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Implications of Information Flow Priorities for Command and Control of Interorganizational
Network-enabled Defence

Organizational Issues, Networks and Networking, C2 Concepts, Theory and Policy

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Abstract

This paper concerns command and control of interorganizational Network-enabled Defence (NED) from information flows point of view. Interorganizational NED involves governmental and non governmental organizations. They are either international or local actors. Typically, these actors have a variety of internal command and control processes, organizational structures and information delivering and acquiring practices. However, in Joint operations where multiple actors are engaged, the actors across the various organizations have to achieve and share situation awareness and understanding. This requires horizontal collaboration and interaction which are not present in traditional hierarchical command and control approaches.

The paper is based on the main results of a prior study that addressed information flows supporting high-level decision-making activities during a sudden crisis situation. The target of the study was the Finnish national administration. This paper presents the results of information flow profile study of decision-makers. The results of the study show that horizontal information flows between the actors are limited. This challenges interorganizational command and control. The paper proposes that command and control is improved based on the results of the information flow profile study. This includes the development of a framework and information and communication technology based services for information sharing.

Introduction

This paper concerns command and control of interorganizational Network-enabled Defence (NED) from information flows point of view. NED is a working title for a concept that uses the principles of network enabled warfare for securing the functions vital to society in Finland. NED is defined to describe how future networks with improved and integrated information and weapon systems can enable Command and Control of Joint and Territorial operations and enable Interagency Collaboration in securing vital functions of the Finnish society in Total Defence (Kaskeala 2005). This definition states that NED is a Joint activity where Ministry of Defence, Defence Forces and other state authorities of Finland and non governmental organizations are involved. The emphasis of the definition is on the integration of information and weapon systems. This integration supports information flowing on NED.

Recently updated strategy for securing the functions vital to society in Finland (Government Resolution 2006) includes the following threat scenarios: a disturbance in the electricity grid, a serious disturbance affecting health and income security of population, a serious disturbance in the functioning of the economy, major accidents and natural disasters, environmental threats, terrorism as well as organized and other serious crime, threats linked to migratory flows, political, economic and military pressure, and the use of military force. These threat scenarios cover both different types of crisis situations as well as serious violation of Finland's territorial integrity, threat of war, armed attack and war. Originally NED was developed based on threat scenarios involving the use of military force. However, NED as a general concept provides a system model about the evolving interorganizational networks of actors securing the functions vital to society in any threat scenario.

Typically, the actors of NED have a variety of internal command and control processes, organizational structures and information delivering and acquiring practices. They both exploit and create information associated with the networks of actors. In Joint operations where multiple actors are engaged, the actors across the various organizations have to achieve and share situation awareness and understanding. However, it has been difficult to anticipate which specific types of information will be required across an interorganizational network. In addition, information sharing requires collaboration and interaction between organizations. These are not in the focus of classic, hierarchical command and control (C2) approaches.

The development, planning and implementation of NED activities require an interorganizational command and control approach and an interorganizational structure that enable a variety of diverse organizational actors to retrieve, share, understand and prioritize information quickly and effectively. The aim of the paper is to increase understanding about the interorganizational command and control approach and structure. The paper is based on the main results of a prior study that addressed the information requirements of high-level decision-making activities during a sudden crisis situation. The target of the study was the Finnish national administration. First, the paper presents the results of the information flow profile study of decision-makers. Then the paper draws implications of the study to the command and control of interorganizational NED.

The frame of interorganizational NED is presented in Figure 1. In a real world situation, a great deal of practices and viewpoints exist amongst various actors. Those do not necessarily have any informational or activity-based interaction or even a will to interact with each others. On the other hand some organizations or other actors have very comprehensive cooperation. The real

world situation is though practically impossible to control or coordinate in traditional way. New solutions to solve the challenge of creating better possibilities to various actors to operate safely and well enough to fulfil their tasks on common theatre are required.

