Modelling & Simulation of Asymmetric Operations to Support Operational Planning

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ABSTRACT

Recent changes in world wide political and military groupings require NATO to maintain a capability for carrying out new types of operations as in the case of Bosnia, Kosovo or Afghanistan. Consequently, operational analysis support tools have to keep up with these new challenges and be able to map and analyze the characteristics of the new types of scenarios, the most significant of which are:

- *Strong interdependencies of military and non-military issues*
- *Multinational (including Non-NATO) operations*
- *Multi-faction conflicts*
- *Low intensity conflict and asymmetric operations*
- *Tasks other than (traditional) military tasks*
- *Severe political constraints on military (or non-military) operations*

NC3A supported by Newman & Spurr Consultancy is developing tools to deal with these new requirements to support individual training and operational planning.

The paper will describe a basic approach to build a system based on an open architecture (GAMMA (Global Aggregated Model for Military Assessment). All interacting objects such as military units, assets, geographic objects and 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 any program changes. All objects in the system can act as intelligent agents. A powerful newly developed order interpreter allows a flexible and user friendly input of strategies and orders to control the dynamic behaviour of the agents which can change during a simulation based on events and the outcome of interactions (e.g. collateral damage, information operations or psychological operations). Another newly developed feature is a statistics manager. This statistics manager can be used to display and analyse the results of a simulation run. It is very flexible and extendible to allow analysing the impact of specific recorded events (e.g demonstrations, riots, sniper attacks, demolishing of critical infrastructure) on parameters like the stability of a government. A prototype for a proof of concept of a model to describe the impact of events on a government's stability called ZETA (Zoran Sea Crisis Effects-based Tool for Analysis of Asymmetric operations) has been developed by NC3A and the Canadian Forces College.

Paper presented at the RTO NMSG Symposium on "Modelling and Simulation to Address NATO's New and Existing Military Requirements", held in Koblenz, Germany, 7-8 October 2004, and published in RTO-MP-MSG-028.

1.0 INTRODUCTION

Recent changes in world wide political and military groupings require NATO to maintain a capability for carrying out new types of operations as in the case of Bosnia, Kosovo or Afghanistan. Consequently, operational analysis support tools have to keep up with these new challenges and be able to map and analyze the characteristics of the new types of scenarios, the most significant of which are:

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NC3A supported by Newman & Spurr Consultancy is developing tools to deal with these new requirements to support individual training and operational planning.

The paper starts with a short description of the new and existing military requirements concentrating on operational planning in an asymmetric environment. It will then describe a basic approach to build a system based on an open (component-based) architecture (GAMMA (Global Aggregated Model for Military Assessment). All interacting objects such as military units, assets, geographic objects and 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 any program changes. All objects in the system can act as intelligent agents. A powerful newly developed order interpreter allows a flexible and user friendly input of strategies and orders to control the dynamic behaviour of the agents which can change during a simulation based on events and the outcome of interactions (e.g. collateral damage, information operations or psychological operations). Another newly developed feature is a statistics manager. This statistics manager can be used to display and analyse the results of a simulation run. It is very flexible and extendible to allow analysing the impact of specific recorded events (e.g. demonstrations, riots, sniper attacks, demolishing of critical infrastructure) on parameters like the stability of a government. A prototype for a proof of concept of a model to describe the impact of events on a government's stability called ZETA (Zoran Sea Crisis Effects-based Tool for Analysis of Asymmetric operations) has been developed by NC3A and the Canadian Forces College.

2.0 NATO'S NEW AND EXISTING MILITARY REQUIREMENTS

Admiral Forbes, Deputy SACT gave a statement at the CNAD Meeting on 6 May 2004 ([1]). He sees the achievement of Coherent Joint Effect, Decision Superiority and Joint Deployment and Sustainment as the key themes for transformation. Modelling and Simulation can play a major role to help to achieve them. The operational planning process (OPP) is starting point for all operations in NATO. The OPP plans the joint deployment and sustainment and plans for a coherent joint effect in the course of action. Decision Superiority plays not only a role in the operation itself but also already in the planning phase. M&S with the possibility to analyse different courses of action can help to achieve decision superiority.

All NATO operations are now performed in an asymmetric environment. M&S has to offer new models and tools that are suited to model and analyse the new environment.

2.1 NATO Operational Planning Process

Even in the new security environment with diplomatic and political strategies military power can't be ruled out and is often necessary to back up diplomacy by the threat of force. Military operations in that

respect will always be joint and combined (multinational). The planning of such missions on the operational level has to be done in the multinational environment bringing different cultures with their planning approaches and traditions together. NATO has established Guidelines for Operational Planning (GOP) that are made to support the Joint Multinational environment in which NATO operates (see figure 1 for an overview on the Operational Planning Process).

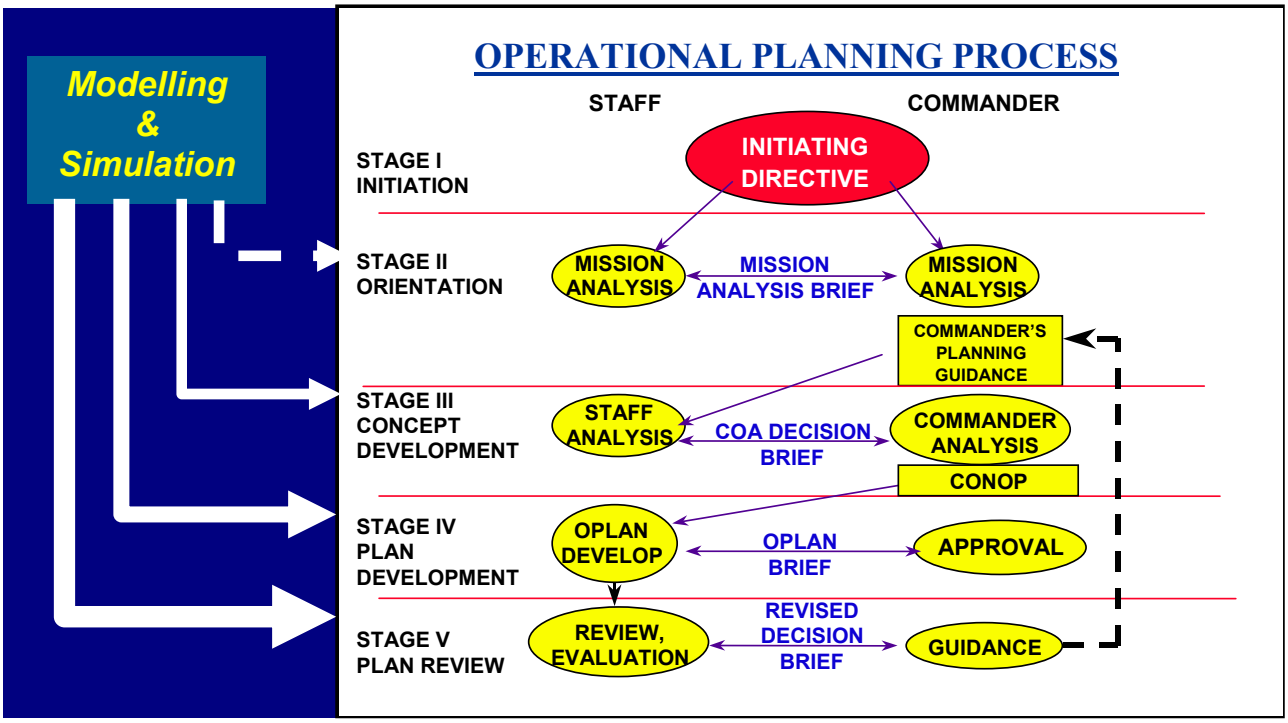


Figure 1: Operational Planning Process

The different stages in the OPP can be supported by M&S., where the level of support increases over the stages. In the orientation stage with the mission analysis M&S can help to identify the right problems. In this phase the "how" to solve the problem is not tackled. This starts in the next phase, the concept development. Here M&S can be very supportive. In this stage are fast running highly aggregated models needed because of time constraints. In the plan development and the review and evaluation more time is available and needed for a more substantial checking of the plans against risks. M&S can play a major role in this.

