Integration of Information Resources to Ensure Collaboration in Crisis Management

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A B S T R A C T :

This article examines the development of collaborative information environments and analyse the possibilities for using them in crisis management. An approach is proposed for building an integrated information environment for management in crises, describing in a technical, systemic and functional aspect the main elements of a collaborative environment. The author present results of test training in using such an environment to support the work of officials in crisis management.

Introduction

The development of information and communication technologies in recent years has provided an opportunity for greater cohesion and collaboration on a common project by physically distant persons in the same way as if they were in close proximity. This was achieved through the integration of information resources into a unified environment for collaboration on various organizational and business tasks and in decision-making and management processes.

Collaborative software, Groupware systems, Workgroup support systems combine computer software designed to assist users in collaboratively solving tasks to achieve common goals.[7] In the broadest sense, they are being consid-

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ered as computer-supported cooperative work (CSCW) software, focused on "how collaborative activities and their coordination can be maintained using computer systems." [4] The concept of "Collaborative work systems" [2] has also been introduced. The use of such systems in the workspace of people or organizations creates the so-called Collaborative Working Environment (CWE). United by common activity - sharing and processing information, users in this environment can communicate or work together, regardless of their geographical location. One example of this are social networks - Facebook, Friendster, Twitter and more.

The first online games between users created by Will Crowther (1975) and a little later by Roy Trubshaw (1978) are considered the beginning of the development of collaboration software. This process has become more widely developed with the advent of dial-up modems, which have expanded the capabilities of home computers to share information and provide online services. Gradually, with the development of technology and the expansion of Ethernet networks began the using of text messaging (chat), voice and video exchange in real time, and later specialized applications, such as common calendars, newsletters, WEB portals for collaboration work, and more.

1. Information communication environment for collaborative work

Collaboration work could be divided into three categories, depending on the level of collaboration (cooperation) and the electronic means used to do so [6, 7]:

- Message (communication) – unstructured exchange of information. These include phone calls, text messaging (chat), etc.;
- Conference – a higher level of collaboration related to discussions and interactive work for a common purpose. Examples include discussion forums, collaboration discussions with the exchange of thoughts and ideas, etc.;
- Coordination – complex, interconnected activities to achieve common goals. In this category, cooperation involves a high level of coherence. Each participant performs his/her assigned activity at the right time, in accordance with the actions of the others in order to achieve the desired end result.

Electronic means of communication are related to sending and receiving messages, files, data or documents between people, thus facilitating the exchange of information. These include: email, fax, audio and video, voice mail, WEB publishing, electronic document and file sharing, text messaging between two users, and more.

Electronic conferencing tools are tools which are used to facilitate the exchange of information, but in a more interactive way. They typically involve more than two users and includes: *web-forums and bulletin boards*, *exchange of text messages (Chat) and instant messaging*, *telephony*, *real-time meetings*, *whiteboard conferences (Data-conferencing)*, *application sharing*, *electronic meeting systems (EMS)*.

Coordination tools are software tools to facilitate the group work of partic-

ipants in a common process. These tools allow not only the exchange of information between employees, but also collaborative work on a common task, such as preparing a common document in an interactive web-based environment, with each employee preparing a part of the document or participating in its joint editing. Other examples are: [1]

- *group calendaring and scheduling* - for scheduling and tracking meetings and events. They are convenient for scheduling and organizing networked event schedules and for automatically notifying participants;
- *group document handling* - enabling the compilers of a document to work on its contents simultaneously, regardless of their geographical location;
- *work flow* - for organizing and managing various sequential activities between employees, for example, document flow (documents are systematized and a path / flow / between employees is defined for each individual document);
- *project management* - for drawing up timetables, milestones, deadlines, participants, for managing resources, for controlling implementation, etc.;
- *knowledge sharing* - for storing information in one place, without pre-processing in any form - diagrams, free text, notes. These types of tools are used to create a resource pool of knowledge in specific areas.

The use of collaborative information environments finds the greatest use in organizations where most of the activities are related to collective processes, i.e. involving more than two employees. Optimizing such processes results leads to reducing costs for physical meetings between participants when working on common projects, moving documents, discussing jointly, or solving common management tasks.

2. An approach for building an integrated collaborate information environment in crisis management

Analysis of crisis management and optimization opportunities

The nature of the tasks and conditions of crisis management of different nature (natural disasters, catastrophes, accidents, etc.) put the problem serious of the effectiveness of the decisions taken by officials acute. Acceptance as appropriate of a reasoned decision in a crisis environment is a complex task that is driven by the following factors:

- unclear, rapidly changing environment;
- incompleteness of the available situation data;
- limited possibilities for mathematical modelling of processes;
- limited ability to verify the correctness of decisions made, etc.

