

# THE C4I SYSTEM CONCEPT AND THE CONTROL OF NATIONAL SEA SPACES

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**Abstract:** The paper analyzes an aspect of the modern control of national sea spaces and tries to characterize the ways and means it is achieved. The C4I system concept is examined as the only viable alternative for bringing efficiency into the system for control of the national sea spaces. The authors examine the major challenges faced during the development of naval C4I-systems and the experience gained by the Bulgarian maritime institutions.

The C4I system concept has found wide acceptance and application in many fields; however, its potential has not yet been fully realized in the control of national sea spaces (CNSS). This article aims at provoking interest in the problem of CNSS and the reason for its implementation in view of the fact that the concept of C4I system control is the only viable alternative for building a suitable system by means of which to protect national interests and to overcome the disagreement between maritime institutions.

The actuality of the topic is determined, on one hand, by the broadened contents of defense as a category in military art,<sup>1,2,3</sup> which includes the safety of maritime transport system, safety of navigation, safeguarding of human life, protection of marine environment, etc., and, on the other hand, by the necessity to conduct new type of operations in CNSS and navigational defense.<sup>4,5,6</sup> The analysis considers the trend for conversion of civil technologies to the military sphere, as well as for conversion of military art into a universal methodology for crisis management.

## Characteristics of Modern Control at Sea

The development of the situation at sea globally and in the region is characterized by uncertainty and unpredictability. It is influenced by the factors shaping national security, which are deeply related to the dynamics of global processes. The economic factors have received priority due to the fact that these factors in conditions of severe competition, unregulated use of sea spaces and asymmetric threats stimulate the in-

crease of risks, violations of legal norms and constant necessity of critical services at sea. They determine the modern CNSS, its subject and the forms and methods used.

The physical and geographical characteristics of the sea spaces of Bulgaria, the high likelihood they to become a zone of intense ship traffic and their geo-strategic location determine their vital importance for the realization of national interests and the counteraction to global threats. They have a complex structure, formed at the boundaries of three macro-spheres (physical, informational and moral) and from three elements (water, land and air). They have different dimensions: geo-strategic, military-strategic, geographical, economic, legal, informational, and ecological. The information dimensions deserve a particular interest since the defense of the national interests at sea, its utilization and especially the counteraction to asymmetric threats require permanent information support, and, in crisis situations – guaranteed information superiority. All this is related to the growing importance not only of the processes of collecting information, but also of those related to its dissemination, sharing and storage. Nowadays, the control of these processes should be organized and carried out above the water, under the water, in the air and in the so-called “information space”. In this conditional space all types of control are integrated into a complex functional system and they take on a new dimension.<sup>7</sup>

CNSS is a combination of adequate to the situation initiatives and activities, coordinated and interrelated according to aims, time, tasks, and place, carried out according to a cohesive plan of the state leadership through a specially designed system for defense of maritime interests of the country and counteraction to the threats at sea. The control is based on the operations of the authorized institutions and the provision of information related to them (providing, collecting, analyzing, and disseminating information about the situation and all the appropriate activities). The emphasis is placed on control at sea in times of crises, which is technologically and organizationally regulated in the underlying maritime conventions. The strength of CNSS is not in registering events and phenomena, but in reacting fast with the most suitable measures, e.g. in carrying out effective operations.

CNSS is a new kind of defensive function of the state, which requires a high level of integration of the maritime institutions, as well as their good preparation and faultless support. Generally, it can be realized through: active defense of the maritime transport system, assistance to navigation, protection of maritime environment and sea resources, prohibition to use the sea against the international agreements, and opposition to violation of national interests.

It ensures the defense of state's sovereignty and, if necessary, the defense of its coast. All these large-scale tasks can be accomplished only within the framework of a special operational concept, provided by a modern information system. Such a system

enables us to have a complete control of CNSS without the constant presence of specialized personnel and means in them.

CNSS provides the linkage between the tasks in time of war and those in peacetime of the Navy; it manifests the preparedness of the state to fight global threats and to defend its interest in time of peace, and in time of crisis – to counteract expansion.

The characteristic features of CNSS are: universality, aerospace support, integrity between institutions, information-electronic character, military organization, defensive purpose, and wide openness for international cooperation. Nowadays, emphasis is put on its information-electronic character, e.g. its main activities aim at providing, analyzing, distributing, disseminating, and storing information, which is done primarily electronically. Control—considered as a part of the management process or as a system of operations—is based on radio-electronic and optic-electronic surveillance, exchange of information and constant coordination of the multilateral activities in CNSS. Therefore, it is very important that the information is reliable and presented in real time. Generally, CNSS can be defined as universal, with vast spectrum of applications in time, space, extent, and methods.

