Use of Simulation to Support the Analysis of Societal Conflict and Counterinsurgency

Uwe Dompke, Ph.D.

NC3A CAT 1, P.O. Box 174
2501 CD Den Haag, The Netherlands.
e-mail: uwe.dompke@nc3a.nato.int

Uwe K.J. Dompke is currently Principal Scientist and Project Leader at the NATO C3 Agency in The Hague, The Netherlands. He will be a consultant starting 2010. His main research areas are Human Behaviour Representation, Modelling and Simulation of Crisis Response and Stability Operations and Campaign Assessment on Strategic and Operational Level. He was Director of the Lecture Series on "Modelling of and for Military Decision Making" of the Research and Technology Organization of NATO. He has directed NATO Research and Technology Board Long Term Scientific Studies (LTSS) on Computer Assisted Exercises, Computer Generated Forces and Human Behaviour Representation in the last 18 years. He received his Master Degree in Computer Science from University of Federal Armed Forces Munich in 1981 and his Dr. Degree in Operational Research and Human Behaviour Representation from University of Federal Armed Forces Munich in 1992. He was nominated for the von Karman Medal of the NATO Research and Technology Organization.

ABSTRACT

GAMMA is a simulation system developed at the North Atlantic Treaty Organisation (NATO) Consultation, Command and Control Agency (NC3A) in The Hague. It is developed as an analysis tool for irregular warfare on the operational level to support operational planning and the assessment of Courses of Action (COA). With its representation of societal factors to measure a given situation regarding stability and its development over time and aims and objectives as part of a counterinsurgency strategy to change a given situation to the better it serves very well as a tool to support analysis of societal conflict and counterinsurgency.

The paper will cover three main aspects: 1. The concept behind GAMMA as an open architecture tool with an own object store which allows the modelling of military and non-military objects and their interactions easily without requiring program changes; 2. The modelling approach used in GAMMA to simulate the creation of incidents in a given scenario (agent-based) and the multi-criteria decision making and system dynamics based approach to incorporate societal data into the analysis of stability operations; 3. Experience gained from the use of GAMMA in different scenarios (exercise scenarios Zoran Sea Crisis and Cerasia, MNE 4 (Afghanistan) and a US DARPA (Defence Advanced Research Projects Agency) experiment with Nigeria and Chad). A summary including a short note on a concept for the validation of the models will conclude the paper.

INTRODUCTION

"Analysis of Societal Conflict and Counterinsurgency" is the theme of the Fourteenth Annual Meeting of the Cornwallis Group. This group is studying various aspects of the interface between the military and civilian actors in Peace and Stability interventions. These actors include on one hand the actors engaged in the intervention as military forces and civilian actors from International Organizations (IO) and Non-Governmental Organizations (NGO) and on the other hand the population and insurgents in the conflict area.

The analysis of Societal Conflict and Counterinsurgency can have different aims. One is definitely gaining a better understanding why societal conflict is happening and what are the factors and their dependencies, which drive the conflict. The same is true for Counterinsurgency, which is not very well understood from a research perspective. Another aim from a practical point of view is to support decision-making. From a NATO perspective this can happen in:

- Defence Planning (long term planning).
- Contingency Planning (medium term planning for possible contingencies).
- Operational Planning (short term planning for a specific crisis).
- Current Operations (short term reaction to a developing situation).

Operational Analysis (OA) is used in NATO to support decision-making and to facilitate good decisions in planning and in the conduct of operations. OA is based on the use of scientific and quantitative methods with a strong emphasis on what-if assessments (comparative methods in which the assumptions are kept the same to compare alternative plans). It is not intended to forecast the future or to make decisions; its main intention is to inform the decision maker and to facilitate his decision-making. In this process systems analysis plays a major role and must include the participation of the decision maker to make his assumptions transparent and to extract his criteria for success.

Main elements for OA support are:

- Experienced analyst(s) as integrated part of the staff element.
- Data, including geography, situation/order of battle, doctrine, assessment.
- Methodology and tools like modelling & simulation, IT (information technology) systems, expert systems, human behaviour representation.
- Interpretation and analysis of the output of the used tools with an application to the problem.
- Communication of results to give explanation and trust.

The above shows how important the human element or the experienced analyst in OA support is, an automated model working as a black box which results can only be accepted but not explained ("take it or leave it") doesn't serve the purpose of supporting (especially senior) decision makers.

Modelling and simulation plays a major role in the tools used to give OA support. A model is a physical, mathematical, or logical representation of a system of entities, phenomena, or processes. Basically a model is a simplified abstract view of the complex reality. The process of modelling a complex system with identifying relevant factors and their interrelationships provides invaluable insights for decision-making. A simulation is the implementation of a model over time. A simulation can never forecast what will happen over time, but it can support a what-if analysis.

Modelling and Simulation has a long history in military OA and especially in the Cold War time some research was spent on force-on-force conflicts, which led to very useful simulation systems, which are still used i.a. for Computer Assisted Exercises (CAX) (e.g. JTTL (Joint Theater Level Simulation) or KORA). With the Comprehensive Approach as issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Bucharest on 3 April 2008[1] a clear shift away from a pure military solution to societal conflicts is taken by NATO. Figure 1 shows how the diplomatic, informational, economic and military parts play together in different kinds of conflict ranging from Peace Support over Crisis Response to Article 5 Missions.

The Comprehensive Approach bears challenges to the OA community. First of all conflicts of this type are not limited to two fighting factions as in most force-on-force engagements, but are multi-national and multi-factional with strong interdependencies of military and non-military issues. They also include low intensity conflicts and asymmetric operations as well as tasks other than traditional military tasks. Furthermore political constraints play a major role in these types of conflict.

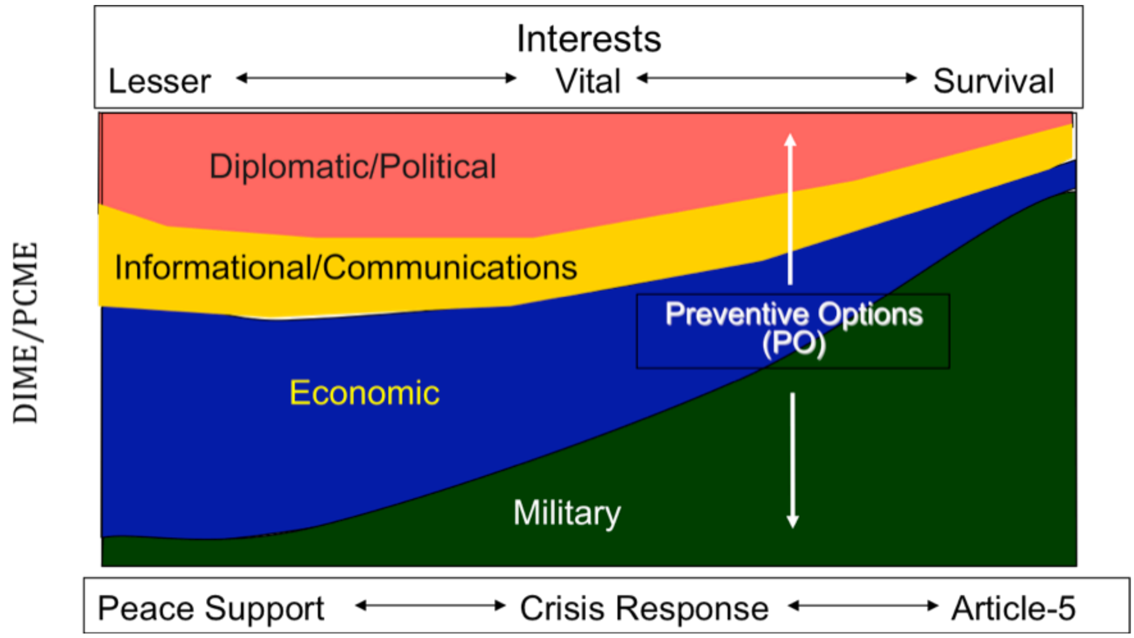

Figure 1: Comprehensive Approach.

Human Behaviour plays a prominent role in this issue, but our knowledge how to represent Human Behaviour in Modelling and Simulation is still limited (see [1] and [2]). Other challenges deal with the aims and end-states associated with these kinds of missions and how we differentiate between failure and success. The development of Measures of Effectiveness

1 “Experiences in Afghanistan and the Balkans demonstrate that the international community needs to work more closely together and take a comprehensive approach to address successfully the security challenges of today and tomorrow. Effective implementation of a comprehensive approach requires the cooperation and contribution of all major actors, including that of Non-Governmental Organisations and relevant local bodies.”

(MoE) in this respect is still in the beginning. The system is complex because critical MoE (such as casualties) can only be modelled effectively at low level but other MoE (such as whether the region has been stabilized or not) must encompass an examination of the whole theatre of operations at the Grand Strategic level. The requirement to include new stakeholders further increases the size of the analytical task.

Typical requirements for decision support tools to support e.g. ISAF are:

- Representation of the Complex Situation in Which the HQ is Operating (Holistic View).
- Data must be Easily Available.
- Reliable in its Results (Validation).
- Results must be Understandable by an Experienced Operator (Transparency of Results).
- Support of What-if Analysis.
- Runtime must be Short to Allow the Assessment of Different Options.
- Understanding of its Use by Operational Users and Integration in the Process.