The collection of data on the situation in a given crisis area must be a continuous process in order to be able to have advance information on the development of the crisis at any time. This data should be automatically accumulated by different sensors and observers of the area when studying the situation. This whole process should cover not only the collection of data, but also their transmission, processing, compilation, systematization and display of maps, documents and technical devices (screens, monitors, etc.). All this requires a lot of effort and time and it is appropriate to optimize this process.

Some researches and developments in this field offer solutions to theoretical and practical problems in the field of GIS technologies,[12] information and mobile networks,[3,15] information and communication environments for work,[10, 11] information security,[13] and others.

The need to work together between the different levels of crisis management clearly raises the question of the exchange of information between participating organizations and individual employees. Some of these problems are:

- lack of sufficiently effective mechanisms to ensure consistency and consistency of available information; [14]
- limited opportunities to synchronize and coordinate between the main types of information presentation - text, graphics and video;
- insufficient parallelism in the work of individual officials when using shared resources (documents, maps, technical means, etc.);
- insufficient capacity for personal and group identification of officials in preparing documents and issuing orders;
- limited possibilities for analysing large volumes of input data and difficult decision making in the presence of inconsistency of input information;
- lack of adequate tools to support decision-making by the manager, especially in the presence of significant risk and uncertainty in the situation.

All this imposes the view that new solutions are needed in order to increase the effectiveness of crisis management. One of them is to create an *integrated communication, information and technology environment for group work*[4] of the management team in accordance with the accepted model of crisis management work. It is also necessary to create appropriate conditions for the pooling of information from different sources, for its shared use for teamwork.

Building a communication and information environment to support the management process in crisis management can be used in:

- storage, processing, maintenance of data sets for different objects and situations;
- preparation of summary text, tabular and graphical information on the status, readiness, implementation and effectiveness of the activities undertaken by the crisis management operational forces;
- consolidation of information and efficient document circulation;

- analysing the development of the crisis, using mathematical and simulation models to examine the effectiveness of the measures taken;
- improving the quality and efficiency of work through the use of expert knowledge;
- supporting decision making at the various levels of government.

Building an integrated collaborative information environment

• The application of technologies and solutions for collaborative work in crisis management provides an opportunity for a more operational way of working, since large part of the tasks performed are related to common, collaborative processes - joint discussions *(briefings)* with geographically remote participants *(RealTime Meetings)*, preparation and exchange of joint documents for troop management *(Group Document Handling)*, organization of workflows for various operational tasks *(Work Flow)*, planning and scheduling of events *(Group calendaring and scheduling)* sharing knowledge related to types of knowledge and management experience *(Knowledge Sharing)*, decision support *(specialized applications)*, etc.

• An approach to building an integrated collaboration environment is presented below in three main aspects: technical, systemic and functional.

• *In technical term,* the collaboration environment is based on the use of a high-availability (High availability) server architecture that includes two active high-speed servers and a shared disk space (array). The servers and the disk arrays are connected by fast LAN connections, and additional synchronization connections are organized between the servers themselves.[7, 12]

• The schematic diagram of the physical architecture is shown in Fig. 1.

Physical servers have basic installed operating systems (OSs) with virtualization support. The application systems (logical servers) are located on virtual machines, physically located on the shared disk array and accessible from both servers. Virtual machines are managed synchronized and distributed by the OS on physical servers. If one of them fails, the virtual machines running are automatically activated on the other. The load distribution is balanced by common management software (hypervisor) installed on the underlying OS.

The schematic diagram of the logical architecture is shown in Fig. 2.

The advantages of this type of implementation are the provision of high reliability, dynamic load distribution, active mode of operation on both servers ("active-active") and no need for application-level clustering (provided globally by the virtualized system, on lower level).

In a systemic aspect, the collaborative information environment includes information subsystems related to the functional responsibilities of officials. The main ones are:
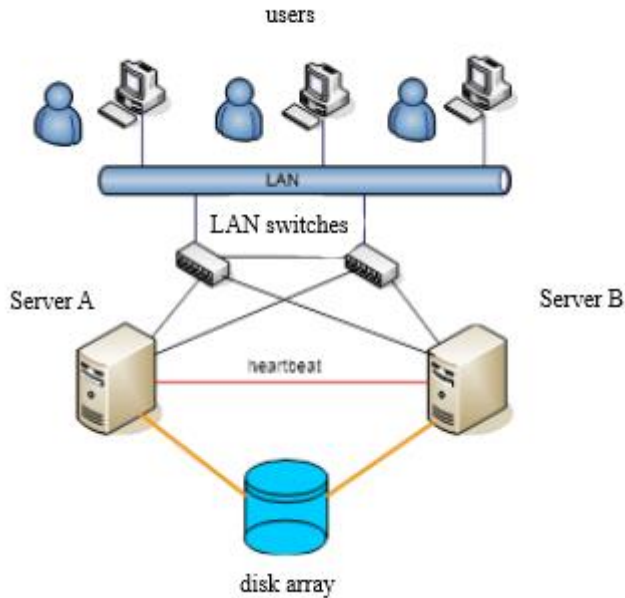
Figure 1: Scheme of physical architecture of integrated environment.[9]

- Specialized group work subsystem;
- Communication and video conferencing subsystem;
- Documentation and information subsystem;
- Messaging and alerting subsystem;
- Geographic information subsystem;
- Modelling subsystem;
- Decision support subsystem;
- Information management and protection subsystem.

