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DISCCO: Generic Support for C2 and Decision-Making

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This is a student paper.

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Abstract

The design of general support systems for military activities would greatly facilitate co-ordination and co-operation between different positions throughout the organization, increase flexibility in solving unknown tasks, and provide more cost-effective solutions. Command and Control (C2), as well as other types of business and military management, show generic features that should be emphasized when developing such general systems. DISCCO (Decision Support for Command and Control) is an integrated set of tools to support this work. It includes Command Support that facilitates the manual work in describing the situation and formulating solutions to accomplish tasks. It also includes Decision Support that, based on AI and simulation technology, enhances the human capability by automatic and semi-automatic generation and evaluation of solutions. Externalizing the situation awareness, a Common Situation Model enables the integration of these support tools but also the collaboration between individuals. The set of tools is generic, since it could be adapted to different situations, and hence support work at different positions in military, as well as civilian, defence organizations.

1 Introduction

Flexibility is the keyword when preparing for the uncertain future tasks for the civilian and military defence. Support tools relying on general principles will greatly facilitate flexible co-ordination and co-operation between different civilian and military organizations, and also between different command levels. Further motivations for general solutions include reduced costs for technical development and training, as well as faster and better decision-making. Most technical systems that support military activities are however designed with specific work tasks in mind, and are consequently rather inflexible. There are, admittedly, large differences between for instance fire fighting, disaster relief, calculating missile trajectories, and navigating large battle-ships. Still, there is much in common in the work of *managing* these various tasks. We use the term C2 (Command and Control) to capture these common features in management of civilian and military, rescue and defence operations.

In a previous CCRP conference, we presented a model of C2 and management with the purpose to provide a link between the C2 community and the design of generic technical support tools [Wallenius, 2002]. Continuing this work, the present paper describes a top-down approach to design support systems for decision-making in the context of C2, as a complement to the prevailing bottom-up approaches.

DISCCO (Decision Support for Command and Control) is a set of network-based services including *Command Support Tools* helping commanders in the human, cooperative and continuous process of evolving, evaluating, and executing solutions to their tasks. The command tools provide the means to formulate and visualize tasks, plans and assessments, but also the means to formulate and visualize changes of the dynamic organization, regarding roles, mandates, and obligations. Also included in DISCCO are *Decision Support Tools* that, based on AI and simulation techniques, improve the human process by integrating automatic and semi-automatic generation and evaluation of plans. The tools provided by DISCCO interact with a *Common Situation Model* capturing the recursive structure of the situation, including the dynamic organization and the goals of own, allied, neutral, and hostile resources. Hence, DISCCO will provide a more comprehensive situation description than has previously been possible to achieve.

The iterative and dynamic decision-making process supported by DISCCO is constituted by a successive development of the tasks, specifying what to accomplish, but also the solutions, specifying how to accomplish it. The potential plans are assessed by predicting the future consequences given that they are executed, and comparing these consequences to the goals of the task. Since this process disregards the actual details of the tasks, it will be useful through all phases of the operation, through all command levels, and through all the different organizations and activities that are involved. Taking this general approach, DISCCO may be used both for civilian and military purposes.

In the following presentation, we will start by briefly describing the ontology by which awareness of the situation could be shared. Based on this ontology, the implementation of the Common Situation Model, the Command Support, and the Decision Support will be discussed. Finally a road map is given, to describe further work needed to make the system operational.

To illustrate the ideas, some screen shots from a prototype version of DISCCO have been provided. The example scenario used in these screen shots depicts a conflict in the fictive country of Gammia. According to this scenario, the governing majority of Gammia has launched a full-scale military ethnic cleansing operation towards the minority Milli population. This has triggered a subsequent invasion of parts of Gammia by the neighbouring Deltians, who belong to the same ethnic group as the Milli people. After several months of discussions, the UNSC mandated a UN peace enforcement mission, the Gammia Force (GFOR), and requested troop contributions from several UN member nations, among them the USA and the major EU nations, including Sweden.[2]

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[2] The DISCCO prototype and the example scenario have been developed at SaabTech AB.

2 Command and Control

As argued in [Wallenius, 2002], the work of commanders and staffs could be seen as a breakdown of abstraction. Tasks assigned on a higher level of abstraction are implemented by assigning tasks to resources on a lower level of abstraction. To optimize the use of the subordinated resources, different alternatives regarding this solution should be regarded before the decision is made. Extending the definition given in [Wallenius, 2002], we propose the following definition of C2, from this point of view:

> *C2 is the act of fulfilling a task assigned to an organization, in terms of designing, evaluating, approving, and executing, a solution on a lower level of abstraction. Hence, a solution is constituted by its subtasks, and by a subordinated organization of available resources, to fulfil these subtasks.*

According to this definition, the design of organization is a substantial part of solving the task. Hence it emphasises that the future military organization will be dynamic and flexible. Depending on the situation and current tasks, new units will be assembled to meet the requirements. Also, novel chain-of-command structures may arise, allowing for different, multiple, or virtual, organizations. [Borchert and Jones, 1999], e.g., investigate such multiple organization trees that change over the different phases of the mission.

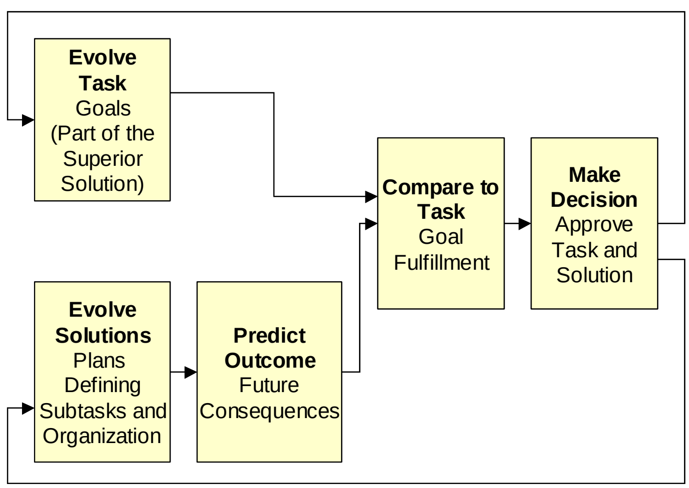

Figure 1. The generic decision-making process.

