

CONTEMPORARY TRENDS IN INFORMATION SUPPORT FOR CRISIS MANAGEMENT

Georgi Kirov

International Business School, Botevgrad, Bulgaria, gkirov@ibsedu.bg

Yuliyana Velkova

International Business School, Botevgrad, Bulgaria, yuvelkov@ibsedu.bg

Abstract: The research regards scientific, technical, and organization problems in the crisis management. The report is dedicated to an implementation of the network-centric approach (NCA) for management of complex heterogeneous systems, which involves experts, information, devices and services connected through a common communication and information environment (ICIE). The application of new, high-tech information approaches in the overall implementation of the network-centric approach is a crucially important mechanism, which sets a new, higher level to the inter-institutional mechanisms of complex decision-making. Crisis management has become more and more complex and science-consuming since the information flows have increased considerably as well as the requirements to both crisis management leaders and their teams in view of the thorough scientific training they must have acquired. The scientific research in the field of crisis management in EU is aimed at establishing innovative approaches, based on contemporary information technologies, which can compile, process and distribute various data/information. The analysis of the present scientific research in EU clearly indicates a tendency of transforming the crisis management mechanism into an integrated information package, which is able to simultaneously tackle communication functions side by side with various other services within an integrated (common) communication and information environment. The analysis of the current capacities has shown that the national crisis management mechanism is of insufficient operational compatibility with the international practices and systems. In order the scientific potential to be used to the maximum of its capacity in view of the accomplished research work and the investments made, an information and communication infrastructure is necessary to be built providing operational compatibility of all segments within the crisis management system. The research aims at developing reference model of network-centric information environment providing operational compatibility between all segments within the crisis management system. The proposed environment will provide software resources for gathering, exchange, analysis and distribution of information. This will allow officials from various institutions to exchange updated data on current changes in a particular situation, to come up with adequate solutions, as well as to pass on instructions for their interaction. The complexity of the investigated problem call for applying an interdisciplinary approach, combining a methodological decision-making framework of NCA with the capacities of the distributed IT for information exchange. The effect from the proposed environment is aimed at transforming the crisis management mechanism into an integrated information package, which is able to provide communication functions and services within an ICIE. The results will be in accordance with UE recommendations for operation compatibility of the national crisis management mechanism with the international practices and systems and use of the scientific potential in the maximum of its capacity in view of the accomplished research work and the investments made.

Keywords: : Network-centric, Crisis management, Distributed systems

1. INTRODUCTION

The increasing number of crises and the respective response operations in the conflict spots of the world – on the Balkans, in Europe and on other continents – have changed irreversibly the security environment and made the countries define anew their responsibilities for security guarantee on national levels as well as a part of collective systems. The need to develop capacities for adequate prevention of emerging challenges and risks, for timely response to threats and for elimination of possible consequences has imposed the necessity of transforming the existent crisis management mechanism into integrated package of special capacities.

Crisis management is a complex of general (principle) decisions and measures of various character, which in their totality come down to: monitoring of security risk factors, analysis and early warning about possible threats, planning of national forces and means for coping with them, cooperation with international institutions in the field, making the necessary decisions, an analysis of the crisis and the efficiency of the measures undertaken by the respective institutions and organs.

EU leads all-rounded coherent policy in the field of crisis management. The so far developed EU legal framework indicates clear-cut political will and specific engagements of the Member States to tackle crises, large-scale disasters and emergencies.

The gained experience and the increased state responsibilities in the collective defense system brought about the need of carrying out in-depth analyses on suitability of the existing national response mechanism response to crises. Particular challenge to crisis management comprises the rapid dynamic changes occurring in the operational environment, with multitude of variables and enormous amount of information to be processed and analyzed. In such circumstances all efforts must be focused on coordination, communication, information exchange and management at all levels. Therefore, the enhanced requirements call for applying a management approach, combining a methodological decision-making framework with the capacities of the distributed IT for information exchange. The mentioned issues can find their appropriate solutions only after various scientific, technical and technological requirements have been met (Kirov & Stoyanov, 2010a).

Among the contemporary approaches to crisis management one of the fastest speed-gaining is the so-called network-centric approach, applied to management of complex heterogeneous systems, involving both people and modern IT. This is an interdisciplinary approach to complex heterogeneous system management which involves experts, information, devices and services connected within and via a common communication and information environment. It requires analysis of a great amount of information, which enforces the development and application of new systems for exchange, processing, storage and protection of information. The mastering and application of new, modern, high-tech information approaches in the overall implementation of the network-centric approach is a crucially important mechanism which sets a new, higher level to the inter-institutional mechanisms of complex decision-making and feedback on their effective execution.

