

# Conceptual solution for the Military Geoinformation System of the Ministry of Defense of the Republic of Croatia

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*ABSTRACT: Ministry of Defense of the Republic Croatia, with the project "Military geoinformation system – VoGIS" started to build a unique geoinformation system for the Ministry and Armed Forces. This system would be in accordance with Croatian and international geoinformation standards and fully conform to the NATO standards. According to the Preliminary design, the goal of the VoGIS is implementation of a geoinformation system that will be the basis for development of all further activities in domain of military spatial data, with special emphasis on creation of military cartographic database and military maps, along with the fulfillment of the Partnership Goals. VoGIS is based on the Croatian Topographic Information System made by the CROTIS standard. In the first phase of the project, the object data model of the basic military topographic database is developed. In the second phase, the original conceptual design of the system is developed and the whole cartographic production workflow based on the spatial databases is developed and implemented. The concept encompasses standardization of collection of special "military" content with upload into a basic topographic database, design of cartographic database model, cartographic generalization, map indexes, map design and production and printing.*

*Keywords: geoinformation system, VoGIS, military cartography, NATO, CROTIS, generalization*

## 1. Introduction

With the project «Military geoinformation system – VoGIS», Ministry of Defense of Republic Croatia began foundation of a unique informatics system for needs of the Ministry of Defense and the Armed Forces; the system that is in accordance with international norms and norms and principles of the other government bodies, and which is tightly connected to the existing geoinformation system of the State Geodetic Administration. According to the Preliminary design (MORH 2004), the goal of the VoGIS is “implementation of a geoinformation system that will be the basis for development of all further activities in domain of military spatial data, with special emphasis on creation of military cartographic database and military maps, along with the fulfillment of the Partnership Goals”. The original concept of implementation of modern geoinformation system is described in this work, along with solutions for all elements of cartographic production based on topographic and cartographic databases and which is developed in company Geofoto d.o.o.; the concept that have not existed before in Republic Croatia.

## 2. Expected project results

By the realization of the project VoGIS the following is established:

- ❑ Efficient multi-user geoinformation system that will include all elements necessary to the Ministry of Defense (MD) and the Armed Forces (AF)
- ❑ System which is in correlation with other existing geoinformation systems in the Republic of Croatia, firstly with the CROTIS system of the State Geodetic Administration.
- ❑ System which enables secure bi-directional exchange of digital information with other members of the NATO and the Partnership for Peace, fulfilling in this way the obligations that Croatia has according to the Work plan 0122 of the Partnership for Peace (NATO 2002).

Accomplished results represent broad basis on which, among some others, establishment of unique cartographic information subsystem inside the VoGIS is based, and which got priority in realization.

The entire project VoGIS encompasses more project parts which are carried out through subprojects, in phases. In the first phase of the project the following essential project parts have been accomplished (Biljecki 2005):

- ❑ Analyses of the existing system of the Ministry of Defense with definition of detailed requirements for future system
- ❑ Description of the entire model of the VoGIS system
- ❑ Modeling of basic topographic database according to the object oriented principles, which includes production and description of conceptual data model with usage of the UML, data catalogue and the GML application scheme for data exchange.

In the second phase of the project it is necessary to develop concept and implementation of entire topographic-cartographic production process, which has as final goal production of the Military cartographic map 1:50, 000 and the Military operations map 1:250,000. The concept has to give a technological solution for appending of a military content in the topographic database, model design and catalogues of objects of all necessary databases, methods and procedures of generalization, design of cartographic symbols and rules, index maps, selection of existing and development of necessary standards and production and printing.