Also emphasised in the definition, is that C2 is an art of decision-making. There are different descriptive and prescriptive models representing how decision-making should be performed, and is performed in practice [Klein, 1989] [Schmitt and Klein, 1999] [Thunholm, 2003] [NATO, 1998] [Montgomery, 1992]. The suggested generic decision-making process in Figure 1 aims at representing these different models from a conceptual perspective.

From this point of view, decision-making always involves defining the goals of a task as well as developing one or several solutions to this task. The development of solutions includes iteration between, on the one hand, suggesting improved solutions, and on the other hand, assessing these solutions. The assessment is performed by predicting the outcome, and by comparing this assumed outcome to the goals. The actual decisions are made when the task, or one of the solutions, is either approved or disapproved.

3 The Vocabulary for Describing Situations

Fundamental for the design of tools to support interaction between commanders must be the structure of the information that is to be shared by this interaction. We argue that this interaction essentially deals with describing the situation, including the recognition of different problems, and the possibilities and decisions to deal with these problems.

As proposed by [Endsley, 1995], there are different levels of *Situation Awareness*: *Level 1,* representing the perception of the elements in the environment within a volume of time and space, *Level 2,* representing the comprehension of their meaning, and finally, *Level 3,* representing the projection of their status in the near future. To support the sharing of awareness, we thus need the means to describe separate elements. Belonging to the enemy, these elements represent threats or problems. Belonging to the own forces, they instead represent either values that need to be protected from the threats, or the possibilities to deal with them. We also must be able to express the capabilities of the different objects, their potential actions, and the assessed impact of these actions. The awareness of these aspects is based on known facts, but also, in lack of facts, it relies on beliefs and assessments.

In the AI community, the term *ontology* has come to mean two things: (1) a representation vocabulary, and (2) a body of knowledge using this vocabulary [Chandrasekaran *et. al.*, 1999]. The role of ontologies has recently come under focus in the Data Fusion community, e.g., by [Boury-Brisset, 2003], who describes a methodology and a building environment to maintain domain specific ontologies, and by [Matheus, *et. al.*, 2003], who suggest a slightly different approach by describing an ontology for describing situations that is generic, since it could be instantiated for different domains.

We refer to the first meaning of 'ontology', by letting the model in Figure 2 represent a vocabulary by which the different levels of Situation Awareness can be represented. Since this ontology could be adapted to express the situation for different positions and levels in the organization, it is also more related the work of [Matheus, *et. al.*, 2003]. Hence, the model defines a number of entities and how they may relate to each other. By these entities it could be expressed what is known and what is believed of different actors involved in the situation.

Explaining this model very briefly, a *Task* represents any kind of objective or purpose. Hence a Task is constituted by its *Goals,* and by references to other objects in the model that are to be affected by these. In turn, *Plans* constitute potential solutions to accomplish a Task. Recursively, these plans define subtasks on a lower decision-level.

The Plans also define *Resources* that can be responsible for achieving these subtasks. Resources represent physical objects, such as soldiers, tanks, ships, aircraft and weapons. They also represent aggregates of such objects, e.g., platoons and battalions, as well as temporary battle groups and task forces. To this end, *Roles* provide the means to define different kinds of long-term and short-term memberships to superior Resources. Hence Roles are used to define dynamic organizations. By the *Task Type* class, it is possible to express the *Capabilities* of a Resource to accomplish different kinds of Tasks. By the Task Type class it is also possible to define *Services*, to express the authority for superior resources to employ these capabilities.

Finally, making a decision is equivalent to *approving* a plan by selecting one of the potential plans for further execution. Accordingly, it is the approved plans that together define the current organization and the corresponding tasks and assignments.

For a further description of the ontology, see [Wallenius, 2002], and [Wallenius, 2004].

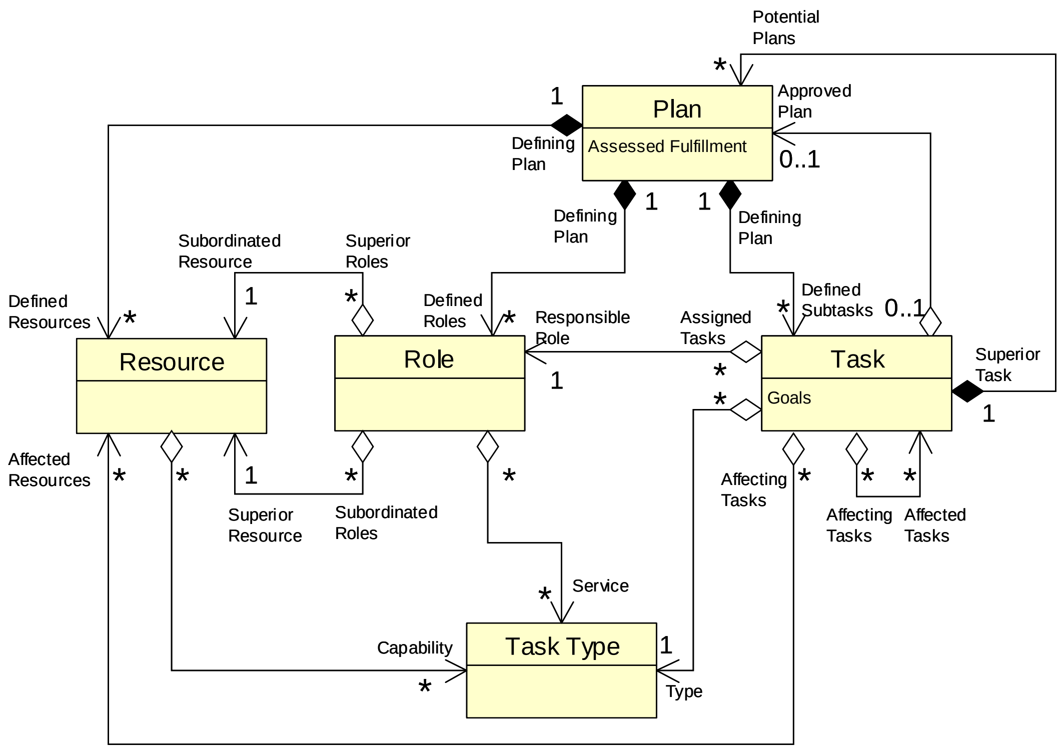

Figure 2. The ontology defining the language to describe situations.