The implementation of the new defense concept requires very good coordination among the different CNSS institutions. Despite their specific characteristics these institutions have much in common – techniques, strategies and procedures; command and control; cooperation; provision and training of the interrelation-aiding forces. In fact, exactly here is the focus of all the difficulties in maritime reform, which includes not only alteration of the property ownership or establishment of new economic relations, but mainly efficient coordination in the sea industry and a new type of civil-naval relations.

At present, CNSS encompasses parallel and duplicated structures with different institutional subordination. Their uncoordinated actions result in an increase of potential efficiency lost. Therefore, the control must be the responsibility of one body. The adopted model in Bulgaria is dominated by the Navy, and is identical to that adopted in Europe.

Worldwide, similar control bodies are established in accordance with the principles of military art and are analogues to combat systems. Nowadays, there are two inter-related tendencies in the development of CNSS, national and international; the latter dominating the former. Priority is given to the joint efforts of the Black sea countries; efforts based on adopted norms and principles of international law and the necessity for a scientific, technological and technical cooperation. Different projects for regional cooperation specify as a priority the development of information network based on C4I systems. This approach is also applied to security, which features unusual trends in the functions of national Navies. These ideas have been realized in the

establishment of the Black Sea Pollution Prevention Board and the Black Sea Military Cooperation Task Group – BLACKSEAFOR.<sup>8</sup> Both structures include C4I-infrastructure features and apply the model of military operational planning.

### **Application of the C4I System Concept to Sea Control**

For the requirements of CNSS, autonomous C4I systems are established in the maritime institutions at all control levels. They provide system integration of the different components and reduce the conflicts between them arising from different organizational structures and subordination. The C4I systems provide the integration of the existing communication means, the databases, etc., of the institutions. Applied in the maritime field, these systems increase the efficiency of supervision, monitoring, and inspections and provide a record of the violations needed to impose sanctions.

The development of the C4I systems began with the first Vessel Traffic Services (VTS) prototypes in late forties. For only half a century they advanced from simple shore radar systems to sophisticated communication systems ensuring safety of navigation. The number of these systems has doubled in the last 15 years accounting to more than 500 VTS nowadays, differing in range and application. This development has resulted from the increase of cargo turnover in ports and shipping, as well as from the risk of collision and ecological disasters at sea.

During the 60s and 80s, the then-existing navigational aids did not provide efficient and accurate navigation. That forced the specialists to focus on VTS capable of aiding ship navigation. The advanced technical aids to navigation highlight the VTS' importance for the shipping and for the navigation rules and control. Nowadays, the VTS cover the whole European coast, except the Black sea coast. The development of the C4I systems, as one of the most important elements of shipping, is based on national and European projects.

The development of the Bulgarian C4I systems started in the mid-eighties. The MoD developed the "Obhvat" system, while the Navy and the Inspectorate of Shipping developed jointly the shore-based automated "Ekran" system. NMB shipping company had their own project "Emona." Due to various factors these projects were not completed, which influenced negatively the sea control and coordination.

After the changes, the C4I system concepts have been oriented mainly towards a specific object of CNSS, sea transport, without taking into account some of their important military-defensive aspects. Despite the limited funding, the Naval Forces continued their work and in 1995 the "Obhvat-4" was experimented. At that time special attention was paid to the sensors and to the organization of information flows. There is still no uniform concept for operational use of such a system but the ideas of applying high technologies go beyond information provision and the prototype has al-

ready become a combat means. This is the first step of the Naval Forces into the information era where weapons automation and the transfer of their control to such systems is a significant move in the functional-technical integration, marking the intellectualization of military activities.<sup>9</sup>

A Bulgarian-Dutch program for developing the organizational and technical structure of a vessel control service started in the second half of 1999. To start with, IAMA developed a fragment of a VTS system providing the safety of coastal navigation in the Bay of Varna. At the moment IAMA is building a uniform automated information and communications system for situation assessment, sea traffic control, SAR, operations planning, cooperation in rescuing ships, etc., capable of reacting in real time. It has a huge potential for information support of the Naval Forces, the Border Police National Service, the Customs Agency, the pilot services, and other users of national sea spaces. Priority has been given to providing the safety of navigation, improving the organization of work and enhancing the ports' competitiveness and the passage capability of the approach waterways at the expense of reduced risk. The development of the concepts of VTS systems can be seen in Table 1.