The concept of trusted social network that is supported by adequate technological solutions acts as a hypothesis of this paper. It creates a shared situation understanding to those actors that are supposed to perform their activities on the same operations area. The hypothesis is situated in the Poppers' (1975) sub-world of possible thoughts. It is supposed that when various actors share suitable information with each other a better common understanding of ongoing situation and the properties of those various actors, as well as knowledge of overall environment is achieved. Further on, this helps actors to direct their own activities and exploit their resources in a way that is more optimized than it would be without sharing information.

Information sharing process is supported by ICT services. Those services do not bind various users to any determined processes or other ways to perform their tasks. They take place in the sub-world called mental, technological and social interpretation. Mental interpretation takes place via the conceptual structure of information sharing. Technological tools form a platform to perform social interpretation. So, this concept does not determine the users way to perform activities. Instead, it gives a technical platform and possibilities to understand the power and meaning of mental interpretation to enhance own ability to perform tasks and to cooperate on suitable levels.

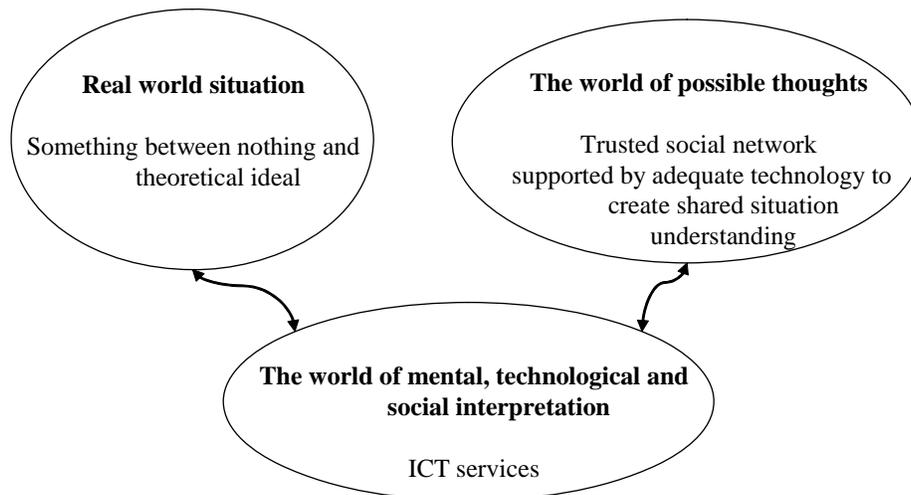


Figure 1. The frame of interorganizational NED, based on (Popper 1975)

In this paper the concept of information is understood as a general term for data, information and knowledge. Data is a set of discrete and objective facts about events (Davenport & Prusak 1998). According to Thierauf (2001) information is defined as structured data that is useful for analysis. Information has a meaning to a receiver (Davenport & Prusak 1998). Information becomes to knowledge, when information is understood and interpreted. Knowledge can be defined as an ability to turn data and information into an effective action (Applehans et al. 1999). As shown in Figure 2, entities interact and create new knowledge from the internal and external data, information and knowledge flows (Kuusisto 2004). According to Maier (2000), information between two entities mostly flows on data and information levels. This can be found obvious on the basis of Habermas's theory of communicative action (1984, 1989). He claims that to start communication, at least one common item must exist between interacting parties. Interaction and its devel-

opment are based on this common item. Typically, two entities do not share all their knowledge items and thus cannot understand all delivered knowledge flows.