4 The Common Situation Model

The Common Situation Model captures the recursive structure of the situation according to the ontology. This set of information is held available to the different tools that will be described in the following sections. Through these tools, the model is in turn accessible by all authorized personnel connected to the network.

In the current prototype, the model is straightforwardly realized by a basic commercial relational database. To cope with, e.g., disturbances of the network, caused by hostile activities or technical problems, and with restrictions regarding available bandwidth, other solutions should however be considered

Ultimately, the scope of the Common Situation Model includes all that is believed of own and hostile decisions. Since this scope is rather large, the complexity of the model is reduced by the exclusion of other types of information, such as information on the environment, e.g., weather, terrain, and infrastructure. Instead, such specific information is referred to, by including links to objects in other databases.

There would also be further aspects of the decisions that cannot be captured by the formal data model. For example, approving a plan is equivalent with giving a formal order to subordinated forces to act according to the assigned tasks. To this end, there must be means provided to the commander to emphasize certain details and priorities, and to exercise his leadership in other aspects. This is supported by the possibility to provide multi-media and unstructured text objects to fill in with subtler and more intangible matters than could be expressed by the model. Again, such information should be linked to, rather than be incorporated, in order to keep the model separated from specific matters.

5 Command Support

Command Support aims at helping the commanders in the human, collaborative, and continuous process of developing, evaluating, and executing solutions to their tasks. Hence, these tools provide the means to interact with all entities that are represented in the Common Situation Model. This interaction includes the maintenance of tasks, plans and assessments, and also the dynamic design of the organization. To this end, the different Command Support tools will support navigating and editing the Common Information Model from different *views* including:

- *Hierarchical tree views* that reflect the recursive structure of the model. Figure 6 gives an example of a tool to browse the directed graph that represents the Organization hierarchy. In this view it is possible to select a certain resource to browse among its superior and subordinated roles, and to depict its assigned tasks and the defining plans that, given that they are approved, represent the decisions on all these entities. Figure 7, Figure 8, and Figure 9, all illustrate a tool to browse the corresponding graph representing the Task/Plan hierarchy. From a selected task or plan it is possible to browse up and down its superior and subordinated tasks and plans. Figure 7 hence describes the conflict involving civilian and military resources in Gammia, and the task for GFOR to solve this conflict. In turn, Figure 8 depicts the GFOR Order of Battle, defining the organization of GFOR, and the tasks for the different higher-level organization units. In Figure 9, these tasks have been broken down to the mission for the Swedish 101. Mech. Battalion to establish surveillance of its area of responsibility (named ‘AOR 101’). In this task view, the goals for the task in different dimensions have been defined, and the two main decision alternatives have been identified. The first alternative is stationary surveillance, establishing fixed observation posts, while the second alternative is mobile surveillance, patrolling the roads in the area. Also the assessment of potential plans is depicted in this view. This assessment will be further discussed in connection with the Decision Support in the next section.

- *Geographical views* that illustrate the entities in a geographical context, i.e., on a map. While traditional situation pictures typically emphasis the positions of different resources, it will, by means provided by the Common Information

Model, be possible to depict also tasks and other relationships. In addition, it will be possible to select the appropriate level of abstraction by zooming up and down through the recursive structures. Two examples of geographical views are given. Figure 10 shows the situation in Gammia on a rather high level, while Figure 11 has zoomed in to the situation in a smaller area. By introducing the possibility to display also the tasks assigned to the different resources, situations such as in Figure 7 can be illustrated in a geographical context. This functionality is however not currently implemented.

- *Time views* that depict the extension of the entities in time. Typically, tasks will have definite or assessed points in time when they are expected to start and end. There will also be dependencies between entities, e.g., a certain task must not start until another task has been finished. These temporal aspects are however not yet part of the model. Consequently there are no examples of time views in the current version of DISCCO.

Similar operations on entities, such as subordinating a resource to another, can be performed in different views. In the Task/Plan tree view, this will be achieved by a right-mouse click to define a new role in the 'Defined Roles' field. In the Organization tree view, the same operation can be performed by a simple drag-and-drop action. Defining tasks, and assigning them to roles, will be performed in the Task/Plan view, but it could just as well be performed by actions in the Geographical view.

The plans are the fundamental entities, defining all other entities in the model. Hence, approving a plan is equivalent with making the decision that these entities, and the relations between them, shall come to existence. Since the plan with its defined entities is available to subordinated resources, a decision to execute a plan is equivalent with issuing orders to the subordinates. Given this importance, the management of the plans should be given particular emphasis. Thus, handling of different versions of plans will be included among the Command Support tools. Perhaps also further stages than 'approved', and 'not approved', representing the status of a plan, will be needed.

6 Decision Support

6.1 Supporting the Generic Decision-Making Process

Decision Support provides 'clever' tools to enhance the human cognitive capability to make decisions. It would thus be of great interest to design these tools with a human decision-making process, such as the generic process depicted in Figure 1, as a baseline. Providing automated tools that support each of the different stages in the process, according to Figure 3, will hence keep the work performed by computers open for interaction. Also, as the different stages could be automated to various extent, the cognitive work could be delegated to the computer for matters when the commanders feel trust in doing so, and when admitted by the current stage of technical development.

As indicated in Figure 9, some examples of Decision Support integrated with the Command Support tools have been implemented in DISCCO 1.0. Hence, following the decision-making process, the screen-shot in this figure depicts the definition of the task to establish surveillance of a certain area, according to the different objectives. As mentioned in Section 5, two alternative solutions have been developed: 'Stationary Surveillance', and 'Mobile Surveillance'. The consequences of these plans have been predicted by a mixture of manual and automated assessments and, in turn, been compared to the preferences. Hence the currently approved plan, 'Stationary Surveillance', is considered not being sufficient regarding the probability to detect illegal activity, whereas the other plan, 'Mobile Surveillance', implies a risk exposure for own casualties. Since, according to these current assessments, neither of the plans is expected to fulfil the goals of the task, the approval of the first plan has to be reconsidered, and further evolvement of either the task or the plans is needed.

