

TURKISH CADASTRE AUTOMATION SYSTEM WITH ESRI TECHNOLOGY

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KEY WORDS: Cadastre Information System, GIS Modelling, Property Information System, Land Information System

ABSTRACT:

Current advances in GeoProcessing, GeoVisualization, GeoDatabase and the successful results of Geographical Information System (GIS) applications orient clients, institutions and organizations to establish their geographic information systems and manage their process and data inventory with these systems.

ESRI technology has being using in Cadastral site in the Turkish Land Registry and Cadastral Information System (LR&CIS). This is a sample GIS application for an integrated and enterprise solution. The pilot project that includes over 1 million owners, over 135.000 parcels has been completed and imlemented at two cadastre office, six land registry office, one regional office and General Directorate within a hierarchical structure.

ArcObject on ArcEditor were used to developed Cadastre Application Software Package, ArcSDE were used to storage and manage data, ArcIMS were used to share data.

This paper presents the system architecture, cadastral data and process modeling, data web services for external users.

1. Turkish Land Registry and Cadastral Information System

In our time in which people have great expectations in accomplishing such services, they need correct, reliable, easy and quick accessible land register and cadastral survey information. The importance of the LR&CIS (Land Registry and Cadastre Information System) project is arisen from such a reason.

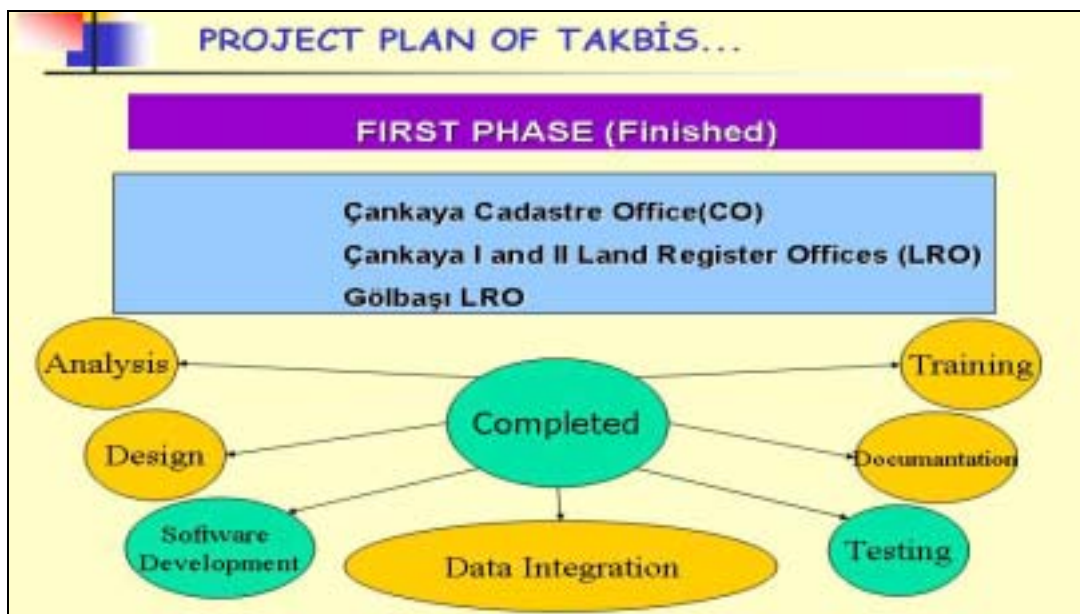
The project aims to form the basic data of all kinds of projects prepared based on positional map data in the standards of the Geographic Information System ;

- to provide accurate, valid and reliable land information required for land and land – related activities and decision markers,
- to transform land register and cadastral survey works and information into a multi – purpose land information system to plan, manage and activate the services by the organization in a better, quicker, more reliable and more effective way to ensure that the data given to other institutions and organizations are used more broadly.

The LR&CIS is a parcel-based Land Information System. It contains geometric cadastral information and property information with respect to ownership. It covers all activities carried out in the General Directorate of Land Registry and Cadastre, in Regional Directorates (25), in Land Registry (1003) and Cadastral (325) Offices.

