Scenario Generation and Assessment Framework Solution in Support of the Comprehensive Approach

Dr. Zlatogor Borisov Minchev
Bulgarian Academy of Sciences
Institute for Parallel Processing / Institute of Mathematics and Informatics
Acad. Georgi Bonchev Str., Bl.25A
1113 Sofia, BULGARIA
Telephone: + 359 (2) 9796631, Fax: + 359 (2) 8707273

Zlatogor@bas.bg

Dr. Velizar Mateev Shalamanov
NATO C3 Agency
Boulevard Leopold III
B-1110 Brussels, BELGIUM
Telephone: +32 (0) 2 707 8141, Fax: +32 (0) 2 707 8771

Velizar.Shalamanov@nc3a.nato.int

ABSTRACT

The Comprehensive Approach to security, including military support to civilian authorities in stabilization and reconstruction operations, is central for the improvement of defense and force planning. More and more the foresight activities support to planning are based on generation and analysis of scenarios (authors have been participated in recent EU and NATO projects like: FORESEC, ESRIF, SAFE, using ideas and tools, presented in the paper). The proposed methodological approach encompasses a multi-level analysis and synthesis for both scenario generation and assessment via M&S as an ad-hoc solution for national usage in the integrated security sector.

The morphological and system analysis are implemented within original ad-hoc solution for the problem in the paper. Our approach is further strengthened with a tool for assessment of scenarios through dynamic simulation with COTS and NC3A products. The solution was a joint work, developed and implemented with the participation of academic research, decision makers and experts from Ministry of Defense, Ministry of Interior, Ministry of Emergencies (currently integrated within Ministry of Interior), Ministry of Foreign Affairs and Ministry of Health - Republic of Bulgaria. The tools are currently fully integrated as a critical element of BEST (Basic Environment for Simulation and Training). Early version of BEST was used in two days CAX - EU TACOM SEE-2006, 1 day CAX - Struma 2008 and further developments are a contribution to NATO RTA MSG-049 study and CAX Phoenix - 2010 preparation. The revealed models and tools are a basis for practical cooperation between Bulgarian researchers and NC3A.

1. INTRODUCTION

Meeting the 21st century security challenges, such as: fighting terrorism, improving energy security, preventing proliferation of weapons and dangerous materials, protecting against cyber attacks and confronting the threat of piracy, evidently requires a civilian and military cooperation in the security sector.

Nowadays, we are starting to talk more and more about “security” than “defense” and putting the single citizen’s security as a highest priority goal. This requires regular coordination, consultation and interaction among all the actors involved. Regarding this NATO has developed a set of pragmatic proposals aimed at promoting such a Comprehensive Approach to Crisis Management by the International Community.

Since the Bucharest Summit (in April 2008) NATO has been seeking to improve its own crisis management instruments and to strengthen its ability to work with partner countries, international organizations, non-governmental organizations and local authorities.

The gathered recent experience in Central Asia, Middle East and Balkans has demonstrated the importance of contributing to the International Community's Comprehensive Approach for the success of operations, which are increasing the civil-military integration/cooperation.

Today the New NATO Strategic Concept will be based on the Comprehensive Approach with the relevant technological support. Within this context, the Alliance is trying to build closer partnerships with other international organizations that have experience and skills in areas like: institution building, development, governance, judiciary and police.

The transatlantic policy within the next 20 years will be closely related to EU/NATO dialogue on security and defense topics and priorities that exists in their both agenda.

In the context of the Comprehensive Approach, currently NATO is developing pragmatic proposals, which seek to make improvements in five key areas of work: planning and conduct of operations; lessons learned, training, education and exercises; enhancing cooperation with external actors; public messaging; stabilization and reconstruction.

According to the Alliance Comprehensive Approach idea for an integrated security (that encompasses both EU and UN) the areas of Consultation, Command & Control (C3) will support NATO and Nations. These C3 areas are gathered around the new challenges like: energy security, climate change, piracy, cyber defense - problem areas that are adding new dimensions for Operational Analysis (OA) and technology support to the already traditional areas of common defense situated around Article 5, crisis response/emergency management, fighting terrorism and maintaining the partnership and enlargement process for NATO.

The new EU agenda (ESRIA) [1] is also considering these problems in the next 10-15 years horizon, when the defense and security boundaries will be less distinct and the security will encompass defense in respect to the society social security and the global context for a "non-isolated world".

Here it should be noted that nowadays the transatlantic role of the Alliance is getting more and to support UN and cooperate with the EU. The last will have to be responsible and to develop own capabilities according to ESRIA in five clusters: (1) security cycle - preventing, protecting, preparing, responding and recovering; (2) countering of different means of attack; (3) securing critical assets; (4) securing identity, access and movement of people and goods; (5) cross-cutting enablers.

Regarding this context the task for generation of scenarios' sets for the future and their validation through an assessment framework solution is inevitable and includes both OA and new technologies integration via integrated Computer Assisted eXercises (CAX).

Further in the paper an overview of this methodological framework solution will be given in two paragraphs: Paragraph 2 - Scenario Generation Process and Paragraph 3 - Scenario Assessment Framework Solution.

2. THE SCENARIO GENERATION PROCESS

In general, the notion "scenario" could be determined as a synthetic description of an event or series of actions and events about the future. The scenario generation process is an activity, which is native to the movie industry and theatre. However in the security area nowadays we also talk about scenarios and "plausible future" determined within a set of scenarios. In this "plausible future" a security policy and security system capabilities are further developed.