In the following sections, the implementation of these different Decision Support tools will be discussed.

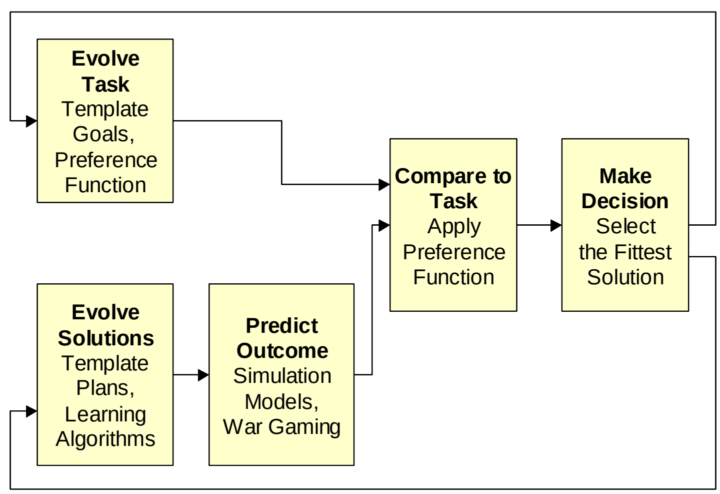

Figure 3. Automated tools supporting the generic decision-making process.

6.2 *Evolving the Task*

Since a task expresses the desire to accomplish something, the hierarchy of decided tasks in the organization constitutes a model of utility. Consequently there is no explicit value, positive or negative, of anything that happens, unless mentioned in the formal description of a task. Hence the Decision Support must carefully facilitate a structured formulation of goals and restrictions. Also, as mentioned in Section 4, this should be complemented with unstructured multi-media objects to allow a richer formulation of the intents to, in turn, reduce the residual between tacit expectations and the explicit utility model.

The structured formulation of task should allow for multi-dimensional goals and restrictions. These *objectives* may be represented by a *multi-attributed preference function*. A definition of such a function, conforming to decision theory with multiple objectives, has been presented in [Brynielsson and Wallenius, 2003], and [Huang *et. al.*, 2003]. This function may represent multi-dimensional objectives, which in turn express the utility of the consequences of different plans.

The set of different objectives for a certain task may be set arbitrarily, depending on the judgement of the decision-maker. There may however be templates defined for different task types, representing typical sets of objectives. To further promote the mixing of computer supported assessments with humans assessments, some objectives may be represented by numerical values, representing well defined measures of phenomena in the consequence domain, whereas other may be represented by less defined scales, such as {'high', 'medium', 'low'}.

6.3 Evolving Solutions

A solution to a task is, according to the ontology, expressed by a plan. In turn, this plan represents tasks, assignments and organization on a lower decision level. To facilitate the evolvement of such plans, there will be means to provide templates representing common solutions to a task type. As a starting point for the decision-maker when developing the solution, these templates will have predefined tasks on a lower level. Through the Task Type class, admitting definition of services, there may also be support to list resources that can be assigned to a certain task. In addition, potential targets for a task, represented by 'affected tasks' and 'affected resources', may be listed to support the decision-maker.

Other support tools, based on different AI techniques, may automatically suggest and evolve plans based on information on the current situation. Again, such automatic handling is complementary to the human cognitive ability. Hence, automatically developed plans should be exposed to evaluation and further development in a manual manner. The architecture of the system, with the division between Command Support and Decision Support, should facilitate development of such AI based support tools, although we have currently no further suggestions on how these should be constituted.

6.4 Predicting the Outcome

The assessment of solutions includes simulating how the situation will unfold, given that the different solutions are applied. During a human decision-making process performed without technical support, this simulation is achieved simply by the imagination of what will happen if the solution is executed, utilizing mental models that capture previously acquired knowledge.

There are several manual methods to externalise the mental simulation, in order to improve the quality of the prediction, and to make it more efficient. In the case of interdependent actors, i.e., when there is an adversary, *game playing* could be used to perform the simulation. Hence, one or several persons could be assigned to simulate the decision-making of the adversary forces. The evolvement of the situation is then discovered using more or less elaborated methodology and support.

To this end, the means to simulate the performance of the forces will be integrated among the support tools. Thus, it must be possible to generate copies of the Common Situation Model, i.e., plans depicting sets of resources, plans, and tasks, into the simulated domain. [Huang *et. al.*, 2003] suggest how this could be achieved by the generation of *agent assemblies* representing the behaviour of resource hierarchies.

The resulting simulation is primarily automated regarding physical behaviour by including simulation models depicting typical abilities such as sensor ranges, transport speeds, and effects from weapons. Hence the simulation still let the human players perform the actual decision-making for the simulated forces. However, to decrease the need for human interaction, and thus save time and human labour, it would be of large interest to automate the simulation also of the decision-making aspect. Hence the decision-making for the adversary forces, but also for the own, subordinated, units should be simulated.

One way of implementing agents with the ability to make decisions is to apply very simple decision rules. To this end, [Ilachinski, 1997] reduces the decision-making problem into a small set of parameters representing the *personality* of the agent, including the ability to move towards alive or injured, friendly or enemy, agents respectively. The problem of this approach, as we argue, is that this set of parameters says very little of the behaviour of real forces. In other words, we have no means to understand to what extent the simulation model corresponds to the real world.

At the other end of the scale, the decision-making of the simulated forces is modelled just as accurately as the decision-making to be supported by the simulation. Hence, a simulated decision-maker would behave according to a model as complex as indicated in Figure 3, utilizing automatic support tools in all steps. Regardless whether it is exactly this model that will be used or not, simulating human decision-making in a completely realistic manner is a very difficult business, equivalent with replacing real decision-makers with the design of fully automated Decision Support.