1.1. Project Overview

The initial LR&CIS project award included two project phases (pilot and initial implementation).The pilot studies has began in early 2001. After the 3 months of analysis studies, 3 months of design work, and 16 months of software development work it has been implemented on actual distributed sites. Now, it has been using by the General Directorate, Ankara Regional Directorate, 6 local land registry and 2 cadastre offices. These sites are integrated into wide area network (WAN) environment.



Figure_1.a : First Phase

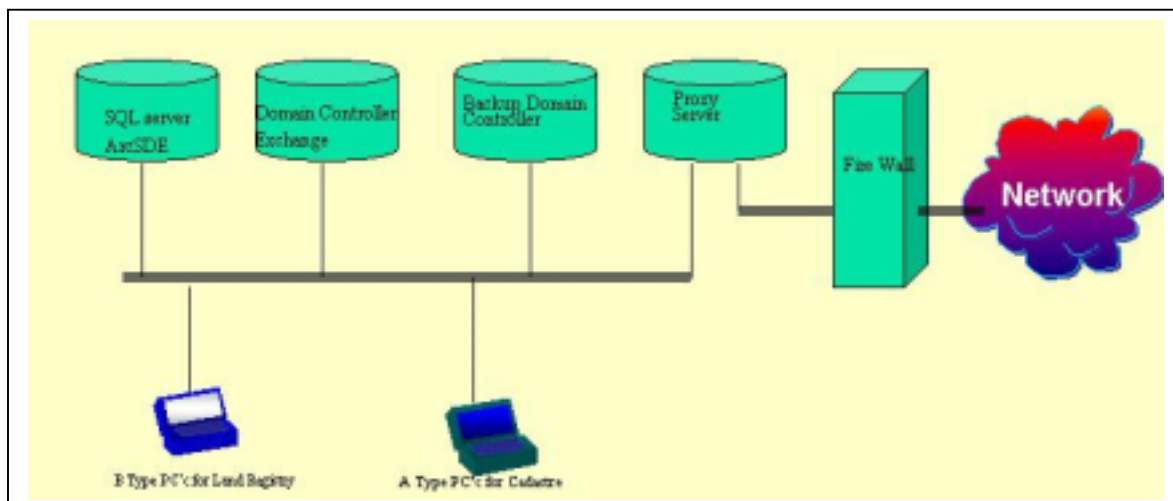
At the first phase, functional testing of the applications was completed. At the second phase of the project initial system implemented at the first regional site and cadastral offices. This phase demonstrated all cadastral functionality over the WAN, introduced some ArcIMS public Web services for internal review and external using and support initial user operations with the new system.