### 3. Basic realization principles

The realization of the system is weighted with two important factors: time and financial means. Process of geo-informatization of the Croatian army and the Ministry of Defense requires reliable, central topographic database which should include topographic elements for specific subsystems like logistics, aviation, training and other. Therefore, some basic principles were set to ensure quick, rational and modern project implementation:

- 1) The application of IT technology has to be maximal. All production processes need to be preformed on IT equipment, all products need to be primarily digital, including maps whose analogue form comes out of a digital form. All processes, especially conversion and production processes need to be as automatic as possible.
- 2) Rationalization when acquiring data. When implementing VoGIS, the principle is used according to which data collected in one institution should be used as many times as possible for needs of a various state institutions. This principle results in

rationalization, but also in data quality as each data type needs to be acquired and updated in authorized institution (i.e. profession). Therefore, the basic topographic database of the Ministry of Defense results from the topographic database of the State Geodetic Administration (CROTIS database). The basic database should be used, besides cartography, for solutions of other topographic projects and tasks of the Ministry of Defense.

- 3) Usage of standards and norms. When classifying and coding a content of a databases it is necessary to use the NATO standards, the ISO norms in modeling and the OGC standards in implementation.
- 4) Production of military maps needs to be formed in a way that would ensure that map is not produced as isolated product drawn on the computer screen, but map needs to be derived by certain technological procedure from previously made cartographic database.
- 5) Change of technology in map production may result in change of appearance and map content, while not decreasing its quality and usage.

#### 4. Implementation concept

Serial production of military maps based on digital technology does not exist in the Republic of Croatia. Moreover, in the Republic of Croatia there is no tradition for production of topographic maps in scale 1:50,000 and 1:250,000, with few exceptions which refer to particular test sheets. In the Republic of Croatia does not exist, as well, tested or in practice confirmed technology for map production based on cartographic databases. And, finally, the Republic of Croatia does not have regulations or technical specifications for production of maps in scale 1:50,000 and 1:250,000.

Listed facts clearly show the complexity and severity of set goals, as well as responsibility the project team took.

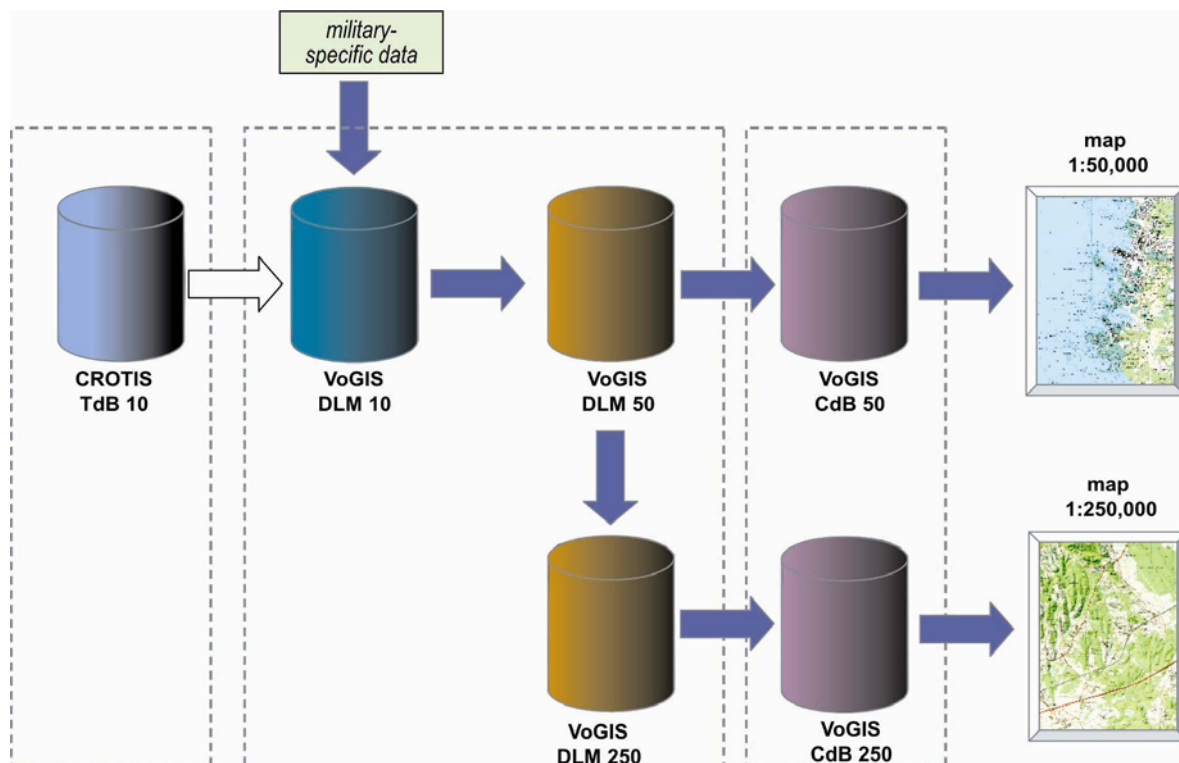
Preliminary project of the Ministry of Defense sets starting and final elements for the project. Starting element of the whole project should be the basic topographic base of the VoGIS system (Digital Landscape Model - DLM) with accuracy +/- 1m that results from over taking and expanding topographic database of the State Geodetic Administration, which is made according to the CROTIS standard. The final products of cartographic component of the system have to be military maps in scale 1:50,000 and 1:250,000 that are in compliance to the NATO standards.