However, according to decision theory [Raiffa, 1968] [Jaynes, 2003], decisions are maded based on uncertain information. Hence, also incomplete models may be utilized to perform the prediction, under the condition that the opinion on this incompleteness is part of the analysis. Thus, uncertainty in the models and the uncertainty in the results of the simulation, should be included in future development of simulation based Decision Support.

6.5 Comparing to the Task

In the case when the decisions are independent of the decisions of other actors, the comparison to the task is quite straightforward. The consequences must be measured in the dimensions given by the different objectives. After that, the preference function is applied to evaluate these consequences according to the goals, and hence rank the different alternative solutions. The uncertainty of the predicted consequences should also be regarded in order to include risk estimation into the decision-making.

The complexity rises however when the consequences depend both of own decisions and the enemy's decisions. The techniques of *Bayesian Networks* and *Influence Diagrams*, tightly related to each other, may be applied to represent such dependencies. These techniques are used to model uncertain casual dependencies, Bayesian inference from observations, and assessment of decisions made from these. [Suzić, 2003] and [Runqvist, 2004] both use Bayesian Networks to estimate the intentions of the enemy in C2 applications, giving a probability number of the different possible intentions. This approach is based on observations made of the enemy's performance, but it does not take into account the utility the enemy might have of the consequences of different actions.

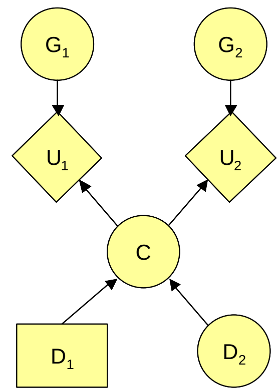

Figure 4. An Influence Diagram depicting the dependencies of two agent's decisions in the C2 case [Brynielsson and Arnborg, 2004].

[Brynielsson and Arnborg, 2004] go further and use Influence Diagrams to model the dependencies between the own decisions and the opponent's decisions, as indicated in Figure 4. This diagram describes the situation from $Agent_1$'s perspective. Hence a decision node, D_1, represents $Agent_1$'s decisions, while a chance node, D_2, models $Agent_2$'s decisions. The consequences, *C*, depends on the decisions of both agents. Finally, the $Agent_1$'s utility, U_1, depends on its goals, G_1, and the consequences, while $Agent_2$'s utility, U_2, depends on the goals, G_2, and, again, the common consequences. According to this view, all information is uncertain, including the belief on the enemy's decisions and goals, and the belief of the consequences of different decisions.

The consequence node C represents the probabilities of different consequences conditioned by different combinations of decisions, D_1 and D_2. Estimating these probabilities correspond to the predicting of outcome discussed in the previous section. This means that each possible combination of decisions needs to be simulated to assess the best own decision.

To further capture the dependencies between the two agent's decisions, [Brynielsson and Arnborg, 2004] investigate whether *Bayesian Games* could be used to model one agent's beliefs of the other agent's beliefs etc., and then derive probable decisions of the opponent together with the best decision, or decisions, regarding own actions. Although by far not completed, this approach seems very interesting for capturing uncertain information and dependencies between decisions in a single model.

6.6 Making the Decision

Given that the different alternative solutions have been ranked according to predicted consequences and the preference function, the actual decision is reduced to a trivial selection of the best solution. Consequently, if all the different stages of the decision process were completely automated, the decision loop in Figure 3 would represent a fully autonomous process. However, this requires that there are essentially no tacit expectations besides those represented by the preference function, and that all possible decision alternatives were represented, and also that the consequences could be accurately predicted for all the different objectives. As such completeness is almost unreachable, the decision-maker is responsible for that, at least, the most important aspects have been considered in the analysis.

Decisions must also be made on the set of potential solutions that should be the subject for further analysis. Hence it must be decided which potential solutions that should be kept for future consideration and which could be eliminated. Also, if the analysis shows that the task is too difficult, the change of goals need to be considered, rather than the change of solutions.

Altogether, we argue that the complexity of all these different aspects implies that the actual decision should not be made automatically, but left for the human decision-maker.

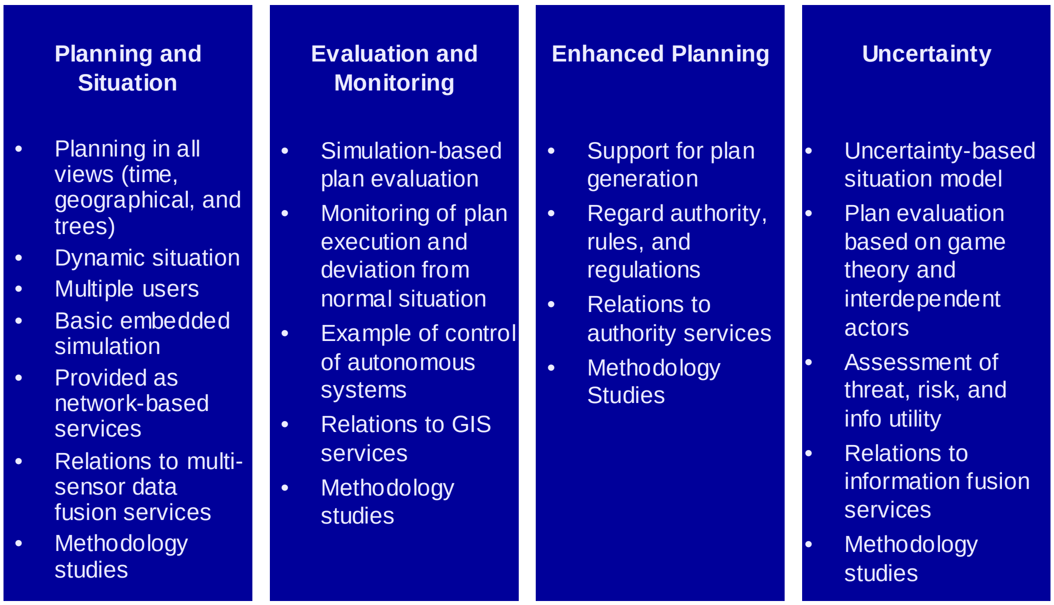

Figure 5. A roadmap for further development of the DISCCO system.

