Standards and new IT developments in Hungarian Cadastre

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Key words: Standardization, Cadastre, Land Registry, Real Property Registry, Cadastral Information Systems

SUMMARY

During the last ten years there were many successful and unsuccessful developments in the Hungarian Cadastral Domain. The base of them is the National Standard of Digital Base Map (Cadastral Map), which was accepted by the Hungarian Standardisation Body in 1996. The standard defines a relational database scheme based on CEN pre-standards. A new cadastral base map instruction system (called DAT) has been developed by the Institute of Geodesy, Cartography and Remote Sensing (FÖMI), which has been operative since 1997. In the National Cadastral Program of Hungary, new cadastral maps (databases) have been created for 500 thousand hectares (5% of the whole territory of the country), based on the standard and instruction system.

The paper outlines the former developments, describes the legal circumstances that belong to cadastre and land registry. The main characteristics of the above-mentioned standard are described. The new, DAT based cadastral data model is outlined in the next section. The similarity and differences are stated between our model and the modular standard for the Cadastral Domain. The real property transactions executed by the new system are detailed.

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1. INTRODUCTION

During the last ten years there were many successful and unsuccessful developments in the Hungarian Land Management Sector. At first, the conversion of real property registry from paper based to relational database form had been accomplished (Complex Decentralized Real Property Registry System). After the completion of this system, the development of a new, integrated cadastral information system has been started, called TAKAROS.
TAKAROS system contains an integrated real property registry with the digital cadastral maps. The project was financed by PHARE funds. The real property registry part of the system has been finished in 2000, and from this time, it is operating in the 116 District Land Offices of Hungary. The digital cadastral map part of the system was unfortunately an unsuccessful development, and up to now, there is no real integrated cadastral IT system at the District Land Offices which solves the principles of the uniform Hungarian Land Registry.
For better public access to the real property registry data, an intranet-type network has been built-up called TAKARNET (network of TAKAROS system). TAKARNET network connects all the members of the Hungarian Land Management sector, and there is a public, but limited access to the system via Internet, too. By this year, the number of the public queries to the system exceeded the 1 million. All the registered users of TAKARNET have admittance to any data of the uniform real property registry.
Beside the elaboration of TAKAROS system, which was carried out by private companies, new developments have been started in the Land Management Sector, mainly in the field of GIS standardization.
The first standard was the Hungarian GIS Data Exchange Standard (MSZ 7771 or HUNEX) which was accepted by the Hungarian Standardization Body in 1995. This standard defines an EXPRESS language scheme for GIS data exchange. HUNEX has an important role in the IT system of the County Land Offices (META).
From cadastral point of view, the most important standard is the Digital Base Map Standard (MSZ 7772-1 or DAT standard), which defines the conceptual model of the Hungarian Cadastral Maps. The Hungarian Standardization Body has accepted DAT standard in 1996. Based on DAT standard, a new instruction system has been developed for the creation, maintenance and updating of DAT based cadastral maps. The Institute of Geodesy, Cartography and Remote Sensing (FÖMI) has developed the standard and the instruction system.
In the National Cadastral Program of Hungary, DAT standard-based cadastral databases have been created for 500 000 hectares (5% of the whole territory of Hungary). The success of the National Cadastral Program of Hungary shows that standardized cadastral databases are the future.
Beside these developments the management of the new cadastral databases at the district land offices has not been solved yet. Therefore FÖMI developed a new cadastral data model (based on the DAT standard and instruction system) for the Land Offices' IT system, TAKAROS. The new data model completely covers the data managed by the Land Offices (cadastral maps, real property registry etc.) and procedures belonging to the Land Offices'

activity (real property transactions, land use registry etc.). The new cadastral data model completely achieves the tasks of the uniform real property registry, since the two parts (cadastral maps and the land registry) are using the same functions, constrains and modules in the operative work.
In this paper the DAT standard, the new data model, procedures and the cadastral IT system are outlined.