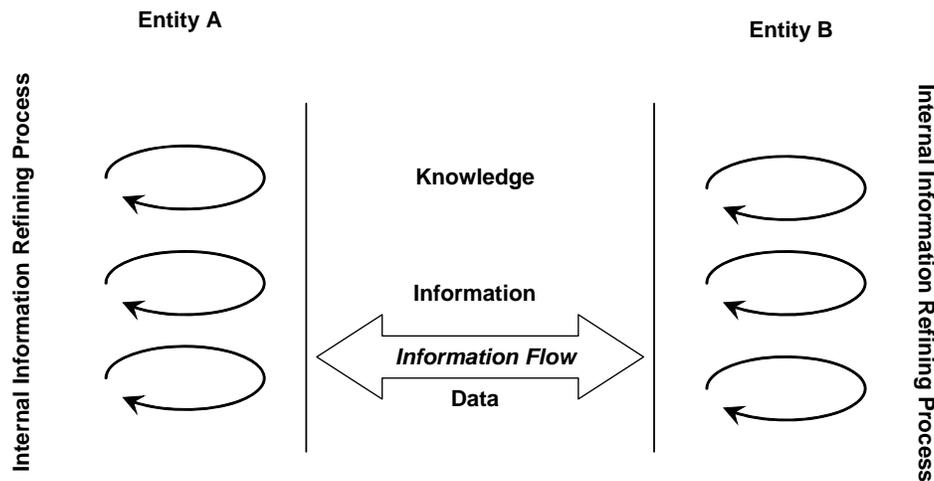


Figure 2. Information Flowing Concept (Kuusisto 2004, based on Maier 2000)

NED involves activities performed across several organizational layers (Figure 3). The layers include a political-strategic layer that guides and is reported by operational-theatre level. Information is delivered and retrieved on each layer and between the layers. NED activities are implemented and managed by a variety of actors, who participate across a diversity of organizations. Especially in crisis management situations there is not any organization having full power over all the other organizations. Experience on crisis management responses suggests that classic C2 approaches seem to be too slow to organize information and actions effectively in networks of actors. In addition, the impact of Information Age has been the decoupling of information flows from the hierarchical military structure (Alberts et al. 2001). So, hierarchical C2 has fundamental limitations in NED context.

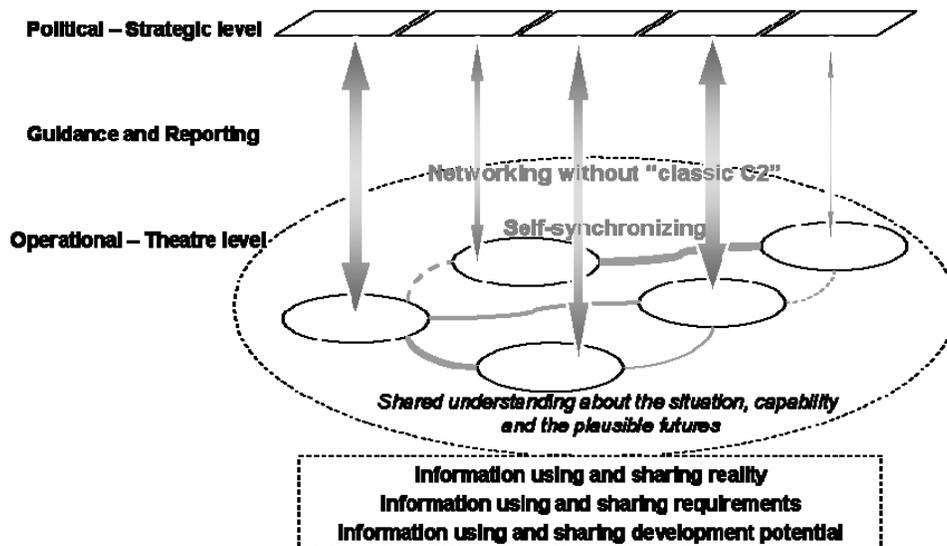


Figure 3. Organizational levels in NED (Kuusisto et al. 2007)

A newly conceptualized C2 approach involves replacing most hierarchical information flows with horizontal flows within and between operational level organizations. Sufficiently rich and

prioritized horizontal information flows can enable diverse organizational actors to self-organize their roles, and to self-synchronize their activities (Kuusisto et al. 2007). In the military environment synchronization is defined as the arrangement of military actions in time, space, and purpose to produce maximum relative combat power at a decisive place and time (DoD 2005). Self-synchronization involves the accomplishment of such arrangement without hierarchical direction. A critical requirement for self-synchronization is high quality information and shared situation awareness (Alberts and Hayes 2003). This includes shared understanding about the situation, capability and plausible futures.