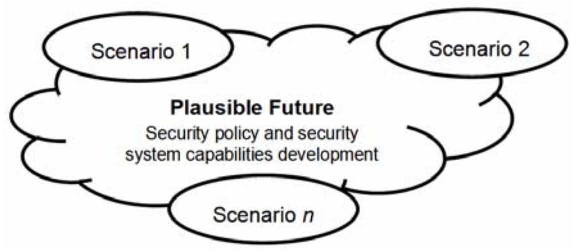

Figure 1: The scenario generation process within the development of "plausible future"

Regarding the idea for "plausible future" development it should be noted that the created scenarios are able to encompass different areas of defense capabilities: security policy development, operations, training, etc.
Apart of this a more detailed description of the scenario generation process with CAX simulation results assessment [2] could be given.

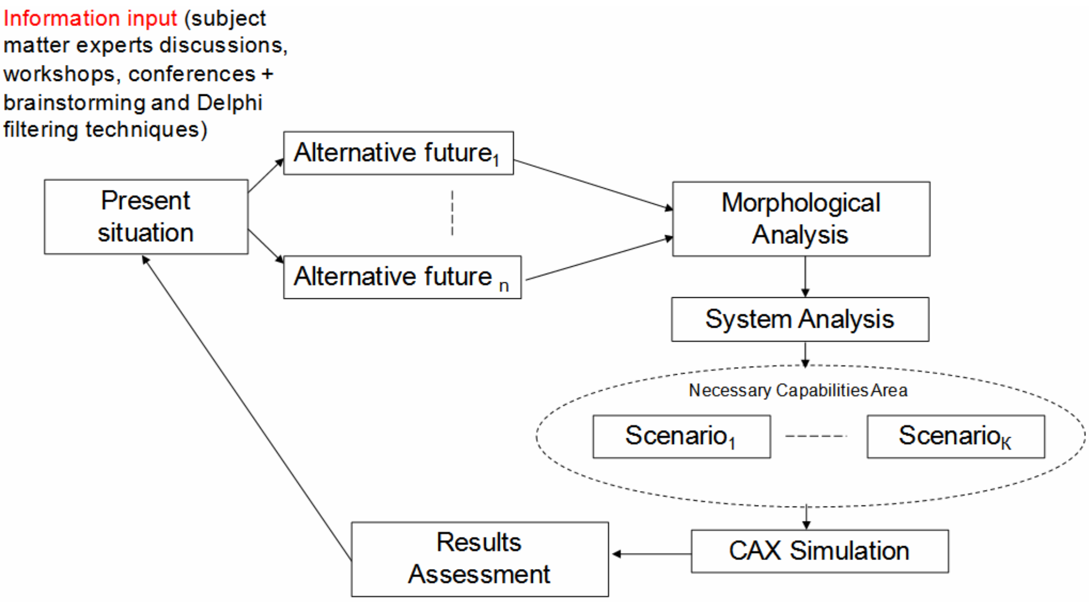

Figure 2: The scenario generation process including CAX simulation and results assessment

As it is clear from Fig.2 the scenario generation is based on initial featured experts' opinions and believes usage as "information input". As far as the information of that kind could be considered as rather subjective, techniques like: brainstorming, backcasting, workshop method (BOGSAT), roundtables, discussions and questionnaires fill-up are used for the initial information gathering supported with tools for group work like: flipcharts, whiteboards, multimedia, etc.
Next the gathered results are filtered with Delphi method.
Later on, a set of n alternative futures is defined. Within these alternative futures morphological and system analysis are used for initial static classification and validation. The selected k scenarios ($k > n$) for

the “plausible future” are next assessed via CAX simulation and mathematical validation. Obtained results are than presented to the experts for feedback control and replanning of the scenario set for the “plausible future”.
This brief explanation will be given in more details further on, noting the fact that within the present methodology an assumption of two types of scenarios is presumed: contextual (general context of the “plausible future”) and situational (different projections within a certain context).
The developed scenarios should have a clear planning chain in the selected time horizon, which in fact means that the experts would be able to trace each step in the evolution of a scenario and to be able to cope with the uncertainty stepwisely by utilizing “cause-effect” couples’ individual evaluation, using heuristics.
The approach is assuming scenario generation into five steps. A specialized software tool - Intelligent Scenario Computer Interface Program Morphological Analysis/System Analysis (I-SCIP-MA/SA) was developed to support of both the morphological and system analyses within the Scenario Generation Process.
Here it should be noted that both I-SCIP-SA and I-SCIP-MA implements uncertainty coping [3] of the experts’ knowledge about the information reliability.

Step I. Preparation

At this step, definition of the time horizon, experts’ team formation, goals definition, database creation, methodological preparation, scenarios’ security level definition and time schedule are defined.

The contextual scenarios database could include different tangibles and intangibles, e.g. global imperatives like: “Earth and Resources,” “People and Institutions,” “Nations and Relations,” and “Technologies and Applications.”

An example of a context scenario that includes these four imperatives and explains the events of 11 September 2001 could be the following: “Earth and Resources” (Global Economy that relies on petrol); “People and Institutions” (Radical Islamic Fundamentalism); “Technologies and Applications” (Liberal technology access and open global market) → “Nations and Relations” (Rich North and Desperate South).

Step II. Strategic Base Analysis

At this step analysis of the strategic base could be conducted over the whole spectrum of national security (e.g. armed forces development for the next 10-20 years; air-defense of a strategic critical infrastructure). In accordance with the scope of the strategic base a concrete focus (symmetric or asymmetric) for the analysis should be determined (e.g. national sovereignty, terrorism, natural disasters protection, etc.).

Step III. Analysis of the Characteristics of the Future

At this step, analysis and selection of the most important characteristics, which are significant for the decision-making process in the planned “plausible future”, are performed. This step aims at narrowing the scenario development field in a reasonable way and, at the same time, producing a scenario explanation of the future projection. Suitable examples for this are the NATO standards and interoperability requirements for the alliance forces.