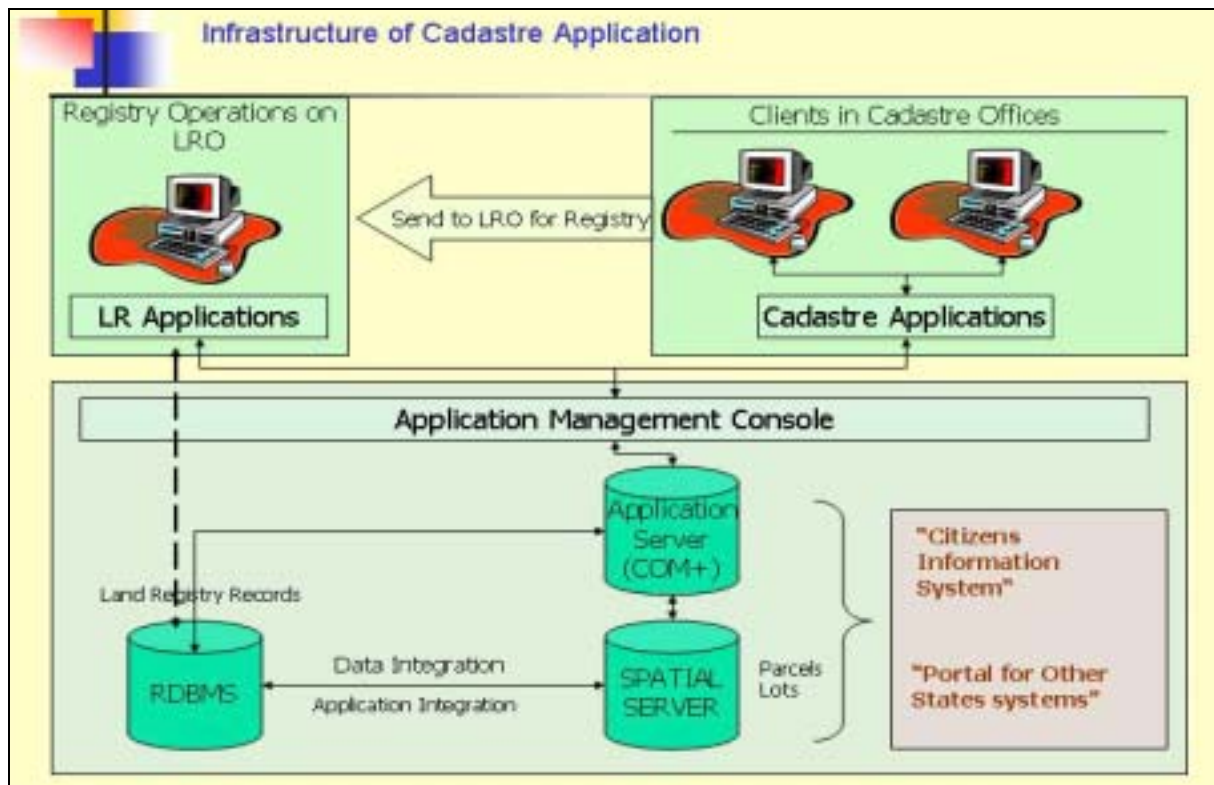


Figure_1.b : Second Phase

1.2. System Architecture

The system is centrally designed. In the center there are 4 servers called; SQL Server, Domain Controller Server, Backup Domain Server and Proxy Server. On the SQL Server, Windows 2000 and SQL/Server RDBMS software are running. Cadastral data is on the geodatabase and is managed by ArcSDE which stores and manages its data on SQL Server. Land registration tables are on the SQL Server. All cadastral and land registry data are integrated by lookup tables. System architecture and system design is shown in Figure_1.a, 1.b .





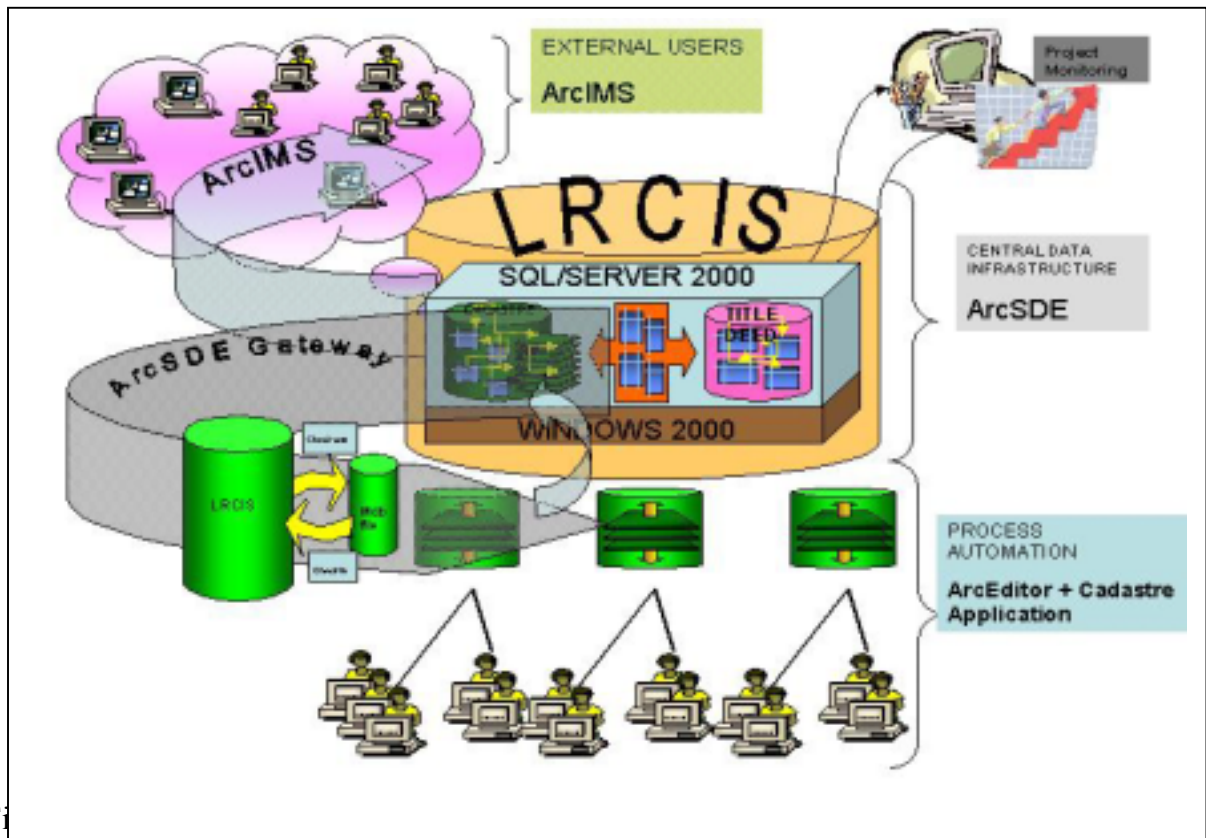
Figure_1.d : Simply System For Land Registry&Cadastre Application