In the following section the simulation system GAMMA (Global Aggregated Model for Military Assessment) is introduced, which is developed at NC3A. The modelling approach used in GAMMA to simulate the creation of incidents in a given scenario (agent-based) and the multi-criteria decision making and system dynamics based approach to incorporate societal data into the analysis of stability operations is explained in the following chapter. After that the experiences gained from the use of GAMMA in different scenarios (exercise scenarios Zoran Sea Crisis and Cerasia, MNE 4 (Afghanistan) and a US DARPA (Defence Advanced Research Projects Agency) experiment with Nigeria and Chad) is highlighted. A summary including a short note on a concept for the validation of the models will conclude the paper.

GAMMA (GLOBAL AGGREGATED MODEL FOR MILITARY ASSESSMENT)

Possible NATO missions range from high-intensity conflict-to-conflict mitigation and peace support operations in different environments (symmetric/asymmetric). To support the NATO Operational Planning Process (OPP) in comprehensive operations a holistic modelling and simulation tool for Course of Action (COA) assessment and end-state analysis was needed but not available. GAMMA was developed to close this gap.

GAMMA is a highly aggregated simulation and assessment model which is designed to evaluate military courses of action (COA) at the operational level in high and low intensity conflict scenarios and thus supports COA selection as a decision aid (see a more detailed description of GAMMA in [3], [11]).

GAMMA includes strong interdependencies of military and non-military issues, multinational (including Non-NATO) operations, asymmetric war fighting, multi-faction conflicts, tasks other than (traditional) military tasks, and severe political constraints on military (or non-military) operations.

GAMMA uses PMCE (Political, Military, Civil, Economic – also known as DIME (Diplomatic, Informational, Military, Economics)) action-reaction modelling and simulation. The aggregated or detailed system state in a given scenario is assessed using societal factors (PMESII (Political, Military, Economic, Social, Information, Infrastructure) are a kind of societal factors known from the Effects Based Approach to Operations (EBAO)).

The concept of GAMMA is based on an open architecture, which describes all interacting objects such as military units, assets, geographic objects etc. in very generic terms. New types of entities, for example new military unit types of all services or non-military elements such as refugees, civilian population, or civilian organisations (such as The Red Cross), infrastructure elements such as power plants or cities etc. can be defined and instantiated easily without requiring program changes.

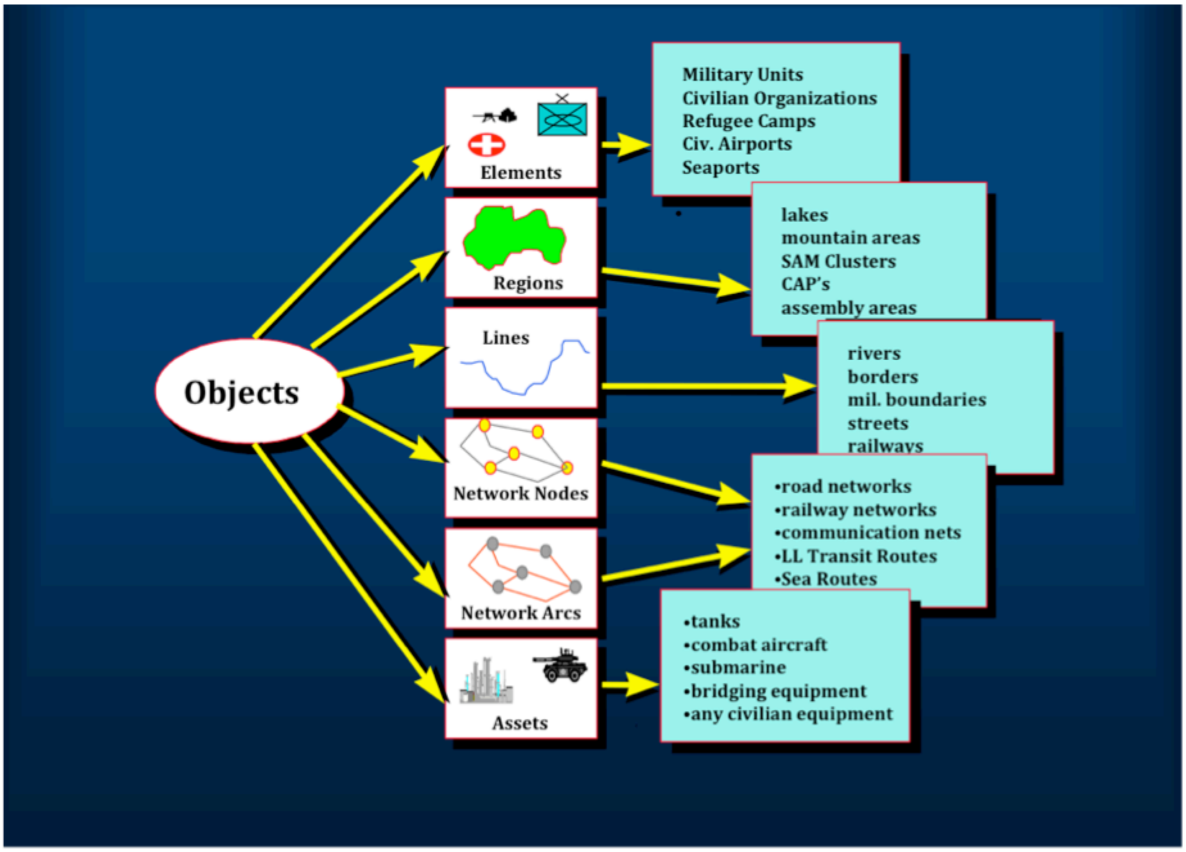

Figure 2: GAMMA Objects.

New simulation modules can also easily integrated as GAMMA components using COM. All components (see Figure 2) use the same user interface, simulation framework, and XML based data providers. GAMMA includes an agent-based incidents module, which allows to model agents, entities or organizations that create incidents (positive and negative).

A multi-criteria decision support tool called ZETA (Effects Based Tool for Assessment), which is integrated into GAMMA, assesses the impact of these incidents and of the planned actions on a given situation. This tool gives feedback on the PMESII factors over time and the degree of achievement of the Operational End-state.

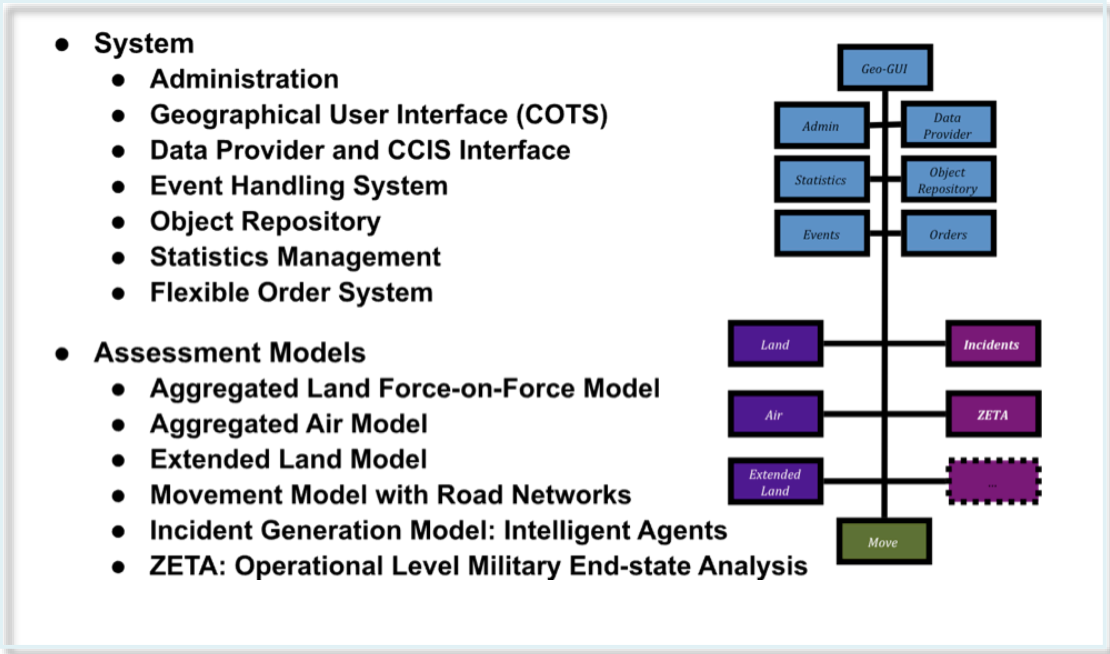

Figure 3: GAMMA Components.

GAMMA INCIDENTS AND ASSESSMENT MODEL

GAMMA has two components, which are built to support the analysis of asymmetric conflicts: the Incidents Model and the ZETA Tool (Zoran[2] Effects Based Tool for Assessment). The incidents model is agent-based and simulates the occurrences of incidents in a given scenario based on a description of the actors and possible external influences (e.g. collateral damage) in a dynamic environment. The assessment model allows evaluating the stability of a region over time based on a holistic approach. Both components are described in the following.

