Multi-Agent Cooperative Management For Geo-Political Risks And Crisis

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The Information and Communication Systems (ICS) have been created forty years ago by commandment to help following military operations and to also help taking strategic decisions. Cooperation between users and ICS has to be taken into consideration in the core of the design. Human sciences, cognitive sciences and basic sciences takes part equally in the ICS method.
An incremental design process is required in order to organize an ICS architecture, to bring out functional and ergonomic specifications, and to structure an ontological application such as a multi-agent cooperation model. This kind of design process which was a success in the military domain for geopolitical crisis could be easily applied in other complex technical systems such as nuclear power, gas and petroleum production, transportation or ecology.
In order to do so, we will explain this method through the successful example of the CHEOPS Project.
In a first part, we will describe its risk management system, then we will put the emphasis on its multi-agent cooperation model, in a third part, we will present a situation analysis as a constructive modelling process and we will finish with an analysis on the CHEOPS project and its possibilities of evolution.

1. CHEOPS Project's risk management system

The CHEOPS Project is based on a fictive crisis simulation called CHEOPS-Tchad, where Tchad is involved in a civil war opposing the government and rebels supported by Libyans. The French Army has to protect the official government against Libyan's threat.
Before the CHEOPS-TCHAD Project, success in crisis management depended mostly on the Military's Attaché (AM) experience. The system was composed of two major parts: the Tchadian operation field and the Military Intelligence Direction (DRM) located in Paris. Protocol constraints regarding communication between them were too important to define a cooperation model.
In the project, each actor has a CHEOPS system and they are linked together. The AM provides its CHEOPS' database with geopolitical information. The DRM's CHEOPS system has a huge image, plan, map and document database .In addition system is connected with a lot of information sources.
The constraint in such a multi-user system is that each user has a specific need in terms of information objects. The thematic layer concept allows each user to build his own vision of the geopolitical operation field selecting relevant objects for him.
In order to model crisis, it is essential to define the event, situation and scenario concepts. An event is a pool of facts; their identification and handling is the base of crisis situation analysis. A situation is a geographical operation field in a given moment and is composed of relevant objects essential for its analysis. A model situation is a situation which has been analyzed and described. A scenario is a collection of model situations. When a scenario is encapsulated in a period, it becomes a crisis.
We can define the crisis concept showing differences between permanent and crisis states.
In the crisis state, the situation analysis is made harder because human discernment is wasted by stress, importance of stakes and indeed cost. The crisis generates a temporal paradox because its analysis and linked tasks, like communication or justification of choices, need time incompatible with crisis resolution. One man can not manage a whole crisis by himself like in the Marc Aurèle time [Marc Aurèle 92]. Only virtual or real human groups working together can face a dynamic and complex situation, and so it is a typical multiparticipant activity.
To meet this group working requirement is one of the main stakes of this domain. Crisis management gets it sense only if it is coordinated which adds a complexity level. This complexity is due to the fact that coordination should dispatch participant productivity without limiting their efficient. Crisis analysis should be split in time, space, speciality, actions and functional roles of participants.

The crisis management ICS anticipation is important but is not always enough to avoid crisis and so it is essential to implement a three parts operational crisis management:

- Anticipated operational management: to plan emergency action, to allocate needed resources and to optimize key parameters.
- Real time operational management: to update situation and decision parameters, and to make plans matching with reality.
- Back to normal operational management : To disengage efficiently allocated resources.

So rules and constrain propagation techniques based planning modules have to be realised. In crisis management ICS, information of the situation is critical but documentary information is critical too. Commented past crisis files make a database which brings comparison point, decisional argument and a base for innovation. In addition on request data extraction can justify decisions and brings complementary information. An electronic document management system, based on indexed full text has to be realised.

In this ICS the emphasis is put on heterogeneous systems interoperability but in order to build a real multiparticipant system, it is essential to develop a strong collaboration between experts who can have different point of view and to be able to organize and deploy a crisis cell very rapidly.

IA can be very interesting to help the decision process particularly with new automatic learning techniques [Kodratoff & al. 87] like the Case Based Reasoning which uses analogy mechanisms, and other learning techniques ([Michalski 86], [Michalski 93], [Mitchel & al. 83], [Kodratoff 86], [Rousseaux & Tecuci 87], [Dejong & Mooney 86], [Barès & al. 94]) which takes benefits of experts produced explanations in order to generalize problem resolution modes.