The research aims at presenting a conceptual model of network-centric information system providing operational compatibility between all segments within the crisis management system (Lazarov, Kirov, Zlateva, & Veleev, 2015). The proposed model will provide software resources and mechanisms for gathering, exchange, analysis and distribution of information. This will allow officials from various institutions to exchange updated data on current changes in a particular situation, to come up with adequate solutions, as well as to pass on instructions for their interaction/cooperation.

2. CONTEMPORARY APPROACHES TO CRISIS MANAGEMENT

A crisis is a sudden or (un)expected change in the normal course of events caused by human activities, social events or natural phenomena which have negative effects on the territory, environment, population, citizens and country's material valuables and for whose prevention, tackling and getting over immediate coordinated actions are needed. A crisis management on a country level is the capacity of government, of state and local administrations to fulfill their functional duties by steering the activities of the state organs and the means designed for that end as well as by guiding and coordinating the actions of the respective NGOs through the established planning and coordinating crisis management structure.

There exists a clearly manifested tendency of changing the philosophy and methodology of complex system management in the security field, especially in their organizational aspect. It expresses itself in the transition from centralized to network management and is directly dependent on changes in the kind of tasks assigned to the respective organizations, the character of the implementation mechanism and the level to which modern technologies are applied. Depending on the hierarchy and centralization, management approaches can be classified as cyclic, interventional, problem-solving and network-centric (Stoykov, Shalamanov, Kirov, Stoyanov, Ivanov & Tsankov, 2006).

Within the cyclic approach the central organ issues directives in the form of orders, instructions and injunctions over regular periods of time. The function is to compensate for the lack of information exchange systems in synchronization of actions. Simultaneously all aspects of cooperative interaction are centralized and the lower levels are deprived of taking the initiative in the implementation of the assigned tasks. Regardless of the pointed shortcomings, this approach is appropriate for organizations of significant static character, lacking sufficient level of interconnections.

The interventional approach is also based on issuing specific managerial directives to subordinate operational levels. Unlike the cyclic one, the application of this approach requires a higher level of communication saturability. This allows a response to emerging threats without being restricted to preliminary setup time intervals, as well as change of preliminary issued orders, if and when it is necessary under particular circumstances. The organization success in following such management philosophy depends to a great extent on the preliminary development and observance of specific behavior patterns and operations – strictly defined process of decision-making with clear-cut mechanisms and procedures.

The development of management philosophy with raising the responsibility of lower-level executives has found certain expression in the approach of limiting the problems. Its essence lies in preliminary outlining of objectives and the means for their achievement. The approach is applicable to unpredictable cases and circumstances without

providing great opportunities in view of details in task and mission implementation of the organization. In other words, the missions are presented to the organizations as something they need to resolve, but the approaches as to how these missions are to find their resolutions are rarely mentioned or put forward.

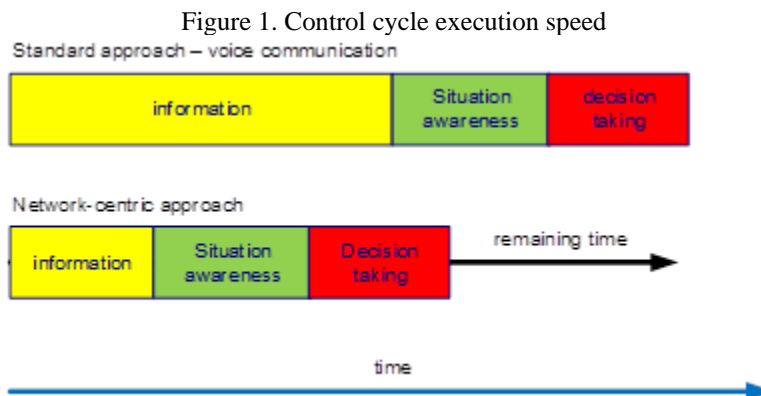
Among the contemporary approaches to crisis management one of the fastest speed-gaining is the so-called network-centric approach, applied to management of complex heterogeneous systems, involving both people and modern IT. This is an interdisciplinary approach to complex heterogeneous system management which involves experts, information, devices and services connected within and via a common communication and information environment. It requires analysis of a great amount of information, which enforces the development and application of new systems for exchange, processing, storage and protection of information. The mastering and application of new, modern, high-tech information approaches in the overall implementation of the network-centric approach is a crucially important mechanism which sets a new, higher level to the inter-institutional mechanisms of complex decision-making and feedback on their effective execution.

