APPLICATION OF PHOTOGRAMMETRIC METHODS TO THE CREATION OF STATE CADASTRE OF REAL PROPERTIES AND GEOGRAPHIC INFORMATION SYSTEM IN THE CZECH REPUBLIC

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PURPOSE:
Automated Information System of Geodesy and Cartography of Czech Republic consist from three relatively self-sufficient information subsystem (SS). Digital cadastre is the main SS - it is formed by two interconected information files (IF): IF digital cadastre map (DKM) and IF Evidence of Real Estates (ERE). IF of DKM is supplied by the data obtained from aerial photographs plotted by the use of numeric, analytic and digital photogrammetric methods.

KEY WORDS:
GIS/LIS, Cadastre, Photogrammetry, Analytical, Accuracy

Return of legal rights after the "velvet revolution" of '89 in Czechoslovakia has given a new not only technical but also political aspect to the project of Forming of an Automated Information System of Geodesy and Cartography (AISGK) [1]. Renewal of cadastre with its proprietary relations has its primary goal in forming a tool for a righteous restitution of real estates owned before the communist rule by citizens and to a legal taxation system of the state. It includes also informations about basic geodetic data, interconnection of East and West European nets and unification of European Datum. In the case of topographic maps it should solve data exchange in the boundary region of formerly divided zones of superpowers.

The new conception of the AISGK respects the prepared legal conceptions of the state [2], [3], [4] and reflects the future State Information System of the Czech Republic (SIS ČR). This SIS ČR is based on four source registers (information systems) of primary data (Fig.1). Uniform localization will be secured by the AISGK, especially in its function named "Register of Real Estates". This is specified by its main identifiers, namely space coordinates and lot numbers. Uniform identification of natural and juridical persons will be secured by the Register of Inhabitants and Register of Organisations. The Register of Territorial Identification divides in an uniform way the state territory division to territorial- administrative units. This register serves in regions simultaneously as Register of Buildings whose basic identifier is the uniform series of space unit numbers on the territory of the Czech Republic as well as uniform series of building numbers in separate regions.

From the point of view of SIS ČR creation the goal of the AISGK forming is unified computerized "source" geodetic and cartographic data base of primary informations as a source layer not only of the SIS ČR, but of all localization information systems of other branches and state administration with aggregated data and of cartographic works in the Czech Republic. This means they will form a "source" layer of stepwise created geographic and land information systems (GIS/LIS) on the territory of the Czech Republic [5] - [8].

The project of the AISGK supposes that the AISGK will consist of three relatively independent information subsystems. These will be mutually interconnected by a superimposed interfacing database file as well as by a software environment. (Fig.2)

1. Subsystem of geodetic coordinates consisting of spatial data (trigonometrical,levelling, and gravimetrical nets of fixed points) covering the entire state territory by which an unified system of spatial coordinates and gravimetrical data in an uniform projection is defined.

2. Subsystem of digital cadastre formed by two interconnected information files :

- Information File of Localization (digital cadastral map DKM),
- Informational File of Evidence of Real Estates (written cadastral documents).

3. Subsystem of topographic information which will realize a localizating basis to create a digital medium scale topographic map. Primary testing data acquisition and securing of necessary connections to above mentioned subsystems will play main part in this case.

Common matter of these subsystems is represented by identification and classification of individual objects. There is one very important task which is given by setting of binding data interface to secure information flow between information systems of interest as well as possibility to access public data network (PDN, or VDS in Czech). Simultaneous solution of relevant software for interactive graphical data acquisition and data base administration is demanded to forming of the AISGK as well as necessary technical means, i.e. applied geodetic, photogrammetric, and cartometric methods. A considerably substantial part is expected to be shared by remote sensing methods.