General Planning and Decision-Making Model

Kuusisto (2004, 2006) studied information and knowledge categories and processes in decision-making. He presented a general system model about planning and decision-making. The model outlines information needed and provided for decision-making to norms, conclusions and input facts that further divided into 15 categories of information (Table 1). In addition, the model includes information refining steps to develop a process model (Figure 4).

Table 1: Information categories of the general decision-making and planning model (Kuusisto 2004)

<i>Norms</i>	<i>Conclusions</i>	<i>Input facts</i>
Mission, vision	Decision	Task
Foreseen end states	Alternatives	Means
Anticipated futures	Possibilities	Resources
Action patterns	Restrictions	Environment
Features	Event model	Events

Figure 4 illustrates a model to understand human, organizational and inter-organizational information sharing and handling process. It shall be noticed that behind all information using activities lies users' competence and value-base. Those items are most important, when shared information is refined for beneficial use. Values and competence are obviously different in case of various actors. So, in some cases, it may be somewhat difficult to find those common items that will make it possible to share mutually relevant information between various actors.

The left side contains information that is mainly situated inside one actor. The right side contains the information that can be considered explicitly expressed facts. Every layer of the model has a specialized task in the overall process of forming situational understanding and using information in situation follow-up, planning and decision-making process. The layer that deals with situation and environmental information as well as features data of actors produces an updated picture of events and the restrictions and possibilities that the environment and the action capabilities of actors have. Explicitly expressed information is the event picture and the information about environmental circumstances. Conclusions are abstracted analysis about restrictions and possibilities for an action. Mostly tacit input information is derived to develop understanding about the possibilities of the development of the overall situation.

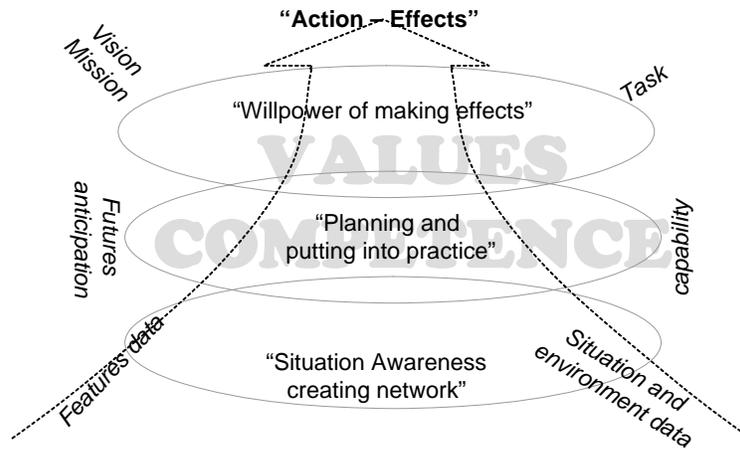


Figure 4. Situational awareness information model

The next layer contains information about competence (resources and means) as input facts. These input facts as well as information about events and environment, and knowledge about the composition and the development of the situation and possible end-states (futures information) are used as basis. The possibilities to act and information about alternate ways to operate are refined to perform planning and execution process. The chain of deduction can be continued until the ultimate decision-making layer is reached. There, all output information from the lower layers shall be available in explicitly expressed form. The whole spectrum of tacit dimension shall be available for the decision-maker. The decision-maker must be able to know the action patterns, anticipate the change of the situation, foresee the end-state of the action and deeply understand the meaning of the mission as a part of the bigger continuum of action. In that sense, decision-making requires rather comprehensive understanding of situation.

Information Profiles

An empirical study about situation awareness in a crisis situation was conducted in governmental organizations in Finland in 2005. The aim of the study was to collect information for improving interorganizational collaboration services and processes of crisis management. The study focused on the changes in situation awareness when moving from normal situations to those involving disruptive events and exceptional conditions (e.g., as associated often with crisis situations). The method of the study was semi-structured interviews. 11 people representing governmental authorities were interviewed. The interviewees were active actors in the area of domestic and international security or tightly related to these actors.