Some other problems which represent knowledge modelling constraints have to be taken into account:

- Databases for objects modelling in space and time, and uncertainty management and management of fuzzy.
- Attention management for relevant granularity scale in space and time: phenomena can be predictable only with a certain spatial-temporal backward.
- Decision help to take pictures of interesting situations, to compare and comment on them. But also to be able modelling something which no longer exists.
- Ergonomics to detect user's intentions from basic actions, to anticipate and solve ambiguity in concordance with user's supposed goals (GEOCOOP [Zacklod & Rousseaux 95]).

2. Multi-agent cooperation model

The CHEOPS-TCHAD simulation has demonstrated that in order to solve efficiently complex collective problems, a multi agent cooperation model has to be design. It is which has initiated the MadeInCoop modelling model. This one can be divided into four main principles:

- The knowledge level cooperative human-machine activity design, which describes users and system activities considering that artificial and human agents have goals and knowledge.
- The cooperation situations positioning in global organisational context, which describe organisation, tasks and characteristics of its agents, and especially which let identify agent sub-groups usually interacting.
- Cooperation dynamic description, which is based on agent interactions.
- Actor cooperative activities description, which models one actor activities in problem resolution, coordination and communication actions.

The Collective General Activity model in MadeInCoop can be divided into three sub models. The first one is a the task model which have to provide a general schematic modelling main activity aims and the means used to reach these goals. It includes a chronological dependency description between aims. In this simulation, we can find two main tasks groups according to the situation: in normal phases, it consists to imagine all possible scenarios and following answers, and in crisis phases, it consists to follow situation and its evolution feeding databases, to analyse events, to define goals and plan the means to reach them. The second one is the agent model. For each agent, the know-how, the responsibilities and the availabilities are defined.

Finally the organisational model defines the negotiation rules between agents and tasks in order to respect characteristics coming from agents and tasks both. The result is the definition of some interaction situation between agents and general coordination principles between inter or intra agents groups.
There is six main agents. The Military Attaché (AM) collect information and send argued reports on the situation (it is a human agent), the event database manager (GETEV) classify each event, the map database manager (GESTCART) manage different maps, provide zoom and can put in relief thematic layers , the messenger (MESSAG) transmit messages (it is a human agent), the news report analyst (ANALYS) translate text news reports into the database format, the tactical simulator (SIMUL) make calculations and simulations in order to estimate current strength or necessary time to move unitsand the arguer(ARGU) let the user from tactical hypothesis to search corresponding events in the database and on the opposite, to analyse a pool of events in order to find strategic hypothesis.
In MadeInCoop, general model draw the background (poser le cadre) where the different cooperation situation will happen which will let agents to solve collectively the problems
The shift between the general model and the cooperation change twice the way to handle the situation .it's a shift from a static view to a dynamic view focused on the interaction between agents and it is a shift for a more detailed view where problem resolution activities and coordination are handled more precisely.
Based on most of the activities on cooperation between human agents we will use the maieutic approach where the cooperation can be modelled with high level dialogues between agents.
Agents try to cooperate they shares a working memory where a history of their dialogues is recorded. This record can be use on 3 different processes:
The first is the problem resolution process which is the progressive exploration of the group "problem space".
The second is the coordination process it's a record of the agent progressive engagement. This process controls the first.
The third is a communication process which let us to follow the steps of a collective speech.
In order to illustrate this model we will use an artificial problem resolution dialog between local crisis management computer agents.
In the scenario, the Tchad is in a civil war context opposing the official government and the rebels helped by Libyans The goal of the system is to help French military direction to take decisions identifying if movements are spontaneous civil war movements which no need French intervention or if these movements are due to the Libyans trying to invade the Tchad area which would need a French intervention because it would be an international law breaking. The last events chronologically logged are the followings:

- Troubles have appeared in the Biltine's barracks which is near the north frontier without having the possibility to know the causes of these troubles
- Street Fights has been signalled in Tchad's capital N'Djamena near the national assembly the consequence is that governmental troops has been sent from the north area to the capital
- The airport of the Tchadian capital has been bombed but the enemy fighter planes has not certainly been identified. Experts are analysing bomb impact pictures .Rebels have old soviets which would not have permit them to commit this bombing

In madeincoop, the collective problem resolution method is based on a "structure induction" method [Simon & Lea74], [Hoc 87].