Phase 1 implementation was conducted at the Ankara corporate offices, and focused on application development and initial data loading operations. System users were limited to the development staff, who included up to 11 cadastral users over the corporate local area network (LAN) environment.

The Phase 2 cadastral implementation has been supporting 40 concurrent cadastral editors accessing the central ArcSDE server over the WAN from the 2 cadastral offices.

Phase 3 will address the full implementation, which will include up to 1,500 cadastral editors distributed over 25 regional directorates and 325 cadastral offices.

The initial ArcSDE server is a Pentium II 2-CPU 700-MHz Windows server platform with 1-GB memory and internal data storage (six 18-GB disks). SQL server is the supporting database technology. The ArcSDE server was shared environment, concurrently supporting the land registry and office automation database environments. ArcGIS desktop platforms was supported by Pentium 4 1700-MHz workstations configured with 256-MB memory. Slow performance tested is caused ArcGIS desktop platform to increase 512-MB memory, ArcSDE Server to transfer into an individual server platform and ArcGIS client access to ArcSDE over the WAN platform to use check-out, check-in mechanism. Check-out, check-in distributed environment is providing an optimum solution for supporting remote client access over WAN environments to centrally administered application environments. The Cadastral System Model is given Figure-2.



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In the Cadastral System Model there are 4 main platform.

- Central Data Infrastructure (Cadastral Data Model)
- Cadastral Process Automation (Cadastral Functional Model)
- Data Serving to External Users via Internet
- System Monitoring platform for General Directorate (top hierarchy)

System architecture is supporting 100-Mbps switched LAN and 2-Mbps/512-Kbps switched WAN to the ArcSDE server environment. Figure 3 shows the communication architecture.