The theoretical basis of the study was the general model of planning and decision-making outlined above. A general view to the relationships between an interviewee's organization unit and its neighbouring units, superior units, subordinate units and collaborators is presented in Figure 5. The interviewees (Kuusisto 2005) were asked about the sources and targets of acquired and delivered information. The results are presented in Figure 6. The results show that information flows are quite balanced. However, only roughly 20% of information flows were identified as horizontal, i.e, received from or delivered to collaborators. As stated in the first Chapter, horizontal information flows are considered as enablers for self-organization and self-synchronization. Therefore, it is assumed that self-organization and self-synchronization faces challenges in current Finnish national administration.

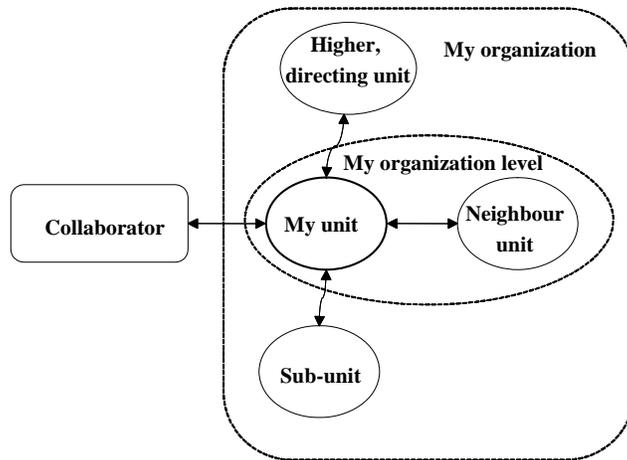


Figure 5. Sources and targets of received and delivered information in the empirical study (Kuusisto 2005)

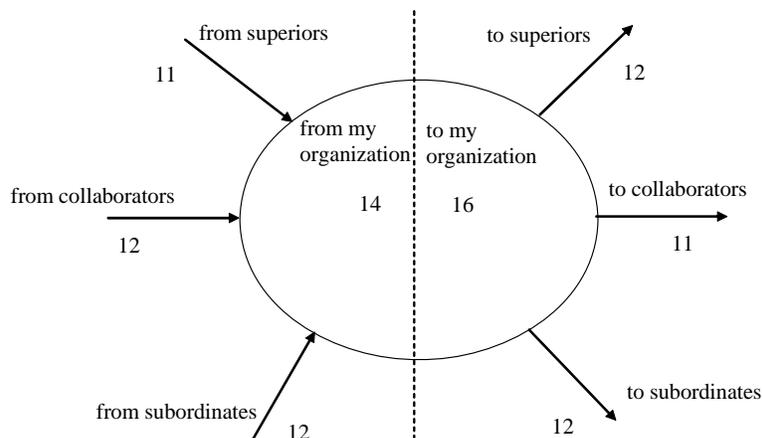


Figure 6. Results of a study about directions (%) of information flows in a crisis situation (Kuusisto 2005)

As shown in Figure 7, the results presented in Figure 6 are quite similar to the results of a study about information flow sources and targets at brigade headquarters level in Finland. The brigade level results are presented detail in (Kuusisto et al. 2004a, b). The most relevant difference between these results concerns information flows to superiors. At brigade level the relative share of information flows towards superiors is larger than at national administration level. It can be assumed that one reason for this is that at the brigade level information flows follow quite strictly the hierarchical command and control of a brigade. One of the tasks of the brigade level headquarters is to deliver information to the upper level. Organizations forming national administration act more independently and typically without highly centralized command and control.