2. LEGAL FRAMEWORK

For the understanding of our cadastral developments the reader must know the legal background of the Hungarian Cadastral System.
There are two Acts which mainly influence the cadastral activities in Hungary:

- Act on Surveying and Mapping Activities (Act LXXVI., 1996.) and
- Act on Real Property Registry (Act CXLI., 1997.).

Act on Surveying and mapping activities defines that cadastral and large-scale topographic mapping (scale 1:10 000) is in the responsibility of the Land Management Sector of Hungary. This means that the cadastral maps must be registered and managed at the Land Offices (20 County and 116 District Land Offices). The Act divides the cadastral map data into two parts. The **state base data** are the data, whose production and maintenance is financed by the central governmental budget, and **base data** are the data, whose production and maintenance is financed by other (e.g. local governmental) funds. The objects belong to state base data or base data defined in the DAT standard. [1]
Act on Real Property Registry regulates the principles and procedures of the real property registry of Hungary. Production and maintenance of the real property registry is the task of the Land Offices Network (including FÖMI). The Act determines that the cadastral map is a part of the real property registry which defines the geometric characteristics of a land parcel (area, boundary etc.). From real property transactions point of view the principles of the real property registry are very important. The principles of real property registry are the following:

- Inscription (any right in the real property registry arises from its registration on the property sheet),
- Publicity (anyone has access to view, to copy or to note any data from real property registry),
- Authenticity (any rights and facts in real property registry are authentic),
- Bond of application (any modification in real property registry must be based on an application),
- Ordering (the order of any registration based on the time of application registration),
- Principle of deed (any registration of rights or important facts must be based on a deed). [2]

Our new cadastral data model completely satisfies these requirements derived from the legal regulations.

3. DAT, THE HUNGARIAN CADASTRAL BASE MAP STANDARD

The role of the DAT standard is to determine the objects to include in the cadastral database, to define their geometric properties, connectional and qualitative characteristics and principles of their integration and their metadata. [3]

The data model of DAT standard is in accordance with prEN 287001:1995, Geographic Information — Reference Model European prestandard. The standard's reference system is the Hungarian Geodetic Datum (HD-72), projection system is EOV (Uniform National Projection System) and the height datum is Kronstadt (Baltic system).

The objects are classified into object-classes, object-groups and objects according to the hierarchical level. Classification of object classes and objects groups is the following:

A	**GEODETIC POINTS**	
	AA	**Horizontal and 3D geodetic control points**
	AB	**Vertical control points**
	AC	**Vertexes**
B	**BOUNDARIES**	
	BA	**Administrative units**
	BB	**Administrative subunits**
	BC	**Land parcels (public)**
	BD	**Land parcels (private)**
	BE	**Subparcels and land use**
	BF	**Soil-quality categories (for arable land)**
C	**BUILDINGS, FENCES AND TERRAIN FEATURES**	
	CA	**Buildings, houses**
	CB	**Building attachments**
	CC	**Fences, abutments, and earthworks**
	CD	**Terrain features**
	CE	**Statues, memorials**
D	**TRANSPORTATION**	
	DA	**Characteristic points of transportation**
	DB	**Transportation in built-up areas**
	DC	**Transportation in rural areas**
	DD	**Railroads and other fixed-way transportation**
	DE	**Airline infrastructure**
	DF	**Transportation structures I.**
	DG	**Transportation structures II.**
E	**SPAN-WIRES, TELPHERS**	
	EA	**Axes of span-wires and telphers**
	EB	**Structures of span-wires and telphers**
F	**WATER AND WATER STRUCTURES**	
	FA	**Rivers and lakes**
	FB	**Public utilities**
	FC	**Water structures**

G RELIEF
GA Contour lines
GB Features of relief
GC Digital Elevation Model
H OTHER AREAS
HA Surveying area
HB DAT database handling unit
HC Expanses

Objects are geometrically separated into three categories: point, line and polygon type objects. The geometry of an object stored in 2D, the third dimension (height) is stored in attributes. The thematic structure of DAT is shown on Figure 1.:

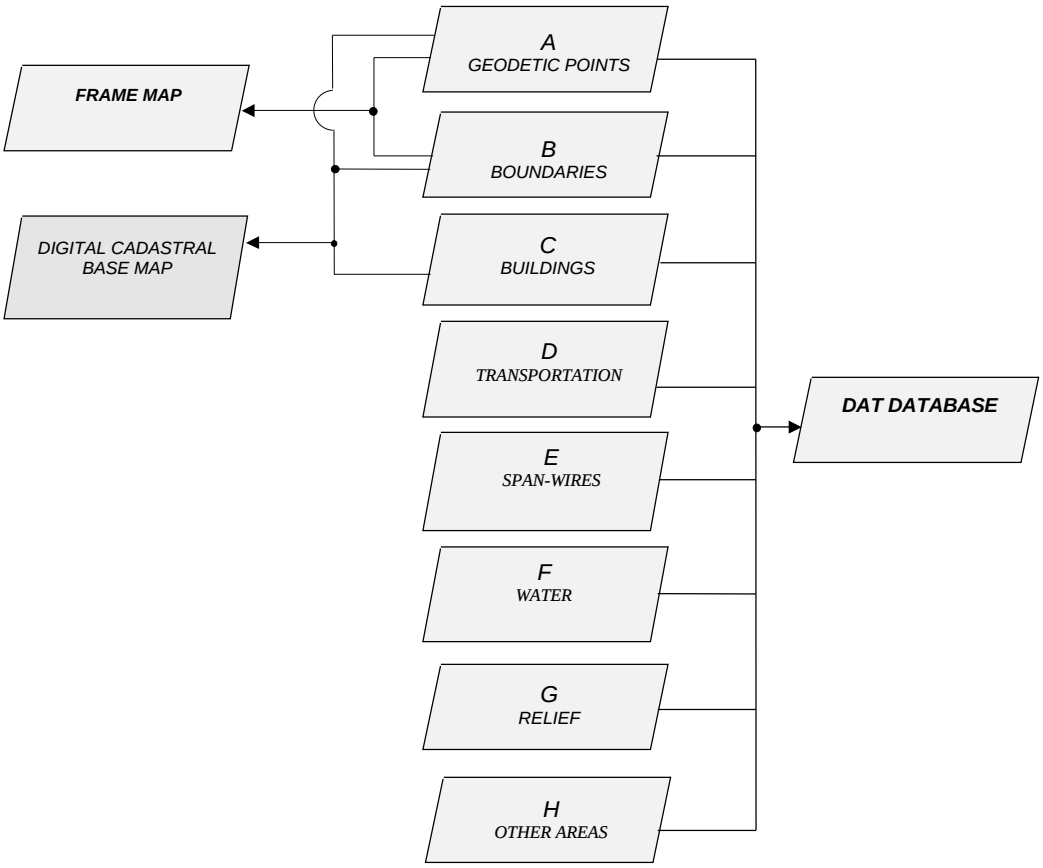

Figure 1.:
Thematic structure of DAT standard

As shown on Figure 1, DAT standard contains much more objects than a cadastral map needs. During the elaboration of the DAT standard, there have been many harmonization discussions among the different sectors of the Hungarian economy. It is the reason why there are so many objects in the standard. But as Figure 1 shows, the cadastral base map contains only 3 object classes. These 3 objects classes are defined as state base data in the standard. In the National Cadastral Program, only the objects of these 3 classes are determined and organized into a cadastral database.

3.1 Geometric and topological elements of the standard

The standard contains the following geometric and topological elements, which is in accordance with the prEN 287007:1995, Geographic Information — Data Description — Geometry, European prestandard.

Geometric elements

Point: 0D geometric element, described with one pair of coordinates.
Line: 1D geometric element, described with two or more pairs of coordinates, can be opened or closed.
Polygon: 2D, closed geometric element, with one or more outer and zero or more inner boundaries.
Boundary: 1D closed geometric element, which is bordering a polygon.
Boundary line: 1D geometric element, which is a part of a boundary.
GRID points: Points, which are the parts of a grid.