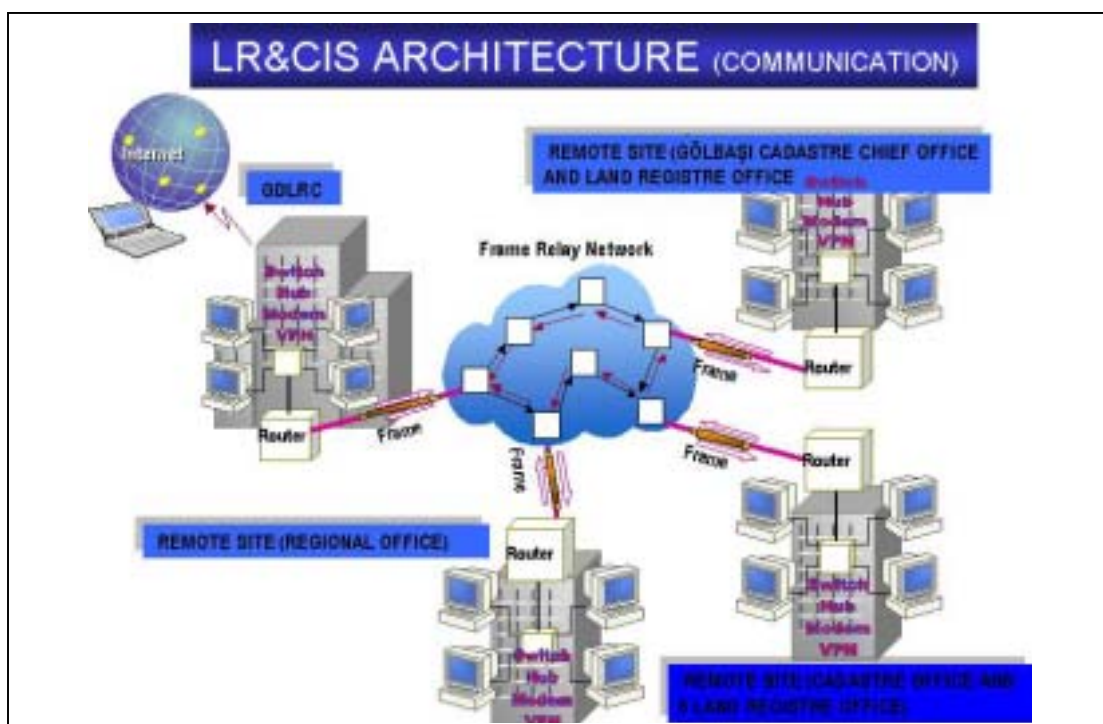


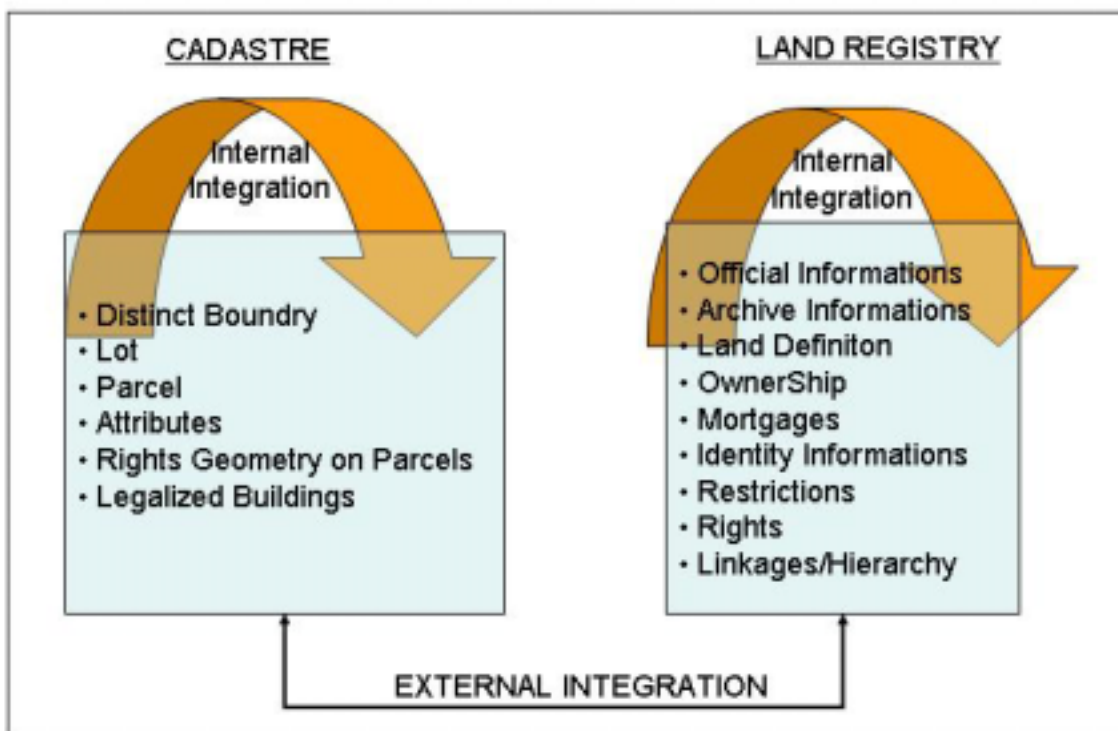
Figure 3: Communication Architecture

1.3. System Modeling

It is necessary to define the data and functional model in order to represent a system. The data model is one part of the conceptual design process. The other part is typically is the functional model. The data model focuses on what data should be stored in the database while the functional model deals with how the data is processed. To put this in the context of the relational database, the data model is used to design the relational tables. The functional model is used to design the queries which will access and perform operations on those tables.