7 A Roadmap for Further Development

DISCCO will be useful to commanders and staffs on different command levels throughout both civilian and military organizations involved in managing resources to achieve tasks. While the concept has been implemented at the prototype level, the full implementation will require a substantial effort of research and development. Yet, the human decision-making will be facilitated at an early stage of this development, and will be further improved by the gradual introduction of new tools and simulation models, as the development proceeds.

The roadmap for the DISCCO system, depicted in Figure 5, indicates the different issues that need to be solved to make the presented tools operational. This roadmap suggests a successive introduction of functionality in four stages. The first stage focuses on the manual description of situation and plans, using the different views in the Command Support tools. The second stage emphasizes the simulation-based evaluation of plans during the planning and execution of the tasks. The third stage involves support to automatically evolve plans. Finally, the fourth stage includes the concepts of uncertainty, risks, and game theory. Also indicated in the roadmap, is the integration of services that are not part of the actual DISCCO system. These include Multi-Sensor Data Fusion, Information Fusion, Geographical Information Systems

(GIS), and security systems managing the authorities to access information and to utilize resources within the organization.

The roadmap indicates that DISCCO has a rather broad scope and that there are several critical issues for its development. These issues include the ontology for the Common Situation Model, which needs to be worked out in a number of details. Especially representation of uncertainty will need much attention. Among the decision-support tools, the integration of simulation will require a substantial effort of research. So far, there has not been much work on the actual design of the user-interfaces, whereas the quality of these would clearly be crucial for the applicability of the tools. Hence the development should be supported by usability and methodology studies, as indicated in the roadmap.

To better show the advantages of the tools, the work according to the roadmap needs to start with developing for a more restricted class of users than has been the case so far. The typical C2 case, according to our definition, depicts work somewhere on the middle levels of a large organization hierarchy, dealing with decisions for abstract resources rather than physical resources, i.e., there are subordinated decision-levels to carry out tasks. Hence, we suggest that further efforts should be addressed to support ground based military forces in which many organization levels are involved in the planning and execution of missions. Suitable levels to be supported include the brigade and battalion levels. These decision levels deal with abstract units, the planning cycles span over a suitable amount of time, and the C2 work is performed in an environment that should admit the usage of ordinary personal computers and the connection to broadband networks. Together, these parameters seem appropriate for the first attempts in developing and using the tools here suggested.

8 Conclusions

We strongly believe that the development according to the roadmap will result in tools that will be useful already after the first stage by increasing the efficiency of a restricted class of users in their work to plan for missions. The framework thus provided will also admit a continuously increasing functionality. From the experiences reached in the first stage of development, the scope could be successively expanded to support an increasingly larger class of users. Hence, further decision-levels, further military services than the army, but also civilian services such as rescue services and police, may be supported. The C2 work for these different users will be significantly enhanced in terms of better situation awareness and faster decision-making.

The most important benefit is however that the interaction between the users will be greatly facilitated by the support to share the mental awareness of the situation, and the awareness of the decisions made on how to deal with it. Consequently, generic support tools, such as provided by DISCCO, will play a significant role in taking full advantage of the network in the future defence.

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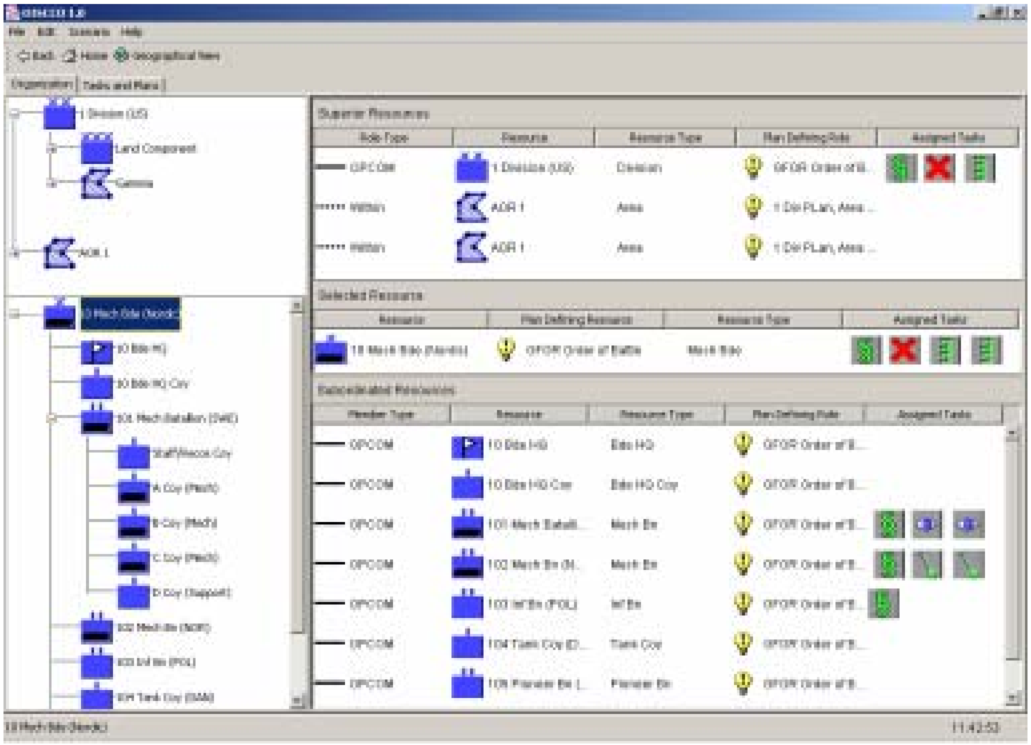

Figure 6. An organization tree view depicting the superior and subordinated roles of the 10. Mechanized Brigade.