Step IV. Definition of Zones of Security Interests

The definition of the zones of interests (regularly national ones) in the security context enables the establishment of a clear geopolitical foundation for the development of the scenarios.

Here it should be noted that, e.g. the membership of the subject of interest in different international alliances and organizations directly influences the definition of zones due to the fact that it requires correspondence with the alliance common interests.

Step V. Development and Analysis of the Scenarios [4]

The development of scenarios is a complex task, that also requiring political approval at it final stage. It takes into consideration the definitions of Step IV and is implemented in thirteen sub-steps:

The first four steps encompass the idea of morphological analysis produced into a hyperspace, represented into a cross-consistency matrix of mutually exclusive alternatives spread amongst finite number of dimensions (key factors).

A). Selection of Main Dimensions

The main dimensions (key factors) of a certain scenario (contextual one) could be found amongst:

- International affairs and security;
- Geopolitics;
- Strategic resources;
- Strategic objects;
- Technological & military progress;
- Economic and socio-economic issues;
- Demography;
- Ethno-religious relations;
- Crime level;
- Natural and industrial disasters and catastrophes;
- Military affairs.

The definition of the basic dimension is conducted as an iterative process of brainstorming sessions (for rough selection) followed by Delphi method application (for finer filtration).

B). Definition and Selection of Alternatives for Each Scenario Dimension

After defining the basic dimensions for a certain scenario generation, for each dimension the experts should determine a set of mutually exclusive alternatives. Here they again use brainstorming sessions combined with Delphi method filtration.

C). Linking Alternatives

Once the alternatives in each dimension are defined, the experts should link them and assign weight (within the selected time horizon for the scenario generation) to each of these links. The idea is to use a weighting scale of positive and negative numbers, which in result classify a given scenario combination into more controllable (positive, active, symmetric) or uncontrollable (negative, passive, asymmetric) scenarios. The weights could be easily notated in colours and percentages within the following scale: strong (red, greater than 50 %), weak (green, less than 30 %), moderate (yellow, between 30 % and 50 %).

Usually, in the passive group are classified scenarios that concern threats like terrorism and in the active one - allied missions.

As a result of Step V completion (A) - (C) a cross-consistency matrix for scenarios' morphological analysis is created. This matrix directly produces different combinations on the basis of experts' opinion, knowledge and experience gathered and filtered through brainstorming sessions and Delphi method post filtration.

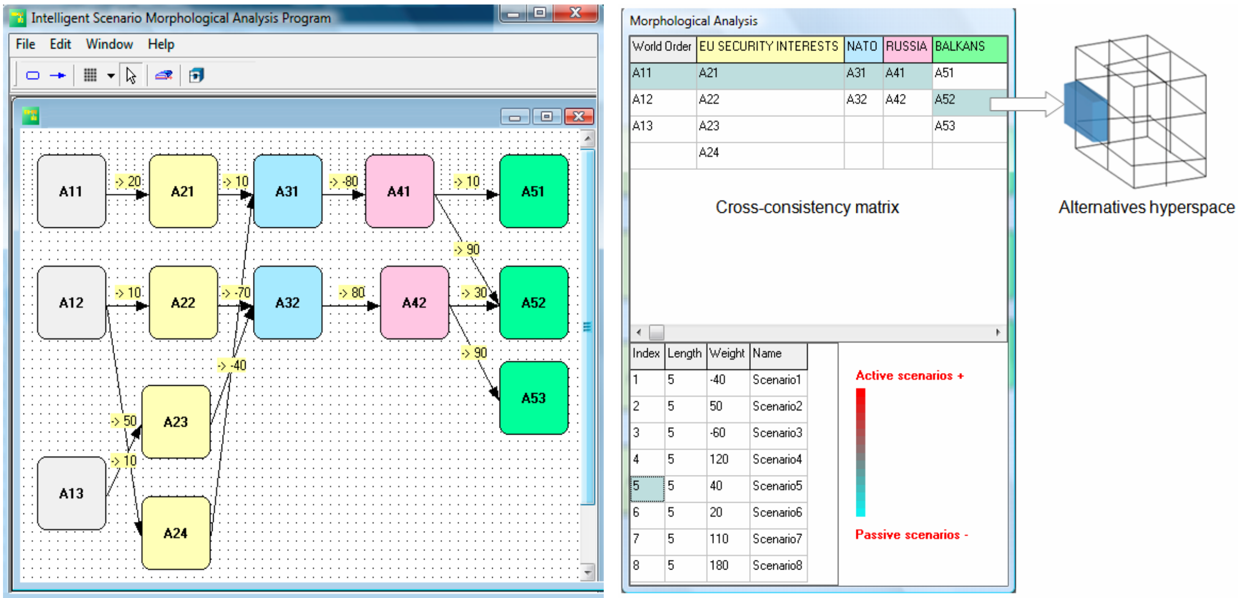

Figure 3: A screen shot of the I-SCIP-MA illustrating the usage of morphological analysis in the scenario generation process

D). Scenario Entitling

Once the different scenario combinations are produced in sub-Step (C), they have to be entitled. The titles of the scenarios are usually selected short, recognizable and straight, e.g.: Generations Clash, New Powers, New Balkans, etc.

This first level of scenario definition is rather flat and creates only the global cross-consistency matrix for a certain scenario set. The reason for this is the nature of the morphological analysis developed for classification and system projections study not for system complete studying.

So, additional deeper system analysis is utilized in order to not only determine "passive" and/or "active" scenarios, but also to discover exactly which elements of a given scenario are important and why by analyzing the developed scenario system sensitivity could be assessed.

Here it should be marked that there exist other COST software products like: CASPER®, J-DARTS® and Think Tools® that support the experts at this stage of the scenario generation for "plausible future" creation.