GAMMA INCIDENTS MODEL

Agents are used in GAMMA to represent paramilitary or terrorist groups (insurgents), groups of civilians such as local populations, NGOs and IOs. Each agent is described by its general character, its intentions and current state, which includes agitation level, perception of the environment and memory (see Figure 4). The general character includes a level of violence acceptance and readiness to risk. Agent intentions can be measured by its interest in the specific PMESII factors (e.g. political or military interest).

[2] Named after the Zoran Sea Crisis scenario in which ZETA was used first.

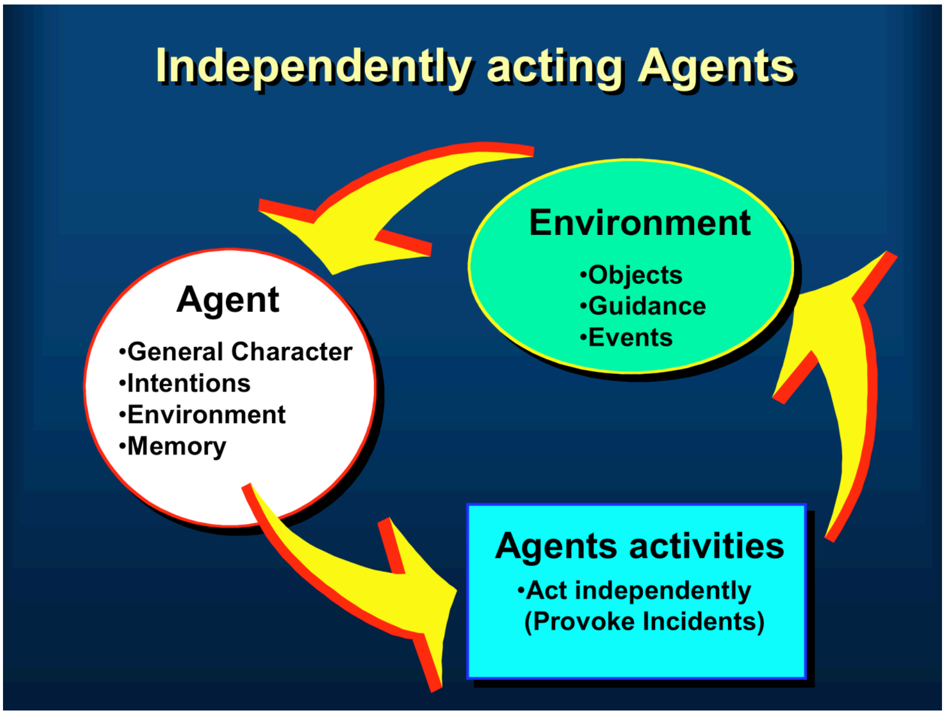

Figure 4: Independently acting agents

Based on the environment and the characteristics of the agents, the incidents model creates incidents. Incidents are scenario specific and are defined by the user. Examples are:

- Demonstration
- Public riot
- Occupation of media or embassy
- Robbery
- Drugs trafficking
- Destruction of private property
- Destruction of military infrastructure
- Sniper attack
- Bomb attack
- Suicide Bombing

Each of these incidents has a target object, which can be:

- Cities
- Civil persons
- Buildings
- Industrial plants
- Military elements
- Etc…

With each potential incident a pre-determined violence and agitation level must be met by an agent in order to provoke a specific incident. The violence level of an agent may change over time. Triggers for changes could be special events such as collateral damage or other actions such as information operations or psychological operations. The agitation level describes the ability of an agent to provoke incidents. It will be lower following an incident and the agent will need time to refresh his ability.

Risk assessment is conducted by the agent and depends on the current situation at the target object in relation to an incident (e.g. patrols, protection levels of critical infrastructure, etc). The decision by the agent which incident is created in a specific situation depends also on his interests. GAMMA provides two different methods: 1. The importance for different societal factors (i.e. potential targets) will be specified for each incident and will be taken into account when looking at the interest of the agent, 2. The ZETA model (see below) is used to find a suitable incident, which optimizes the impact by the agent on the current situation.

The simulation of incidents is done in following steps:

- Movement of the agent to a specific location based on his interest taking his knowledge about the environment into account (cross country or on road networks).
- Generation of potential incidents, taking the agent's characteristics (violence level, readiness for risk, agitation level) and the environment (e.g. patrols, checkpoints) into account.
- Calculation of the priority for an incident dependent on the agent's intentions or the impact on the societal factors (when using the ZETA model).
- Selection of the incident with the highest Priority,

In the current version of GAMMA all incidents are shown on the map during runtime. At any time statistics about the number and kind of incidents in a specific region can be shown on top of the map. Incidents can have an impact on other simulation modules (e.g. a demonstration can block the road network and has an impact in the movement model). Events from other models like collateral damage can have an impact on the behaviour of the agents.

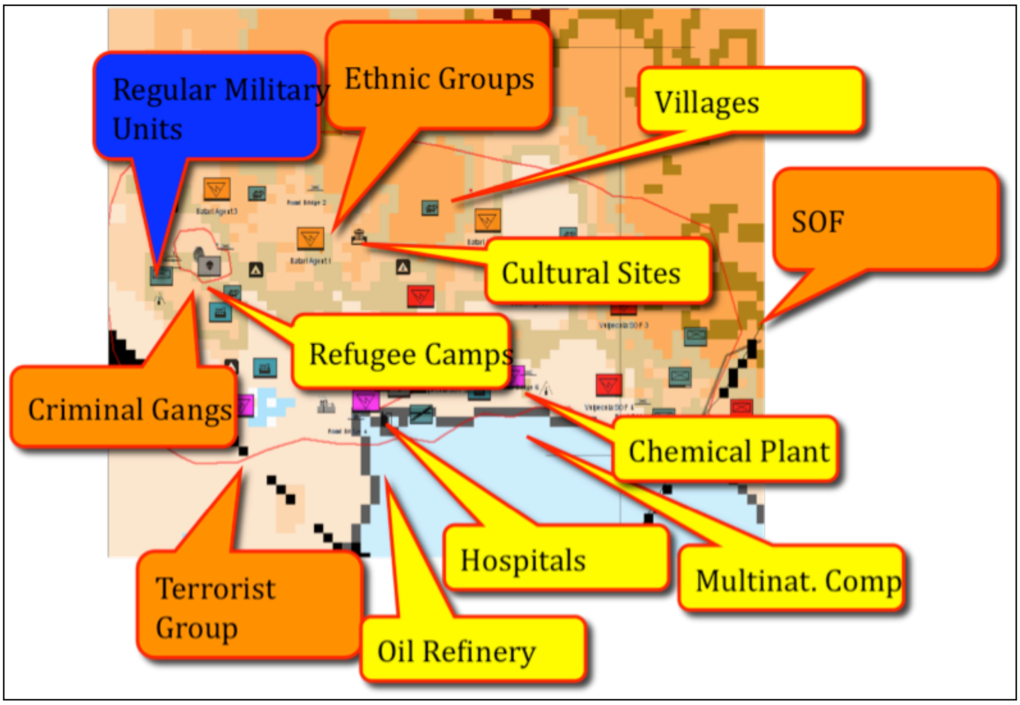

Figure 5: Example - Crisis Environment.

Figure shows an example for a crisis environment as modelled in GAMMA. The criminal gangs, a terrorist group, ethnic groups and special forces (SOF) create incidents in this scenario. Figure 6 shows the results of the simulation when run without any alliance actions or with alliance actions in form of patrols and checkpoints. It can be seen that the number of incidents is smaller and also the kind of incidents is changing.

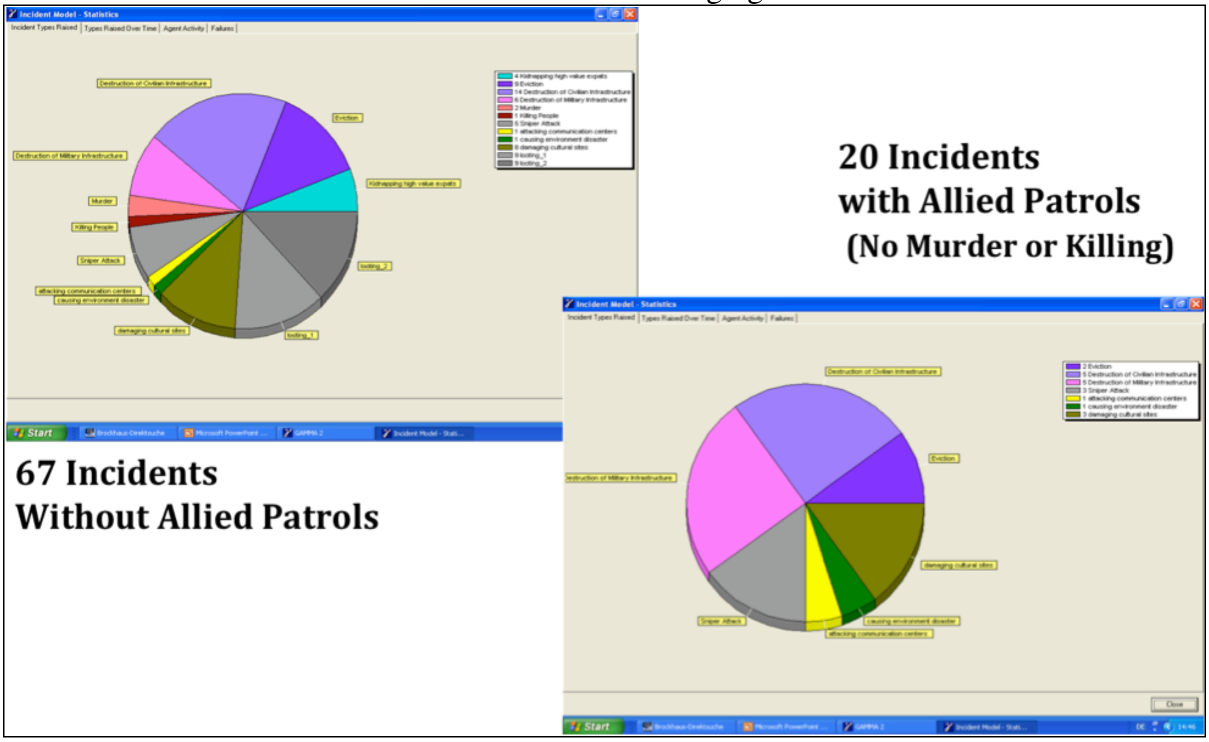

Figure 6: Comparison of different COAs.

