

# Contracts for Information Sharing in Collaborative Networks

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## ABSTRACT

In crisis management, units from different organizations collaborate for achieving a common goal. The success of such collaborations depends partly and not insignificantly on the composition of the network of collaborating units. In the initial phases of a crisis management operation, there is often a great deal of uncertainty about the nature and the extent of the crisis. The uncertainty may lead to contradictory and otherwise imperfect information sharing among the organizations and agencies that are responsible for engaging the crisis. This in turn, may lead to suboptimal and inefficient compositions of the collaborating network. This paper suggests the use of contracts for information sharing for ensuring that the information sharing indeed facilitates efficient formation of collaborating networks.

## Keywords

Collaboration, Information sharing, Contracts

## INTRODUCTION

This paper deals with the formation of collaborative networks in crisis management. The focus is on the Swedish crisis management system, as this is part of our applied research. The collaborating teams are formed according to an agreement of division of responsibilities. The agencies have in turn the responsibility both for making the operative plans and for the allocation of required resources. Such operational tasks are internally assigned to detached units within the agency. The resources may range from personnel to other physical resources such as transportation or mobile power supplies. The resources and required measures of given resources depend on the crisis at hand: transporting a person injured in an accident requires an ambulance, while supplying transportation for several thousands in an evacuation situation requires considerably more capacity.

We assume in this paper that the formation collaborative networks for emergency management are regulated by a collection of contracts. This includes agreements and common practice between the Government and the responsible agencies; the agencies and the resource providers; and within the agencies. The critical aspect we are investigating is that of information sharing in the initial phases of the formation of a collaborative network for crisis management. In the early stages of a crisis, there is rarely a clear picture of the crisis and its extent, making the required composition of the collaborating team hard to determine. Depending on how the initial information is perceived by the actors, they may interpret, or execute, the formation contracts in rather different ways, which in turn may lead to suboptimal resource allocations and network formations. It is therefore critical that there are some principles in effect for ensuring coherence in the interpretation and sharing of the initial information.

The contribution of the paper is an outline of a set of principles for information sharing for improving the efficiency and adequacy of the formation of collaborative networks in the early stages of the engagement of a crisis. We also suggest how contracts can be used for enforcing those principles. In this paper, we present our initial ideas concerning those principles and their enforcement.

**Reviewing Statement:** This paper represents work in progress, an issue for discussion, a case study, best practice or other matters of interest and has been reviewed for clarity, relevance and significance.

## BACKGROUND

### Swedish Crisis Management

In the Swedish crisis management system, a crisis triggers several agencies to execute their respective contingency plans in order to fulfill their responsibilities. By law, the agencies are autonomous and make the contingency plans independently of each other. The agencies are further required, by law to collaborate in the engagement of a crisis. These two aspects of Swedish jurisdiction yield the two main assumptions for this paper:

- (Assumption 1) Agencies are independent
- (Assumption 2) Agencies collaborate

The detachment of operative units is determined both by the characteristics of the crisis and by the contingency plans made up by each responsible agency. For an agency to be able to detach adequate units, it is required that the initial information it receives about a crisis adhere to some principles, such as accuracy and timeliness. Agencies must also be able to understand how other agencies will react on the initial information about a crisis, which puts further requirements on how information should be shared in the initial stages of a crisis. Section 3 investigates such principles for information sharing.

### Networks of Resources

The deployment of adequate resources is critical for crisis management. In this paper, we distinguish three types of resources. The first type comprises the operative units detached from the agencies, which can be said to belong to their respective agency. The second type comprises resources supplied by third parties (and not owned by the responsible agencies), which may be other agencies, private companies, or international organizations. For example, the Armed Forces may supply resources for clearing roads after natural disasters, or private airliners may assist in the evacuation of Swedish citizens. The third type comprises resources that are used or consumed by resources of the first and second types. Examples of such are communication equipment, gasoline, and weather forecasts.

In the Swedish system, by Assumption 1, the agencies plan for the deployment of resources independently of other agencies. They thus need to form agreements with providers of resources of the second and third types. It is often the case that there are dependencies among resources that affect the deployment. For example: experts may need transportation prior to their insertion; and some equipment may require authorized personnel for operation. When an agency engages a crisis, we say therefore that it deploys a network of resources consisting of (i) the detached operative units and the contracted resources of the second type; (ii) the resources on which those depend; and (iii) all the resources used or consumed by those resources.

During collaboration between the agencies (assumption 2), the networks of resources independently deployed by the agencies form a composed network of resources consisting of all the resources contained in the component resource networks. The composed network exhibits further dependencies between resources that could not have been foreseen when the agencies made their contingency plans. In particular, two agencies may have contracted the same provider of a resource of the second type, which may cause the contingency plan of one or the other agency to fail. Further, by assumption 1, the agencies may not have planned for the consumption of resources of type 3 by other agencies, which may lead to resource shortage during a crisis engagement. Due to possible dependencies between resources, deploying one resource, also the resources on which it depends must be deployed, in particular when the resources belong to different agencies. For example, when the responsible medical unit deploys ambulances, it needs to know that the roads are clear, otherwise it would deploy a helicopter.