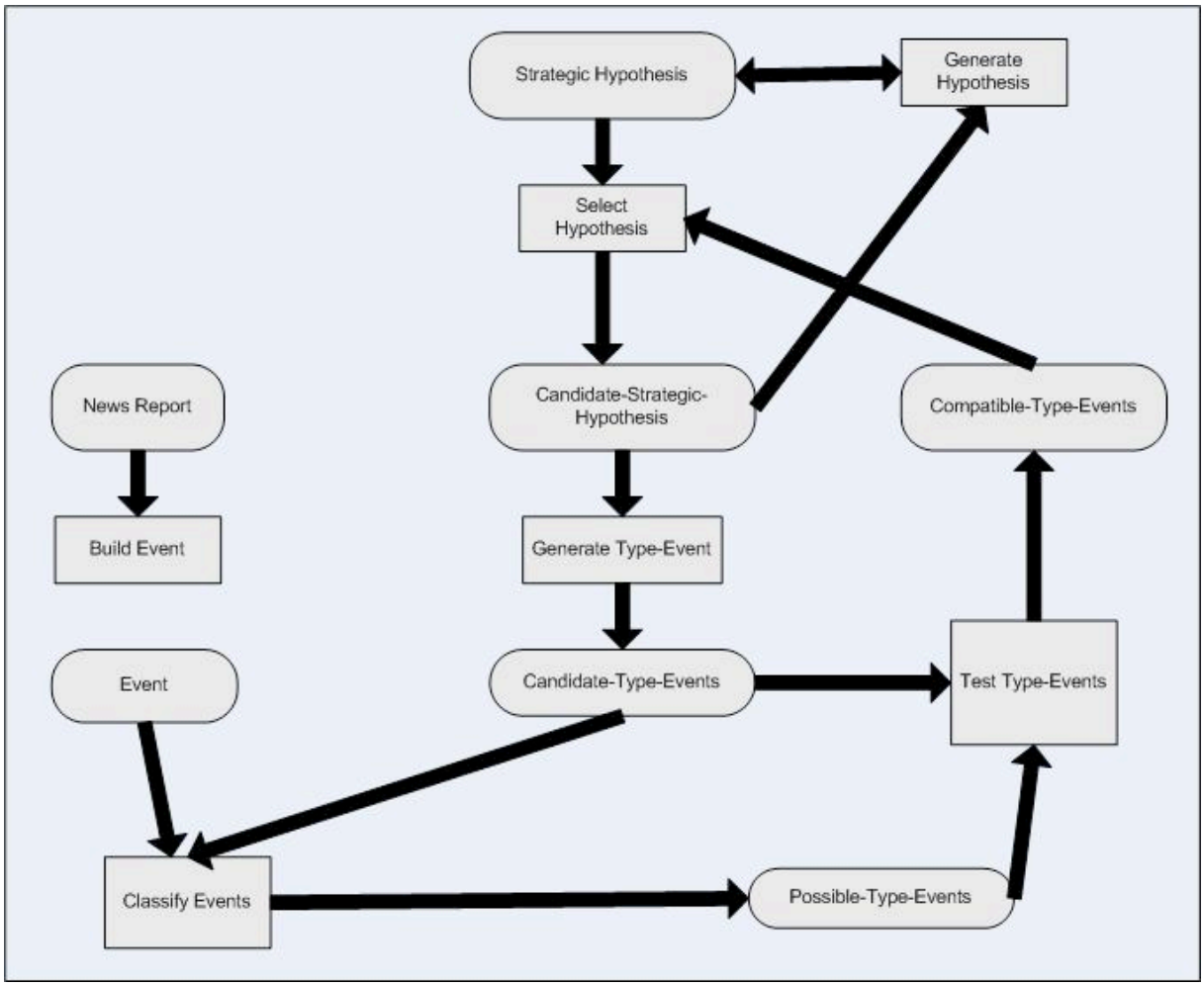

Fig1: Inference structure

An event is build from a news report before to be paired with candidate type events.
The quality of these pairings select possible types-events which compatibility with context is selected with confrontation with possible type events precedently identified.
In the following example, two strategic hypotheses have been generated: and the AM try to select the "protestation troubles" hypothesis. The process begins with extracting some properties of the news report (C1, C2, C5, and C6). From the candidate hypothesis, the AM generates a candidate type event with the C1, C2, C3, C4 properties. Comparing it with the capital's troubles he is concluding that "student protestation" is a possible type event to model these troubles Te following step is to test the possible type event to verify that it let define a compatibles type events pool with other candidates type events The conclusion of the test is not favourable because an other interpretation of the events exists: "spontaneous mutinies" which associated with "student protestation" is compatible with "protestation troubles".