Topological elements

Nodes: 0D topological element, related to a point. There are three types of nodes:

- Isolated node: which is not connected to any edge,
- Connected nodes:
  - End node: which is bordering an edge,
  - Intermediate node: which is on an edge, but not bordering it.

Edge: 1D topological element, which connects two end nodes directionally.
Ring: 1D closed topological element, which is described by connected edges.
Face: 2D topological element, which is described by one outer and zero or more inner rings.

3.2 Data quality

In DAT standard the data quality elements are in accordance with the prEN 287008:1995, Geographic Information — Data Description — Quality European prestandard. The data quality groups are the following:

- Origin of data,
- Amount of data use,
- Quality of geometric data,
- Quality of attribute data,
- Actuality of data,

- Completeness of data,
- Consistency of data,
- Technology of data collection,
- Data protection,
- Authenticity.

Data quality groups can be connected to the following data level:

- DAT database or a part of a DAT database,
- Object classes and object groups,
- Objects,
- Attributes.

From data quality groups we want to outline the geometric quality and data actuality requirements, since these factors shows dominantly the quality of the new cadastral databases.

Tolerance classes:

For the distinction of different geometric quality, the standard classifies four different tolerance classes, based on the data collection method and surveyed area:
T11 — digital new surveying on the field in built-up areas,
T12 — digitization of existing analogue maps in built-up areas,
T21 — digital new surveying on the field in rural areas,
T22 — digitization of existing analogue maps in rural areas.

The vertices are also clustered into four groups:

R1: marked dominant vertices of administrative units, subunits and land parcels of built-up areas
R2: other vertices of administrative units, subunits land parcels of built-up areas and marked vertices of land parcels of rural areas. Dominant vertices of buildings, wires etc.
R3: Other vertices of land parcels of rural areas, buildings, wires etc.
R4: Other vertices, which cannot be clustered into the three above groups (e.g. vertices of subparcels).

Identification RMS value of vertices (cm)

	T1		T2	
	T11	T12	T21	T22
R1	3	20	5	45
R2	5	25	7	50
R3	6	30	10	60
R4	8	45	19	90

Table 1.: Geometric accuracy of vertices

Data actuality

Data actuality is one of the most important data quality factor. In DAT standard the two main data actuality factor are the following:

Map rectification periods

Geographically demarcated database	Period of map rectification	
	Recommended	Acceptable
Built-up areas of towns, resorts and industrial areas	10 years	30 years
Built-up areas of villages	15 years	30 years
Rural areas of settlements	15 years	40 years
Areas of land consolidation	Depends on claim	

Table 2.: Map rectification periods

Map rectification is the procedure, when the changes between an earlier cadastral status and the present one — which are not documented in deeds — are working into the database. Other changes, which are documented in deeds, can be characterized by the updating period of data.

The other important actuality factor is the updating period of data in the database. DAT standard defines the following data updating periods depending on the type of data:

Updating periods of data

Type of data	Updating period	
	Recommended	Acceptable
Registrations in Real Property Registry	Immediately	1 day
Changes in land parcels	Immediately	1 week
Dominant structures	1 month	3 months
Other state base data objects	1 month	3 months
Other base data objects	2 months	6 months

Table 3.: Updating periods of data

3.3 Metadata

Metadata of DAT standard are in accordance with the prEN 287009:1995, Geographic Information — Data Description — Metadata European prestandard.

DAT standard defines metadata, which are required for the description of DAT database or datasets derived from DAT database.
The main groups of metadata are the following:

- Identification of dataset,
- Overall data of dataset,
- Quality of dataset,
- Reference system,
- Geographic and temporal dimension,
    - Operativeness of dimension,
    - Horizontal dimension,
    - Vertical dimension,
    - Temporal dimension,
- Determination of data content
    - Description of objects,
    - Description of attributes,
    - Description of relations and constrains,
- Description of classification
    - Orderliness of classification,
    - Elements of classification,
- Data administration
    - Organization and its role
    - Contact person and his role
    - Turning over
- Actuality of metadata.