The first problem which authors faced was disproportion in scales of the original (1:10,000) and scale of the maps. As very unfavorable ratios 1:5 and 1:25 eliminated direct production of a smaller scale map from a bigger scale map, project team had to find a solution for data "flow" trough a system (trough databases of different scales), while keeping in mind that printed map is actually only a media on which spatial data is shown (Kraak and other 1998).

Considering that a GIS system of the Ministry of Defense had to fulfill several expectations and not only map production, the project team developed a concept which in the center has topographic databases (Digital Landscape Models) and in which databases of smaller scale (i.e. accuracy) develop from bigger scale databases (Figure 1).

The basic Digital Landscape Model (DLM10), after appending the specific data, becomes a basis from which, with specific generalization procedures, is produced the

topographic database (DLM50) of smaller accuracy (planned is +/- 5m) which is used as basis for production of the Cartographic Database (CdB50) of the scale 1:50,000 and as original for the topographic database (DMK250) of accuracy +/- 25m which will be used as original for production of the Cartographic Database (CdB250) in the scale 1:250,000.



Picture 1: The Concept of the Military geoinformation system of the Republic of Croatia

#### 4.1. Standards

DIGEST standard for coding was used when modeling the DMK10 and other databases. This significantly eased model links (mapping). Topographic data of accuracy i.e. scales 1:50,000 correspond to the conditions of the NATO alliance for regional level planning and are often issue of exchange. Therefore, there is a condition set that when modeling, the standard *Vector Smart Map Level 2* (VMap2) should be used as much as possible.

New concept of military topographic-cartographic system of the Ministry of Defense can be seen on the map production concept, too. State Geodetic Administration produces topographic maps for public (civil) usage which leaves for the Ministry of Defense only to produce military topographic maps. Reduced functionality (not in quality) has to be noticeable in the content and visual appearance of maps, as well as in speed and economy of production and easiness of maintenance. Newly produced military maps will not be used by so wide spectrum of people as the maps of the Military Geographic Institute have been used, but only by users inside the Ministry of Defense and the Armed Forces.

The consequence of these principles is elimination of objects insignificant for military needs which brings towards more simple and more readable cartographic display. On the other hand, the cartographic data model encompasses even bigger number of attributes then needed for production of the Military Topographic Map 1:50,000 (MTM50), so that different versions of the maps can be made, applying different cartographic designs with the same data.

When choosing scale for a topographic database that would be used as basis for production of the map 1:250,00, the main argument was again the NATO standard for exchange and planning at international level, the *Vector Smart Map Level 1* (VMap1). For production of the map 1:250,000, the standard JOG-G was defined according to the NATO's requests.

Basic characteristics of the content of the cartographic database, concerning the military character, express the changes developed in the perception of topography because of technology development of the military equipment (e.g. neither hydrography nor vegetation do not represent insuperable barriers in transportation as 20 or 30 years ago).

## 4.2. Data flow through the system

Two procedures characterize data "flow" through the system: mapping and generalization. Mapping is procedure which connects all object classes and attributes of an original model to object classes and attributes of a produced model. Mapping is designed with help of the software tools and is executed automatically.