E). Scenario System Evaluation

The scenario evaluation in the context of the Generalized Systems Theory is produced by means of the idea of dual Influence/Dependence (feed-forward/feed-backward) positive numbers usage in the evaluation of preliminary defined objects (that represent different alternatives, resulting from the morphological analysis) and the created relations between them for a certain scenario part of the "plausible future" [3].

As a result of this, the causality modus is implemented and a final quadratic classification of the scenario objects (e.g. terrorists, infrastructure, people, etc.) into active (yellow, upper right), passive (blue, upper left), buffering (green, bottom left) and critical (red, bottom right) is produced and generalized into a Sensitivity Diagram.

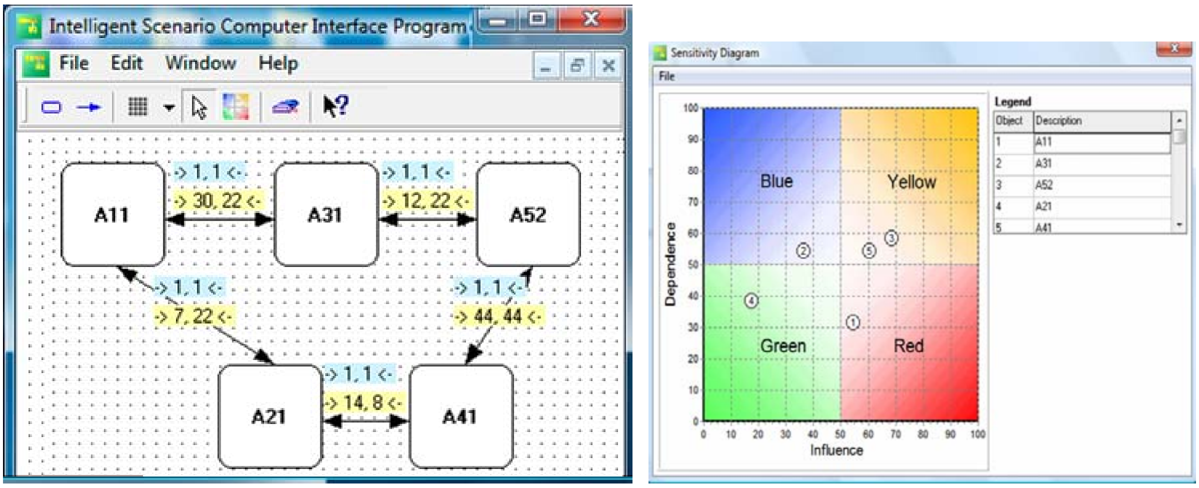

Figure 4: A screen shot of I-SCIP-SA illustrating the usage of system analysis (left) and the resulting Sensitivity Diagram (right) representing the aggregated scenario system sensitivity

F). Scenario Logic Selection

Scenario logic selection is a process for description of links between different scenario objects and the key object. The scenario logic shows the tendencies in the scenario, e.g. "Winners - looser," "Crises & crisis response," "Evolutionary development," "Permanent transformation," "Shock therapy," etc.

G). Scenario Wild-Cards Analysis

The scenario wild-cards are events that differ from the scenarios in their counteraction which should be planned, i.e. in some sense wild-cards are the emergencies in a given scenario. Good examples for scenarios wild-cards are events which remove a given plot in the scenario (Balkans join NATO/EU), developments with global impact and scale (Internet, social networks), and system cataclysms (global terrorism, religious fundamentalism, meteorite crash with the Earth).

H). Scenario Text Elaboration

The elaboration of the text of a given scenario is good to be organized along five basic elements: common status, theatre (in the broad security context), actors, conflict character, scenario progress indicators, and other supporting information. As a result of this step a readable text that concerns the scenario's basic elements and context is produced. This stage could be supported with the world class methodology [5] and software solutions like Final Draft®.

I). Development of Scenario Portfolio

Developing the scenario portfolio is a difficult task because it virtually refers to the definition of sufficient number of scenarios for a given problem, which is quite ambiguous and confusing in practice.

As a general recommendation, the following three steps could be accomplished:

- Definition of the whole spectrum of scenarios resulting from the morphological analysis cross-consistency matrix;
- Selection of these scenarios from the cross-consistency of the scenarios that cover most of the alternatives;
- Selection of the number of scenarios in accordance to the scenarios' goals.

J). Scenario Validation

The process of scenario validation should check precision, realism, relations between different scenarios and the other processes of strategic planning, programming and goals. This step is performed within the experts and further extended within the computer environment (see Paragraph 3).

K). Scenario Approval

This stage jointly with sub-Step (J) is performed in the responsible organizations from the security sector similarly to Steps II-III on experts' level and then the result is sent for final political approval. In this process the following tasks have to be accomplished: national security political vision conformation, exemplifying of the level of political and military consensus, personal and organizational response utilization, coincidence check with Step III, appearance of further control in strategic planning on the basis of lessons learned from the scenario planning procedure.

L). Scenario Presentation

The process of scenario presentation is related to Step I and especially to the scenario's security level. Usually it is performed at two levels: internal (among a small group of experts from the responsible organizations from the security sector) and public (among a broader audience of experts and observers on national and international level).

M). Implementation of the Scenarios

In general, the implementation of the scenarios is a question of political and strategic goals definition of a given country. Usually, this presentation is in support of the allied goals for international and regional stability and security, e.g. defining the vision for Western-Balkans, Black Sea Area, Europe, etc. Finally, in the case of context scenario development an application for long-term planning and the perspectives for future international strategic partnerships and shaping of the security environment is possible.