In functional aspect, based on the above subsystems, the information environment provides the following major information and communication services: [9]

- *common information portal*, with websites for individual user groups, designed to prepare and exchange documents (text, graphics, multimedia) and to publish information with different access rights;
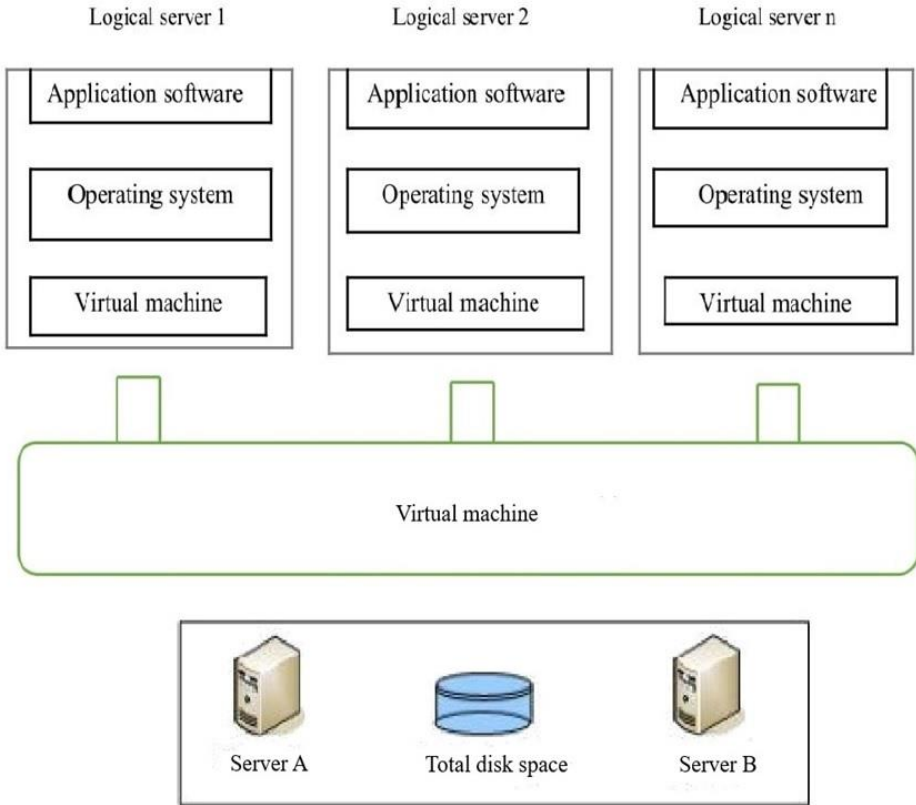
Figure 2: Scheme of physical architecture of integrated environment.[9]

- *video and audio conference* between the participants in the discussion, with the possibility to share simultaneously presentations, diagrams, graphs, documents;
- *IP telephone and video telephony services* on the network, using IP telephones and / or computers;
- working with electronic documents and organizing document flow - creation, editing, approval, signing with electronic signature, publishing and printing of documents;
- working together *on a common electronic document* that can be edited by certain participants in the network, regardless of their geographical location, with control being initiated by the initiating process;
- *geographic information services* for the use of electronic maps and georeferenced information;

- *services for joint discussion of information and organization of briefings, work processes* and other operational activities (defining briefings, distribution of tasks, publication of results, management);
- *services related to message boards*, recording notes in a public place (web sites), asking questions (one to one), conducting surveys, scheduling meetings, etc.
- *information sharing services* - sharing a common window between users for the simultaneous use of electronic maps, documents, diagrams, diagrams, software applications and workspaces;
- *specialized information services* to support emergency management;
- *drawing up mathematical and simulation models* of processes and probable interactions in the development of the crisis environment;
- *e-mail services* - for exchanging text messages, files, etc.

An important element of such information environment is the integration with systems for obtaining operational and sensory information via land, water and unmanned aerial vehicles, in real time, as well as its visualization before the crisis centre. They will support the work of the Crisis Centre in the collection and analysis of visual-sensory information [8] and in assisting decision-making in crisis management.[5] The integration of such system in a group work environment will provide an opportunity to obtain and remotely send visual-sensory information from the location of the critical situation to the crisis centre in real time, both in crisis situations and in training and exercises.