1.3.1. Data Model

A data model is a conceptual representation of the data structures that are required by a database. The data structures include the data objects, the associations between data objects, and the rules which govern operations on the objects. As the name implies, the data model focuses on what data is required and how it should be organized rather than what operations will be performed on the data.



To use a common analogy, the data model is equivalent to an architect's building plans. It is necessary to define the spatial reference, database design and data content in order to identify a data model of system.

1.3.1.1. Cadastral Data Defination

Cadastral data are focused on immovable properties and have two main components:

- Geometry of properties
- Attributes of properties

Property geometric data composed of quarter or village boundaries, blocks, parcels, parcel segments, parcel corner points, ground control points, and buildings.

Property unit that should be registered can be a parcel, a construction (building) or a servitude. Parcel is the smallest unit of fixed property. Parcel unit must exist and be registered before all rights and burdens can be registered. Construction belongs to the parcel on which it is built. Servitude is a usage right of property that is limited by servitude geometry. All these property unit should exist in the field and registered on the deed.

Attributes of properties are meta data which defines and give information about the geometry. Attribute data is not limited, but at least owners, rights, mortgages, annotations should be defined and registered with geometric data at the same time.

1.3.1.2. Spatial Reference

The spatial reference for a feature class describes its coordinate system (for example, geographic, UTM, and State Plane), its spatial domain, and its precision. The spatial domain is best described as the allowable coordinate range for x,y,z coordinates. In Turkish Cadastral system UTM projection is used. Turkey has 7 zones composed of 3° meridians. 7 geo databases with the same coordinate system has been designed for 7 different zones (Figure 4)

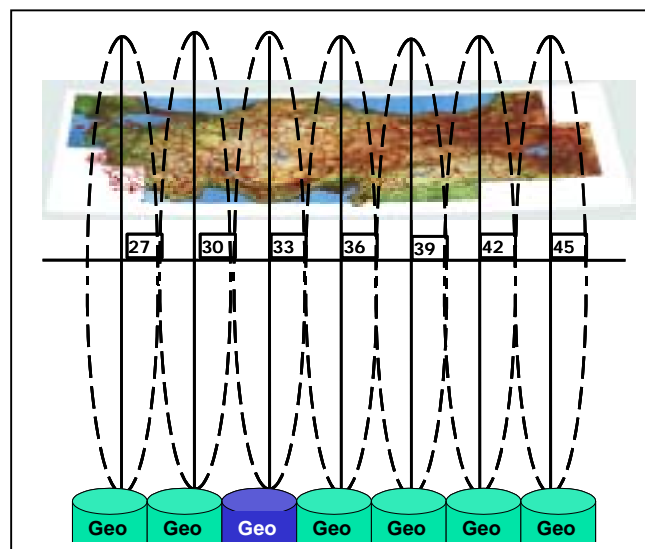
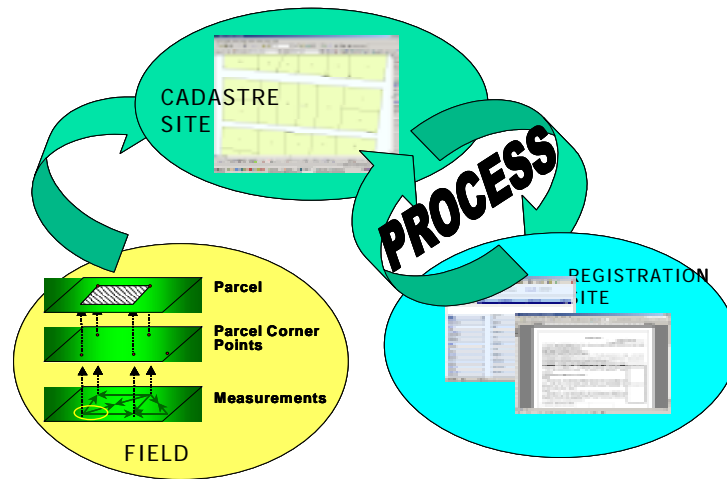


Figure 4: Spatial Reference of Turkish Cadastral System

1.3.1.3. Processing of Cadastral Data

Cadastral data borns in the field by surveying during the initial or primary cadastral activities. As a result of primary cadastral activities two main products are generated; cadastral maps and title deeds. After this, cadastral data live on the maps, by cadastral activities carried out by cadastral offices and title deed data live on the registrations by land registration activities carried out by land registration offices Figure 5.