Agents may change their behaviour as a result of certain events happening during simulation, such as:

- Enemy Invasion Into Own Country or Area of Interest.
- Severe Civilian Casualties During Military Operations.
- Severe Incidents.
- Destruction of Religious or Cultural Sites.
- Outcome of Military Operations.
- Collapse of a Country's Government.
- Outstanding Political Events.

In GAMMA this is modelled by sending a message from the respective model (e.g. the air model for collateral damage) to the incidents model which results in an update of the parameters of the agents (e.g. change in the accepted level of violence or agitation level). Figure 7 shows the increase of incidents over time after the arrival of Alliance Forces (assumed a more aggressive posture of insurgents in this case). Figure 8 shows the change of the kind of incident over time, when the behaviour of the agents change because of external events.

GAMMA ZETA MODEL

The ZETA Model was developed to support the identification of the main societal factors relevant to the stability of a government in a specific crisis situation and how insurgents and own actions influence them over time. ZETA is a generic time-step based dynamic simulation designed to explore and display interdependencies between societal factors and their influence on the overall system state. The system may be defined as a theatre of operations, or may be scaled to higher or lower levels of aggregation.

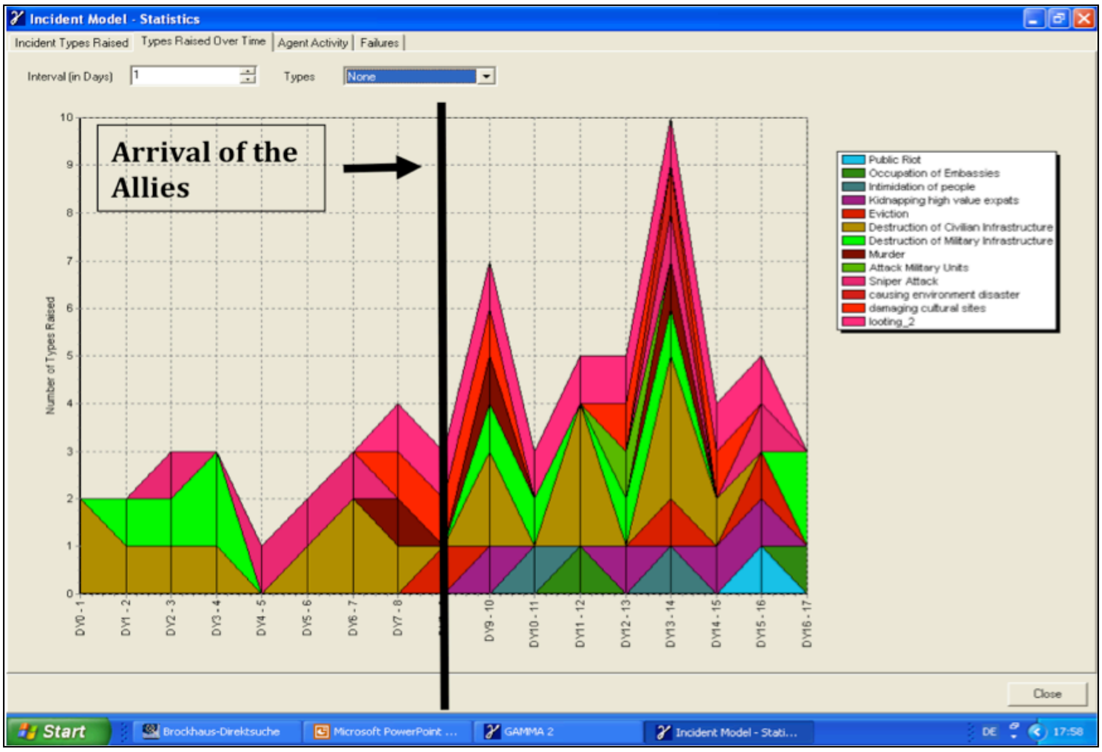

Figure 7: Dynamic change of agents behaviour.

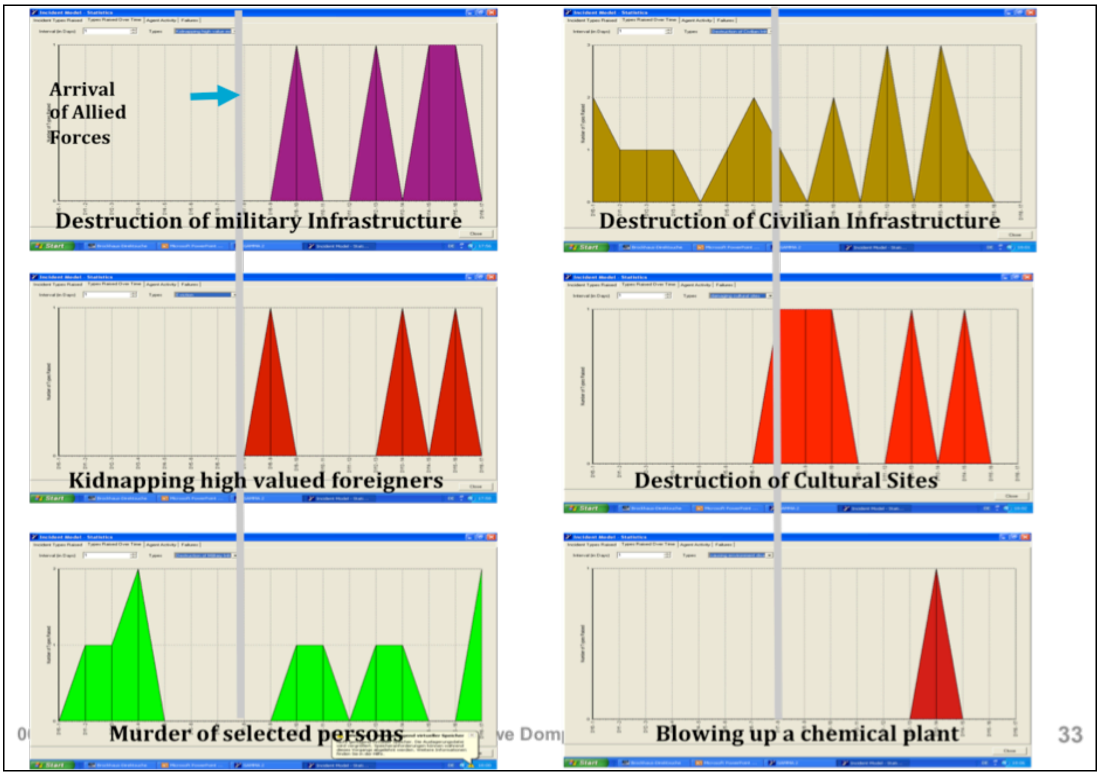

Figure 8: Change of incidents types over time.

The model was developed in order to provide operational analysis decision support to the joint operational level campaign planning process in the context of asymmetric conflicts occurring most likely within a stability operation. The result of this analysis can be used to compare different COAs regarding their impact on the stability of a government in a conflict situation. It is not restricted to military actions but covers the whole spectrum of the comprehensive approach (diplomatic/political, economic, humanitarian, military).

To derive the relevant factors the concept of Viable Peace (see [5]) is used (see Figure 9). A conflict occurs, when the institutional capacity in a region is unable to control the drivers of conflict active in this region. Viable Peace is reached when the institutional capacity is able to stabilize the situation by controlling the drivers of conflict. To get to this point not only the drivers of conflict in a given conflict situation have to be diminished by an external capacity but also the regional institutional capacity has to be built up to have a long lasting effect on the crisis situation.

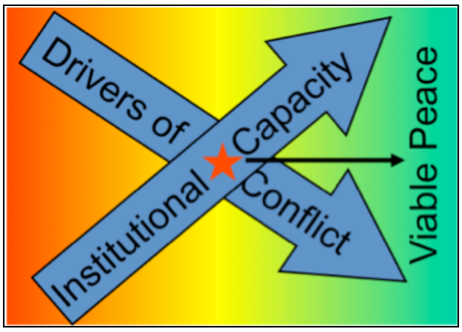

Figure 9: The concept of viable peace.

That means that in such a situation in which the society is threatened by insurgents the external support on the political, military, economic and humanitarian level has to support the threatened society by diplomatic/political support, building up the economy, training the security forces and humanitarian aid at the same time it is fighting the insurgents (see Figure 10).