2.2 Asymmetric Warfare

Asymmetric warfare can be defined as "Conflict deviating from the norm, or an indirect approach to affect a counter-balancing of force." (David L. Grange - National Strategy Forum). Asymmetric warfare is best understood as a strategy, a tactic, or a method of warfare and conflict.

Following asymmetric operations are part of an asymmetric doctrine:

- 'Counter-Will' Operation
- 'Counter Access' Operation
- 'Counter Precision Strike' Operations

- 'Counter Protection' Operations
- 'Counter Information' Operations

These kinds of operations have to be analysed by M&S tools. At the moment not very many tools are available, but in the nations and also in RTO are several activities underway (e.g. MSG-024 on M&S support to Non-Article 5 Operations or SAS-053 on a Virtual Institute for Human Behaviour Representation).

3.0 REQUIREMENTS FOR THE M&S SYSTEM

As seen above M&S must support the analysis of effects in operations and not just give some details about the sequence of an operation. At this point it becomes clear that classical simulation systems that are used as exercise drivers don't have this ability.

Another important point is that simulation systems for an asymmetric environment must deal with a big spectrum of possible applications that can range from movement to force-on-force events, or terrorist and guerrilla activities with their impact on the stability of a government. Also the activities of NGOs/IOs and all activities in the area of civilian military cooperation have to be looked at. This means that the simulation system must provide one graphical user interface and one data interface that can be used by all different modules. To simplify developments the simulation system should provide an object repository, an event handling system and a statistics package. All this can be best implemented in a component-based architecture.

4.0 GLOBAL AGGREGATED MODEL FOR MILITARY ASSESSMENT (GAMMA)

GAMMA is developed by NC3A together with Newman and Spurr Consultancy and is used now in the operational planning courses at NATO School Oberammergau and by different nations. Reference 2 and 3 gives more information about the GAMMA development.

4.1 GAMMA as a component-based system

GAMMA is a Component-Based System with the following modules:

- Administration and Application
  - Simulation Manager
  - Application
  - System Utilities
  - Help
- Graphical User Interface
  - Graphical Display System
  - Coordinate Manipulation
- Object Management
  - Object Store
  - Gamma Annotations

  - Gamma Elements
  - Gamma Networks
  - Gamma Regions
- Statistics
- Data Provision
- Event Handling Models
  - Incident Model
  - Intelligence Model
  - Lanchester based Interaction Model
  - Aggregated air war model
  - Movement Model
- Order System

Figure 2 shows the GAMMA object repository. All newly developed models can reuse existing definitions and exchange information with already existing modules. This feature allows a rapid development of new tools. E.g. the implementation of a movement model for the intelligent agents could reuse the existing networks in GAMMA.

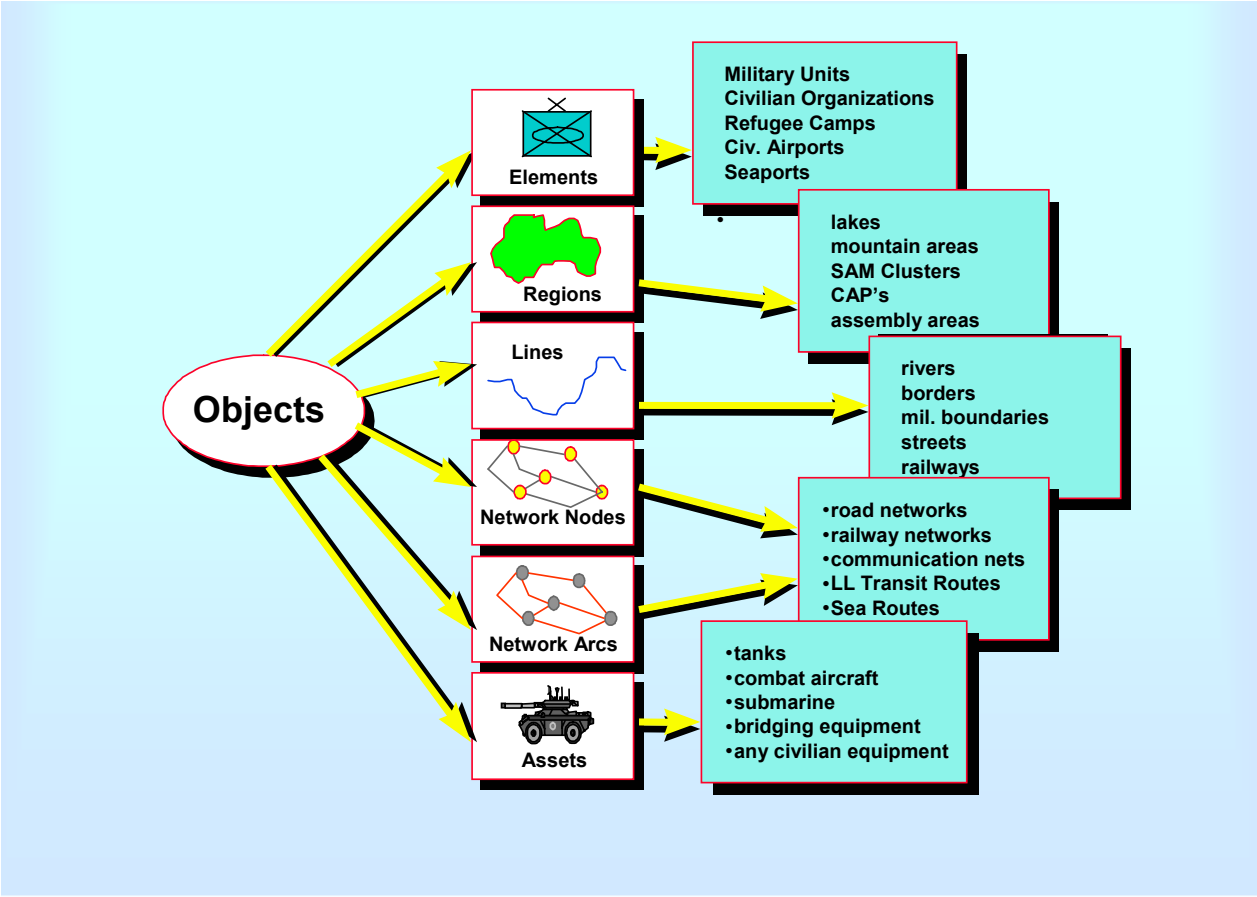


Figure 2: GAMMA Object Repository

4.2 Independently Acting Agents

New multi-sided low intensity conflict scenarios are now used in NATO and in the nations in exercise and training as well as for analysis. These kinds of scenarios need a different simulation support than attrition based high intensity conflicts. An independently acting agents model was integrated in GAMMA to give support for such scenarios. Results are shown for a fictitious scenario called the Zoran Sea Crisis Scenario.

In GAMMA all objects (e.g. terrorist/paramilitary groups and groups of local civilian population) are represented as agents. They have their own goals, a memory function and interact with the environment. The Allied Forces are controlled by conditional rules, which can also use a memory function as a parameter of the forces.

Agents in GAMMA are elements with special properties that enable them to act independently (see Figure 2).