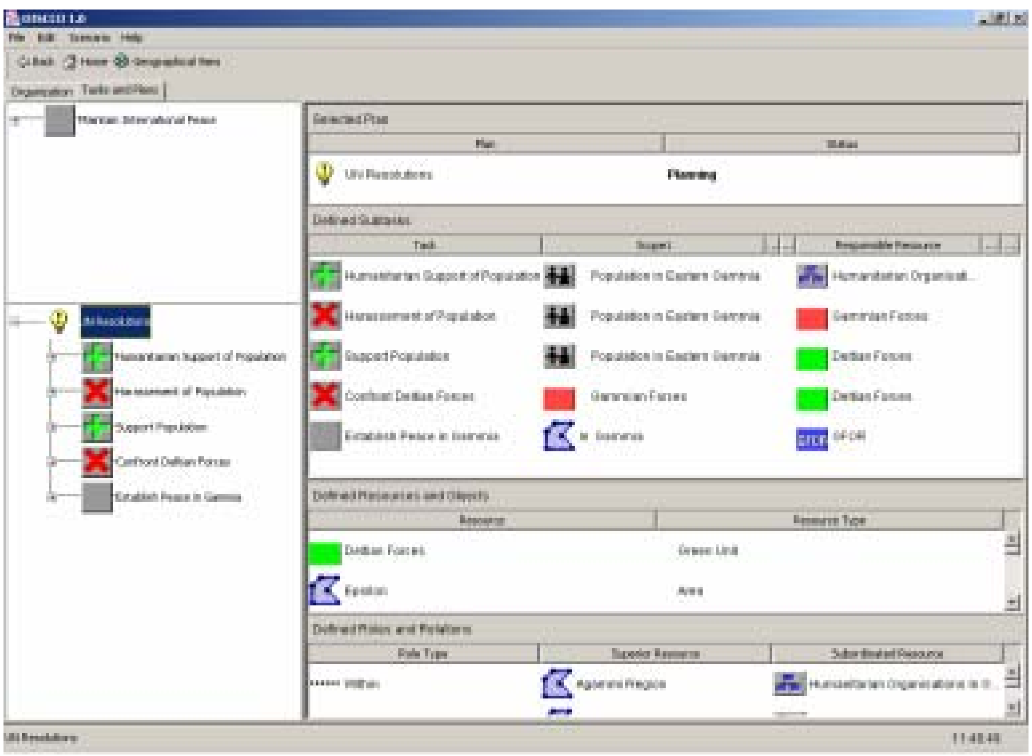

Figure 7. A Plan view defining the situation in Gammia and the main task for the U.N. operation.

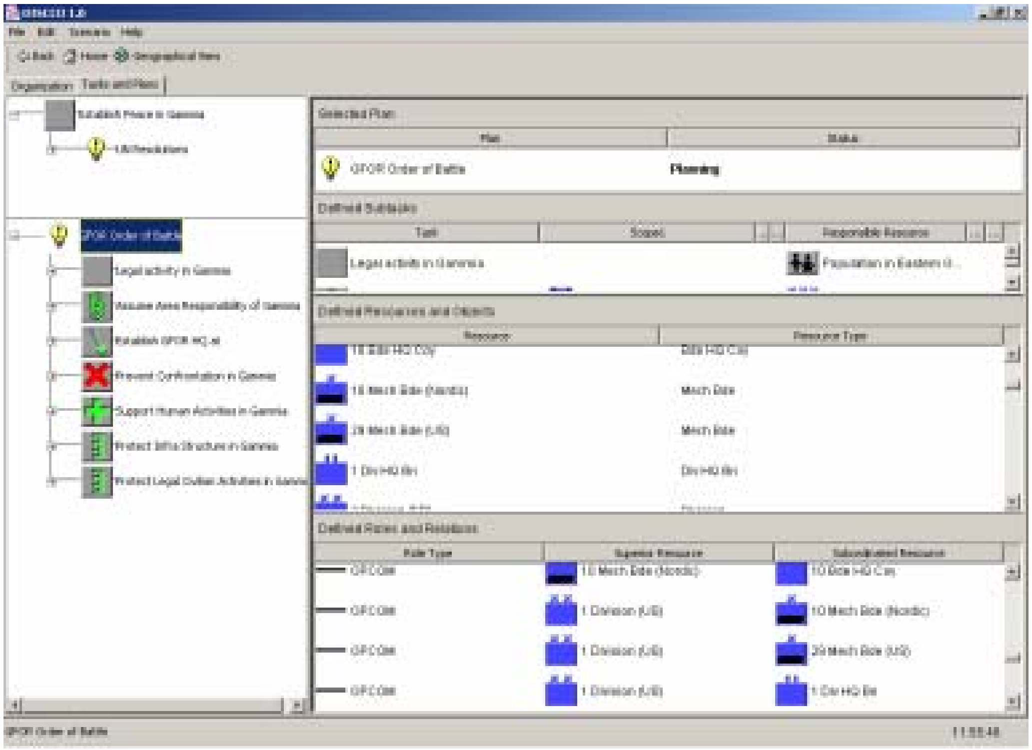

Figure 8. A plan view depicting the GFOR Order of Battle.