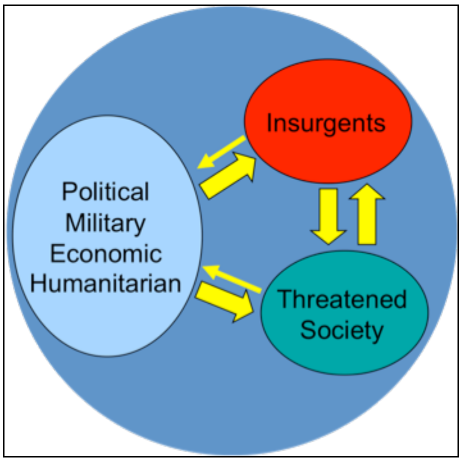

Figure 10: Threatened Society.

The modelling approach of ZETA is shown in Figure 11.

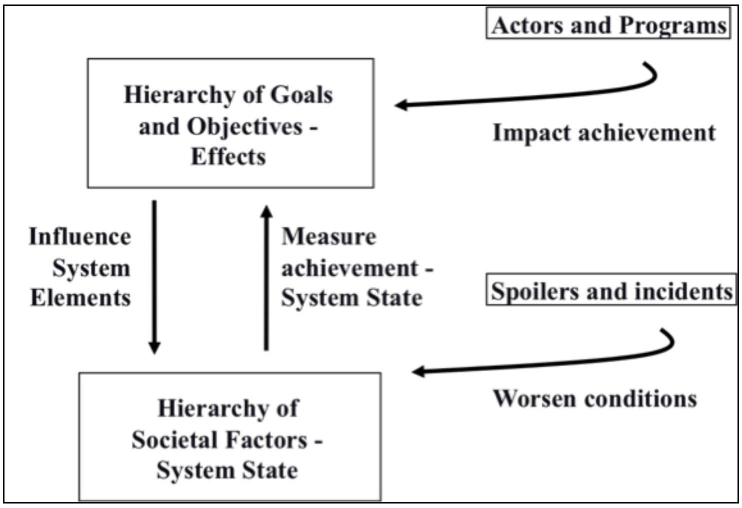

Figure 11: Modelling Approach in ZETA (see [6]).

The hierarchy of goals and objectives (effects to be achieved) represents a plan or Course of Action, which is intended to influence the system elements and therefore the system state. To make it work or to achieve the impact actors and programs (resources) have to be established. Actors can be NGOs, IOs, military units etc. Programs represent funded projects, which has an impact on the system state like World Bank Programs to develop the infrastructure. A hierarchy of societal factors represents the system state. In a typical conflict situation spoilers and incidents worsen the situation with their negative impact on the societal factors in order to reach their goals. The system state is monitored to measure the achievement of the hierarchy of goals and objectives.

The system state functionality value is derived from the values of its associated subsystems (societal factors) and their associated system elements. The societal factors for a specific scenario are derived using the MPICE (Measuring Progress In Conflict Environments see [7]) framework (see Figure 12).

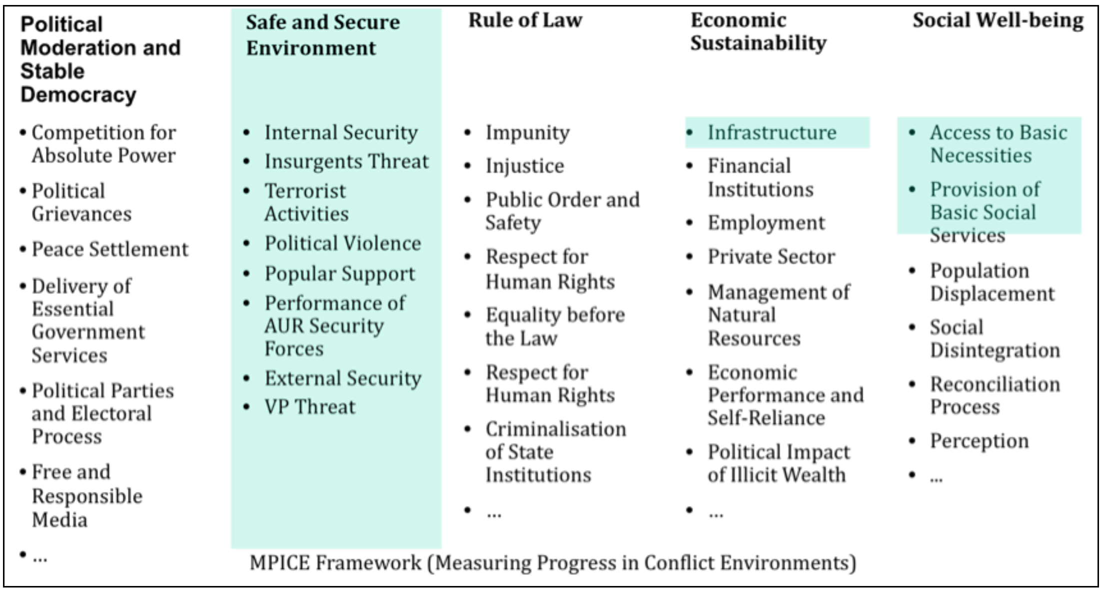

Figure 12: MPICE Framework (primary military functions in green).

To calculate the overall value of the system state Multi-Criteria Decision Making (see [8]) with a weighted sum of the societal sub-systems and elements is used. Each element has besides its weighting factor a so-called criticality, which represents its importance and non-substitutability for the functioning system. The system inherent recovery or degradation of system elements represents changes in the system value over time, which are not caused by direct actions or incidents (e.g. recovery of the economic system when not disturbed by spoilers and incidents).

The values of the system elements may be derived in one of three ways:

- As an analyst input (e.g. the initial input for the start state).
- As a calculated value based on an algorithm that incorporates the original value, the effect of spoilers and incidents against that system element and the weight, criticality and recovery or degradation values assigned to that system element (System Dynamics approach).
- As a linked value. The value of one system element may be linked to another system element value or to a value in the effects based plan model (e.g. if the objective of rebuilding critical infrastructure is properly resourced it can have a direct impact on the system element critical infrastructure).

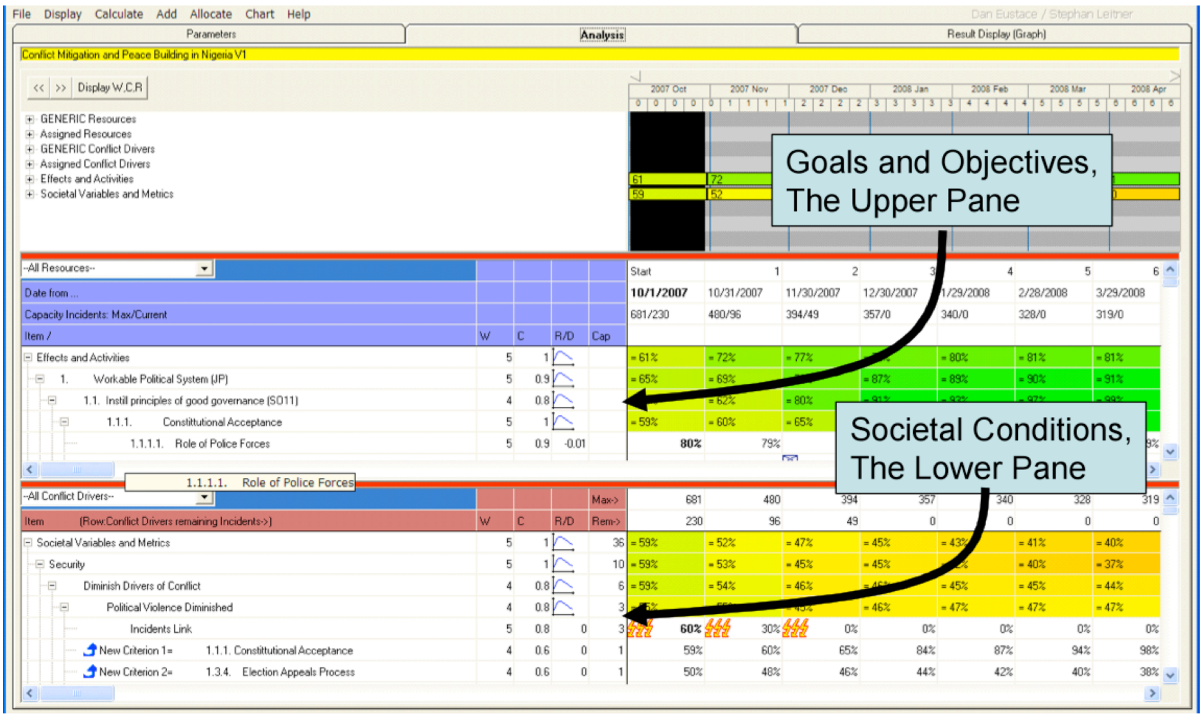

Figure 13: User Interface of ZETA

Figure 13 shows the user interface of ZETA with the goals and objectives and the system state or societal conditions. Figure shows the graphical output of ZETA. On a timescale the values of the system state, the sub-systems and the different system elements can be displayed. The user has the choice of which ones are displayed and in which colours. The timeline is normally measured in weeks. In

Figure a sample COA analysis with markers for relevant events (e.g. achievement of 75% of effect 001) is shown.