3. SCENARIO ASSESSMENT FRAMEWORK SOLUTION

The generated scenarios assessment is a multiaspect task that in the present approach encompasses:

- Computer Simulation via CAX;
- CAX Human Factor Analysis;
- Economical Assessment;
- Mathematical Scenario Validation;

3.1 Computer Simulation via CAX and Human Factor Analysis

The scenario assessment framework solution is based on the established in 2006 - Joint Training Simulation and Analysis Center - Civil Security (JTSAC-CS).

The main objective of JTSAC - CS is to provide scientific and educational support to the Integrated Security Sector on the bases of Operational Analysis (OA) and Computer Assisted eXercises (CAX), conducted jointly by subject matter experts from the security sector, scientists from Bulgarian Academy of Sciences and leading national and international high-tech companies and consultants [6].

The basic JTSAC - CS capabilities are integrated around the Basic low-cost Environment for Simulation & Training - BEST. This environment has been developing since 2005 within a series of projects and tested with the EU TACOM SEE 2006, Struma 2008 exercises and in 2010 will be part of Phoenix 2010 exercise.

BEST is integrating CAX simulation via CAX-ENVironment (CAX-ENV) and six additional modules.

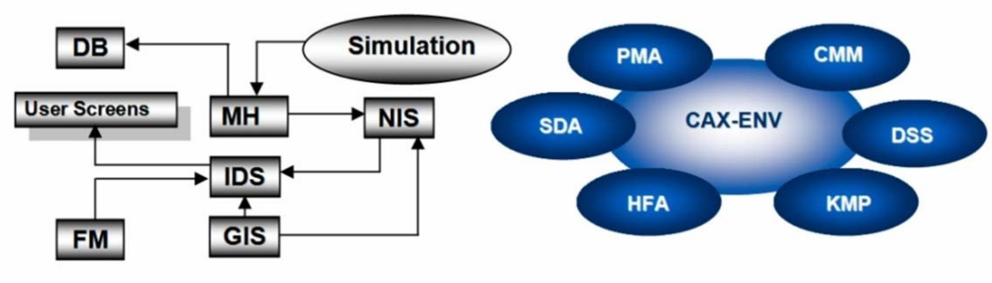

Figure 5: CAX-ENV and other BEST modules

CAX-ENV is an element of BEST that encompasses a network system for: Message Handling and Instant Messaging chat (MHS); Integrated Display System (IDS) for displaying different fused information about simulated events: geographical, seismological and meteorological information (via Geographical Information System), exchanged messages log via a Web Information System integrated into a network information system (NIS) that allows remote Field Modules (FM) integration for mobile C2 Center construction, including WAN, LAN and satellite TCP and VoIP communications and video surveillance (including night vision cameras); Finally the completed simulation is archivated in to a Data Base (DB) for After Action Review and Post Mission Analysis.

According to [7], [8] BEST building elements are: The Change Management Model (CMM) [9] is giving the context of the security sector transformation in the sense of security sector concept development and experimentation through CAX. In this sense, CMM provides also the link with the end-user of CAX; The Project Management and Assessment (PMA) implements tools and methods for economical evaluation planning and control on the bases of COTS like: MS Project®, QPR Balanced Score Card® and own ad-hoc developed software solutions; The Scenario Development and Assessment (SDA) implements a four step process: structural (morphological) analysis, system analysis (both developed within own ad-hoc developed software I-SCIP-MA/I-SCIP-SA [3]), dynamic systems risk forecasting, showing general tendencies in the simulation timeframe (developed with the COTS Powersim Studio®) and agent based simulation (developed with NC3A software for agent based simulation - GAMMA®);

Following developed scenarios the requirements define CAX ENVironment (ENV) architecture, designed by System/Enterprise Architect®, OpNet® (for communications), ARIS® and using NAF, DoDAF standards [10].

The Decision Support Systems (DSS) package provides a set of distribution tasks solvers for emergency delivery of resources (water, food, medicines, blankets, clothes, etc.), people evacuation, rescuing and network (electrical, water or road) distribution problems;

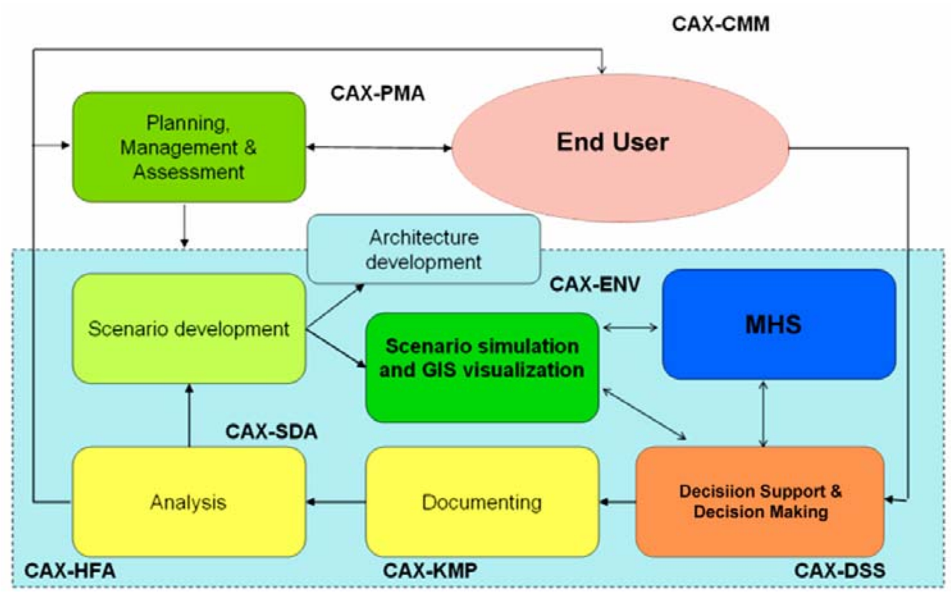

Figure 6: JTSAC-CS BEST methodology

The Knowledge Management Package (KMP) is providing an integrated space for archivation of results in electronic form, from ongoing or already passed CAXs, available in a WWW environment (http://www.caxbg.com/);

Finally, the Human Factor Analysis (HFA) gives a possibility via questioners fill-up, battery of psychological tests (including: alertness, attention, stress, fatigue etc.) and neurofeedback tracking for evaluation in a qualitative manner the real involvement of the trained participants in CAX and for improvement of their results/performance, i.e. an ability to learn and improve their knowledge and reactions for hypothetical, plausible scenario based hypothetical/future situations [11].