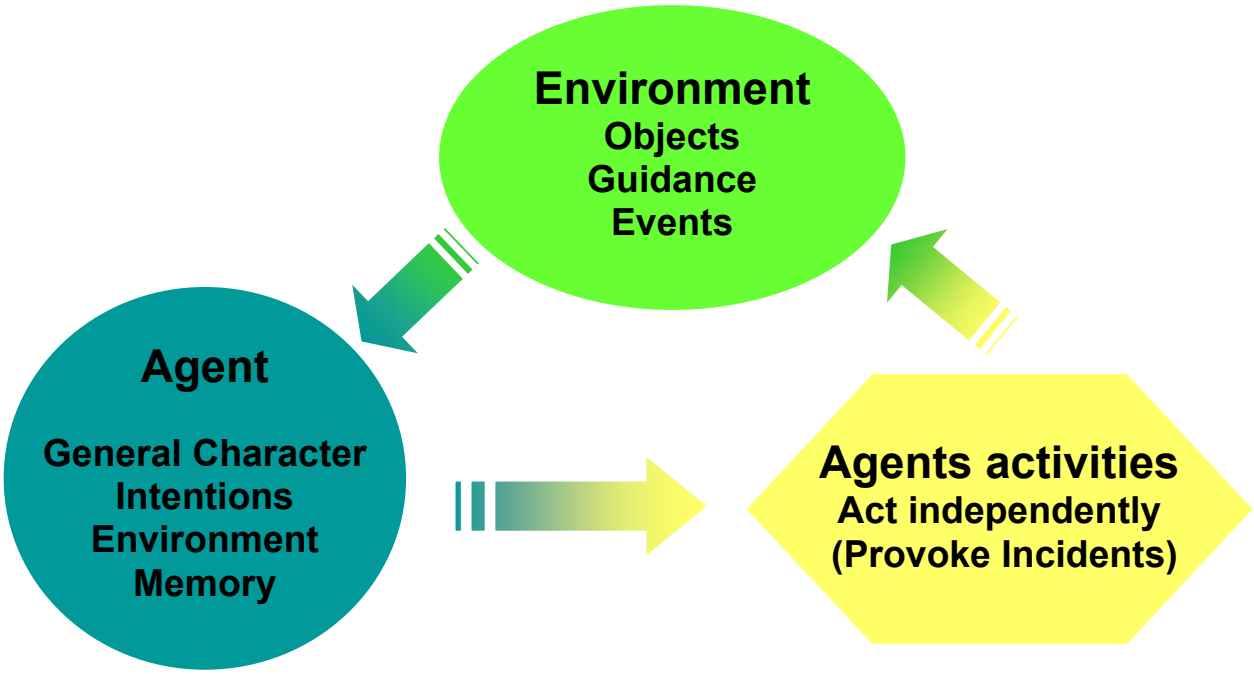


Figure 3: Independently acting agents

Whether or not and how agents act depends upon:

- their general character
- their intentions
- their current state and
- the environment.

The agent's general character determines what kind of activities he is ready to perform in principle. This general character is described by:

- Morality level
  (0 <= moral level <= 1; 0 = criminal, 1 = saint)
- Readiness to risk

Their intentions are described by:

- political interest
- military interest
- economic interest
- ecological interest
- psychological interest
- interest in serving own benefit

The current state of the agent is described by his agitation level, this is his readiness to initiate activity. Each activity initiated by an agent presumes that the respective agent has an agitation level that allows him to perform such an activity. The needed agitation level to do a bomb attack is e.g. higher than the one needed to initiate a demonstration. The agitation level of an agent is dependant on his activities he has done in the past (e.g. after doing a bomb attack his agitation level will go down and it takes some time that he will recover to build up his agitation level again) and dependant on events that happened to him in the past like meetings with patrols.

Agents can create certain type of incidents, incidents types can be user defined for a specific scenario. Examples are:

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

Incidents have a target object, this can be:

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

Figure 4 shows how they are represented in the GAMMA user interface.

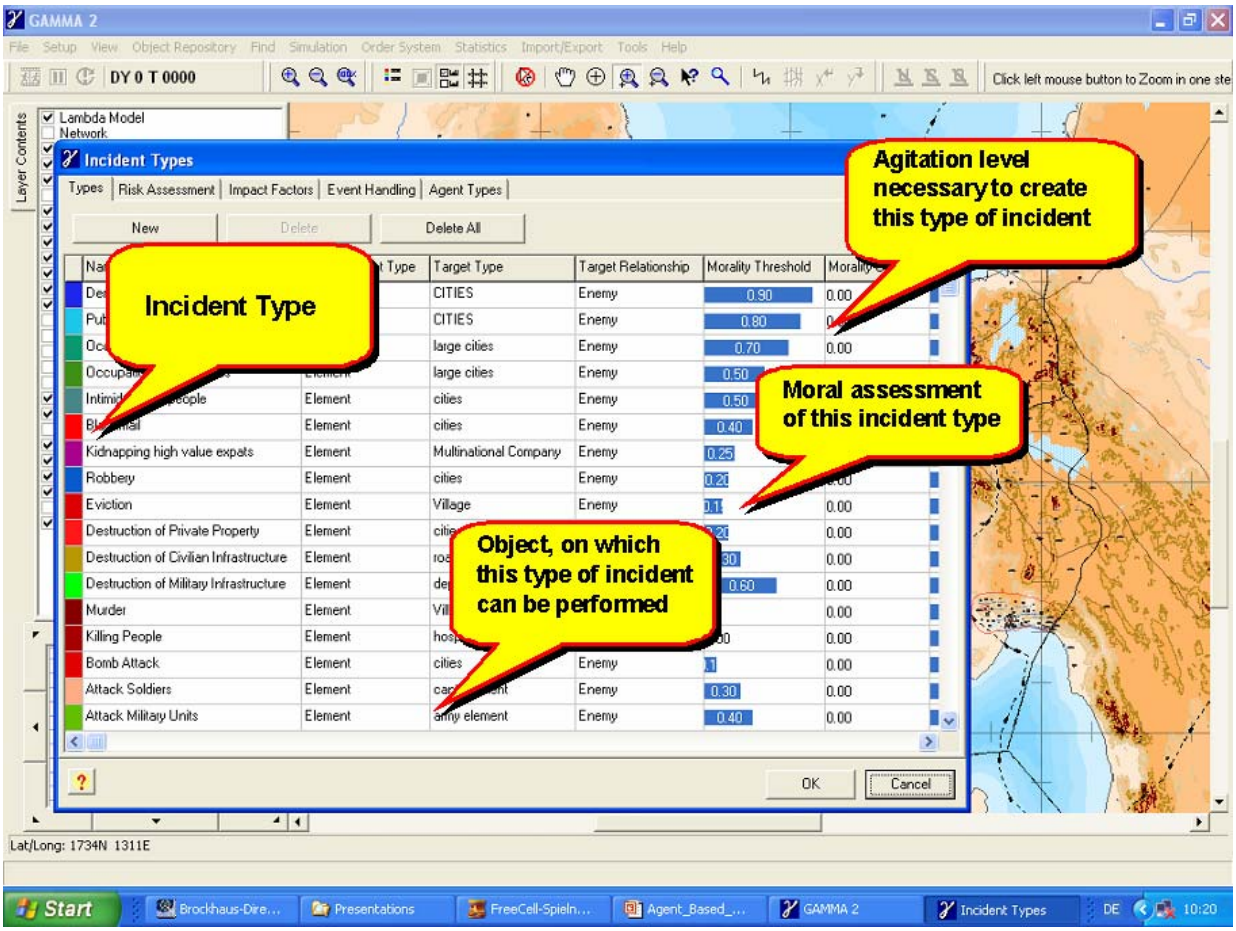


Figure 4: Incident types

For each incident a moral and agitation level that must be met by an agent to provoke an incident are combined. In addition, for each incident an impact on the political, military, economical, ecological, and psychological situation is given which is used to determine the interest of the agent and the outcome of the incident on the situation. Figure 5 shows the impact of the incidents.