The work on the AISGK started due to its social importance by the solution of the subsystem of

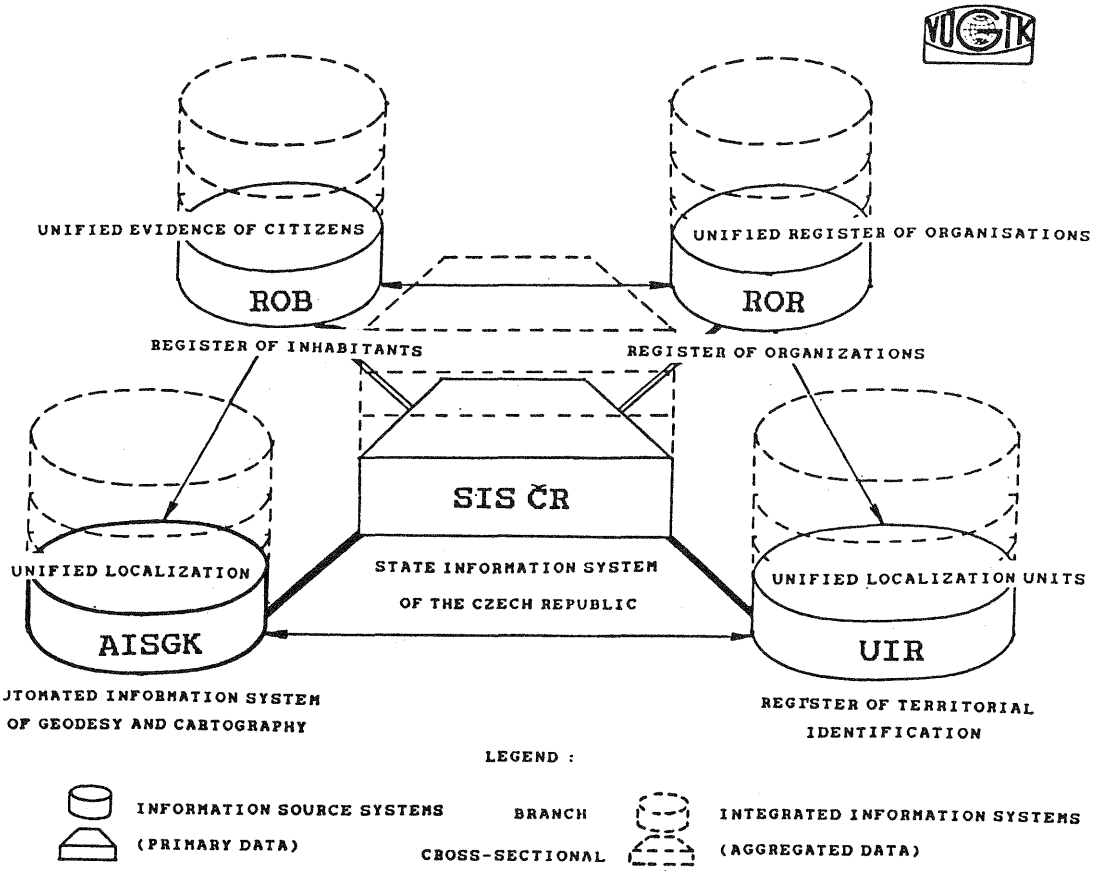

Fig.1. Outlines of the SIS ČR

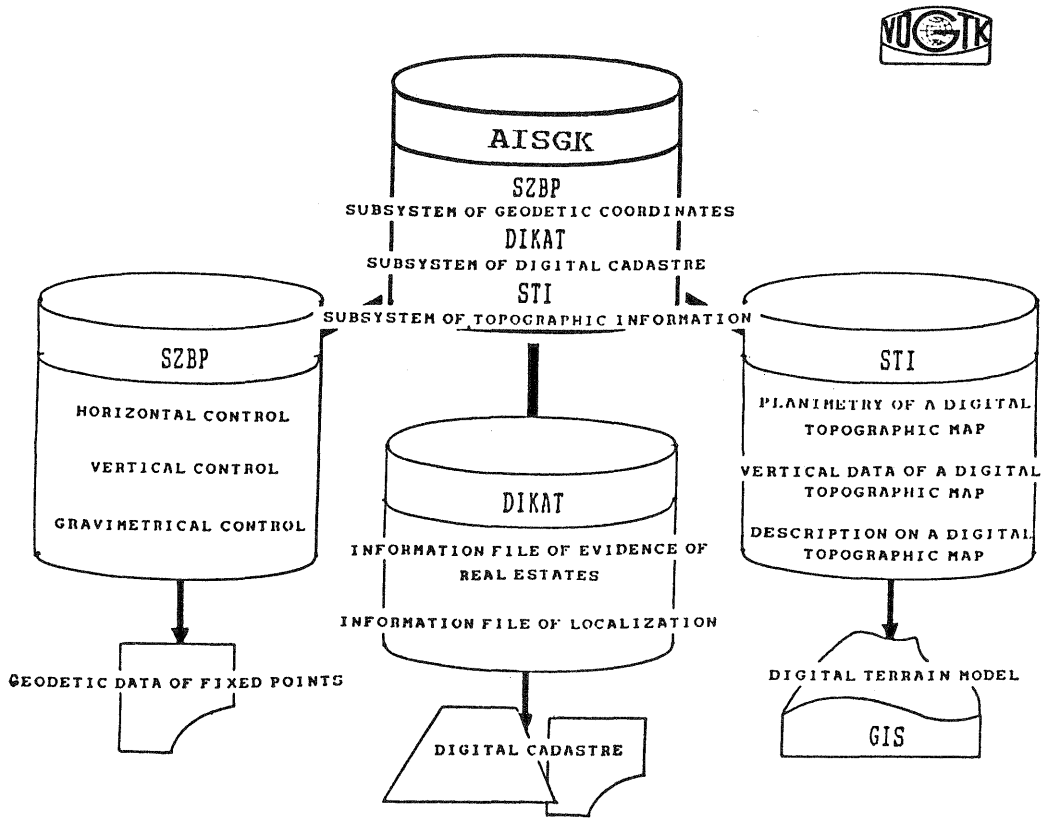

Fig.2. Outlines of the AISGK

geodetic coordinates (SZBP) and subsystem of digital cadastre (DIKAT). A fully integrated hardware and software is assumed to be applied to processing and updating of both subsystems. As especially DIKAT will be operated on an IBM mainframe of the Cadastral Service of the Czech Republic (in Prague) as well as by individual cadastral offices (on 32-bit-workstations and PC's) on the whole state territory (76 offices) the applied hardware must be able to operate in a communication net. In the first step there will be a locally independent solution and this will be followed later after mastering all technical problems by an application of the public data net (PDN). Simultaneous solution of relevant software oriented to graphical data acquisition and data base administration will be secured as well as other necessary technical means to relevant software to interactive graphical data processing and data base administration.

During the search of corresponding soft- and hardware the necessity of an "open" system reflecting all demands of various user applications was taken into account. This searching phase and successive proposals to uniform technical solution of workstations by up-to-date hardware and corresponding software resulted in a recommendation to realize the business with the Intergraph Corporation [9].

Basic software is represented by interactive data bases of the graphical system MicroStation version 32 for UNIX WS, 4.0 and 3.3 for PC and corresponding program superstuctures, particularly I/SCAN, I/RAS and MGE/SX together with the data base system ORACLE (I/RAS and MGE/SX also in PC versions). The acquisited data input to user's environment is formed by the data base system DBase IV preceeded by the integrating MS DOS operation system. To secure data analyses of the DIKAT subsystem the program packet MGE (MicroStation GIS Environment) and relational database system ORACLE is applied. The role of integrating environment plays the operation system UNIX in this case (Fig.3).