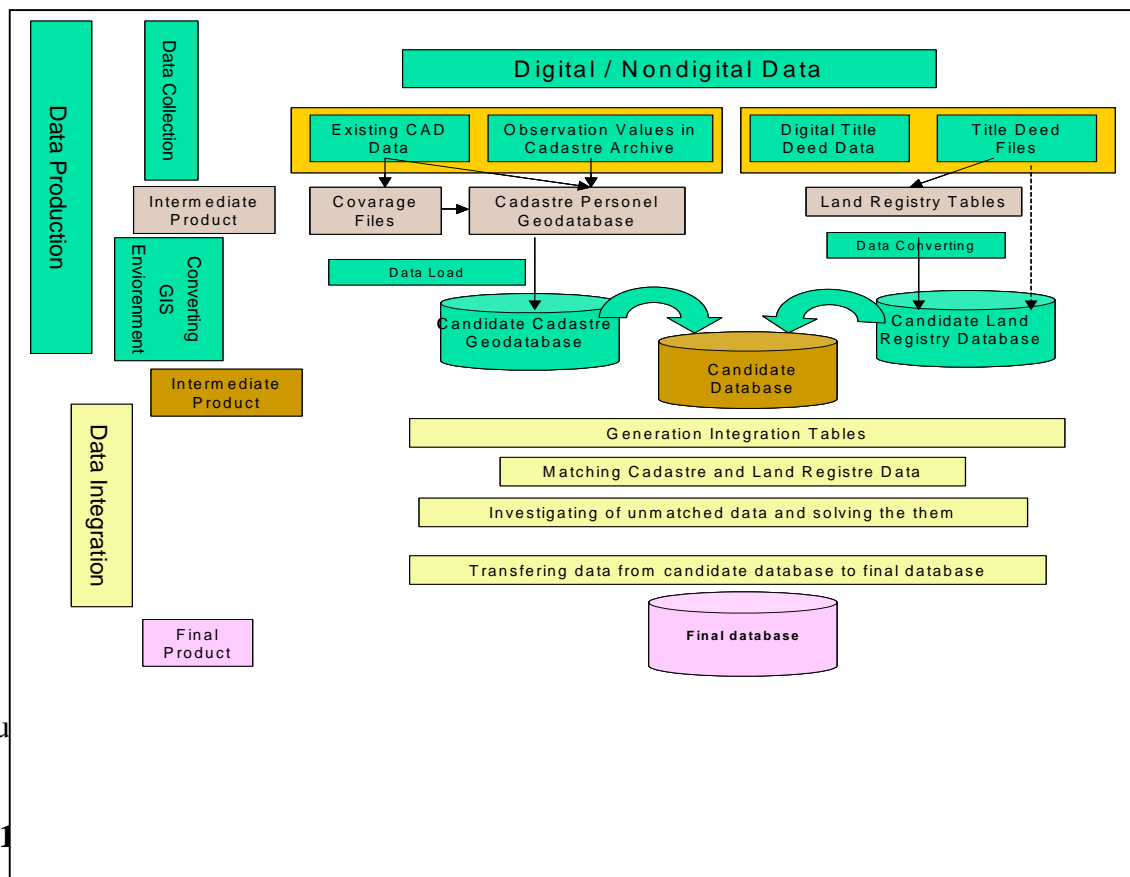
1.3.1.4. Data Content of Project

In the pilot area two main types of data are collected. Raster and vector data. Raster data is registered using ground control points. All map sheets and sketches are scanned and linked to the related parcels. Vector data are mainly converted from CAD data and others are collected from field measurements. Measurements data are not stored in the geodatabase. They are used for calculating the coordinate values and generating parcel data which are stored in the database.