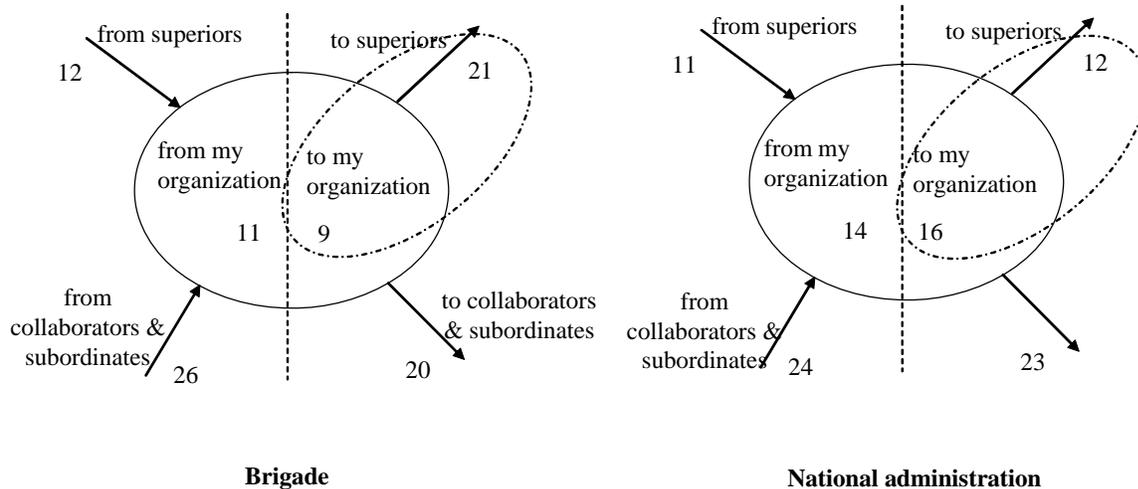


Figure 7. Information flows (%) on brigade level and on the Finnish national administration level in Finland (Kuusisto 2005)

In the study concerning Finnish national administration, the more detailed findings about the sources and targets of information flows according to information categories presented in Table 1 are following:

1. Most information flows are conclusions (38% of information flows) and norms (34%). Clearly fewer information flows are input facts (28%). These differences are slight but it can be stated that shared information contain more conclusions and norms than input facts.
2. Most input facts flow from collaborators and subordinates to an organization. Most conclusions flow internally in an organization and to superiors. Most norms flow from collaborators and internally in an organization and to subordinates and superiors. So, conclusions, norms and input facts have slightly different sources and targets.

Findings concerning information flows on the layers of the general decision-making and planning model are the following:

1. On the event layer the emphasis of information flows is from collaborators and subordinates to an organization and to superiors.
2. On the environment layer the emphasis of information flows are from collaborators, subordinates and internally in an organization to an organization.
3. On the resources layer the emphasis of information flows are from collaborators, subordinates and internally in an organization to an organization and to subordinates.
4. On the means layer the emphasis of information flows are from collaborators, subordinates and internally in an organization to an organization and to superiors.
5. On the task layer the emphasis of information flows are from superiors and internally from an organization to everyone.

It seems that information is required to produce aid for understanding the situation, planning the activity and support decision-making inside own organization unit. That is obvious thus being trivial. But the interesting part of information flowing is that cooperation partners are seen more or less as source of information. This kind of one-way viewpoint to information flowing does not support cooperation optimally. If functioning cooperation is required, the information flow should be equally multilateral amongst all cooperating parties in the network. Same kind of information should be delivered to the network partners that it is wished to receive from them.

Based on the findings presented above it seems that three functional subsystems are identified. The first subsystem is formed around events, environmental information, features, action patterns, event picture and restrictions. An actor in that subsystem collects event and environment data, combines them with existing norms, refines them and delivers the results to superiors as well as uses the results as basis for further activities. The second subsystem deals with the forming of basis for decision-making. In that subsystem an actor analyses and implements tasks, joins information about resources and means to information about anticipated futures and foreseen end-states as well as forms possibilities to act. The third subsystem focuses on decision-making itself and activities needed for implementing decisions. It consists of analysis of tasks and decision-making as well as dissemination of orders and instructions and reporting of implemented activities.

The study presented in this chapter is based on the theoretical model, which was derived from the literature, and which provided organization and consistency to the interviews. The number of interviewees that participated in the study was limited. In addition, the empirical data is based on the interviewees experience and not on actual measurements of information flows in a crisis situation. So, the empirical data summarized above give only rough view on the topic. However, the results appear to be logical and consistent with both theory and practice in terms of crisis management.

Implications on C2 and Organization Development

The findings presented above have implications for several areas of management, decision-making, planning, optimization and performing of information operations (IO). It is obvious that focusing simply on organizations' internal information flows is not enough when planning and conducting implementations or managing Joint operations. Additional stress should be put on the issues concerning interorganizational information flows, C2 and organizational structure as well.