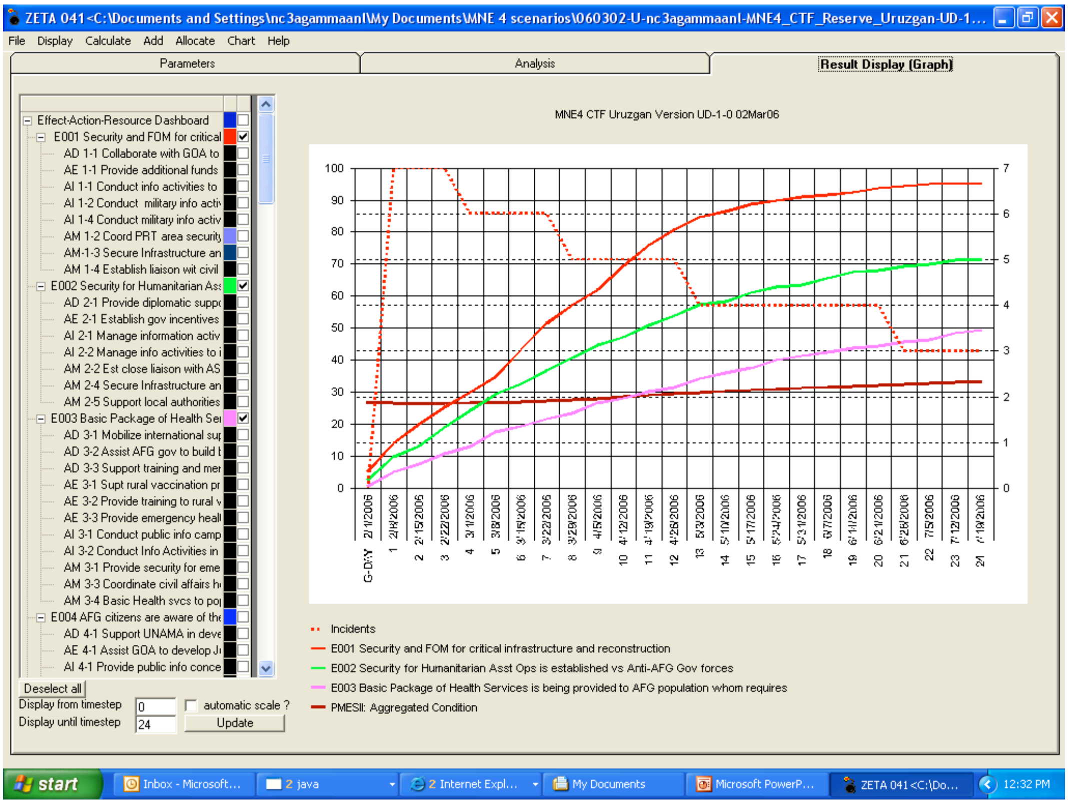

Figure14: ZETA Graphic Output.

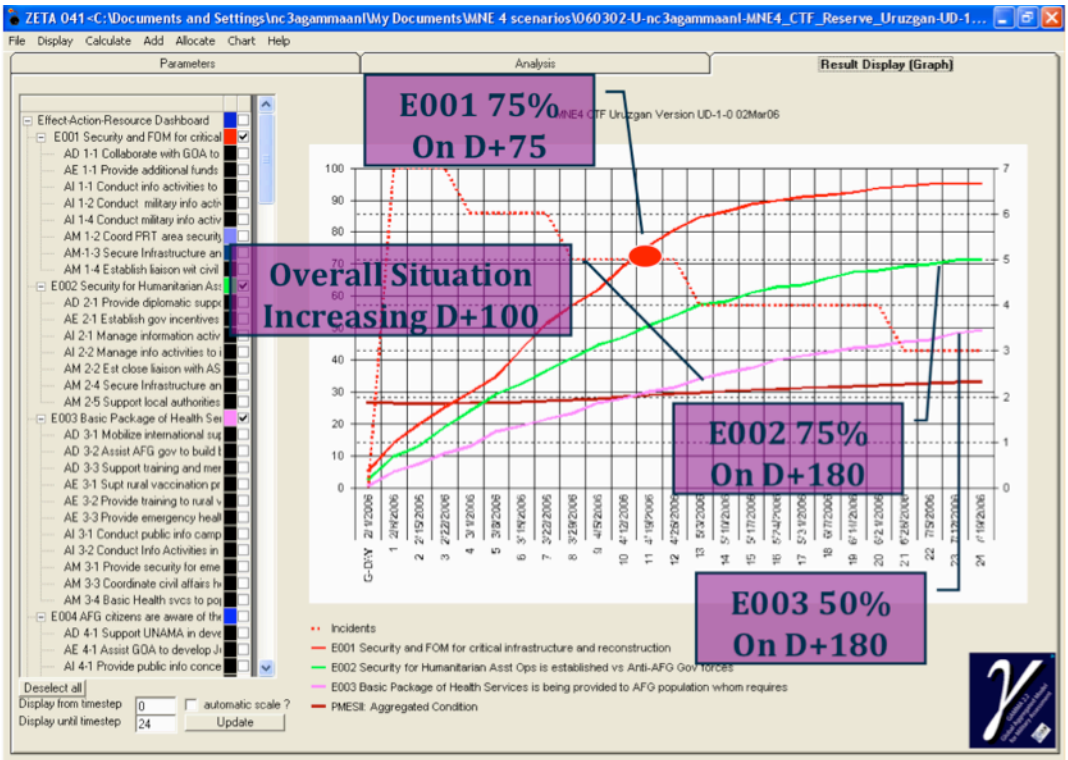

Figure 15: Sample COA analysis.

Currently six scenarios are modelled with ZETA:

- Virtual NATO Exercise Scenario (Zoran Sea Crisis).
- Farah Province in Afghanistan (for Multinational Experiment (MNE) 4 NRF).
- 5 South-West Provinces in Afghanistan (for MNE 4 CTF).
- Nigeria as Conflict Mitigation/Control Scenario.
- Chad as Peace Support Operation.
- Cerasia NATO Exercise Scenario (Horn of Africa with Virtual Countries).

Typical questions ZETA can answer are:

- When might the operational level military end state be achieved?
- What impact could the COA have on insurgents' activities?
- What might be the status of any effect, action, actor or element at any point in time?
- How have resources in the comprehensive approach been sequenced and utilized?
- Does the COA include sufficient and correct DIME resources in order to achieve the end state?
- Which DIME actions appear to have the most effect?
- Which societal factors and elements appear to be the most critical?
- How might different assumptions impact on the end state?

To answer these questions ZETA is very often used as facilitating tool for discussions with subject matter experts and decision makers to extract the relevant societal factors and their relevance. What-if analysis is very helpful in answering above questions.

USE OF GAMMA IN EXERCISES AND EXPERIMENTS

The GAMMA development started as part of the OA support to the NATO Operational Planning Course (OPC), which uses the Zoran Sea Crisis scenario. The module ZETA has been developed in a first version together with subject matter experts during this course and has then been tested and further developed in follow on courses also in cooperation with other nations (Canadian Forces College, German Armed Forces Staff College).

GAMMA has also been used in two experiments. The first was the Multinational Experiment 4 (MNE 4) and the second an experiment conducted by the US Defence Advanced Research Projects Agency (DARPA).

GAMMA IN MNE 4

Multinational Experiment 4 (MNE 4) was the fourth in a series of multinational experiments designed to test and validate Effects Based Approach to Operations (EBAO) concepts and tools. The MNE 4 participants were Australia (Observer), Canada, Finland, France, Germany, Sweden, The United Kingdom, The North Atlantic Treaty Organization (NATO) and the United States. The entire range of EBAO was tested including: knowledge-base development and Effects-based planning, execution and assessment. The exercise scenario was playing in Afghanistan (see Figure 16).

GAMMA was the chosen supporting tool for the assessment of Courses of Action (COA) and decision support. It was originally planned to use it in the Effects Based Planning (EBP) process. During the experiment it became clear that GAMMA could as well support Effects Based Execution (EBE) and Effects Based Assessment (EBA).

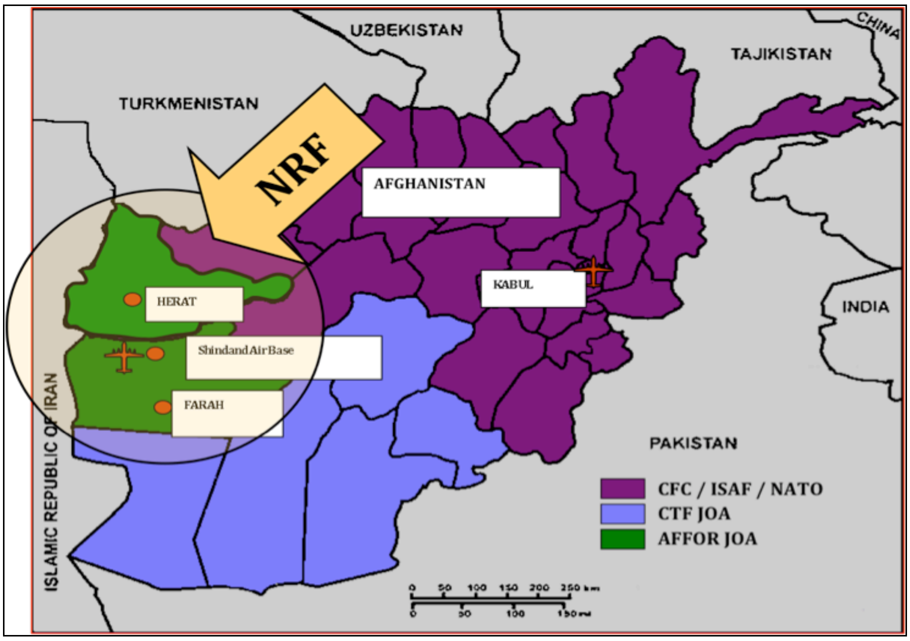

Figure 16: MNE 4 Scenario.