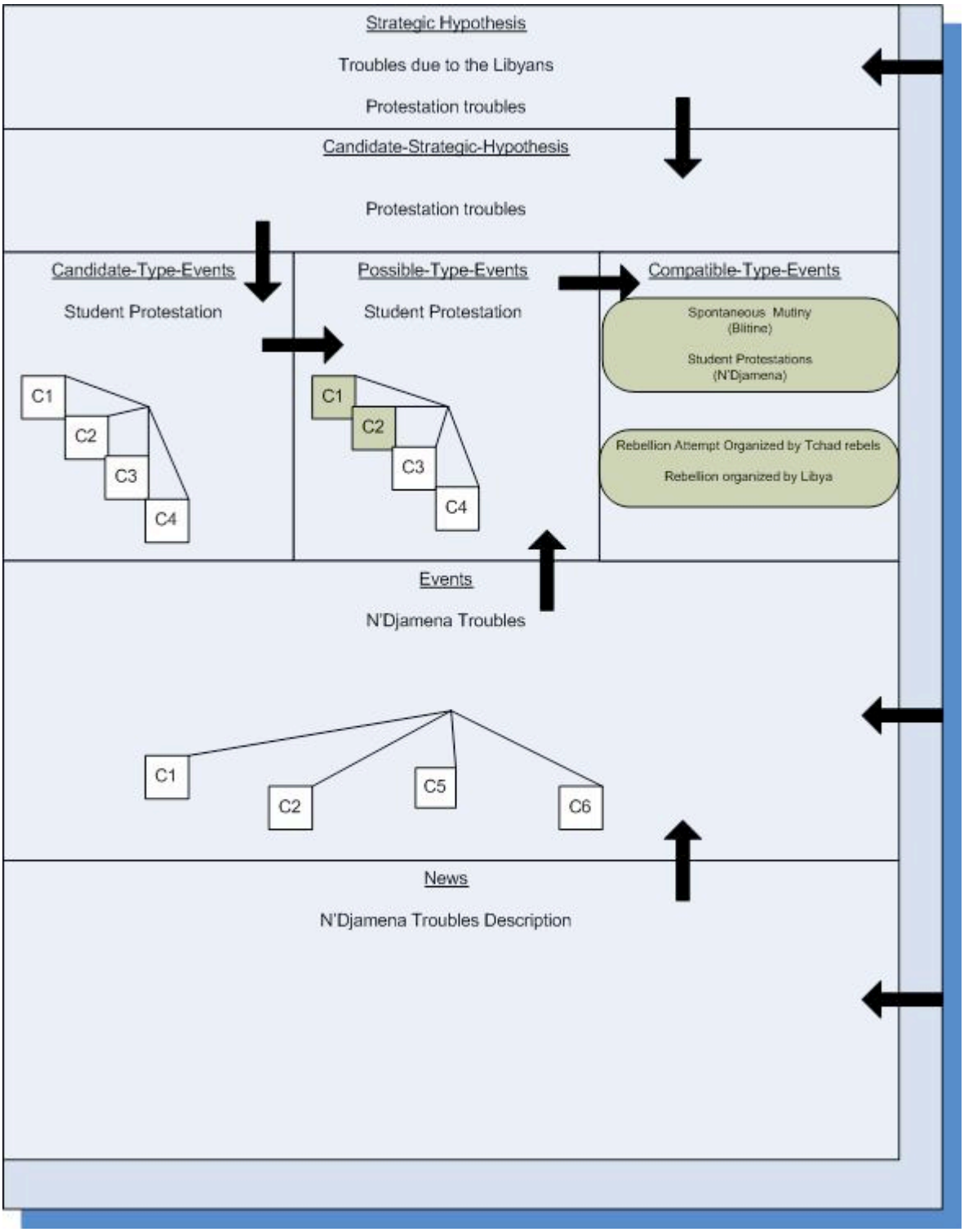

Fig2: Virtual memory workspace of the local crisis management PC

This tab present an extract from the virtual dialog between agents:

	Interpretation based on the problem resolution process	
1	MA: Did you received the description of the N'Djamena events? It seems to be protestations organized by students near the opposition. This confirms that Biltine events are probably just the consequence of a problem linked with the soldier's salaries and so it is interior troubles…	Build-Event Classify-Event Test-Type-Event Select-Hypothesis
2	ARGU: I disagree the cause of Biltine events is unknown and the M'Boutoul ethnic group implicated in the Biltine events is with the rebels	Classify-Event
3	MA: Can you show that is it possible that rebels can be implied in recent events?	Test-Type-Event
4	ARGU: Yes I can demonstrate it.(Demonstration following)	Classify-Event Test-Type-Event
5	MA: What are the consequences?	Generate-Strategic-Hypothesis
6	ARGU to SIMUL: Can you make an estimation of forces in presence in the south area taking the last events into consideration ?	Generate-Strategic-Hypothesis
7	SIMUL to ARGU: Integration rebel forces and Libyan regiments the force ratio is unfavourable for Tchadians	Generate-Strategic-Hypothesis
8	ARGU to MA: If Libyan rebels are implied this mean that an attack in the north area may happen at any time. The Chadian defensive potential is low in this area	Generate-Strategic-Hypothesis
12	MESSAG intervention: I just have the news that we was waiting for : It is possible that fighter planes which have bombed the N'Djamena Airport was from the Marchetti SF-260 type	Build-Event
13	MA to ARGU: You may be right	Select-Strategic-Candidate-Hypothesis
14	ARGU: Why this opinion changing?	Select-Strategic-Candidate-Hypothesis
15	AM: Because the airport bombing has probably been committed by Libyans who have this type of fighter planes which can means that a huge invasion may be in preparation	Build-Event Classify-Event Test Event Select-Strategic-Candidate-Hypothesis

The actions of the coordination model of the same as for the collective problem resolution (CPR) but different memory areas have to be reserved. A common group position area have to be reserved where are recorded all the arguments and decision validated by the group and reflecting the "official" point of view of the group. An individual area has to be reserved to put the individual group member's decisions when they are different from the group decision

The implementation of coordination acts is mainly determined by group members actions on virtual memory workspace Its structure as for type: ACTION(OBJECT, PLACE,RIGHT,SEQUENCE).

3. Situation analysis as a constructive modelling process

When we talk about crisis management intention interpretation, mission preparation or battlefield intelligence with militaries or civil servants, they have a clear advice on the concept of event. For them a fire or a bombing is clearly an event.
For these operational actors the world is made of objects which exist in a reduced space and time and which have behaviours [Cauvet & Rolland 92] and of events which happen and which have to handle in order to control the situation.
For them a decision helper system should be a representation of the operations field with plans, map and picture.
A representation of real objects with their associated properties and a model which let the user to translate the real situation into a simulation where he can simulate the actions to take and their consequences
The CHEOPS system has been designed and specified with operational officers. This representation could bring to an efficient digital representation only avoiding some aporias [Chaudron 94] [Poirel et Chaudron 94]
In a first time the event concept to be clearly defined
To be considered as an event in a crisis management context , an event have to gather some properties : it has to be linked with fact and so with environment objects to be localized in space and time., to be linked with a considered environment the event is interpreted [Sperber 92] ,to be linked with an intentional context [Sieroff 92]

We can wonder if in designing crisis management systems we try to rationalize and make a situation collectively understandable. This model is based on a deterministic concept: the same fact produce the same effects and if you understand the causes of a crisis you can avoid this crisis the next time that the cause will merge.

4. Conclusion

As a conclusion, we can say that this project through the design of the CHEOPS collective crisis management system has contributed to a knowledge gathering method for ICS.
The goal was to adopt a global description on the knowledge level without neglecting industrial organisational constraints
The industrial context has its own requirements and the feasibility of each program has to be demonstrated, especially for important programs. A ICS helper to the military crisis interpretation has been developed taking the CHEOPS-TCHAD scenario as a narrative base. This scenario was based on experience of an expert in geopolitics. In the design process, a system integration method has been adopted in privileging an abstract model of knowledge.
The experiment was a complete success and it let us to increase incrementally the experimentation field to other concrete cases adding to the technological objectives a scientific goal
In order to increase reusability and genericity to further the reflection of the in-depth nature on engaged. This work widely opened to the human sciences have been concluded with ontological primitives descriptions and inference structures for the geopolitical crisis interpretation
A lot still have to be done but the matter is scientifically rich enough to let a lot of researchers in multidisciplinary domains to bring their contribution. This subject is a challenge for our societies because beyond technological and scientific aspects ICS invite us to collective intelligence.