In this section we wanted to give a short outline about DAT standard which is the base of the new cadastral data model at the Land Offices of Hungary. As the above-mentioned tables show, there are very rigorous quality requirements against the objects stored in the DAT database. In the National Cadastral Program, half a million hectares have been transformed into this relational database format with these rigorous requirements. But unfortunately, there is not yet any map manager system in the Land Offices which can handle these cadastral databases. Therefore the databases are losing their actuality which is one of the most important factors in the case of cadastral systems (see Table 3.: Updating period of data).

FÖMI — like the developmental, operational respond of TAKAROS system — decided to develop a new data model and application for TAKAROS system, which completely integrate the cadastral map and the real property part of the Land Offices IT system. [3]

4. DATR, THE NEW CADASTRAL SYSTEM FOR THE LAND OFFICES

DATR (DAT standard based Mapping System) achieves all the integration, and legal requirements defined in the DAT standard and the Acts mentioned in section 2.

The main vision in the development of DATR has been that the cadastral map is the geometrical representation of objects stored in the real property registry in accordance with

the Act on Real Property Registry. The system must provide the authentic updating of real property registry and the cadastral map together. [3,4]
These requirements conducted us to the following decisions:

- There is no need to replace any modules or functions operating in the existing real property registry system called TAKAROS, the new system must use from administrative point of view the same functions, procedures like the older one.
- The DAT standard based cadastral database must be stored in the same database as the real property registry, therefore we need only one database scheme and we are able to enforce the database integrity.
- The internal database of the cadastral map must be compatible with the database defined in the DAT standard and instruction system.
- There is no need to have any map editor or modification function in the new system, all the changes must be carried out within a database transaction. This unfunctionality provides the authentic updating of cadastral maps.
- Only the use of standard functions of the graphic operation system can solve the graphical representation of cadastral map data, therefore we do not need any commercial GIS software. It is very important from financial point view.
- The system must support the real-time queries of TAKARNET network, so the on-line cadastral map service will be available.

Main characteristics of DATR [5]:

- Total integration with TAKAROS system
  - Database structure,
  - Ability system,
  - Transactions,
  - Data service,
  - System administration,
- Uniform database structure:
  - One scheme,
  - Administration of changes,
  - Enforcing of database integrity,
- Tracking of temporal changes:
  - Archiving,
  - Displaying any arbitrary status of cadastral map,
  - Updating in background procedure,
- Real-time queries via TAKARNET network:
  - Integrated search with the real property registry,
  - Real-time map generating,
  - Minimizing network weighting,
- Modular, self-calibrating architecture
  - All the functions are in modules,
  - Explicit and implicit communication among modules,
  - No client side configuration needed to insert any new module,
- Easily extendable

- Uniform calling interface and protocol
- Usable base modules,
- Opened module API

- Operation system and RDBMS
  - Windows NT 4.0 or Windows 2000 server and client,
  - ORACLE v8.05 RDBMS (because it is operating at the Land Offices, but the functions are compatible with the higher version ORACLE RDBMS too.)

4.1 Core data model of DATR

The core data model of DATR is very similar to the core model defined in Cadastral Domain Model [6]. In DATR we are using the following core data model (see Figure 2.)