As well as these internal influences the actions of other parties like patrols and checkpoints also have an impact on the memory of the agents and the generation of incidents in a specific situation. The model works on the following basic assumptions and descriptions of the elements in a way that for each step:

- the movement of the agent to a specific location where he can act in regard to his interest is determined and
- the potential generation of incidents when an agent arrives at some location is checked, taking his characteristics and the environment (e.g. patrols or checkpoints) into account

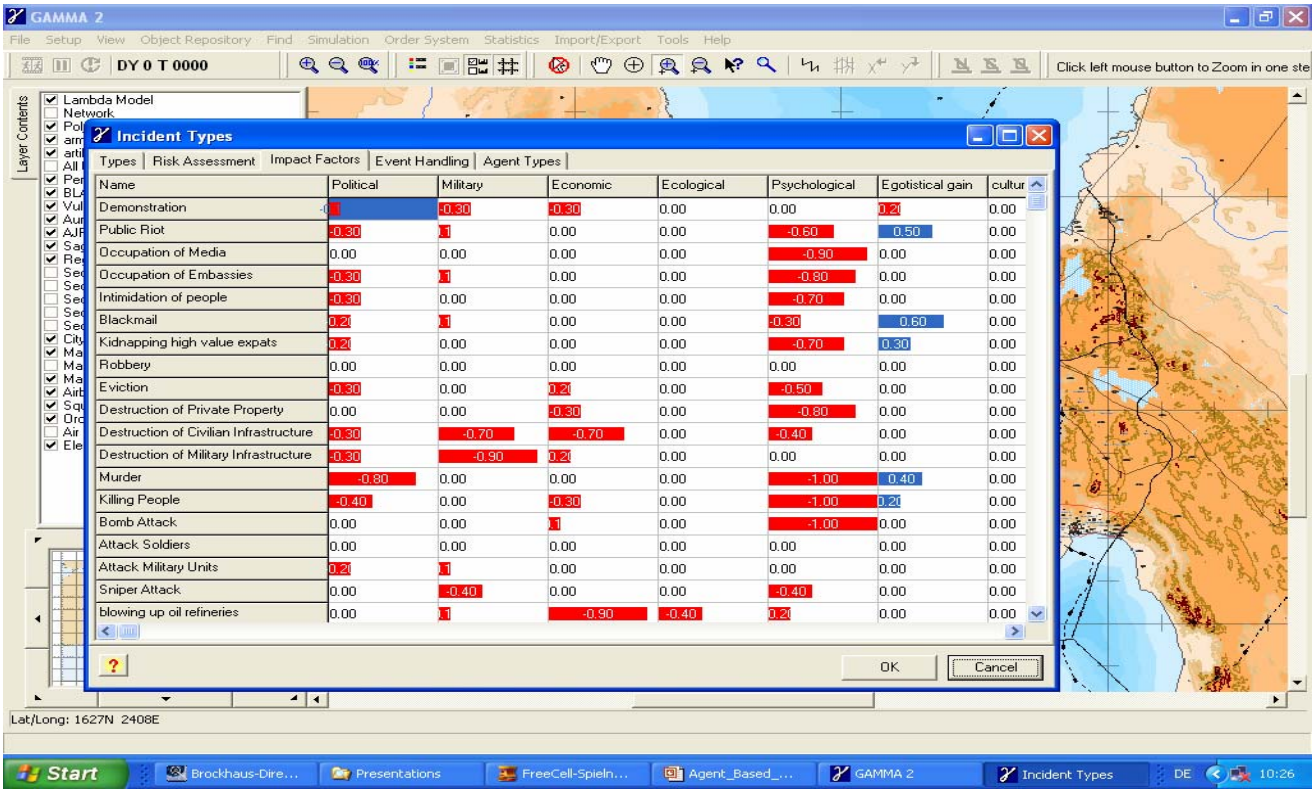


Figure 5: Impact of incidents

The movement of agents can be done in 3 different ways:

- The agent can move randomly cross-country (see figure 6).
- The agent is using the road network, preferring least recently visited routes (see figure 7).
- Moving on roads to an objective, using shortest path (see figure 8)

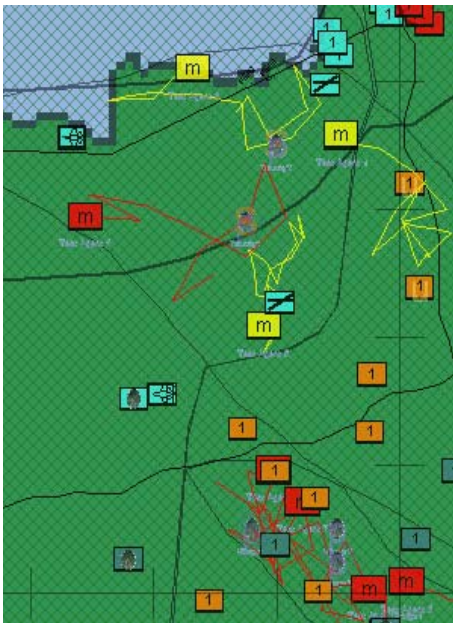


Figure 6: Agent moves cross country

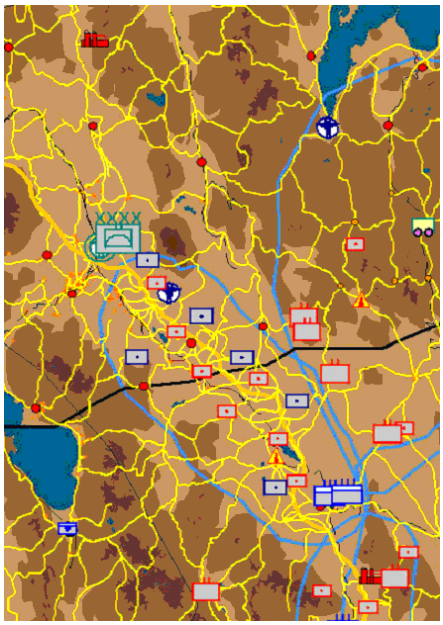


Figure 7: Agent is using the road net, preferring least recently visited routes

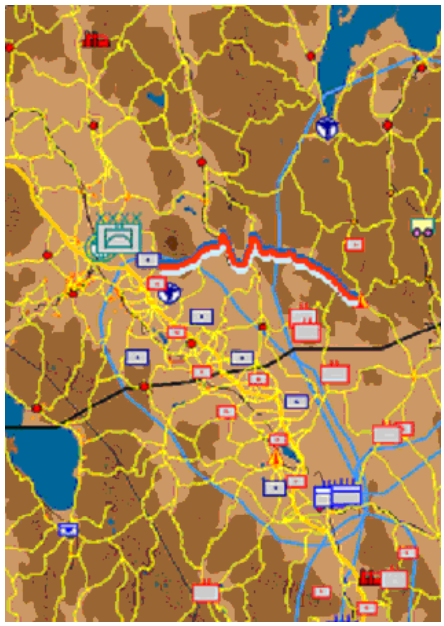


Figure 8: Agent moving on roads to an objective, using shortest path

When the agent arrives at a location a list of possible incident types is complied. First, a subset of incident types is generated from the list of all possible incidents types based on those:

- For Which Suitable Victims are Available,
- The Risk is Below the Agents Accepted Risk Threshold,
- The Moral Quality is Equal or Higher Than His Moral Level,
- The Required Agitation Level is Equal or Less Than His Current One

Then the priority is calculated based on the intention of the agent, the risk and the agitation level. The incident with the highest priority will be generated. The Incidents model records the incidents that are generated and shows the results in a user configurable form within the statistics package. GAMMA allows the incidents model to generate incidents by raising an event within the simulation manager component; this allows possible extension for the future.

The GAMMA intelligent agents were used with the Zoran Sea Crisis scenario. Here are some results.

Figure 9 shows the area around a major city called Capella with some intelligent agents and some infrastructure objects.