During the renewal of cadastre and its transformation to the digital form (DIKAT) data acquisition by survey, cartometry and photogrammetry is expected in a similar way as in other European countries [10]-[12]. The geodetic control will be completed by the Geodetic Positioning (GPS). The most frequent survey metod is the polar one using electrooptical telemeters-tachymeters with registration or total stations (with application program, e.g. GEUS). Cartometric digitizing of existing sources is realized by digitizers with fixed or free cursor and output in vector form or by scanner with raster output. Application processing subprograms are ready (for raster data e.g. Intergraph software I/RAS).

As regards photogrammetry there the analog method with digital data recording is proposed as well as analytic or digital ones. Analog and digital evatuations will be applied to renewal of cadastral maps by new survey in the form of Basic Large Scale Map of the ČSFR. Its part forms also densification of detailed geodetic control by block aerotriangulation. The basic parameter of a new digital cadastral map is the survey accuracy class in connection to the importance of mapped area. The accuracy is defined by the mean square error in coordinates, the respective values are given in Tab.1.

The analog method is realized on stereophotogrammetric instruments as Stereometrograph and Topocart of C.Zeiss Jena. Plotted data are on-line registrated on PC's (by an application program, e.g.FORES). Analytic block aerotriangulation is realized on precise stereocomparator Stecometer of C.Zeiss Jena with direct output of a PC. The analytical method will be realized on the analytic evaluation system InterMap Analytic of Intergraph with possible direct data processing software MicroStation using IMAN subprogram.