3 NETWORK-CENTRIC APPROACH TO MANAGEMENT OF COMPLEX SYSTEMS

The network-centric approach combines management capacities with the contemporary network technologies. This mechanism allows intense information exchange in a comprehensible format among management participants while following the principles of information security, regulated information access and coordination. The basic concept is based on the idea of representing management interactions with the help of the network model. The model consists of parallel working network nodes which interact so as to implement particular functions of the management system. Network points can be illustrated with the various ministries, agencies and organizations, including specialized crisis action units, analysis centres, etc. The nodes' basic functions are to elaborate assessment of the threats and to propose particular measures for tackling a concrete disaster or accident. Network nodes function on the basis of information exchange, characterized by high dynamics and change of direction. Network node interactions comprise duties and services, which can be regulated through official and non-formal agreements, administrative procedures and requirements. The network-centric approach to crisis management has the following advantages:

- Interdisciplinarity – it makes use of the expertise of various specialists;
- Concepts of the sort of concrete functions are being used instead of national and international instructions;
- Opportunity for the lower-level units to make decisions in the implementation of the assigned tasks.

Figure 1 shows how Network-Centric Operations (NCOs) increase the efficiency of rescue operations. Two alternative management mechanisms are analyzed - the standard one, based on voice communication and the network-centric one, based on modern information technologies. The main criteria for evaluating the two alternative approaches are related to the correct understanding of the situation, making the right decision and realizing the effects of the exchange and coordination of information).

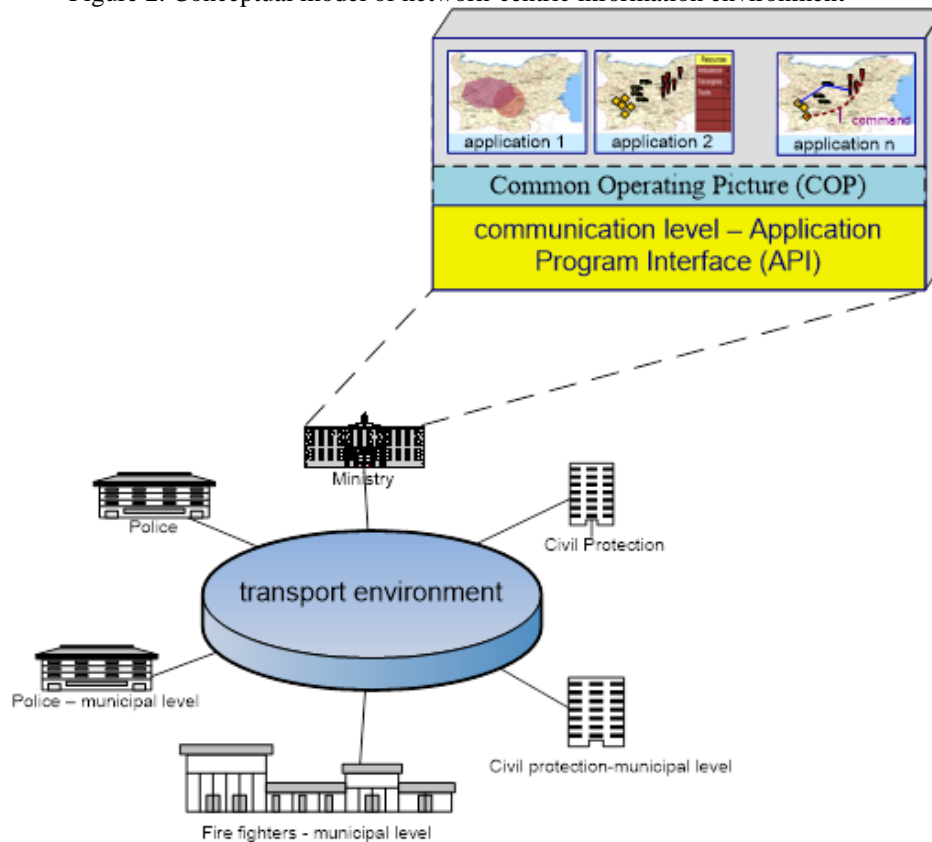


The principles of the network-centric approach (Department of Defense, 2005; William, 2007) for complex system management assume that the information environment consists of two parts – transportation and management (Figure 2).

- The transportation part provides communication functions and services for synchronized information exchange.