The results above, which focus quite generally on a crisis situation in an interorganizational context, apply equally well to IO. In either case the same phenomena concerning information exchange at the level of general situational understanding exists. To gain mutual understanding or to influence by information, or to protect one's own information space, interacting parties should have common information flows. The first part of the empirical study discussed in the previous chapter focused on information content and update frequency priorities. The results of this part of the study are presented in (Kuusisto 2005) and (Kuusisto et al. 2007). According to these results, in a crisis situation, the common information flows should cover mission and vision, anticipated futures and foreseen end-states, resources and means, as well as information about tasks (Kuusisto et al. 2007). Sharing of these information flows supports the collaborating organizations to form virtual strategic level (Figure 8). Synthesized information of the virtual strategic level is needed when each collaborating organization is forming its alternatives to act internally. The collaborators need not to share all the information flows and related processes and organization structure about mission and vision, anticipated futures and foreseen end-states, resources and means and tasks, but those information flows that are needed for self-organization and self-synchronization of activities. When alternatives to act are formed, an organization is having sufficient information capability to proceed with making and implementing decisions.

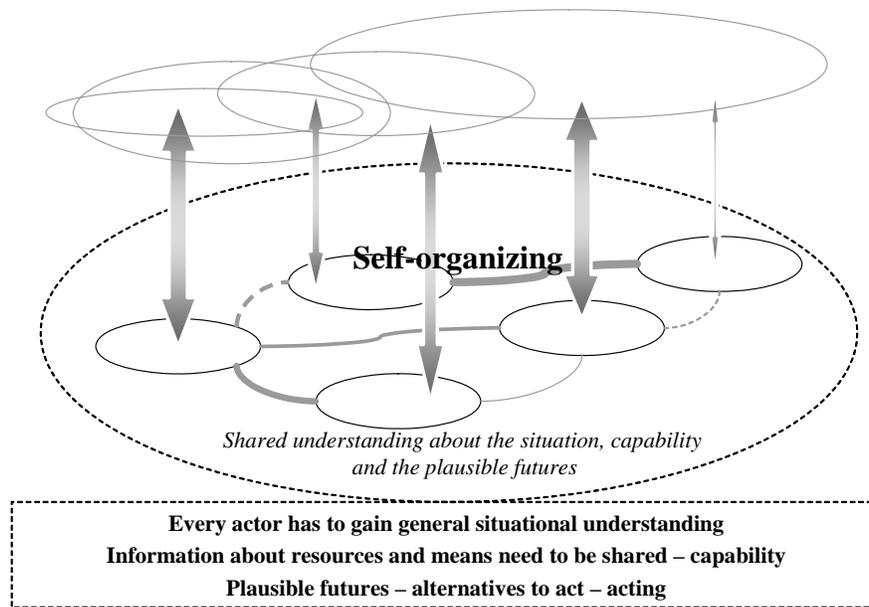


Figure 8. Virtual strategic level

In general this means that organization structure should support common information flows with interacting parties. Organizations should gain understanding about information exchange requirements to be able to form their existence to fulfil those challenges that they face when interacting with other organizations or actors. Organizations should determine information exchange profiles for themselves and their counterparts to optimize interactivity. This interactivity may be internal or external. It may be directed to the directions of superior, subordinate or peer level. Those organizations or parts of organizations that are working with the same kinds of issues should have common information flows. It can be concluded that to develop interorganizational structures and their working processes, it is rather essential to find as interworking information flows. In NED this means that all of the interacting actors (e.g., including military, governmental, non governmental and local actors) should have shared information flows. In addition, they need technology based services supporting such information flows.