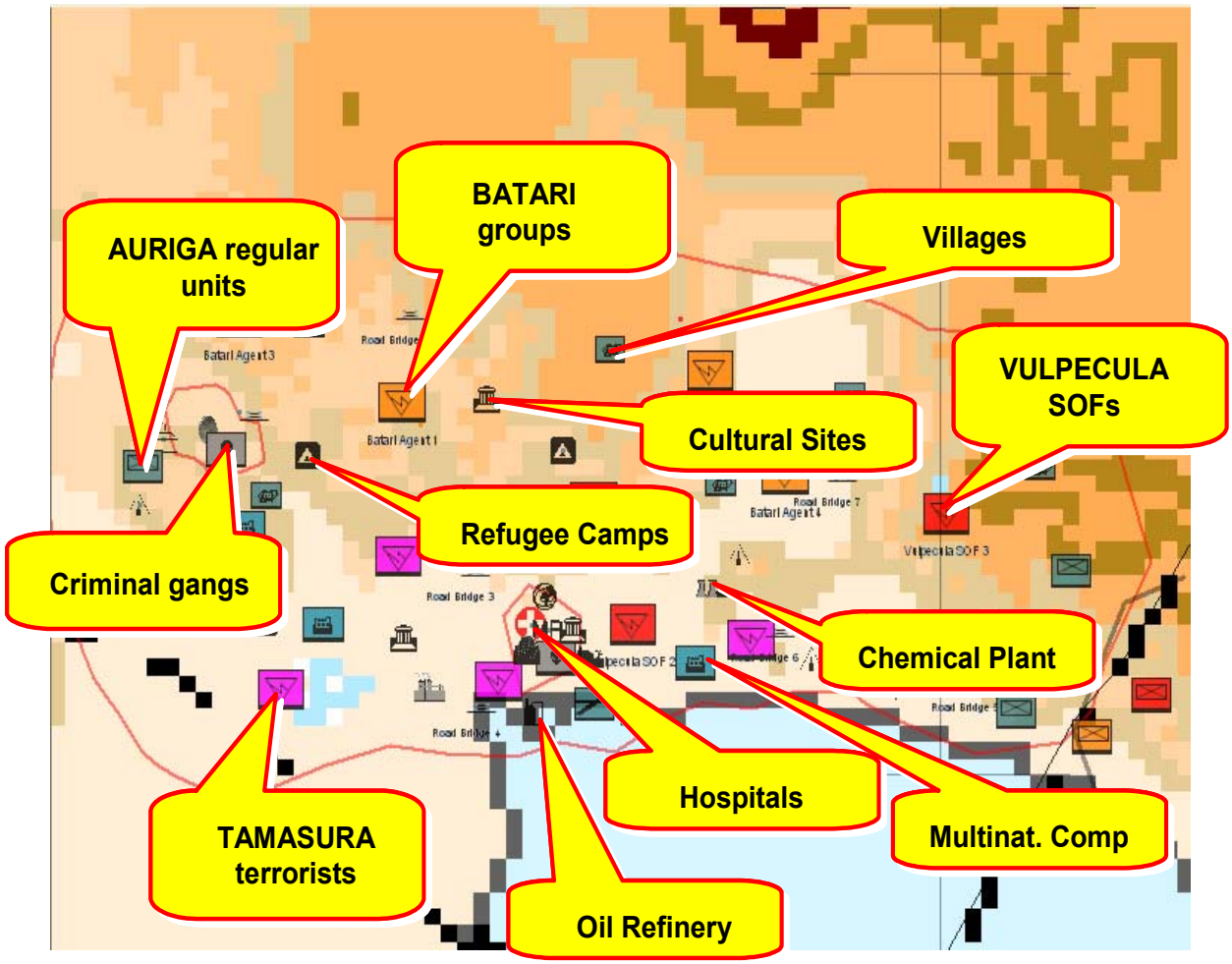


Figure 9: Intelligent agents around Capella

Figure 10 and 11 show results from the simulation. In the case of allied patrol fewer incidents happen. Especially no murder or killing incidents are happening.

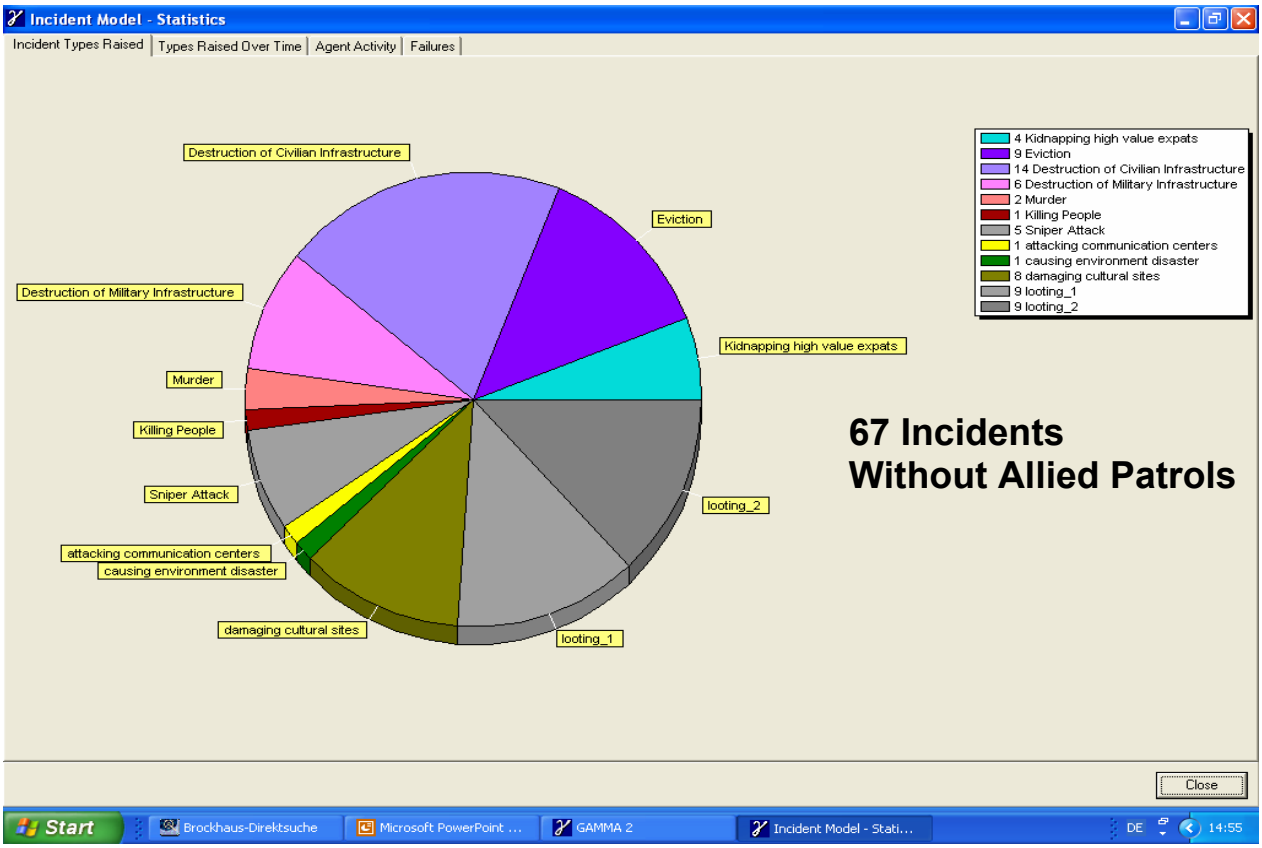
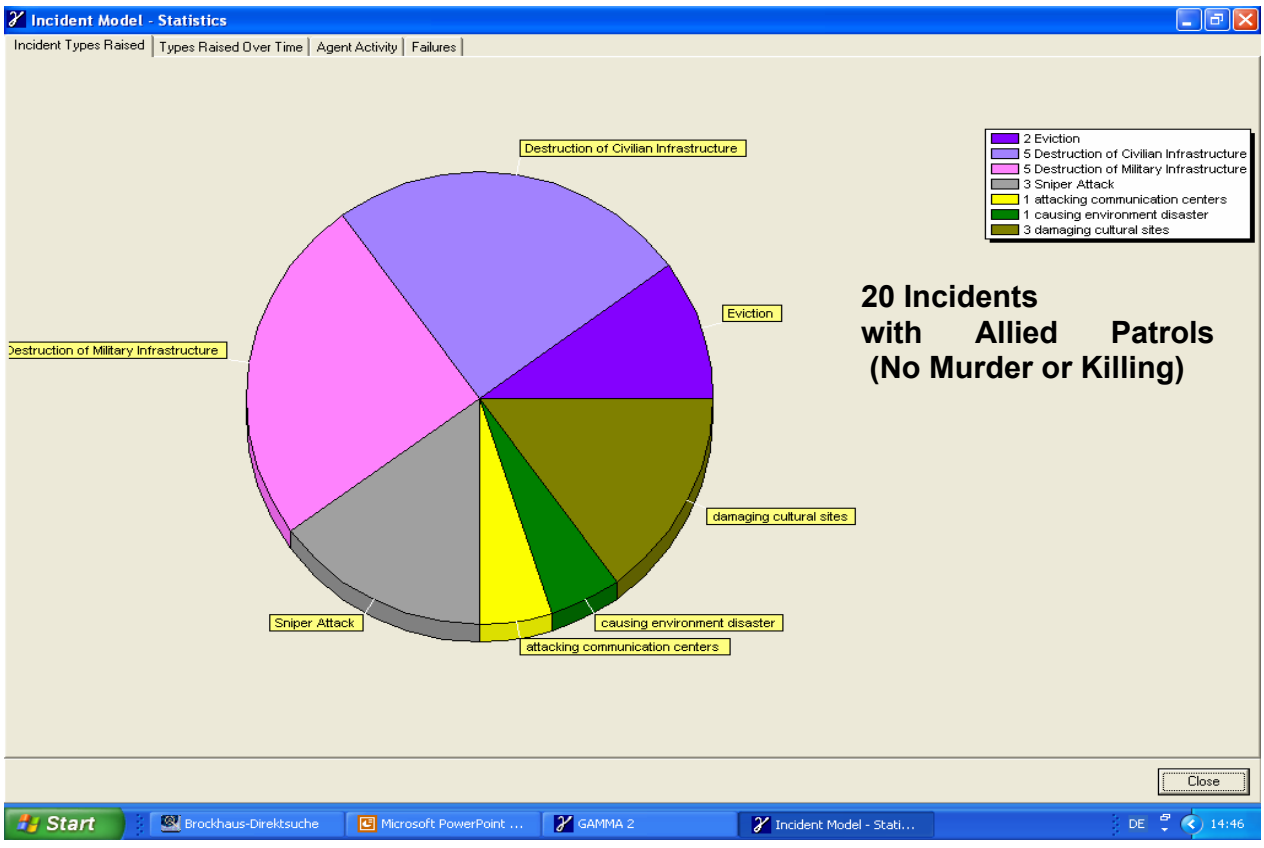