- The management part includes a set of software applications, which will provide the persons in charge with the needed functionality according to their competences and duties in the crisis management process. The proposed network-centered information environment will provide an opportunity for obtaining a Common Operational Picture (COP) which includes (Kirov, 2015):
- A common picture of the particular situation being received in each organization as a result of exchange and summary of operational information from various sources;
- Total awareness of the objectives of the strategic management levels and of the policies for their attainment;
- Passing on organizations' objectives and tasks to lower executive levels in a comprehensible mode;
- Drawing plans for coordination the actions of all operational units without changing or distorting the specific purposes of separate organizations;
- Monitoring the performance of lower levels so as to intervene, if necessary, in view of correcting observed shortcomings and weaknesses;
-

Figure 2. Conceptual model of network-centric information environment



4. A CONCEPT FOR A CRISIS MANAGEMENT NETWORK-CENTRIC ENVIRONMENT

The principles of network-centric approach considering the opportunities for decision-making at lower levels and intense information exchange put specific requirements towards the network-centric environment architecture. On the one hand, software applications have to be designed so as to sustain the functional requirements of a particular organization, on the other – these applications must exchange information so as to provide common operational picture (COP). This necessitates the implementation of a distributed architecture, which can provide transport infrastructure and offer interface standardization between different organizations' applications (Kirov & Stoyanov, 2010b).

The architecture and technological implementation includes *software modules* and *transport infrastructure*.

Software modules. This part of environment architecture includes a set of software applications assisting the employees' work within a particular organization, participating in the crisis management process. This set of applications provides specific services, which are different for each organization, depending on its functional responsibilities and duties. All applications share a common feature - COP, allowing the creation of a common idea about the situation and the use of remote application services. Software applications are usually used for planning the available resources, decision-making, assigning tasks, etc. The major advantage of these applications is their ability to exchange information and use databases of different organizations, this way providing officials with opportunities for joint services and mutual analysis of various alternatives before taking actions. The main characteristic features of the applications can be summarized as follows:

Ability to collaborate – It means information exchange between territorially separated applications. The collaboration aspect aims at taking into account the opinions of all participants in crisis management before the most appropriate/ right decision is made;

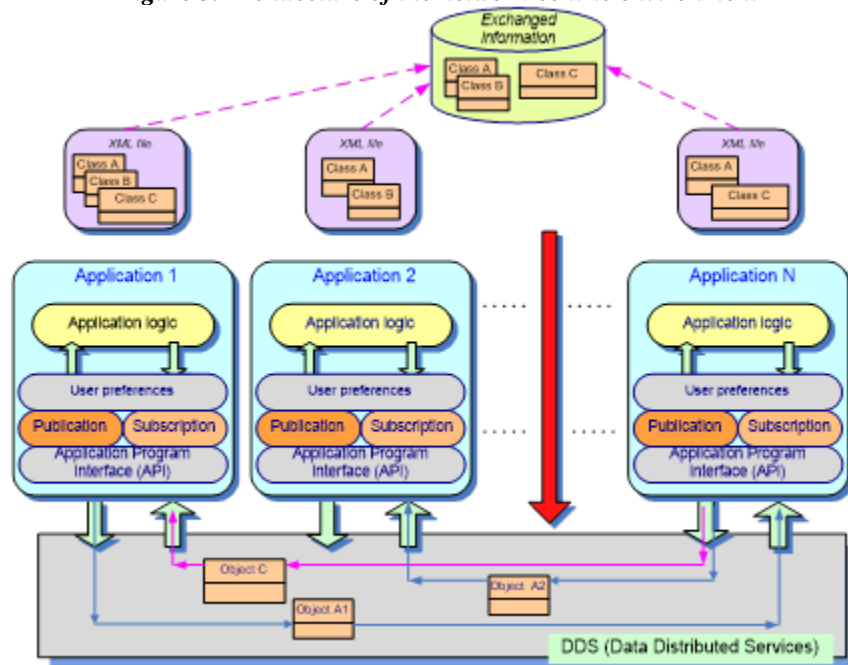
Ability to synchronize actions – The network-centric approach requires that entities be able to rapidly synchronize among themselves, independent of direction from superiors. This will enable them to flexibly adapt actions, to take advantage of opportunities and minimize impacts of changing or emerging threats

Ability to share situational awareness - Individuals will need not only to develop their own situational awareness, but they will need to share this awareness with a wide range of participants. They will need to see how others perceive the situation, and be capable of processing information from many sources while remaining focused on current tasking;

Ability to conduct collaborative decision-making - The ever-changing nature of crisis environment requires that commanders involve many elements, including other commanders and non-traditional communities of interest, in the decision-making process. This allows taking into account the impact which decision-making may have on tasks implemented by other organizations.