3.2 Economical Assessment

The economical assessment of the generated scenarios for the "plausible future" is important for putting realism in long-term defense planning and capabilities development processes. An approach was developed in relation with the context of project management methodology to assess cost of the exercise and potential cost of implementing C2 system following the results of the CAX, based on related scenarios of interest. It should be noted that the developed approach for economic analysis and project management, which is a part of the already described BEST environment [7], [8], [12] combines: different architecture (system, operational and technical) development keeping the DoDAF/NAF standards, multicriteria alternatives evaluation, planning and development of project plan and Balanced Score Card assessment of three types of resources: time, cost and people. The time schedule is measured with timetables and the performed activities via time sheets and algorithms for assessment using methods like ABC and expenditure/benefit analysis.

As far as the complete economical assessment requires an acceptable risk for emergencies, which play the role of wild cards, a risk plan should be developed in case of resource spillage/shortage. This process could be supported with optimization algorithms like linear programming, dynamic optimization and other heuristic methods and COTS software like Matlab®.

3.3 Mathematical Scenario Validation

The mathematical scenario validation requires availability of time series data sets that are representing the observed past and assumed future dynamics of different scenario building elements, dimensions and alternatives.

Official sources of information of that kind could be found, e.g. in: Annual CIA Fact Book [13], Stockholm International Peace Research Institute [14], Global Terrorism Database [15], Economics Web Institute [16] and UN Office on Drugs and Crime [17].

Here it should be marked that nowadays there have been developed a lot of mathematical solutions both in linear and non-linear forecasting (e.g. using decompositions in: Volterra, Fourier, Taylor and even wavelets, multiple regression analysis, etc.). What however is important is the complex nature of the scenarios, which certainly requires a general system view.

Regarding this the present idea is to use available time series data and to try experimentally (assuming time series non-linear dynamics existence and non-stochastic nature of the observed processes) to build a multidimensional space $\mathbf{R}^m$ (m - is the number of studied dimensions) represented by a m-dimensional polytope with $m + 1$ vertices - Δ^m, i.e. the convex hull of a certain scenario elements (scenario's alternatives) and to try to project a point x_i (certain scenario alternative) from this simplex Δ^m in time, p steps (days, months, years in accordance with the time discretization) ahead.

An assumption to use the non-linear forecasting [18], [19] in time series for the above described multidimensional simplex Δ^m is made.

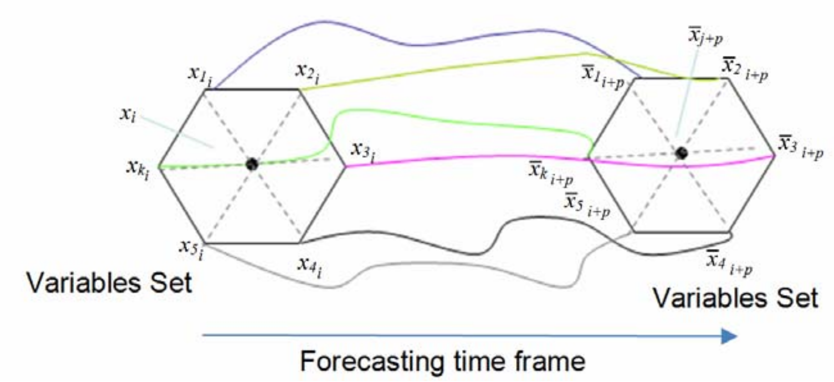

Figure 7: Interpretation of the non-linear forecasting as a mathematical method for scenario validation

The idea represented in Figure 7 demonstrates the forecast of the point x_i (considered as a variable - scenario alternative) assumed to be dependent within other nearest neighbouring points x_{k_i} (other scenario alternatives - variables). The predicted value of $x_i \rightarrow x_{j+p}$ is obtained by keeping track of the x_{k_i} neighbours dynamics giving them exponential weights depending on the original distance.

In the case of Euclidean metrics usage and p steps ahead prediction, the non-linear prediction calculation could have used the modified [19]:

$$x_{j+p} = \sum_{i=1}^{M+1} \bar{x}_{k_{i+p}} e^{-\alpha \left\| x_j - x_{k_i} \right\|},$$

Where:

||.|| is the Euclidean distance in M dimensional space;

x_{k_i} - k^{th} closest neighbour to x_i;

$i,j > N$, $k + p < N$, N is the first half of data points used for forecasting of the second one;

$\bar{x}_{k_{i+p}}$ - k^{th} closest neighbour to x_i, p steps ahead;

M - work space (embedding in case of single time series reconstruction) dimension;
p - number of steps ahead; α - expert-defined constants defined for the different dimensions M. The notation of space dimension M is used because the real simplex Δ^m dimension m could be initially unknown and $M < m$.
The error ε could be estimated in different ways but what was empirically evident that it is not necessary to consider ε of more than integral cubic degree of accuracy:

$$\varepsilon = | x_{i+p} - x_i | = O\,(h^3)$$

A forecasting result with an admissible error of this forecasting gives the dynamics of the non-linear interdependencies between the scenario elements and in some way is an evidence for the system character of the created (from linked scenario alternatives) Δ^m simplex (representing a scenario from the "plausible future" set).
Here it should be noted that the presented in [19] method for forecasting is modified in two key directions:

- usage of available scenario alternatives time series dynamics assuming a certain model system dimension m instead of reconstructing the scenario system from a single component (alternative), i.e. an ergodic nature of the system, which generally in the discrete environment is not always possible [18];
- implementation of different weights α_i (i =1,…, m) for the different time series curves correction for achieving the desired ε.