GAMMA was used in the OA cell, which was embedded in the Blue Planning Cell. The input data, which was needed for GAMMA, came from different sources (see Figure 17).

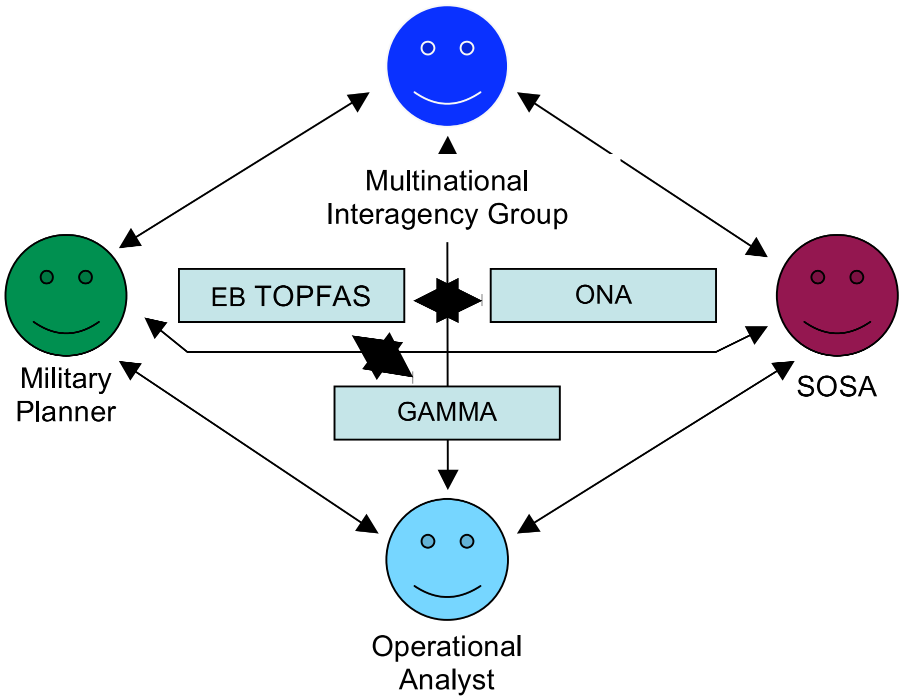

Figure 2: Use of GAMMA in Planning.

First the analysed and assessed scenario data from the knowledge base (System Of Systems Analysis (SOSA) data stored in the ONA (Operational Net Assessment) database and exported into EB TOPFAS (Tools for Operational Planning Force Activation and Simulation)) had to be put in. The ONA database is used by the SOSA analyst and is very detailed to allow him to do his analysis. It therefore includes much more data then needed for GAMMA (and even for the military planner). For GAMMA purposes an excerpt of this data with the most relevant information was needed. This was achieved by a manual filtering through the SOSA analyst who identified the most relevant information for the assessment of the operational plans. In this step he also added information based on his assessment, which is part of the analysis in GAMMA: the weighting of the relevant factors and an assessment about the substitution of specific factors.

Secondly the EB Plan had to be put into GAMMA based on the input from the military planner into TOPFAS and information from the Multinational Interagency Group regarding the comprehensive approach. The OA analysts participated in all relevant meetings personally or in the virtual workspace.

OA analyzed the plans using ZETA at specific points in the EBP process (e.g. in preparation of the wargame) as well as on an ad hoc base for an on demand analysis in due time. The presentation and discussion of the results was done in the form of PowerPoint briefings together with the military planner, who could use and did use the slides in their update briefings (see
Figure ***18*** as an example). Special questions to these briefings were answered online or in personal meetings. Additionally OA contributed to the virtual discussions on the virtual conference system IWS.

Conclusions and recommendations from the participation with ZETA as assessment tool in MNE 4 are:

- ZETA is very well suited to support the exercise setup by an analysis of the scenario setup regarding possible COAs and their effectiveness as well as options for opposing forces.
  - ➢ The setup of an exercise or an experiment should be supported by OA using an analysis tool to assess different option regarding aims and objectives of the experiment.
- The scenario setup and the user (OA) training are time critical.
  - ➢ The setup and the training have to start at an early stage.
- Assessment tools like ZETA can’t be used as Black Box. The setup and input into the system and the interpretation and communication of the results has to be done by an experienced OA analyst.
  - ➢ An OA cell needs to be embedded into the staff with connections to all relevant players.
- The validation of the used tools is very important for the acceptance of the assessment results by the planners.
  - ➢ For the validation of tools a budget and the support by subject matter experts has to be planned.
- Military – civilian interaction is essential for the comprehensive approach. The OA cell can help to facilitate by using tools like ZETA.
  - ➢ Exercises for the military – civilian operational planning using a comprehensive approach with OA participation should be set up.

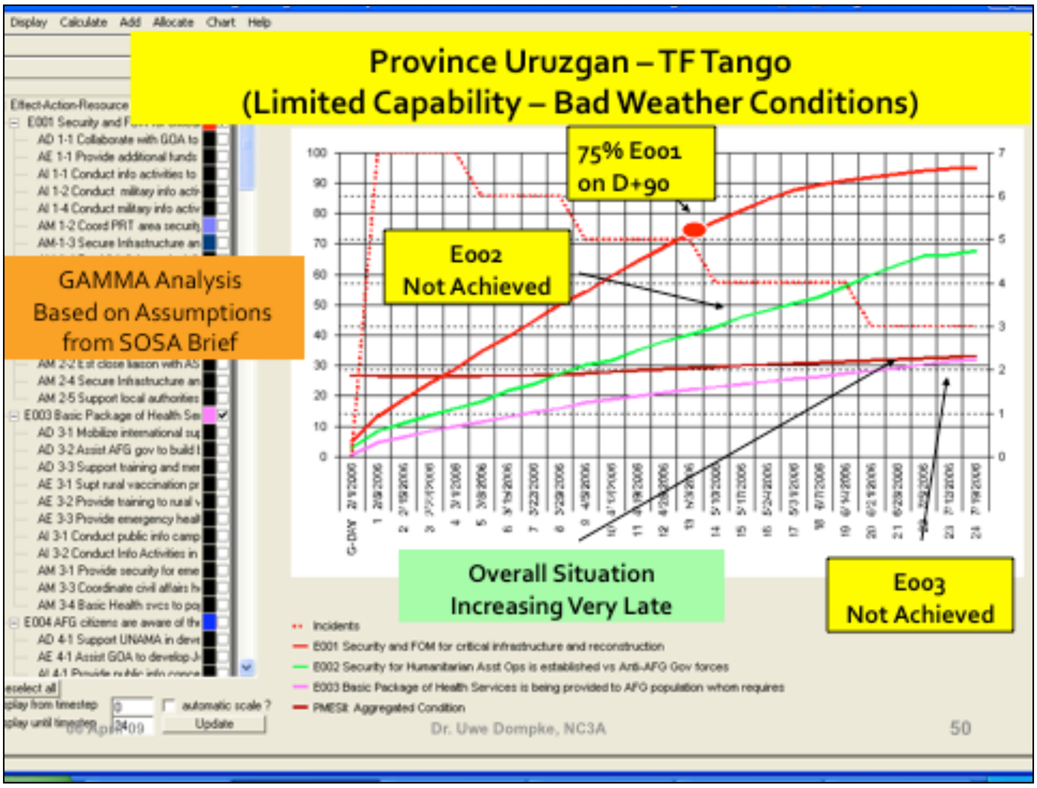

Figure 18: MNE 4 ZETA Analysis.

GAMMA AS PART OF THE DARPA CIVIL-MILITARY COLLABORATIVE PLANNING EXPERIMENT

GAMMA was part of the Integrated Battle Command Program (IBC) of DARPA as one of the exploration tools (see Figure).