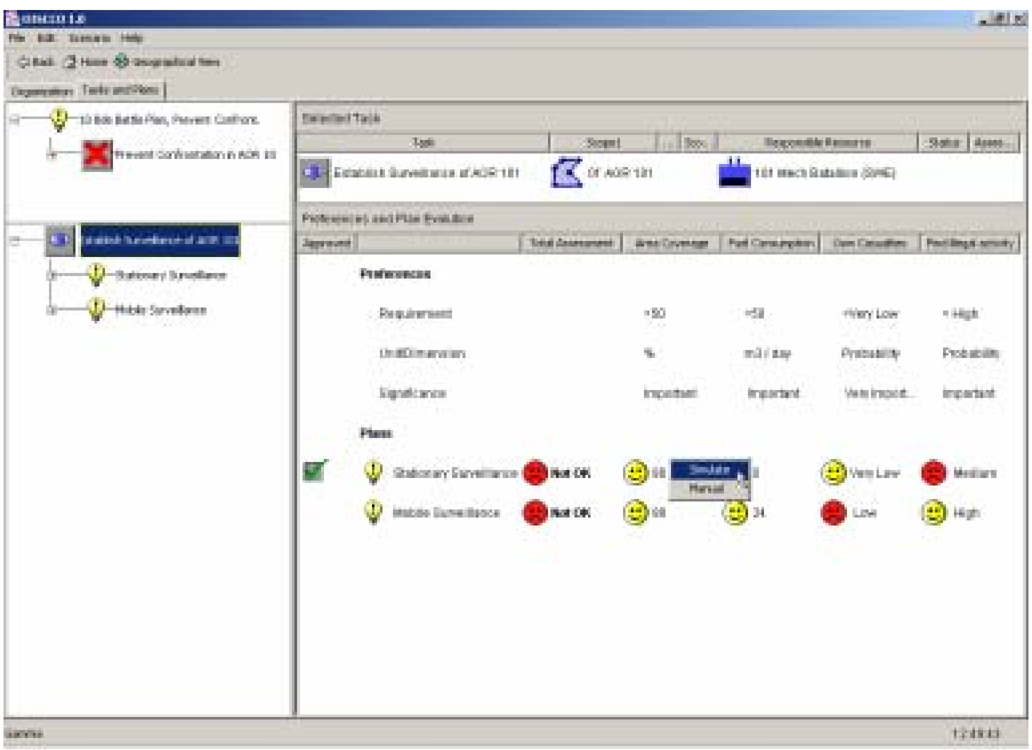

Figure 9. A task view depicting the potential solutions on how to establish surveillance of a certain area.

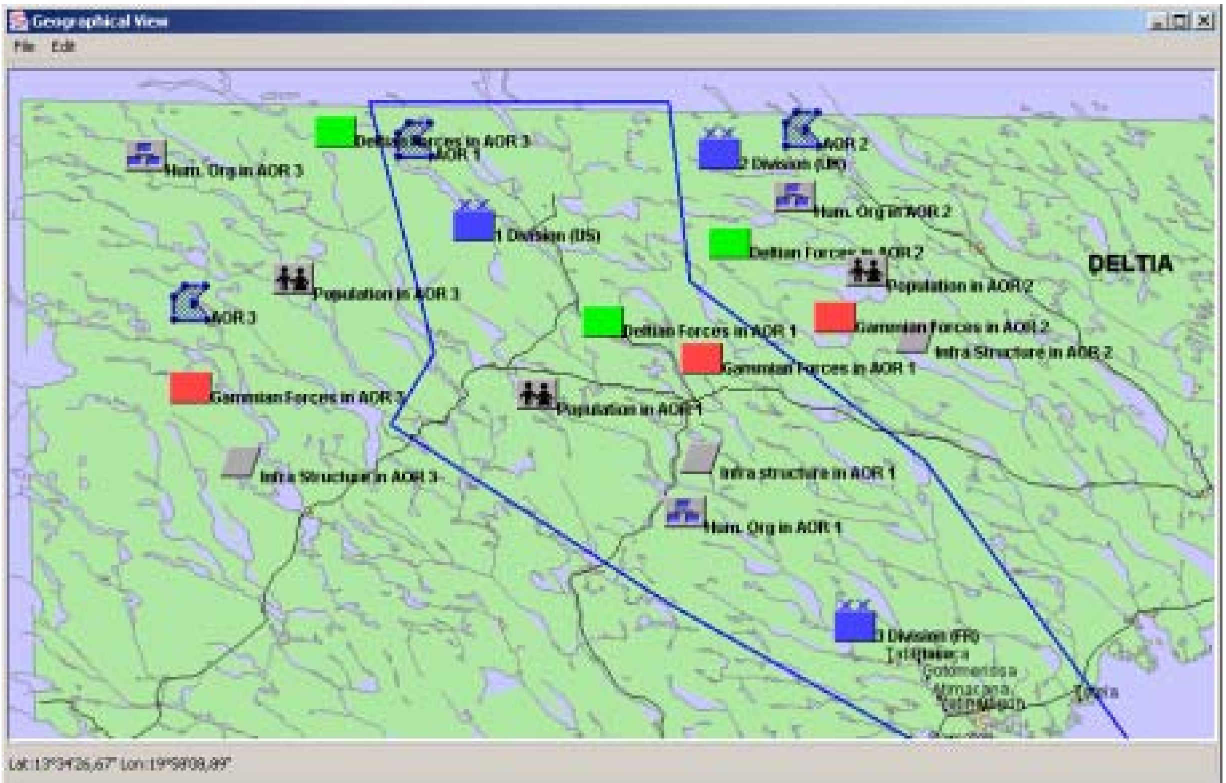

Figure 10. High-level forces and other entities of different affiliations are depicted in a geographical view.

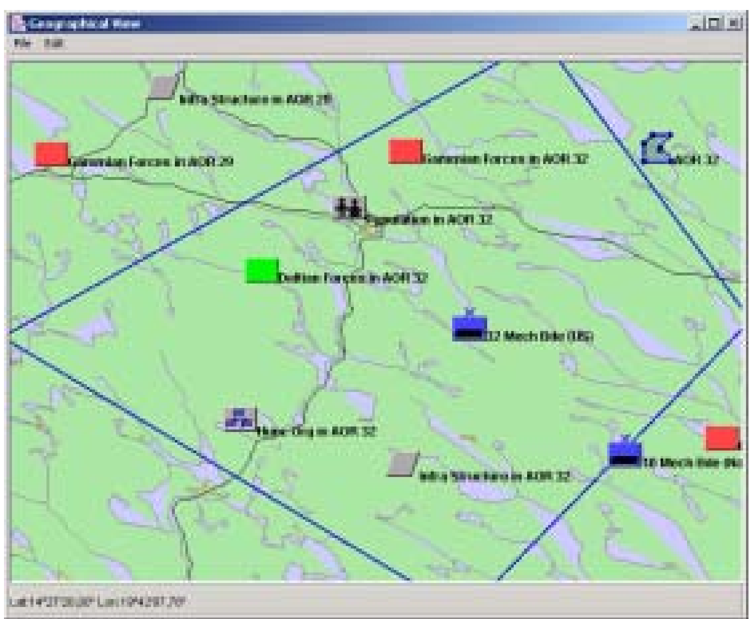

Figure 11. Zoomed in, the geographical view depicts forces and other entities on a lower level of abstraction.