It is worth mentioning of the experience of the sea section of the Border Police National Service in the end of 2002 when a cutter was included in the sea C4I-system using "Transas" equipment.

In the recent years, with the development of the doctrinal concepts for use of the Naval Forces<sup>10</sup> and especially with the development of the theory "operations of providing the sea sovereignty" (a variation of the seamen's term "naval control and protection of navigation"), the views<sup>11,12,13</sup> on the application of the C4I system concept in the Naval Forces have been broadened and aimed mainly towards their organization and conduct. Their operational architecture contains in its kernel a provisional "primary" CNSS operation,<sup>14</sup> which is a functional system of concrete techniques, tactics and procedures based on various international documents. Until now, in the realization of the concept, this very elementary operation has been underestimated, which is a retreat in principle from the system approach. The system analysis technology requires one to start with a description of missions at tactical, operational and strategic level of all elements of such a system, investigation of their functional relations, the volume and character of the information flows and after that to look for their technical solution.

The implementation of the C4I System Concept is connected with overcoming some disparities, which come along the reform in maritime business and the national institutions. The main disagreement is related to: the differences in regimes depending on whether the country functions in time of peace, crisis or war; different maritime institutional and national organizations, "aviation" and "maritime" approaches to sea

traffic control; the theory to be ascertained and the practice which precedes it in the field of sea control; the difference in the sea control authorities' methods, resulting from the lack of common tactical doctrines; the legislative nature and the military way of conducting most operations connected with CNSS.

The disagreements become especially clear in the forces' control and command system, in their information support and the applied methods of control. They are reflected in the training of Bulgarian seafarers, which is apparent from the recent state of maritime education, forcefully framed by the educational reform without considering the fact that it is subjected to different logic and generally accepted international criteria.

The practical application of the C4I System Concept provides solution of the above-mentioned challenges and settles the complicated relationships within CNSS. In this context, the efforts should be aimed at: unifying both the control theory and the methods, operations and procedures applied in different institutions, ascertaining normatively the C4I systems by a state standard; creating integrated information environment for all subjected to control and uniting functionally the data-gathering units with the maneuvering forces; redefining of the main elements in the theory of coast component in the system for surveillance and development of adequate tactics for its application.

The C4I System Concept initiates the application of the situational approach in CNSS. Priority is given not to make final decisions but to develop a methodology and to create an environment for immediate decision-making in complex situations. This type of control is not related to some new theories; it is a new methodology initiated by the revolution in communication and information technologies. It actually provides substantial increase in leadership culture and the application of teamwork principle is mandatory. The CNSS' situational control presupposes prediction of situation development and determination of main tendencies. To this end it is necessary to organize the collection, storage and analysis of all the data and information about it, irrespective of time of receiving, but considering the fact that the recent information has a priority.

### **Application of the C4I System Concept in CNSS**

In the developed countries, the pragmatic approach to build the subject of their sea control around the navigational safety systems gains wide popularity and acceptance. Their development is coupled with sea traffic control as part of the control of risk at sea, as well as the protection of sea environment. They are compatible with the automatic control systems of the Navy, and supply them with up-to-date information which is necessary in time of peace, crisis control and combat operations. They fol-

Table 1: Legal Requirements of VTS

№	Phase	Main IMO Documents	Application	
1.	VTS	SOLAS Convention	Rule 5/8-2 Vessel Traffic Services	
			Rule 12 in the new amendment of Chapter 5	
IMO Resolution A.857(20) Guidelines for Vessel Traffic Services				
IALA Manuals and Recommendations				
IALA VTS Manual				
5.		IALA Recommendation V-103		
6.	SRS	SOLAS Convention	Rule 5/8-1 Ship Reporting System	
			International Convention for Search and Rescue at Sea SAR	Chapter 5 Ship Reporting System
			IMO MSC.43(64) Resolution	
			IMO A.851(20) Resolution	
10.	AIS	IMO MSC.74(69) Resolution		
11.		SOLAS Convention	Rule 19 in the new amendment of Chapter 5	

low the military systems logic and have military systems' hierarchical structure at strategic, operational and tactical level. Systems development has several different aspects – to establish the necessary legislative basis, to provide appropriate technical equipment, to create organization, and to train personnel. All these problems are solved within the frame of a unified operational concept.