Digital photogrammetry should be applied especially during proprietary relation renewal to real estates in connection with the renovation of cadaster of real estates :

The present written documentation of the Evidence of Real Estates includes informations about 12 millions of lots in 13 thousands of cadastral units and about approximately 2 millions of inhabited buildings. These data were in the past updated continuously by batch processing on mainframes. The documentation is oriented mostly to user's relations to real properties [13]. Proprietary relations, especially in such cases when lots were used during the past rule by so called socialist organisations, can be documented on the basis of original cadastral maps. These were successively devastated and at about 4 % of them completely destroyed after 1945. Nevertheless in some regions where for reasons of lack of time or economy the updating of cadastral maps by new survey is not possible, these old cadastral maps can be confronted with existing maps of the Evidence of Real Estates. Even if old cadastral maps are mostly in the 1 : 2 880 scale and each cadastral unit means an isolated coordinate system, transformation of their data into the maps of Evidence of Real Estates is possible, e.g. using identical cross sections of individual map sheets of scanned graphical data. There does not exist any possibility of direct transformation of their content to unified coordinate system and projection using identical points that can be determined on the spot.

This possibility was tested by digital photogrammetry. Raster image of an aerial photographs of a respective territory (its reality was proved at the 800 lines/inch) can with the software I/RAS by Intergraph first transform by control points to the uniform coordinate system (on a graphical station this lasts nearly 50 second) and then with the help of tested identical points of situation of old original maps and the photograph of the terrain transform locally the whole information of these originally graphical maps into the photograph. This is the way how continuos work with the data base of original maps content can be processed. Even more other various thematic layers (e.g. resuls of land consolidation) can be connected to the content of original maps. And relatively quite exactly the original proprietary boundaries of lots can be identified on graphical workstations and digital cadastral map (coordinate cadastre).

We are well aware that a stepwise realization of the whole project of the Automated Integrated System of Geodesy and Cartography will be possible in the present conditions of the Czech Republic only with active cooperation with specialist of the most developed countries of the world. We are really very thankfull for such helping hands, in these days especially to the American Intergraph Corporation. Our research facilities will try to tranform all gained knowlidges a technical help to practical use. We want to concentrate ourselves mostly to technical items (as software and hardware), technologies, organization, legislation, and economy [14]. Our main problem will be external and internal coordinations of systems. It is very esential to prevent in present stay of transition to free trade and rebirth of private property in our land to prevent any disturbation and secure optimal conditions to effective data exchange that plays an important economic role. The primary and also very urgent task is to define and agree to necessary standard, first of all exchange format of object oriented data.

Table 1

Accuracy Class	Control Points	Detailed Planimetry Points
	m_{xy}	m_{xy}
3	0.06 m	0.14 m
4	0.12	0.26
5	0.20	0.5

Parameters of applied aerial photographs (of 23 by 23 cm format) are given in Tab.2.

Table 2

Accuracy Class	Image scale	
	f = 88 mm or 152 mm	305 mm
3	1 : 3 400	1 : 2 000
4	1 : 6 800	1 : 4 000
5	1 :13 600	1 : 7 000

Forward overlap is 80 %, side overlap is 30 %.

