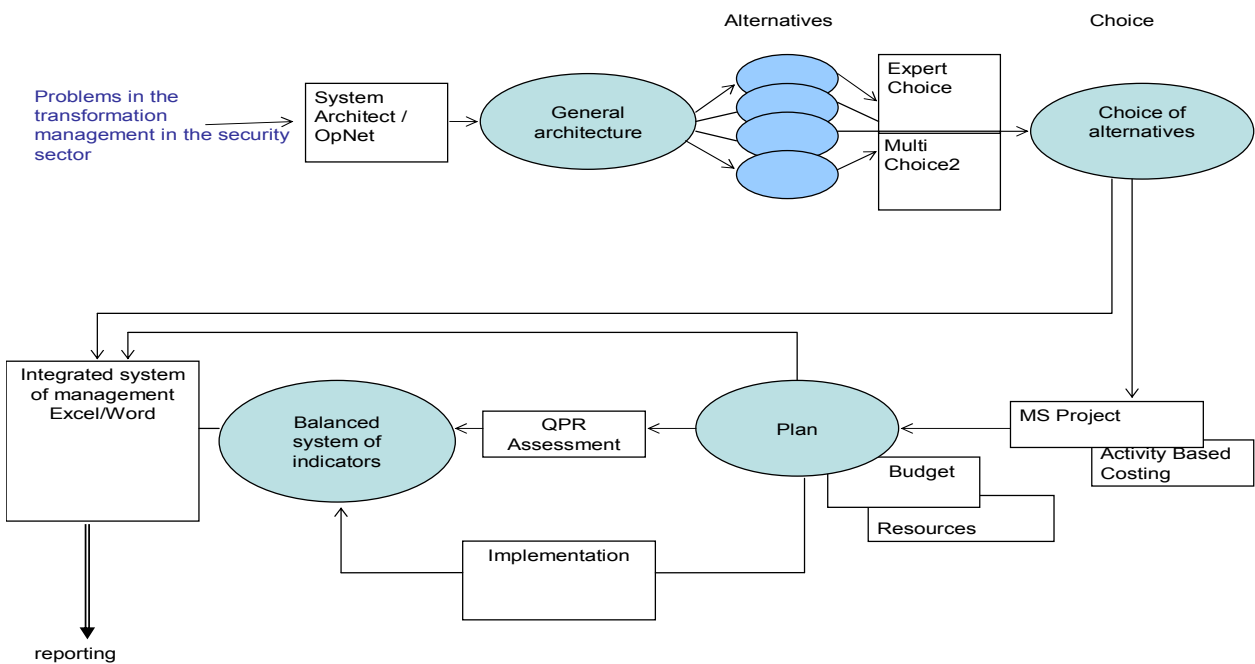

Fig. 8. M&S in CAX Planning

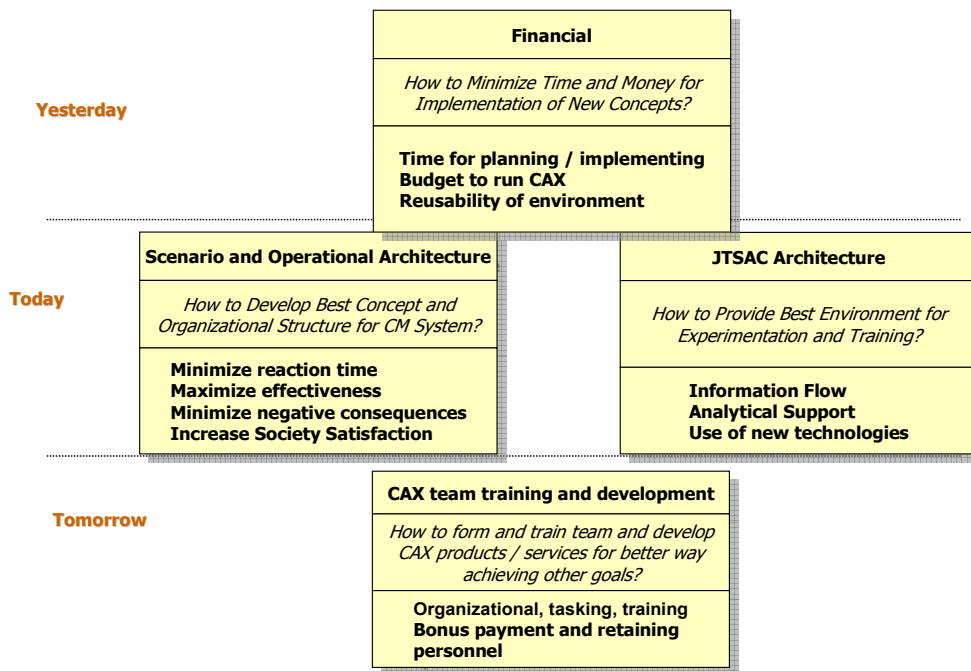## 5.2. Result oriented assessment and drafting of lessons learned.

Fig. 9. M&S in CAX Assessment

During the EU TACOM SEE-2006 and the larger process of establishing JTSAC-CMEP, a special attention was paid to developing a model for assessment of the CAX as a tool for change management through experimentation and training. Using the standard model for Balanced Score Cards special questionnaires were developed for CAX participants / users of JTSAC, CAX developers and CAX stakeholders / leadership of ministries. The four areas covered are: Financial effectiveness, Operational adequacy, Architecture and CAX support, Influence on capacity building for CAX team (see Fig. 9).

Work is under progress to link these questionnaires with the process of planning and implementation of the CAX, development of JTSAC and overall process of emergency management transformation in order to improve measurability of the change management process and to upgrade it to classical economical mission.