### Contracts

We are currently developing a contractual formalism for expressing both formal and informal agreements between agencies. For usability concerns, we aim at making the formal notions expressible in an accessible high-level language, for example Service Level Agreements (IBM, 2003). In our formalism, a contract has a signer and an owner, and it is composed of a set of terms, which are sub-divided into action terms, validity terms, and trigger terms. A signer is an agent that promises to adhere to the action terms in the contract. An owner is an agent that can hold the signer responsible to one or more terms in the contract. An action term describes what a particular signer

needs to do. A validity term tells under which circumstances the (terms in the) contract need be adhered to. A trigger term tells when and under what circumstances the contract is to be executed.

From the informal description of a contract above, we can give some further preliminary indications on the development of our formalization. Agencies are formalized as subjects in our contract language. Since we are focusing on information sharing, the action terms should formalize both requests and delivery of messages. The messages could be formalized as forms that precisely describe the information to be requested or delivered. It is important that the action terms capture both the message and the subjects that are intended receivers and senders. Further, action terms need to include timing constraints for the sending of information. A trigger term should be uniquely interpretable as an actual event or condition in a crisis. Given the occurrence of a particular event or condition, it would then be possible both to determine whether a contract should be triggered, and in the aftermaths, to determine whether a subject was liable for violating a contract. Similarly, the validity terms need to be interpretable as actual states-of-affairs of a crisis. The validity terms should capture both timing concerns and the conditions of a crisis that may affect the validity of the contract. In civil society, the laws often play the role of semantics with lawyers as interpreters of the contracts into the law and the states-of-affairs of a crisis. Enforcement of our contracts may be achieved by the signers' unwillingness to brake a contract. A broken contract (i.e. when a term hasn't been adhered to) may result in a law-suit or compensation claim. We give two examples of how contracts could be formed so to express the informal agreements briefly sketched in the previous section.

#### *Contracts for responsibility*

A contract is signed by an agency and the Government (on behalf of the people) saying that the agency taking responsibility for some specific part of emergency management. (e.g. the Police have the responsibility for enforcing law and order). In return, the Government promises to give the agency a share of the budget. The owner of the contract is the Government, giving it the right to hold the agency responsible.

#### *Contracts for resources*

In the case with agreement between agency and private company, a contract is both owned and signed by the agency and a resource provider. The provider promises to provide a resource for some kind of compensation. In the terms, it may be specified what triggers the exchange and what measure of the resource should be provided.

### **Information Sharing**

Information management in crisis management situations, involve important aspects of different organizations, units, individual actors or agents; types of information sources and information types and channels for processing the information. This information flow between units (organizations and/or individual actors) may be synchronous or asynchronous and loosely or tightly coupled to related activities [Hansen and Järvelin, 2005]. When performed in a crisis management situation, this may be a highly ad-hoc situation and in a very dynamic context. Therefore, it is of great importance to be able to initiate and manage the flow of information between actors in an effective way without critical disturbance.

This complexity is caused by the fact that actors, groups of actors and organizations have various knowledge levels. The information itself might have different meaning for different actors and hence create an obstacle for interpretation on site. Furthermore, there might be situations in which people/groups of people do not get the adequate information, which in turn might lead to unfortunate decisions when solving an ad-hoc problem. The information itself might have different meaning for different actors and hence create an obstacle for interpretation on the actual site of crisis and may lead to complexity in assessments and appropriate feedback. In a crisis situation, the different professional roles/rules/conditions etc within participating organizations may act as barriers with respect to the flow of information and communication between organizations and actors.

Detlor and Yuan [2005] mean that a system that should support and manage collaboration and information sharing in both a centralized and distributed situation, may support 6 tasks:

- Decoding and reporting
- Identifying information sources and links to experts
- Selection and contact with appropriate groups
- Organization (the availability and roles of participants)
- Operation (gathering and transferring of updated information)

- Judgment and investigation

One factor that leads to collaboration is the division of labor in a specific situation. Especially in situation where time is critical. Another reason for collaborating and sharing information (and knowledge) is to share a specific source and the possibility to learn from other agencies.