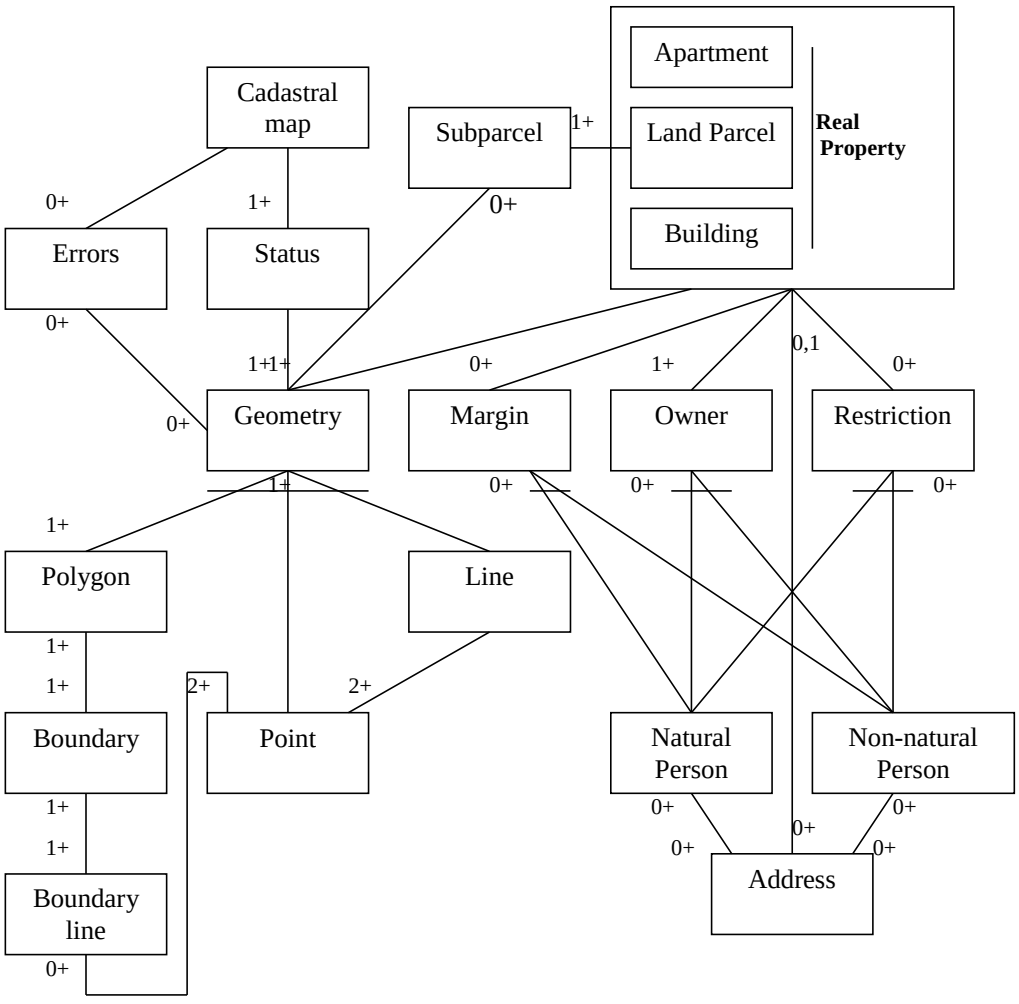

Figure 2.: Core data model of DATR

As shown on Figure 2., there could be three types of real property: apartment, building and land parcel, but a real property must be one of them. In our real property registry, the apartments have no geometric representation, only the land parcels and buildings have one.
In the part of geometry, an object can be point, line or polygon type object. Therefore if a cadastral map object has no connection to the real property registry (e.g. railroad), there is no relation between the real property and the geometric tables (0+ indicates, that there are zero or more relations to the tables). Structuring of geometric tables is unambiguous.
The object called Margin has a very special role in the real property registry. Margin provides the ordering principle of real property registry. If the Land Office receives any application related to the real property, the Land Office must register it and Margin shows the flag of the application on real property. Of course there could be zero or more margins on the real property (0+). The margin also register the person who made the application, therefore there is a link to the natural or non-natural person.
The role of the owner is unambiguous. One real property must have at least one owner (1+), which could be a natural or non-natural person.
The real property could have an address or not (0+).
There could be rights (e.g. easement, mortgage) and restrictions related to the real property. The Restriction object makes for this purpose. The Restriction can be connected to a person too.
Each person (natural or non-natural) — who has any connection to the Land Office — is registered in the database with his address, too.
This core data model has been physically achieved in DATR system and is able to manage the cadastral map data and real property registry in an integrated way.