5.3. Public-private partnership to support M&S.

To have effective M&S influence on experimentation and training especially in the area of consequence management it is essential to arrange a fruitful public-private partnership following the establishment of partnerships with institutions, administrations, forces, and the academic sector.

If academic institution plan to play a role in bringing together other partners and to emphasize the role of Operational Analysis and M&S, there is the a need for diverse and intensive financing of the academic body (in this case CoE-OA) in order to be strong enough to initiate interdisciplinary, result-oriented project such as EU TACOM SEE-2006 and the JTSAC-CMEP. As presented in Fig. 10, the main end-user of CAX is Administration and Forcers, but it can also be used to support experimentation for the industry and training in academic institutions. Of course, the process of implementing CAX is intensively used as a base for research. This can help support research, training, experimentation and overall change management, using multi-source funding of CAX, including the use of public-private partnership models.

The experience from such efforts must be transferred to educational institution as soon as possible along with the value of its practical empirical data.

In such an environment M&S will most actively be involved in the change process for the administration, forces, business, research and educational institutions, and will be used to reinforce change process and to provide sustainability in the long term.

M&S tools are best developed in the academic environment, but in order to be used as an instrument for transformation and experimentation have to be embedded in PPP process. Given the experience from the EU TACOM SEE-2006, CAX is a very good candidate for this.
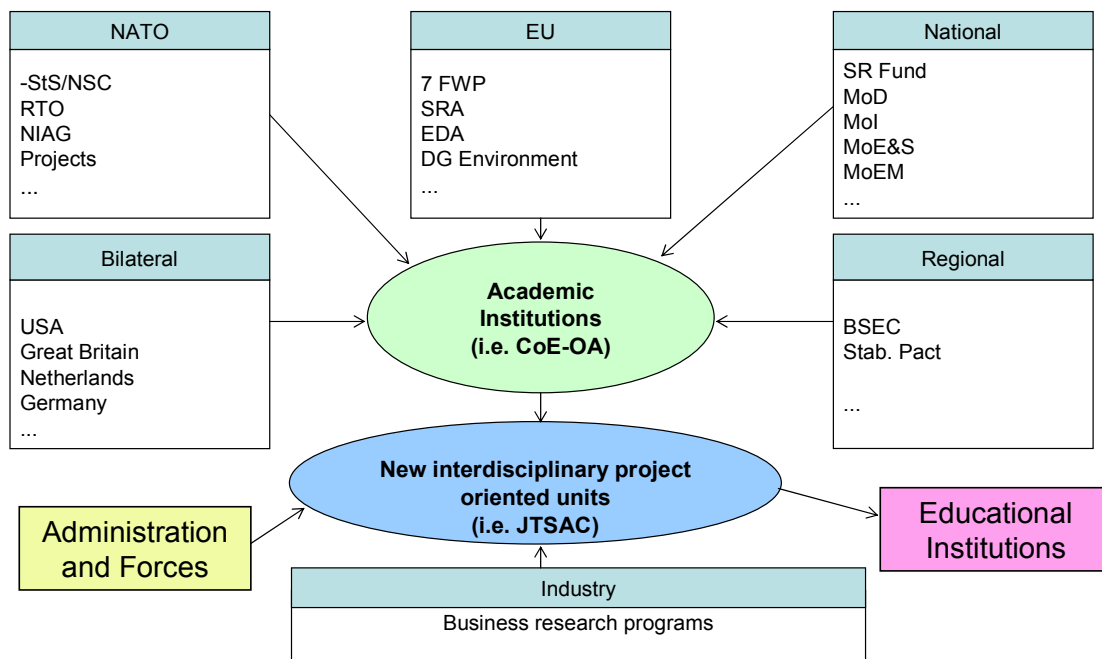

Fig. 10. PPP model in M&S for Transformation of Training and Experimentation

6. CONCLUSION

This paper is focussing on the practical implementation of research in the area of M&S under NATO SfP 981149 Project during EU TACOM SEE-2006 CAX. Many of the results will be further elaborated in the framework of MSG – 049 TG. The main thesis of the work is that the new security environment requires ISS that can be achieved through a third generation of SSR. This reform is a change management challenge, where CAX based CDE and training could be very effective tool for transformation. M&S as a key element for CAX is the transformation instrument for the experimentation and training.

What we see nowadays is a growing number of new and diverse concepts; hence the need for their rapid experimentation and adaptation in the security sector is higher. Most of the new concepts are of "horizontal nature", which requires cross cultural training and the development of information sharing and synchronization instruments.

The key element in concept implementation / change management is the personnel. This requires the inclusion of more people in the loop for experimentation, including their intensive training. Because of that, especially in countries without high budgets for security the low cost and flexibility of training environment is a prerequisite for the large-scale implementation of new concepts.

Of course CAX are one of the most effective tools for such a change, but we have to consider MAX as balancing alternative in training and experimentation - again in order to reduce cost and make the use M&S in more countries possible.

The evolutionary development (prototyping) and rapid implementation of the results of experimented concepts is required. As an example, our team used SfP 981149 project to establish CoE-OA and build capacity under which JTSAC-CMEP was developed to support EU TACOM SEE-2006. Lessons learned form the exercise are directly used in IEMS Feasibility Study to prepare architecture and implementation plan for nation wide Integrated Management System, starting with one district pilot project.

The integration of the efforts of Administration / Forces, R&D / E&T academic institutions and business based on M&S environment is a must in achieving the transformational goals not only in experimentation and training, but in the third generation of SSR. This could lead to implementation of the concept of Integrated Security Sector.

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