DIKAT
Digital Cadastre of the Czech Republic

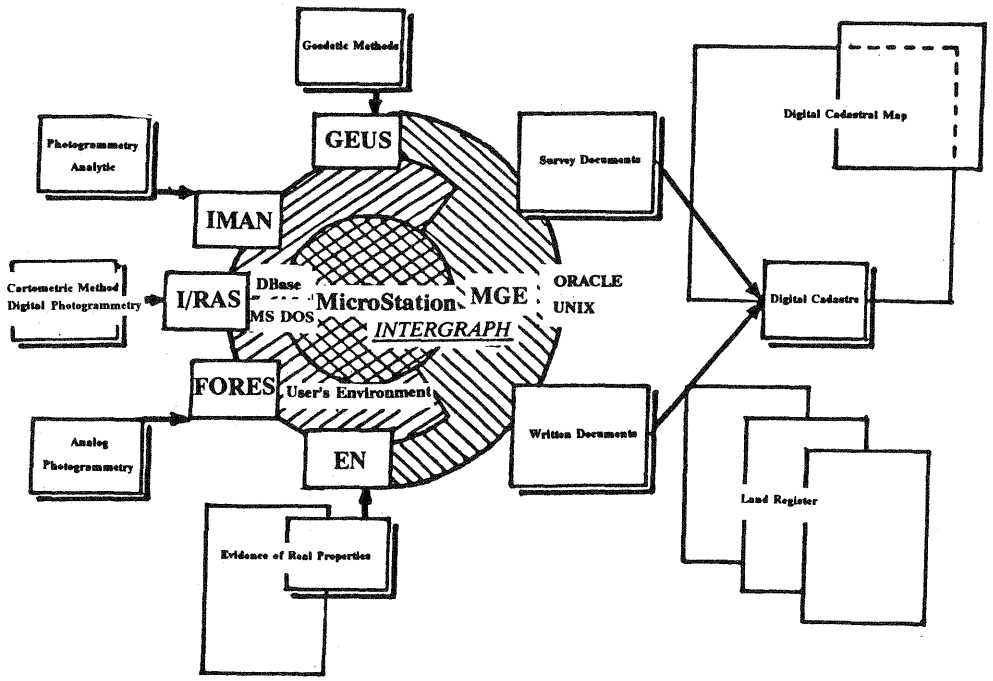

Fig.3. Outlines of software configuration of DIKAT subsystem

References :

[1] Roule, M. : Anteil photogrammetrischer Methoden an dem Aufbau des automatisierten Informationssystems der Geodäsie und Kartographie in der ČSSR. 16th Congress of the ISPRS, 1-10 July 1988, Kyoto-Japan, presented as poster panel, not published

[2] * : Zákon ČSFR ze dne 29.4.1992 o ochraně osobních údajů v informačních systémech (The Law of the Czech and Slovak Federal Republic About Personal Data Protection in Information Systems)

[3] * : Zákon ČSFR ze dne 28.4.1992 o zápisech vlastnických a jiných věcných práv k nemovitostem (The Law of the Czech and Slovak Federal Republic About Registrations of Proprietary and Other Material Titles to Real Estates)

[4] * : Zákon ČNR ze dne 7.5.1992 o katastru nemovitostí ČR (The Law of the Czech National Council About the Cadastre of Real Properties of the Czech Republic)

[5] Ulč, J. : Technologie geografických informačních systémů a jejich aplikovatelnost v nových evropských demokraciích (Technology of GIS and its aplicability in new European democracies) Intergraph Europe, CAMP'91, Praha, 13.6.1991, Přehled informací VÚGTK,6,1991.

[6] Lieberasch, R. : A System Approach to Land Information Systems. Surveying and Mapping, 48, 1988, 3, p.161-171

[7] Jeyananandan, D. : Zur Systematik territorialer Informationsszsteme. Vermessungstechnik, 36, 1988, 12, p.398-401.

[8] Eichhorn, G., Wieser, E. : Die Bedeutung von Landinformationssystemen für Kommunal- und Landesverwaltungen und für die allgemeine Volkswirtschaft. Z.Vermess.Wesen, 113, 1988, 11, p. 531-539.

[9] Intergraph : Prospects and Manuals

[10] Hvidegaard, J.- Krüger, J.C. : Conversion of the Danish Cadastral Maps to Digital Form. Geodetical Info Magazine, September 1990

[11] Berberich, H. : Automatisiertes Liegenschaftskataster - Stand und Entwicklung in Baden - Württemberg. Allg. Vermess.- Nachr. 95, 1988, 1, p. 11-30.

[12] Hemelrijck, J.van : Automatisation progressive du Cadastre belge. Bull. trim. Soc. Belge Photogram. Télédét., No 167-169, 1987, 4, p. 3-19.2

[13] Souček, Z. : Automatizace písemného operátu evidence nemovitostí (Automatization of Written Documents of the Evidence of Real Estates) Sborník konference MIS'91, Praha 1991, p. 263-268

[14] Roule, M. : K problematice výstavby AISGK v ČSFR (Questions of Forming the Automated Information System of Geodesy and Cartography), Geodetický a kartografický obzor, 36, 1991, 6, p.127-142