The international maritime conventions and the respective national laws based on them regulate the implementation of CNSS, as well as the technical-organizational basis of the C4I systems that support CNSS. Nowadays, most maritime countries work persistently on the improvement of the legislative basis, in which the contemporary requirements for safety at sea and sea environment protection are reflected. Special attention is paid to the development and functioning of VTS as one of the most important facilities providing safety of shipping in ports and coastal areas (see Table 1).

The technical ground for practical application of C4I system concept in CNSS includes technologies and equipment for: collection of data (sensors based on various physical principles and remote control devices including satellites); data processing for communication and navigation; data systems integration, data protection and data

systems security; automatic identification systems. The importance of these means and technologies should not be underestimated; however, it should be noted that they only provide support to the concept and should not be brought forward to a leading position.

The major subject of sea control is the state. The state delegates the organization and implementation of control to the relevant institutions. Their efforts are functionally combined in a system for control of national sea spaces (SCNSS) in traditional maritime states. It is organized by the Navy and functions as a naval structure, which adequately meets modern threats.<sup>15</sup> Such systems are structured in advance in accordance with the declared interests, recognized needs and real capabilities. There exists always such a system in the general structure of state government and military control, which is further developed and maintained in a relevant to the situation condition. Even in cases when such a system is not especially organized and developed, when there is a need, the system self-organizes, i.e. its main components come to existence. Table 2 illustrates the main functions of such a system, which uses some existing structures developed on the basis of the C4I-system concept.

To be able to realize its functions with utmost precision, CNSS should operate a well deployed structure. Generally speaking, it includes the following subsystems: command; control and communications/information support; maneuverable execution forces; post-reconnaissance cover-up and imposition of sanctions and/or for rendering services in crises situations; for support, training and preparation of personnel and forces; readiness and duty staff; and reserve.

Nowadays, this subdivision is provisional, since computer networks form 'a unified system for information and control' integrating all subsystems and even system components from different organizations. In this way, new functional relationships are created capable of enhancing the quality of control and considerably reducing its cost. In this case, the application of system approach guarantees increase in efficiency by at least 30 percent, compared to the traditional methods of control applied by independent control systems.

## **Conclusion**

The system approach is widely applied in developed countries in all spheres of state building and especially in the development of protective structures with civil and military designation. The maritime control promoted by them is subordinated to the strategic concept for protection of national interests, and the implementation of the C4I system concept provides an instrument suitable for the purpose. It offers active counteraction against all threats to national and regional security. Their asymmetric nature and the redefined national interests require this control to be considered not

Table 2: Basic CNSS functions.

Functions in support of the Armed forces		Creation of a complete tactical picture		
		Ensuring of connections for a fast and reliable information exchange		
		Direct sensor consumer information emissions		
		Information warfare		
Functions in favor of navigation	AIS Automatic Identification System	'ship-to-ship' mode - prevention of collision		
		'ship-to-shore' mode: - receiving information about ships and their cargo; - a technical VTS method.		
		SRS II Ship Reporting System - insuring safe and efficient shipping; - Protection of the seas (when transporting dangerous cargoes)		
	SRS I Ship Reporting System - crew safety crew at sea; - increased efficiency in SAR operations.			
	VTMIS Vessel Traffic Management and Information System	VTMS Vessel Traffic Management System	VTS	Organization and control of harbors and approaches to them, as well as in narrow seas, control on following the sailing rules and regulations.
				Ensuring safe shipping in complex navigational meteorological and hydrological situation;
				Conduct of search and rescue operations and oil pollution follow up operations
			Assistance with port authorities (pilot, tug, operators, etc.)	
			Navigational control of coastal waters as state security measures, informational backup of border and customs authorities.	
	National and international VTS data exchange on ships			
Additional	Creation of a common information media			
	Record on trespassing and penalties			
	Planning of operations			
	'Situation' workout and training			
	Networking with similar systems			

Applications of the system concept CA1

only as an element of the mechanism for preventing conflicts but also as a fundamental part of the management of country's maritime policy, of the exploitation of

marine resources, their protection, etc. Regardless of the expenses and the difficulties, the implementation of the C4I system concept in CNSS is absolutely necessary for the performance of the Navy missions and for the improvement of state governance. The research conducted during the last few years and the analysis of our and international experience allows us to make the following conclusions:

- There is a common trend of increasing the integration of the various institutions by the functioning C4I infrastructure and unification of their control functions, which results in higher efficiency and reduced maintenance costs.
- The operational and economic expedience gives priority to military forces due to the fact that the C4I system concept is best developed there, and because they have the necessary means, aids and qualified personnel for the good performance of the tasks pertaining to control.
- The state-of-the-art maritime control is based on the development of an integrated information environment for the situation at sea, getting information from all information-collecting structures and providing authorized access for the interested parties.
- The control systems of national sea spaces are developed with the help of the Navy and are maintained as military defense structures. The C4I-infrastructure is a universal instrument for modern situational management.