Figure 10 and 11: Incidents without and with allied patrols



GAMMA allows a dynamic change of agent's properties during the simulation. Reasons for a change could be:

- 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

The following results are achieved under the assumption that the arrival of allied troops in the ZORAN SEA Area would activate the TAMASURA terrorists and make the BLA fighters more unscrupulous (figure 12 and 13).

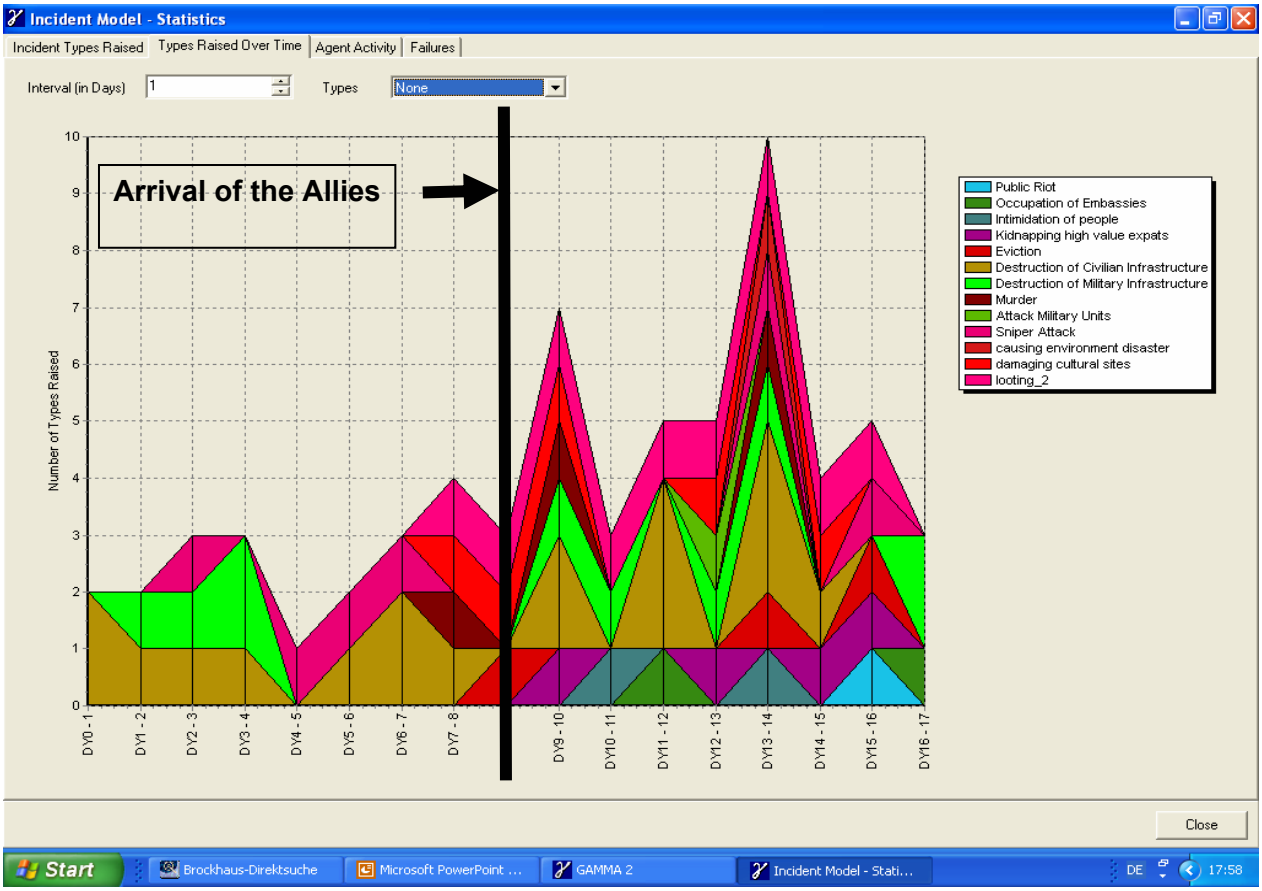


Figure 12: Change of incidents after arrival of allied forces

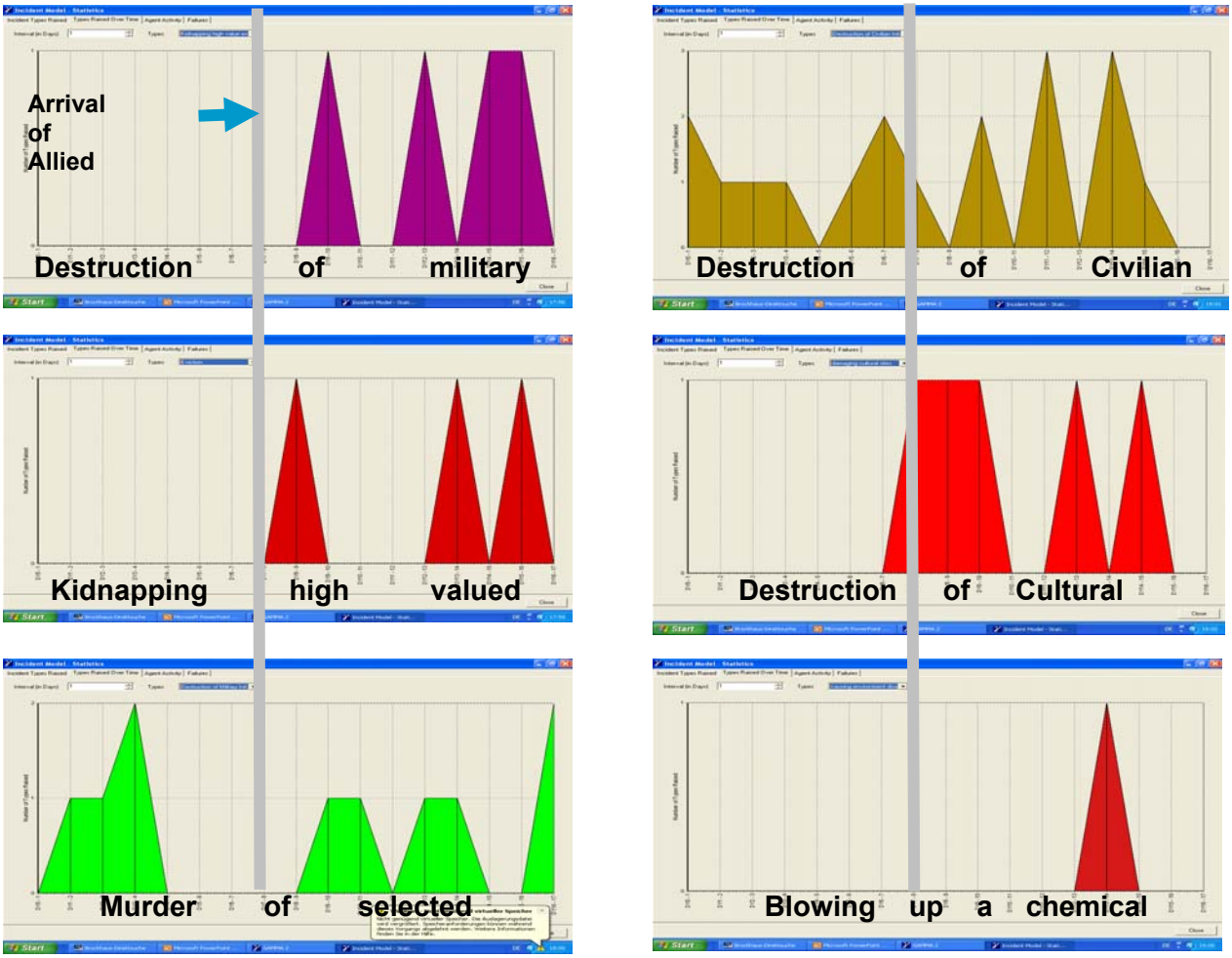


Figure 13: Change of incidents type after arrival of allied forces

4.3 Analysis of the Stability of the Aurigan Government

In the Zoran Sea Crisis scenario is the stability of the Aurigan government a very important factor. The stability is threatened by terrorists and non-state actors (BLA) which are supported by covertly operating special forces. Allied forces are deployed to stabilise the region.

In a first simple model the relationship between

- The stability of the AURIGAN government
- The capacity of the BLA/VP Special Forces (SOF) to mount attacks in AURIGA
- The effectiveness of the ALLIANCE COA in terms of impacting BLA/VP SOF capacity is portrayed (see figure 14).

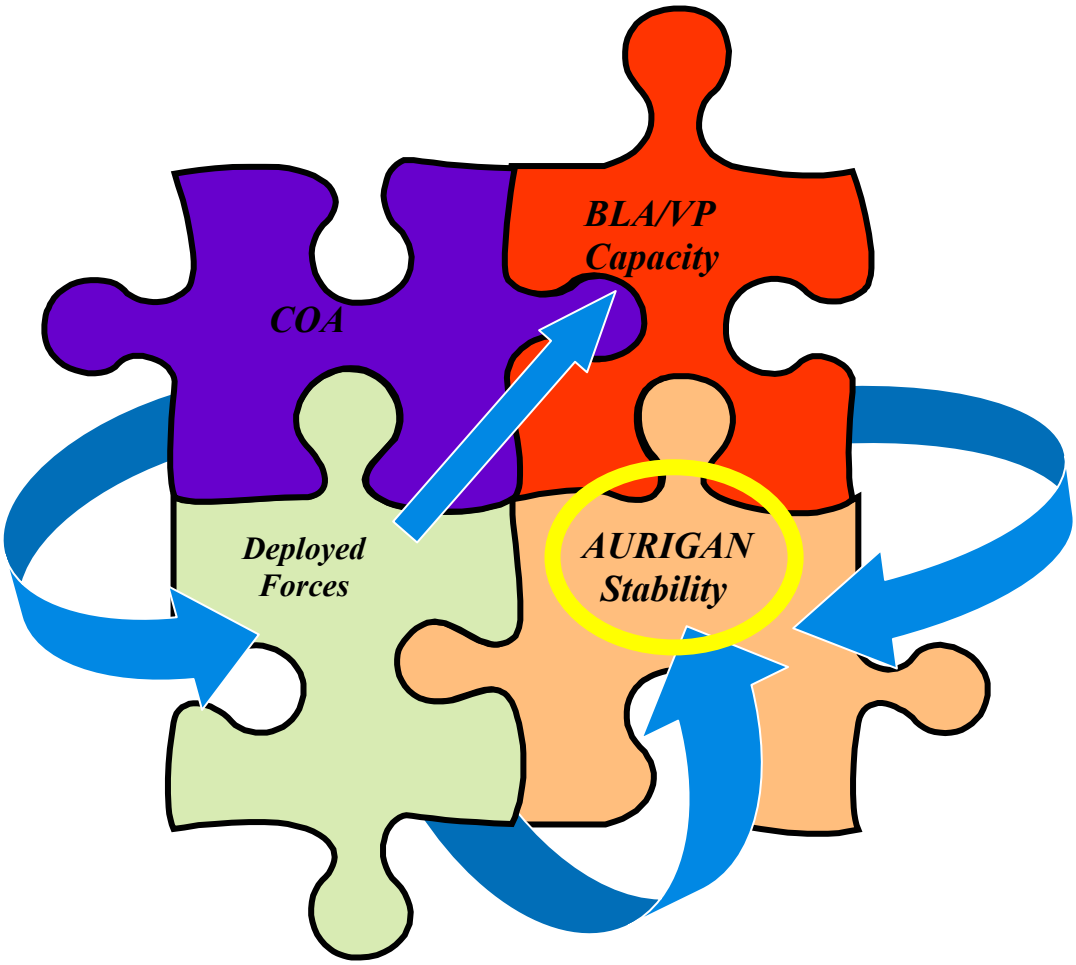


Figure 14: Stability of the government

The stability of the government is calculated as a function of following parameters which are each characterised by a weight factor and a criticality:

- Political leadership
- Civilian population
- Critical infrastructure
- Military assets
- Transportation nodes
- Transportation channels
- Communication nodes
- Industrial assets
- Urban infrastructure

The capacity of the BLA/VP SOF to mount attacks in AURIGA is based on:

- Number of fighters

- Mobility
- Command and Control
- Access to WMD
- Sustainment
- Will to Fight
- Internal Clan Cohesion
- Cohesion of the BLA
- Information Operations

The capacity to counter to attacks is based on a weighted list with criticality of:

- Reduce Quantity of BLA-Fighters
- Control Mobility
- Reduce Command and Control
- Locate and Destroy WMD
- Reduce Sustainment
- Reduce Will to Fight
- Reduce Internal Clan Cohesion
- Reduce Cohesion of the BLA
- Impact Information Operations

NC3A implemented together with the Canadian Forces College a proof of concept prototype of ZETA. Figure 15 shows the main screen of ZETA.

Figure 16 shows results from ZETA. The black line shows the stability over time (in weeks). It is assumed that the government will fall when the stability is under 40%. The results of the simulation runs have been discussed with subject matter experts and seem to be plausible.