Shared Information Frame and Technology (SHIFT)

Shared Information Frame and Technology (SHIFT) is a concept and technology under development in Finland to support information sharing in crisis management. SHIFT deals with one of the Multinational Experience 5 (MNE5) challenges stating that: “Information sharing among nations, organizations, and agencies is currently insufficient to support a comprehensive approach. MNE5 products and solutions related to this challenge will be primarily policy, process, organization, and technology-oriented.” SHIFT is not a coalition or whole-of-government capability, but rather seeks to replace the current practice of building only bilateral information exchange connections and relationships between and among governmental, non-governmental, private and local actors in the regions of crises.

SHIFT framework provides the actors of crisis management and NED with collaboration potential (Figure 9). It’s objective is to enable collaboration and provide enhanced possibilities for synchronization of the planning and use of resources. It describes possibilities to co-operate between separate chains of command using a trusted information sharing environment.

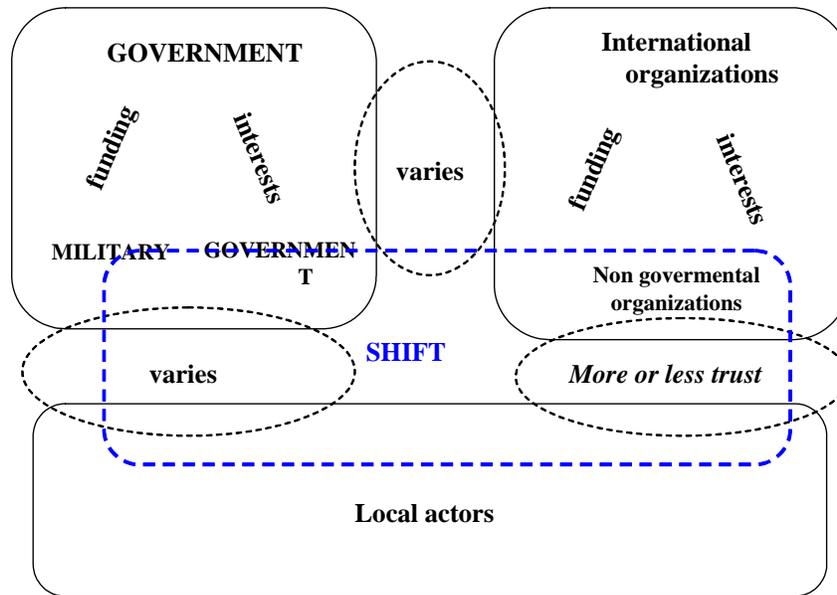


Figure 9. Trust and shared ICT services between actors of interorganizational crisis management (SHIFT workshop 2006)

SHIFT is based on an assumption that one of common interests is safety, and a desire to act de-conflicted make the environment attractive enough for the most relevant actors in the field to use. SHIFT is both an information source and a possibility to disseminate or share information. SHIFT encourages exploring and - if necessary – refining the existing information sharing policies that may prohibit sharing, even when it is essential in order to achieve the desired effects or to avoid accidents or losses.

As described in Figure 9, SHIFT framework points out that most trust can typically be found between non governmental organizations and local actors. Trust between government and local actors as well as government and international organizational varies. SHIFT technology is about architecture, information management, administration, services and tools that will be developed iteratively along with the progress of the framework to implement new methodology and features for testing, training and experimentation purposes. The development of technology is driven by Service Oriented Architecture (SOA) and Commercial-Of-The-Shelf (COTS) principles.

Conclusions

The results of an empirical study at Finnish national administration shows that horizontal information flows between organizations are limited. However, focusing simply on organizations' internal information flows is not enough when planning and conducting implementations or managing Joint operations of NED. Additional stress should be put on the issues concerning interorganizational information flows, C2 and organizational structure as well. The common information flows between organizations should cover mission and vision, anticipated futures and foreseen end-states, resources and means, as well as information about tasks. These information flows are needed to be shared by collaborators to be able to form alternatives to act internally in each collaborating organization. Shared information frame and technology (SHIFT) addresses

collaborating and information sharing. It is under development in Finland. The theoretical background and technology of SHIFT will be experimented during MNE5 exercise.

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SHIFT workshop on 14.-16.11.2007, Helsinki. (Results in figure 9 are based on a breakout session, where attendees were discussing about organizing and trust of various actors on crisis management situation.)