The practical implementation of these conclusions could be realized by fulfilling the following recommendations:

- For successful introduction of the C4I system concept in CNSS, a state standard that regulates the development and use of such systems has to be established;
- For utilization of the limited resources, parallel and concurrent structures have to be integrated and the duplicated elements eliminated;
- For efficient functioning of the CNSS system it is necessary to have: a new management culture, recognition of the situational approach in management and education; wide use of the basic principles of the system approach and the new information technologies.

The C4I concept is the only viable alternative to overcome the disparities within the CNSS system, which is being developed now. Relevant insight into the C4I concept and its proper implementation has a great methodological importance for the development of a working national maritime policy.

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- <sup>1</sup> Peter Petrov, VADM, BU N, “Towards Creation of a Unified Information System of the Navies of the Black Sea Countries,” *Information & Security: An International Journal* 6 (2001): 94-101, <[http://www.isn.ethz.ch/onlinepubli/publihouse/infosecurity/volume\\_6/a4/a4\\_index.htm](http://www.isn.ethz.ch/onlinepubli/publihouse/infosecurity/volume_6/a4/a4_index.htm)> (14 March 2004).
- <sup>2</sup> *United States Coast Guard – Model Maritime Service Code* (Washington, D.C.: US Department of Transportation, 1995).
- <sup>3</sup> *White Paper on Defence of the Republic of Bulgaria*, adopted with a decision of the Council of Ministers of the Republic of Bulgaria on April 4, 2002 (Sofia: Ministry of Defence of the Republic of Bulgaria, 2003), English translation is available on-line at [http://www.mod.bg/white\\_book/ENWP.pdf](http://www.mod.bg/white_book/ENWP.pdf) (13 March 2004).
- <sup>4</sup> EXTAC 1012 – *Maritime Interdiction Force Procedures*.
- <sup>5</sup> EXTAC 1013 – *Regional Naval Control of Shipping*.
- <sup>6</sup> Petrov, “Towards Creation of a Unified Information System of the Navies of the Black Sea Countries.”
- <sup>7</sup> EXTAC 1012 – *Maritime Interdiction Force Procedures*; EXTAC 1013 – *Regional Naval Control of Shipping*.
- <sup>8</sup> *Agreement on the Establishment of the Blacksea Naval Cooperation Task Group*, <[www.blackseafor.org](http://www.blackseafor.org)> (20 March 2004).
- <sup>9</sup> Petrov, “Towards Creation of a Unified Information System of the Navies of the Black Sea Countries.”
- <sup>10</sup> Petrov, “Towards Creation of a Unified Information System of the Navies of the Black Sea Countries;” *White Paper on Defence of the Republic of Bulgaria*.
- <sup>11</sup> Stoyan Balabanov and Karmen Alexandrova, “C4I System Reengineering: Essential Component of Bulgarian Armed Forces Reform,” *Information & Security: An International Journal* 5 (2000): 41-59, <[http://www.isn.ethz.ch/onlinepubli/publihouse/infosecurity/volume\\_5/a2/a2\\_index.htm](http://www.isn.ethz.ch/onlinepubli/publihouse/infosecurity/volume_5/a2/a2_index.htm)> (14 March 2004).
- <sup>12</sup> *C4ISR Architecture Framework, Version 2.0* (C4ISR Architecture Working Group, December 1997).
- <sup>13</sup> *DoD Architecture Framework (DoDAF), Volume I: Definitions and Guidelines*, Version 1, (Washington, DC: DoD Architecture Framework Working Group, February 2004).
- <sup>14</sup> *United States Coast Guard – Model Maritime Service Code*.
- <sup>15</sup> Balabanov and Alexandrova, “C4I System Reengineering: Essential Component of Bulgarian Armed Forces Reform;” *United States Coast Guard – Model Maritime Service Code*.

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