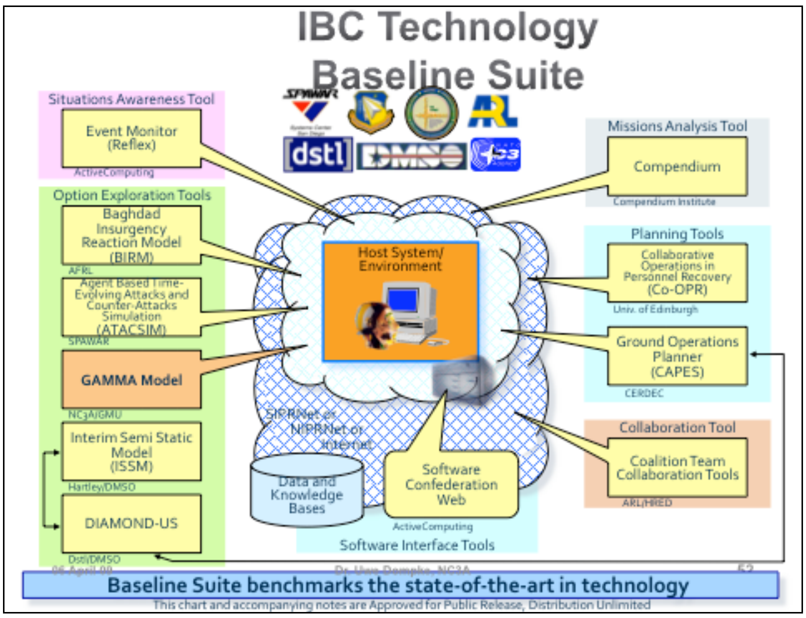

Figure 19: DARPA Integrated Battle Command (IBC) Program.

In the first phase of this project ZETA was used to facilitate the development of a sub-Saharan scenario (Nigeria) under the lead of George Mason University (Prof. Dave Davis, see [6]). In several workshops with subject matter experts from different organisations (see Figure) relevant scenario factors were identified which could be used as an input for ZETA. That way a database with effects and activities, organizations, programs and spoilers, societal variables and metrics, as well as an incident database were developed and in a prototype version of ZETA integrated.

Participating Organizations in Nigeria Scenario Development

ACDI/VOCA	Embassy of Nigeria	SAIC
ACSS	GD (JFCOM)	STA
ACT	GMU/POPP	USAID DCHA/DG
Active Computing	GMU/ICAR	USAID/CMM
AFRL	GMU/SPP	USAID/JS
Alion (JFCOM)	IFES	USIP
CAA	JFCOM	
COE	Logostech	
Consultant	NC3A	
DOS/CRS	NDU	
DARPA	SAIC	

Figure20: Participating Organizations in Nigeria Scenario Development.

One result of the project was that the GAMMA scenario development as used in the process facilitates very well the knowledge development with a heterogeneous group of subject matter experts.

After the scenario development effort the Saharan Sentinel Experiment was conducted.

Figure represents the structure of the experiment as it was set up. The experimental objectives were to assess the ability of a software connectivity tool to manage the interplay between traditional battle models (EAGLE) and planning tools (CAPES) with societal dynamics models such as ZETA and the use of assessment tools to support the decision-making in a military – civilian environment (now comprehensive approach). The technical part of the experiment with using CoWeb (Software Confederation Web) as interface tool ran very well. Planning results from CAPES and ORBAT information from EAGLE could be transferred over the Internet to GAMMA and could be used in ZETA[3].

The scenario for this experiment was changed to a peace support operation in the Lake Chad region on short notice as part of the experiment setup. The scenario development for ZETA was done with the Senior Mentor Len Hawley (ret. Undersecretary of State Department) and a former US Ambassador of Chad as subject matter experts. Both were impressed with the ability of ZETA to represent the geo-political situation in the scenario. They said that they got invaluable insights into the situation from the discussions with the OAs during

[3] In this experiment a stand-alone version of ZETA was used, whose functionality is now integrated into GAMMA.

the scenario development. ZETA worked very well in facilitating this process. The time for fully using ZETA for an assessment of different courses of action was too short, but the results with the not in full fidelity developed knowledge base were promising.

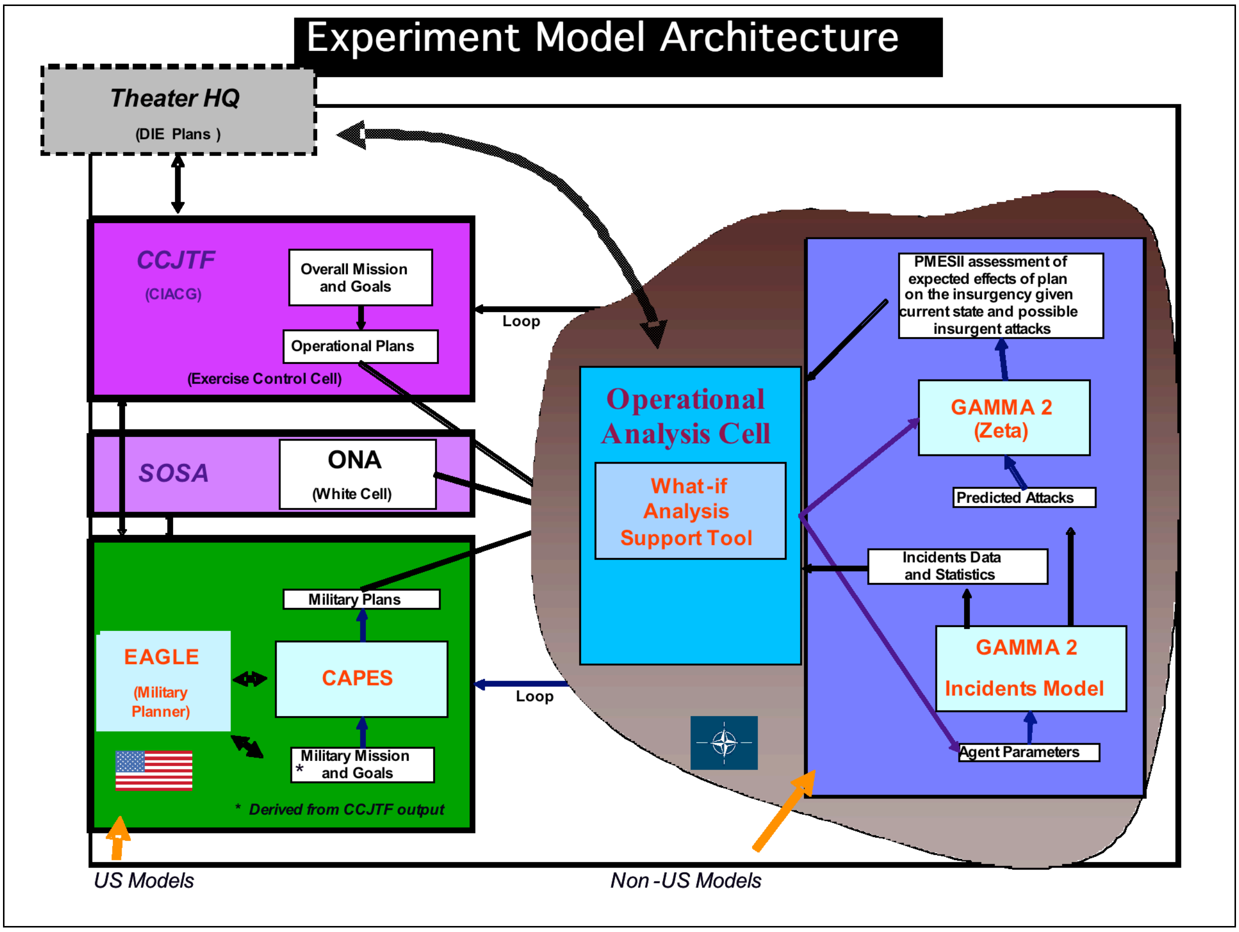

Figure 21: Saharan Sentinel Experiment Structure.

SUMMARY

As the experience with GAMMA and ZETA has shown, Analysis of Societal Conflict and Counter Insurgency can be supported by Modelling and Simulation, but not without interpreting and communicating results of the analysis to the decision-maker. Experienced Operational Analysts are very important in this process and can add great value to the decision-making process.

A major finding is further that these kind of tools could very well be used to facilitate discussions with subject matter experts and decision-makers to extract relevant factors and their interdependencies with the result that especially the decision-maker is aware of his own assumptions about the situation.

When quantitative results from the simulation are used to support the decision process the validation of the model is essential for the decision-maker to trust the advice. Validation is "the process of determining the degree to which a model and its associated data provide an accurate representation of the real world from the perspective of the intended uses of the model"[4] In "GAMMA Validation Concept" (see [9]) George Akst's approach (see [12]), interpreting Bob Eberth, "… validation is the failure to invalidate after a concerted effort." is recommended for the validation of GAMMA. This definition implies that "… validation is ascertaining that the results are "plausible," …" He goes on to identify three other requirements for this plausibility: 1) The results must be reasonable, 2) changes in the inputs must produce logical changes in the outputs, and 3) unexpected results can be explained. Although Akst is careful to restrict his comments to analytic combat simulations they can be extended to the asymmetric domain as well.

In the validation concept for GAMMA are validation events and decisions with responsibilities by stakeholders defined (see

Figure). The concept closes with the recommendation on the structured use of subject matter experts in validation board meetings to facilitate a full validation and not just a face validation.

Validation Events and Decisions	Users	Developers	Boards
Define M&S Requirements	P	S	
Set scenarios to be used	P	S	
Identify board membership	P	S	
Collect scenario data	S	P	
Revie w scenarios	S	S	P
Conduct simulations		P	
Report and brief on simulations	S	P	
Review simulation outcomes	S	S	P
Identify required excursions and sensitivity runs	S	S	P
Conduct excursions and report on outcomes		P	
Conduct final review of excursions			P
Make validation determination			P
P: Primary responsibility, S: Supporting			

Figure 22: Validation Events and Decisions.

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