Transformation procedures from DMK10 base to DMK50 base and from DMK50 to DMK250, namely between topographic data in different scales, is performed with so called model generalization. Model generalization is defined as controlled reduction of data in spatial, thematic and time sense (Weibel 1995), and encompasses following processes:

- ❑ Selection of object classes
- ❑ Selection of certain objects according to the attributes and appearance context
- ❑ Geometry change (areas in lines, areas in points, lines in points)
- ❑ Filling blanks that are result of selection (preservation of topology)
- ❑ Simplification of networks (roads, waters)
- ❑ Geometry smoothness.

In model generalization procedure there is **no object movement** so that required accuracy of topographic data is not damaged.

Cartographic generalization is conducted when transferring data from topographic to cartographic databases (from DLM50 to CdB50 and from DLM250 to CdB250), and includes:

- ❑ application of map specific displays
- ❑ movement of objects
- ❑ text positioning.

Procedures of model and cartographic generalization are performed with the GIS program tools, partially automatically. When modeling databases and planning generalization processes; purpose, subject, display, means for display and originals were taken into account (Frančula 2000).

It is important to mention that the implementation concept was presented two times to the experts from *Defense Geospatial Intelligence* (Great Britain) and *National Geospatial-Intelligence Agency* (USA) and in both cases had excellent rating.

## 4.3. Map design

According to requirements of the Ministry of Defense, the appearance of the map, i.e. cartographic symbols need to be in accordance with the existing Croatian standard.



1:250,000 are formed inside one UTM zone with division to 3 columns and 8 rows, while size of one sheet is  $2^{\circ} \times 1^{\circ}$ .

Number of sheets in scale 1:250,000 necessary to display whole territory of the Republic of Croatia is 15. Division to sheets of map 1:50,000 is performed by division of map 1:250,000. A sheet 1:50,000 is formed inside one of 1:250,000 sheets by dividing in 6 columns and 5 rows, each in size 20' x 12'. Number of sheets in scale 1:50,000 necessary for display of entire territory of Croatia is 179. Number of sheets is possible to decrease with expansion of borders of the neighboring sheets.

When naming the sheets, the principles are firstly set. According to the basic principle, the name of the sheet is given according to the settlement with biggest number of inhabitants. The principles describe procedures when sheets have part of foreign territory on them and when there are no settlements on the maps, etc.

## 5. Conclusion

New, original concept of the geoinformation system of the Ministry of Defense is modern, open and standardized system that enables the Ministry to accomplish all set goals, towards its users (the Armed Forces, various Administrations...) and to member states of the NATO alliance and the Partnership for Peace. System leans on the most modern principles and technological implementations of today's geoinformatics.

Production procedure that this project suggests is introduction of two topographic databases (DLM50 and DLM250). The basic database in scale 1:10,000 that develops from the CROTIS system of the State Geodetic Administration will be the original for production of the topographic data base 1:50,000 which will be the original for the topographic database 1:250,000.

Bases produced this way become secondary products of the VoGIS system, where each database has its own GIS functionality – it is used as a database for a GIS analysis of medium (1:50,000) and large areas (1:250,000). This means that database DLM50 is used for spatial analysis at regional level and DLM250 for analyses on state and interstate level. These databases do not contain smaller and less important objects; have less density of objects and components which enables analysis of bigger surfaces and bigger number of objects. It is important to point out that these two DLM databases are made according to the NATO standards (VMap1 and VMap2).

The basic VoGIS database (DLM10) remains highly-precise detailed database for analysis at local level and, what is most important, the source for all Ministry's geotopographic products.

The concept of the topographic-cartographic production of the Ministry of Defense is this way accommodated to the state topographic-cartographic system, i.e. leans on and can fulfill the system of the State Geodetic Administration. This way the Ministry of Defense can use all existing resources of the State Geodetic Administration and when planning future activities need to coordinate with the SGA. This way the funds that the Republic of Croatia invested in data, information and knowledge are used in the maximum manner.

## 6. Literature

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