### INFORMATION SHARING PRINCIPLES

If we assume that there is an object (crisis situation) that is the focus for a collaborative and information sharing efforts, then this object is a shared concern for different actors (organization, groups and individuals) in a specific social community and situation. This specific situation is then also a concern not only for those close to the situation but also to those concerned in general. The creation and initiation of the crisis management is achieved by means of, e.g. a division of labor, communication, and agreements that is both formal and informal, such as formal and hierarchical decision-making to informal and pragmatic judgments. An actor or groups of actors, is connected to a social environment through different set of formal rules (such as social, legal, professional rules and regulations) and informal (tacit rules such as who have the best knowledge for a specific task). These rules as well as the different roles the actors or units have, will guide and affect the creation of an ad-hoc group of actors collaborating and sharing information between actors. In this paper, we are more focused towards the use and effects of formal rules or contracts agreed upon between different actors/agents.

We propose to introduce and design the concept of contract for information sharing. We aim at formalizing the concept similarly to the contracts described above. The purpose of having a contract for collaborative information handling in a specific crisis management situation is that a) all actors involved should be able to have access to the same incoming external information about the specific event, and b) actors/agents should as much as possible, and where appropriate, share local or internal and relevant information with other actors or units involved in the situation. With contracts, these requirements can be enforced and tailored with great precision for different situations. The information that are to be shared need to:

- be the appropriate information for the situation and task at hand, both regarding the administrative and operative actions. There must be agreement on how to process data and information that is updated; relevant; contextually relevant content; and qualitative.
- be timely. Actors need to be able to ensure that certain pieces of information are used by other actors at a certain time during the process.
- be shared by the intended actor(s)/organizations. It is vital that the relevant piece of information reaches the right destination (actor or unit).
- be understood by different receivers. Shared information need to be by different actors with different experience, knowledge, or jurisdiction.
- pass different positions (e.g. operative, legal, or hierarchical). In a collaborative environment, there are also certain procedures of information handling that require that certain information is shared across different operative and legal positions, and thus need to be cleared and secured before presented to others.
- use interoperable technology. It is important that the rescue groups are equipped with technological means to receive the information and then to assess and make decisions on that information
- be processed for adaption and extraction. Information from different sources and different types of information need to be extracted, summarized and merged for assessment and judgment.

### Contract for Information Sharing

The following is an outline of how a contract for information sharing may be formed. Assume that there are two agencies, A and B, which would benefit from information sharing in the initial phases of a crisis management situation and before detaching units. Assume that C is a contract for information sharing.

*Signer and owners of C.* The signers should be both agencies, since there is no point in only one of the agencies promises to share the information according to the principles laid out above. The owner of the contract need not be any of the two agencies. Rather, it should be the stakeholders, or a representative for the agents that are supposed to benefit from that the agencies perform according to their mission. Thus, the owner of the contract could be a representative of the citizens of Sweden, or the Government. As owner, an agent can then hold the agencies A and B responsible for not having shared information according to the principles laid out in the contract.

*Trigger and validity of C.* The validity of C would be set out to be from the time of signing until the signers are released from the contract by the owner(s). The trigger should be determined by the particular crisis type in which the two agencies collaborate. For example, the activation of an agreed indicator for a particular crisis type may trigger the execution of the terms of C. (The agreement on an indicator, is settled in an auxiliary contract.)

*Terms of C.* There are first of all terms that facilitates the contract itself: e.g., one that refers to the agreed indicator mentioned above, and one for an agreement on a common crisis description language. More importantly for this paper there should be terms for information sharing. Each agency can specify, perhaps in negotiation with the other agency, the appropriate information it needs from the other agency for the particular crisis type. Here it could be specified also the desired accuracy of the received information. The timeliness of the information is possible to express by a term introducing counters and/or timestamps on the execution of the terms of the contract. That the information is shared between the two agencies is given by the contract signing, however, the parties can make inclusion and exceptions to the contract for tailoring which other agencies or actors they wish to share the information with. Similarly, the sharing of sensitive information can be excluded by a term in the contract.

For the technological aspects, we can use terms for specifying exactly with which software and hardware the information should be processed, to any level detail (e.g. version of the compiler of the used operating system). Finally, it may be specified in the terms how the information may be processed and further distributed, e.g. whether information may be extracted and to whom the extracted information may be forwarded.

The intended benefit of using contracts for information sharing as outlined above is that an analysis of such contracts can give a measure of the adequacy of existing contingency plans. An analysis can for example give an indication of weak links in collaborative contingency plans. Since crises by nature often face emergency workers with unexpected demands and collaboration needs, an analysis of existing contracts may not suffice. Our suggested framework could in such cases serve as a tool for incrementally improving contingency plans, based on the experience of new kinds of crises, with respect to contracts for information sharing.

## CONCLUSION AND FUTURE WORK

We have identified that the mode in which information is shared in the initial stages of a crisis is critical for the success of collaborative engagements in the crisis. It is the high level of uncertainty about the crisis that makes the formation of collaborations sensitive to how information is shared. We have proposed to use the notion of contracts for information sharing for making the information sharing process more efficient according to a set of requirements we have outlined. Future work includes first and foremost the choice of contractual formalism and the actual formalization of contracts for information sharing.

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