4.2 Real property transactions in DATR

Real property transaction is one of the most important procedures in the Land Office's activity. Its legal and surveying relations must be handled very rigorously in an integrated cadastral system. The real property transaction in DATR contains the following steps (see Figure 3.):

- Application registration in order to map data service,
- Allocation of affected real properties,
- Generating of changing area,
- Data service for changing (map and real property),
- Closing of affair (end of data service for changing),
- *Changing data in an other system (e.g. ARC/INFO),*
- Application registration for uploading map changing
- Uploading changed map data to the work map,
- Automatic and manual checking of changed data,
- Adding a clause,
- Closing of affair (end of changed data uploading),
- Application registration for changing real property registry,
- Transactions in real property registry,
- Deed and updating (legally valid map and real property),
- Closing of affair.

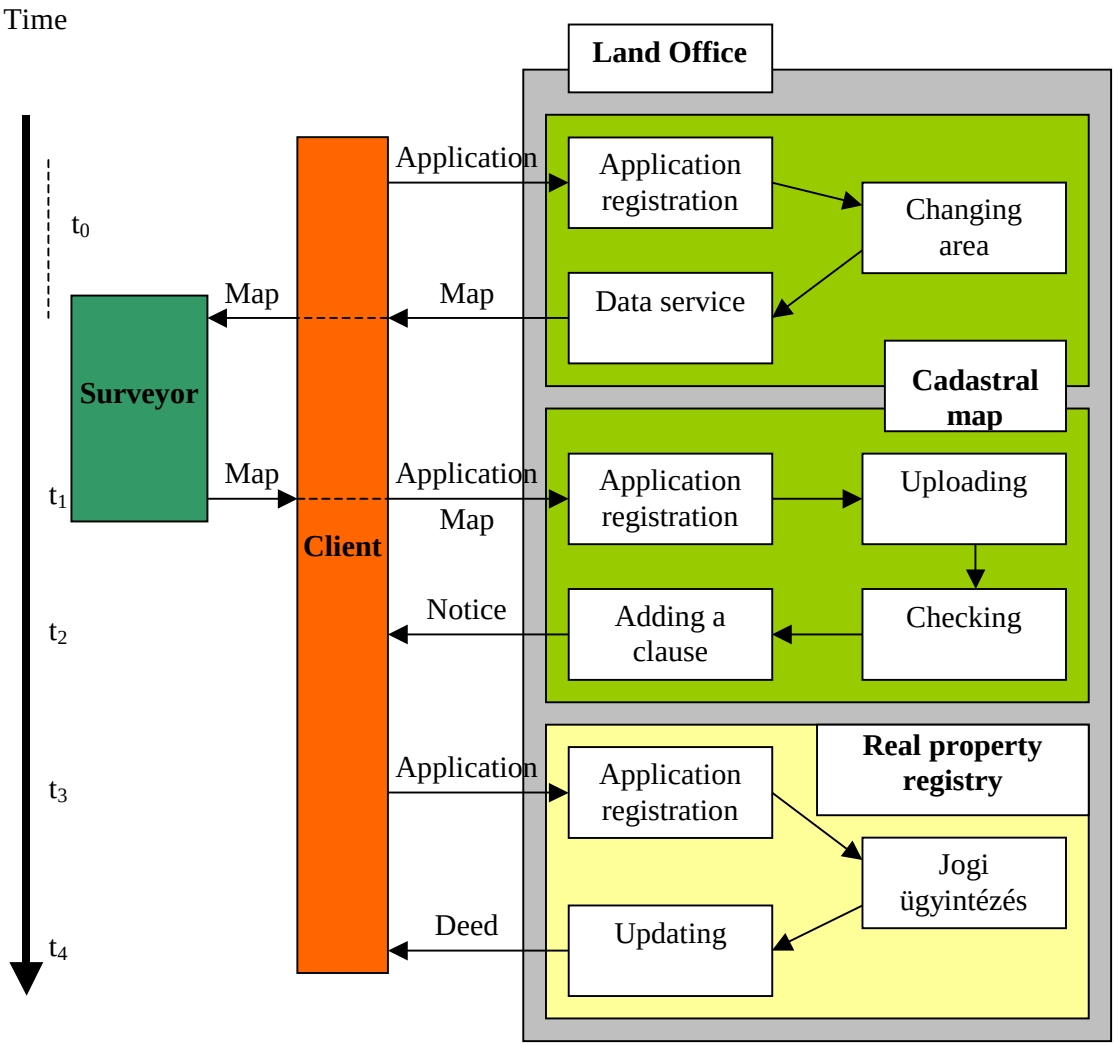

Figure 3.: Real property transaction in DATR

Application registration in order to map data service
This procedure is carrying out by the application registration module of TAKAROS system or in DATR, but physically the result is the same in the database.
Allocation of affected real properties
Allocation can be executed by three ways:

- Listing of lot numbers of parcels,
- Selection of real properties and other objects on the map,
- From the selection of the real property registry.

Generating of changing area
DATR generating changing area with the boundary of the area, land parcels and objects belongs to the land parcels and other objects within the changing area.
Data service for changing (map and real property)

The client receives the map and real property registry data. Data service is available in different forms (e.g. ESRI SHAPE, DXF etc.).

Closing of affair (end of data service for changing),

Changing data in an other system (e.g. ARC/INFO),

Application registration for uploading map changing

Same as in the case of data service

Uploading changed map data to the work map

Work map is a distinct area of the database.

Automatic and manual checking of changed data

Checking contains the following tasks:

- Formal and syntactical checking,
- Checking of inner consistency (e.g. links),
- Checking of geometrical consistency (e.g. topology),
- Temporal consistency checking (e.g. coincidence to the map data service)
- Checking of integrity (e.g. integrity with the real property registry).

Adding a clause

During the addition of a clause, the following procedures are executed:

- Objects of the changing area will be erased (only logically),
- The objects of the working map will be uploaded to the legally valid map (flagged with clause)
- The new real properties will be uploaded to the real property registry (flagged with preliminary)

Closing of affair (end of changed data uploading)

Application registration for changing real property registry

Same as in the case of data service

Transactions in real property registry

Deed and updating (legally valid map and real property)

This task finalizes the changes consistently both in cadastral and real property database. In the case of the cadastral map it means:

- The erased objects will be deleted physically,
- The clause-flagged objects will become legally valid.

Closing of affair

5. CONCLUSIONS

In this paper we wanted to give a short outline about the new IT developments related to cadastre in Hungary. We dealt with the Digital Base Map Standard (DAT standard) which has a very important role in the Hungarian cadastral activities. In the last sections, we introduced our new IT development DATR which completely achieves the legal and technical regulations and requirements of Hungarian Real Property Registry.

The data model of DATR is very similar to the data model that has been evolved in the modular standard for the Cadastral Domain [6]. In the case of DATR, we wanted to build an operating cadastral map based on the real property registry system and now it is working. This fact shows that the modular standard for the Cadastral Domain is a good way to "provide the "common ground" for data exchange between different systems in the cadastral domain"[6]. Our DATR solution is not as flexible as the Cadastral Domain, because of the

specific requirements of our legal system. For the further needs of our clients, such an opened, flexible standard (mentioned in [6]) is recommended in every cadastral information system.

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BIOGRAPHICAL NOTES

Szabolcs MIHÁLY: Director General of Institute of Geodesy, Cartography and Remote Sensing (FÖMI). He is the author of DAT standard and co-author of DAT instruction system. He is heading the Geographic Information Technical Committee of the Hungarian Standardization Body. He is the representative of Hungary in FIG Commission 3, Spatial Information Management.

Zoltán WENINGER: Head of Land and GIS Development Center of FÖMI. He has participated in the development of real property registry IT systems from the beginning. He is leading the development team of TAKAROS, TAKARNET and DATR system.

Gábor SZABÓ: Leader programmer and system architect. He has participated in the development of TAKAROS, TAKARNET system as system architect and programmer. He is leading the development of DATR system.

Gyula IVÁN: Head of department of GIS at FÖMI. He is a co-author of DAT instruction system, GIS and DAT expert in National Cadastral Program. He is leading the GIS team in the development of DATR system. He is the co-author of Digital Topographic Database Standard (MSZ 7772-2).

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