The presented method does not claim to produce correct assumptions for the future, because it is calibrated with the available data from the past (i.e. the forecast is produced for a known time period variables' dynamics and later projected in the future p steps) but similar to uncertainty coping [3], [20] combines the experts' assumptions for the future in a reasonable and at the same time general manner within the system context (by means of the scenario system) and with a measurable ε error.
However, because of the system view of the scenarios and their building alternatives, the validation method allows looking for interdependencies in the generated scenario system similar to the one of Kondratiev economic cycles [21] but in the broader security context.

3.3.1 Example for Practical Implementation the Mathematical Scenario Validation Method

As far as the disclosed mathematical scenario validation method is rather abstract a short illustrative example will be given taking the scenario system analysis as a basis and assuming an existing (preliminary defined) contextual scenario.
Initially, a scenario system model of terrorist attacks is developed in the I-SCIP-SA environment (Figure 8). The developed model includes seven alternatives: "Terrorist Attacks", "GDP of Central South Asia", "Weapons Export", "Opium Production", "EU Cooperation", "NATO Cooperation" and "Neighbouring". This scenario system model (called "Asia Opium Control 1987-2007") is assumed to be developed in the scenario context "New East" [2]. The model is developed with in 21 years context - 1987-2007 (see the blue labels of the links between the alternatives) because of the mathematical time series non-linear forecasting data availability.
Further on, an weighted links (see yellow labels over the links) of these scenario alternatives produced within expert support could generate a Sensitivity Diagram (Figure 10 - left) with the following alternatives classification: critical/red ("NATO Cooperation", "EU Cooperation") active/yellow ("Terrorist Attacks", "Opium Production") passive/blue (no such within the current weights) and buffering/green ("Weapons Export", "Neighbouring", "GDP of Central South Asia") .

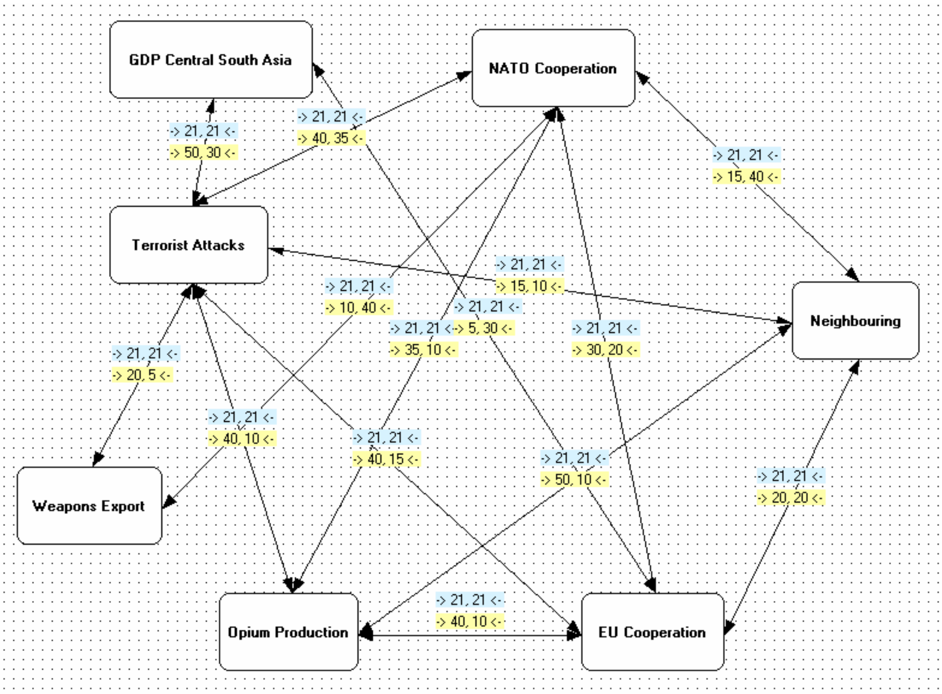

Figure 8. A screen shot of the scenario example: "Asia Opium Control 1987-2007"

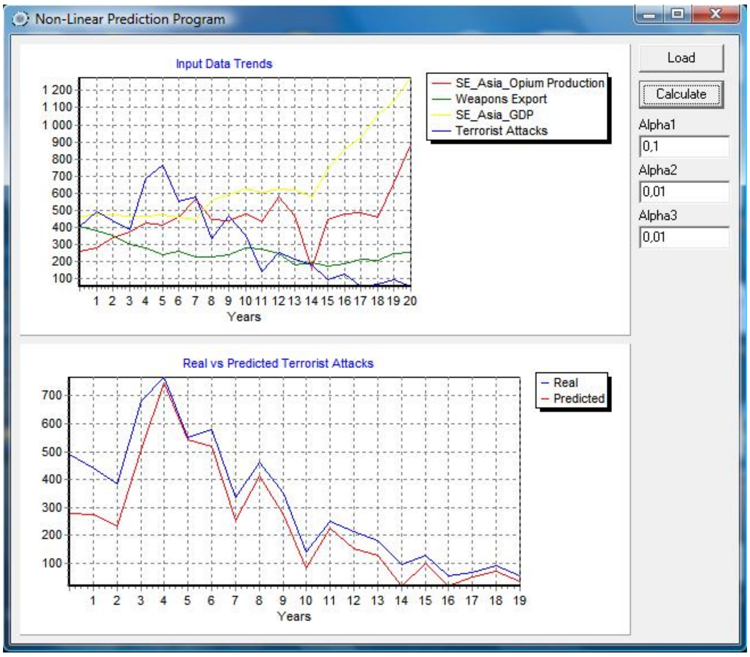

Figure 9. Non-linear forecasting of "Terrorist Attacks" alternative in "Asia Opium Control 1987-2007"