Implementation of the approach and achieved results

Based on the approach described above, WEB-based information environment was built to collaborative work to assist officials and to ensure their interaction in operating crisis management tasks. In 2019, a training session was held with this information environment, which included teams from almost all ministries, as well as several state organizations in the Republic of Bulgaria, and the territorial administration covered 28 districts with 265 municipalities. The communication took place through the transmission medium of the Internet. For the training, WEB-portals for the work of officials were defined, with profiles by groups and organizational units with different rights to access common information resources.

Users received preliminary information from a public website (www.icis.bg). Access to the group work environment is obtained after authentication with a username and password. Email, Web-portal (Sharepoint) and real-time video conferencing were used to exchange information.

During the training a system for document circulation was built, for organizing work processes, events and briefings with the possibility of videoconferencing between the headquarters of the crisis centre and all categories of participants in the training.

All users of the group work environment (355) received alerts and up-to-date information on the operational environment, according to the training

plan, and were able to make full use of the communication and information services provided (1135 e-mails and messages were exchanged). These services include:

- Work area (disk space);
- E-mail;
- Geographic information system;
- Integrated video conferencing system;
- Exchange of short messages in real time (Chat);
- Shared files and documents;
- Web-based formalized documents;
- Calendars of the working groups;
- Web-based network monitoring.

All categories of users received visual up-to-date information on the operational environment from a geographic information system through a common information portal (see Figure 3). The load on the network (WAN) and the servers during the training is given in Table 1 and Table 2. The collaborative information environment also provided the ability to share documents, remotely access a screen, share ideas on an electronic whiteboard, and more.

Table 1

	WAN			
	in-pass	**in-block**	**out-pass**	**out-block**
maximum load	6,94 Mb/s	1,16 Mb/s	9,38 Mb/s	0,00
medium load	1,12 Mb/s	0,27 Mb/s	2,38 Mb/s	0,00
for 8 hours	4,04 CB	979,41 kB	8,58 CB	0,00
95 %	3,16 Mb/s	-	6,24 Mb/s	0,00

Table 2

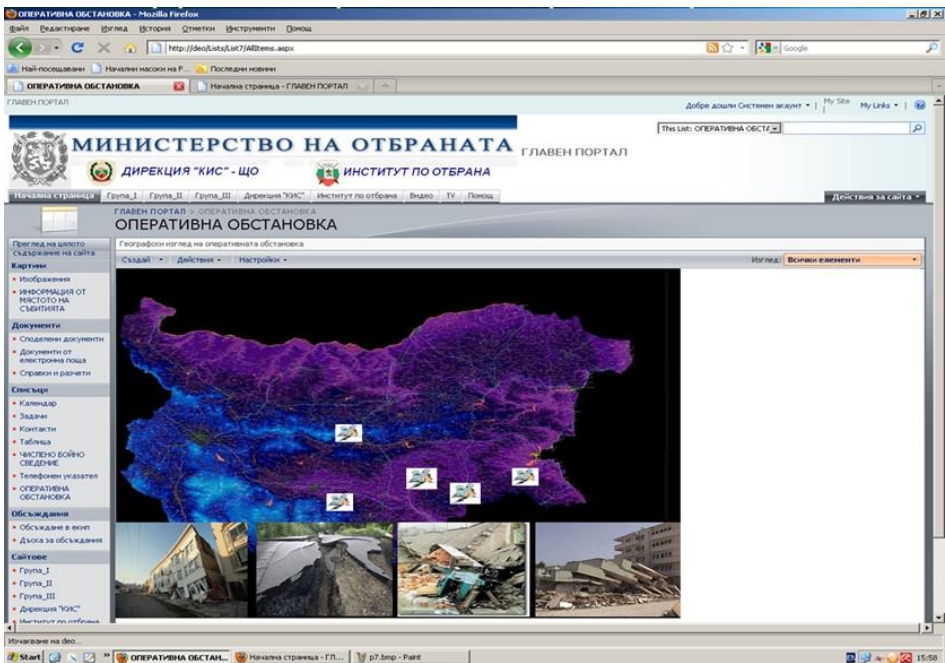|	Servers			
	ShPo	**mail**	**LyncE**	**LyncEF**
maximum load	2679 KBps	631 KBps	2196 KBps	1218 KBps
minimum load	43 KBps	65 KBps	7 KBps	8 KBps
Medium load	586 KBps	271 KBps	340 KBps	195 KBps

Figure 3: Integrated information portal of a crisis management collaboration system.

Conclusion

The development of systems for building an integrated communication and information environment for group work required the process of preparation and decision making by the management team, allows to manage and share information flows of any type with shared use of different resources. In this way, the information exchange will be more efficient, the decision-making process will be improved and at the same time, the response time in case of emergencies will be reduced.

Acknowledgments

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