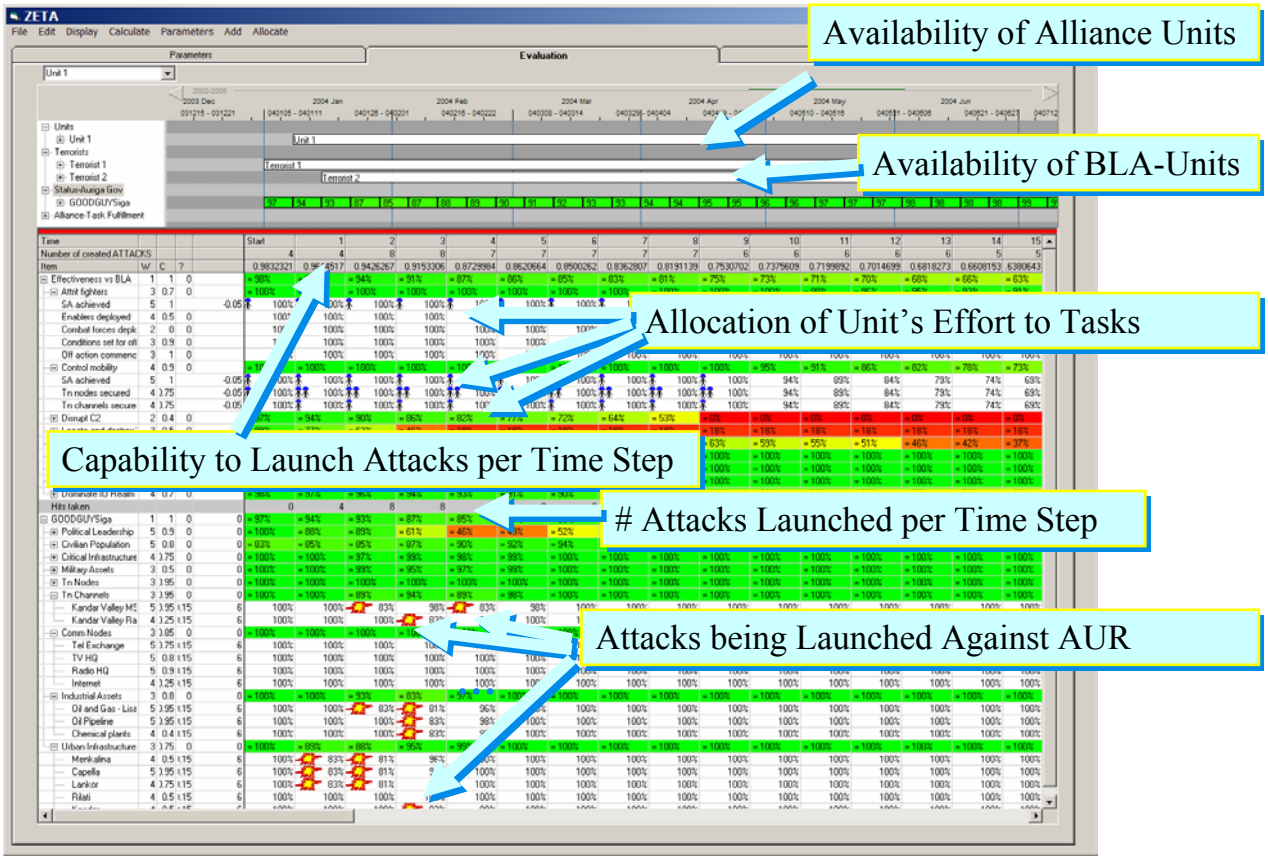


Figure 15: Main screen of ZETA

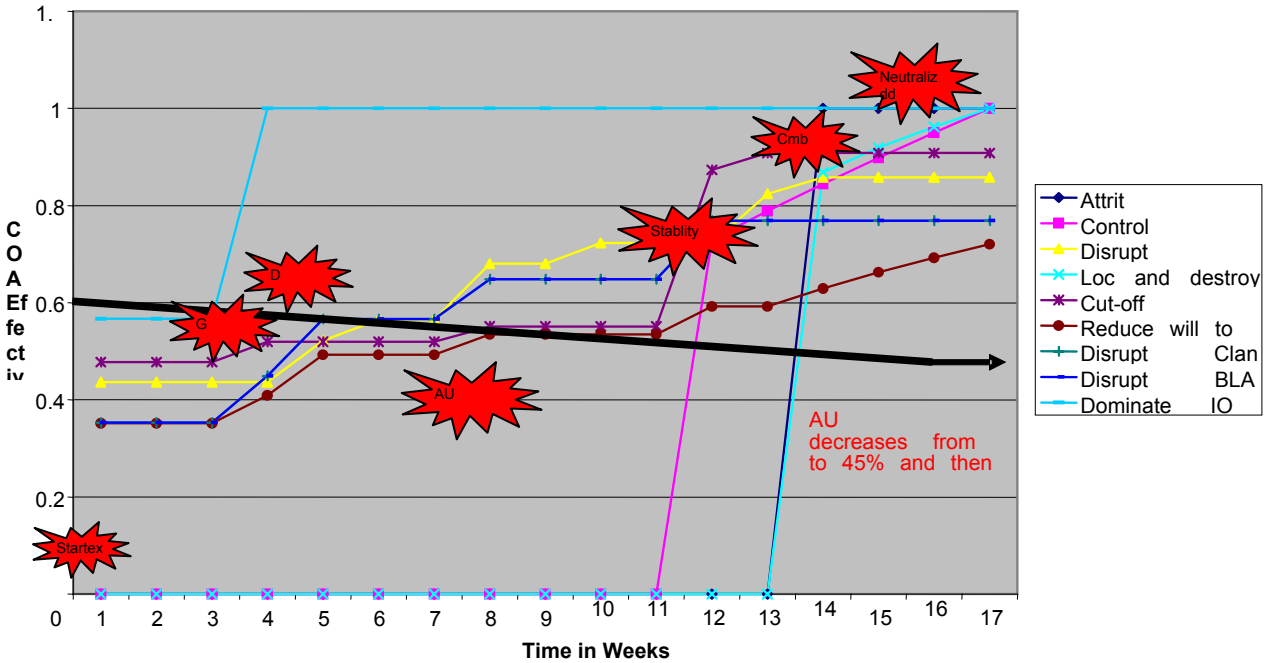


Figure 16: results from ZETA

5.0 SUMMARY AND OUTLOOK

Following points are important:

- M&S Support is Essential in Operational Planning
- The Asymmetric Environment Requires Specific Approaches, e.g. Intelligent Agents
- Component-Based Systems Like GAMMA are Needed to Offer Functionality and Flexibility Especial in an Asymmetric Environment
- M&S Must Draw Conclusions on Effects and Not Just Give All the Details
- GAMMA with the Intelligent Agent System and ZETA (Which will be Integrated in GAMMA Soon) are First Steps in the Right Direction
- Other Work Especially on Human Behavior representation is Still Needed

[1] Statement by Admiral Forbes, Deputy SACT, Conference of National Armaments Directors (CNAD), AC/259-N(2004)0002, 6 May 2004

[2] Uwe Dompke, Stephen Yates, Wolfgang Nonnenmacher (2002) GAMMA (Global Aggregated Model for Military Assessment) – Design and Functionality, *Conference Proceedings I/ITSEC 2002*, Orlando

[3] Uwe Dompke (2003) Concepts for Training of Joint Combined Operations Planning based on Modelling & Simulation Support, *Conference Proceedings I/ITSEC 2003*, Orlando

[4] Stephan Leitner, Dan Eustace (2003), ZETA (Zoran Sea Crisis Effects-based Tool for Analysis of Asymmetric Environments), GAMMA User Group Meeting, NATO School Oberammergau, December 2003

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Wolfgang Nonnenmacher was until recently Principal Scientist and Project Leader at the NATO C3 Agency in The Hague, The Netherlands. His main research areas are Human Behaviour Representation and Modelling and Simulation of Crisis Response Operations. He has developed the GAMMA prototype.