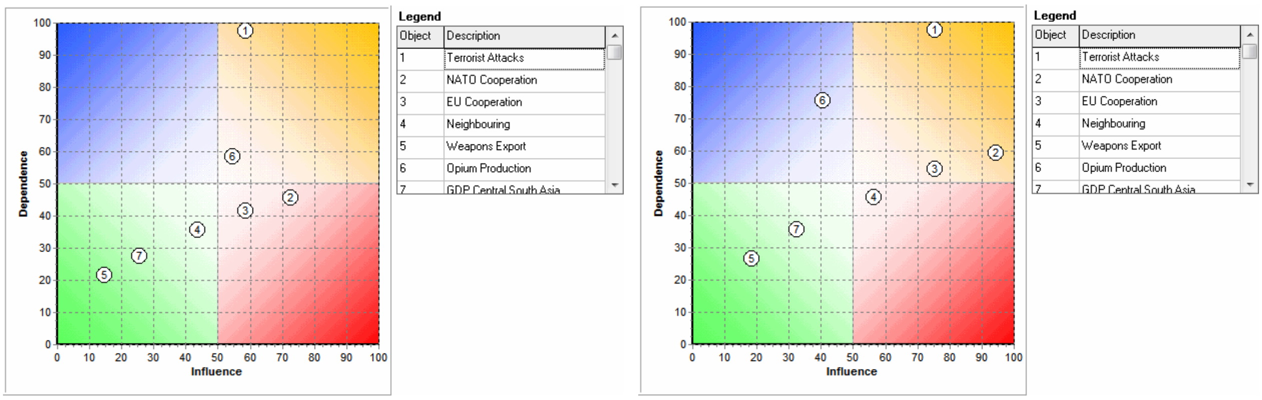

Figure 10. Sensitivity Diagrams of "Asia Opium Control 1987-2007" before (left) and after (right) the non-linear forecast usage and experts correction of the "Opium Production" alternative link weight

Secondly, a non-linear forecast (Figure 9) of the "Terrorist attacks" (the used data is for Europe) time series data is produced within the algorithm described in 3.3 and a Borland Delphi® ad-hoc application by using the scenario alternatives time series data: "Opium Production" (for South-East Asia region), "Weapons Export" (total for the world), "GDP of Central South Asia" dynamics for the period (1987-2007) by using the data from [13], [14], [15], [16] and [17].
So, we are able to forecast the future disposition by means of classification of "Terrorist attacks" in the Sensitivity Diagram four zones (green, red, blue and yellow). The given example demonstrates almost complete predicted and real time series data match for the whole time period of 21 years (the complete period is from 1987 to 2007, but on Figure 9 - 1987 and 2007 are excluded from the graphics because of the forecast algorithm requirements for known start and end variable/alternative values (i.e. 1 → 1988, 2 → 1989, …, 19 → 2006 within the "Years" axis) with an admissible absolute error ε ($\varepsilon < 10$ % from the predicted (red line on Figure 9) and real (blue line on Figure 9) values of the "Terrorist attacks" time series data). As it is clear from Figure 9 between 13 → 2000 and 14 → 2001 the "Terrorist attacks" in Europe have been diminished.

Finally, using the non-linear forecast results and available time series data, the scenario "Asia Opium Control 1987-2007" could be modified (for the period: 13 -14, i.e. years: 2000 - 2001), e.g. by correcting of the "Opium Production" link weight (looking on Figure 9 "Opium Production" dynamics for the same period – 2000-2001) in relation to the "Terrorist attacks" ones (by means of diminishing the link weight value) and obtaining the result shown on Figure 10 - right, i.e.: new Sensitivity Diagram with the following alternatives new (moved) classification: critical/red ("Neighbouring") active/yellow ("Terrorist Attacks", "NATO Cooperation", "EU Cooperation"), passive/blue ("Opium Production") and buffering/green ("Weapons Export", "GDP of Central South Asia") .

The presented scenario example and control solution does not claim for uniqueness but only shows the originality of combining both non-linear forecasting in time series data and trend tendencies clear observation within the system analysis. Both processes are support by ad-hoc developed software and implemented in the scenario generation and assessment framework in support of the Comprehensive Approach different projections.

4. CONCLUSIONS & FUTURE WORK

The presented approach of bounding scenario development with morphological, system analysis, human factor analysis, CAX, mathematical forecasting and economic assessment gives a possibility for complete and explanatory methodology production in support of the integrated security sector.
The implementation of the simple multiaspect BEST environment gives an opportunity to involve both human and societal dynamics dimension in this research area.

Future developments of tools for scientific and economic analysis (like SWOT and PEST) around agreed scenarios through use of CAX, but utilizing and other more complex exercise environments will help to improve our national capabilities for planning of structures and operations, providing contribution to the Comprehensive Approach, similar to US Joint Operations Environment.
Future work is also envisioned in relation with the improvement of scenario development and analysis tools using CAX environment with more focus on comparison of mathematical and experimental approaches as well as link between security and economic policy analysis of the scenarios and related institutional arrangements.

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