Communication infrastructure. The demand of attaining compatibility, integration and service virtualization, taking into account users' preferences, requires a new approach to distributed information systems implementation. In network-centric approach the information coming from different sources must be distributed to all participants according to their demands and preferences (QoS). Basic rule concerning the exchanged information is 'the right data at the right time in the right place'. In other words, a user is more interested in a particular type of information rather than in the initial sources providing it.

Figure 3. Architecture of the network-centric environment



The concept of network-centric environment is based on the idea of providing structural methodology, standards and instruments for integration of separate applications into a common information and communication environment.

This architecture provides a technical framework for development of a network-centric environment that allows operation compatibility and provision of services for all applications (Kirov, Zlateva, & Velev, 2015). The architecture the different applications interoperate through a common transport environment or standard mechanism for data distribution - DDS (Data Distribution Service) (Corsaro, Querzoni, Scipioni, Tucci-Piergiovanni & Virgillito, 2006). DDS provides communication functions and services that exempt the programmer from the procedures needed for integration of software applications and their interrelated communication (Wang, 2008). The applications communicate through Application Program Interface (API). This way each application can call the communication functions and services from DDS (Figure 3).

5. CONCLUSIONS

The proposed environment will provide software resources for gathering, exchange, analysis and distribution of information. This will allow officials from various institutions to exchange updated data on current changes in a particular situation, to come up with adequate solutions, as well as to pass on instructions for their interaction.

The expected results and effects from the network-centric environment can be summarized in the following items:

- Detailed research in the field of crisis management including analyses of the legal base, organizational structure and basic elements in crisis management process, their interdependence, tasks, activities, information flows, types and frequency of information exchanged;
- Reference model of network-centric information environment providing software tools and standardized mechanism for information exchange between territorially separated applications;
- Initial package of software modules, which will provide tools for assisting the functional performance of the different crisis management organizations;
- Common standard for development of software applications participating in network-centric environment and defining a set of rules for their integration;
- Common operation picture, (graphically) delivering the entire situational picture to each and every organization as a result of summarizing the operation information from various sources and different organizations.

REFERENCES

- Corsaro, A., Querzoni, L., Scipioni, S., Tucci-Piergiovanni, S., & Virgillito, A. (2006). *Global Data Management*, IOS Press.
- Kirov G., Zlateva, P., & Velev, D. (2015). Software Architecture for Rapid Development of HLA-Integrated Simulations for Critical Infrastructure Elements under Natural Disasters, *International Journal of Innovation, Management and Lines*, B. C., Sullivan, K. T., Smithwick, J. B., & Mischung, J. (2015). Overcoming resistance to change in engineering and construction: Change management factors for owner organizations. *International Journal of Project Management*, 33(5), 1170-1179.
- Kirov, G. & Stoyanov V. (2010). Network-Centric Architecture for Crisis Management System, *International conference-CompSysTech'10*, ACM 16-17 June, 2010, Hotel "Rodina", Sofia, Bulgaria, pp. 161-167.
- Kirov, G. & Stoyanov V. (2010). Problems at Implementation of Network-Centric Capabilities for Management Control Systems, *International Scientific Conference, Informatics In The Scientific Knowledge 2010 ISK'2010*, Varna, 24-26 June, Bulgaria, 2010, pp. 64-79.
- Kirov, G. (2015). Simulation approaches for research and analysis of complex system, *Information system in management*, ISBN 978-619-160-469-2, Avangard Prima Press.
- Lazarov, B., Kirov, G., Zlateva, P., & Velev, D. (2015). Network-Centric Operations for Crisis Management Due to Natural Disasters, *IJIMT International Journal of Innovation, Management and Technology* vol. 6, no. 4, ISSN: 2010-0248, pp. 252-259.
- Department of Defense , Net-Centric Environment Joint Functional Concept (2005). Version 1.0, Defense Technical Information Center (DTIC), April 7, 2005, <https://apps.dtic.mil/sti/pdfs/ADA490440.pdf>.
- Stoykov, M., Shalamanov, V., Kirov, G., Stoyanov, V., Ivanov, I., & Tsankov, A. (2006). *Integrated System for Emergency Management (Architectural Methodology)*, Change Management Series, Softrade.
- Wang, N., Schmidt, D., Hag, H., & Corsaro, A. (2008). Toward an adaptive data distribution service for dynamic large-scale network-centric operation and warfare (NCOW) systems, *Proceedings IEEE Military Communications Conference MILCOM*, pp. 1-7.
- William, Y. (2007). *Network-Centric Service-Oriented Enterprises*, Published by Springer, ISBN 978-1-4020-6455-5 (HB), ISBN 978-1-4020-6456-2 (e-book).