- **Raster Data Set:**
 - 68 pieces of digital map sheets at 1:250.000 scale (80MB), colored
 - 16 pieces of digital map sheets at 1:25.000 scale (17MB), colored
 - Ankara city map (10MB), colored
 - 3000 pieces of Map Sheets (20MB), black&white
 - 5000 pieces of Measurement sketches (30 MB), black&white
- **Vector data set**
 - 1:250.000 scale database of Turkey, mainly used for planning purposes
 - Quarters (140)
 - Blocks (6.000)
 - Parcels (135.000)
 - Registered Buildings (20.000)
 - Ground Control Points (15.000)
 - Owners (1.000.000)

1.3.1.5. Data Collection and Integration System

There are variety of data sources in the cadastral system. Most of them are graphical data (uncoordinated in UTM) in rural area and CAD data in residential area. All kinds of data are converted into geodatabase which is the same standarts. Data collection and integration mechanism is presented in F1gure 6.



Figure

1.3.1

Cadastral data is enabling to use by external users via internet. This service is providing by ArcIMS. Main services are presented below:

- Standard zoom in, zoom out, pan, and information display functions are available
- Accessing and displaying data authority is limited to the owner.
- Query by attribute (by province name, district name, quarter name, block no and parcel no) is possible.
- Query by map sheet name in different scales (1:100.000, 1:50.000, 1:10.000, 1:5.000, 1:2.500, 1:1.000 and 1:500).
- Query by coordinate (box) extends
- Selection by map sheet index
- Exporting graphic and related non-graphic data in National Data Exchange Format
- Displaying Statistics of selected and exported data
- Calculating data purchase fee
- Loading converted data into the local machine

1.3.2. Fuctional Model

The cadastral functional model is designed fully in compliance with the applicable regulations of daily procedures of the Cadastral Offices.

It is possible to classify all Cadastral activities in 3 main groups.

- Procedures depending on requests: Plan sketch, application sketch
- Control services: Most of the cadastral work is carried out by survey contractors. These works should be checked and approved by Cadastre Office. Some of these

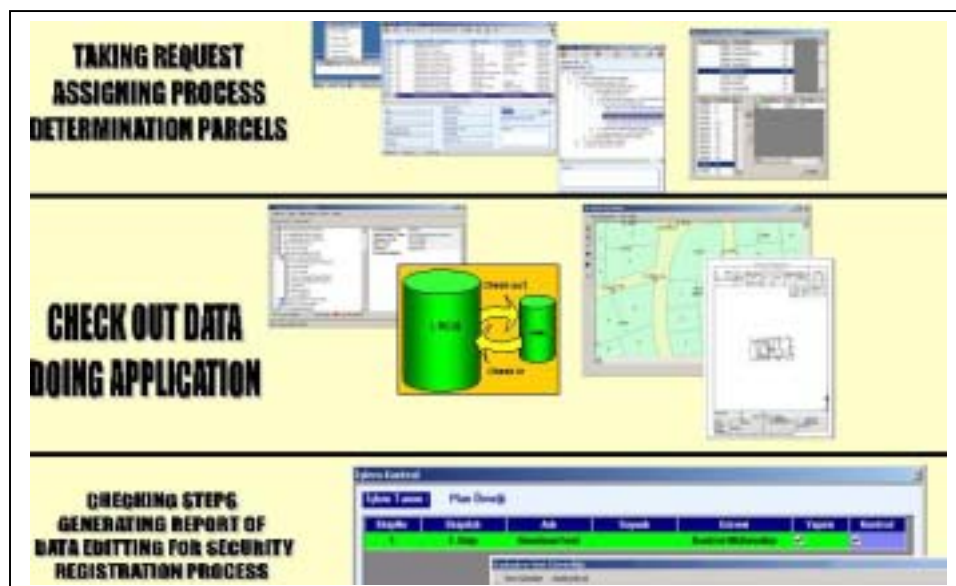
activities are Sub-division, union, Physical Land planning, leaving and saving parcel from road, expropriation process. The results of these procedures should be sent to land registry office for registration purposes.

- Other works which are carried out at cadastre offices like prime cadastre activities and cadastre renovation activities.

A versioning (short and long transaction) mechanism is used for each job in the Turkish Cadastral Functional Model.

It was a MUST to establish full automation in cadastral process. After all the data are converted to the computer environment, updates are undertaken automatically by the process performed. At the end of each process historical data is generated and stored into the database. Main steps of a cadastre process is presented below and figured_7 ;

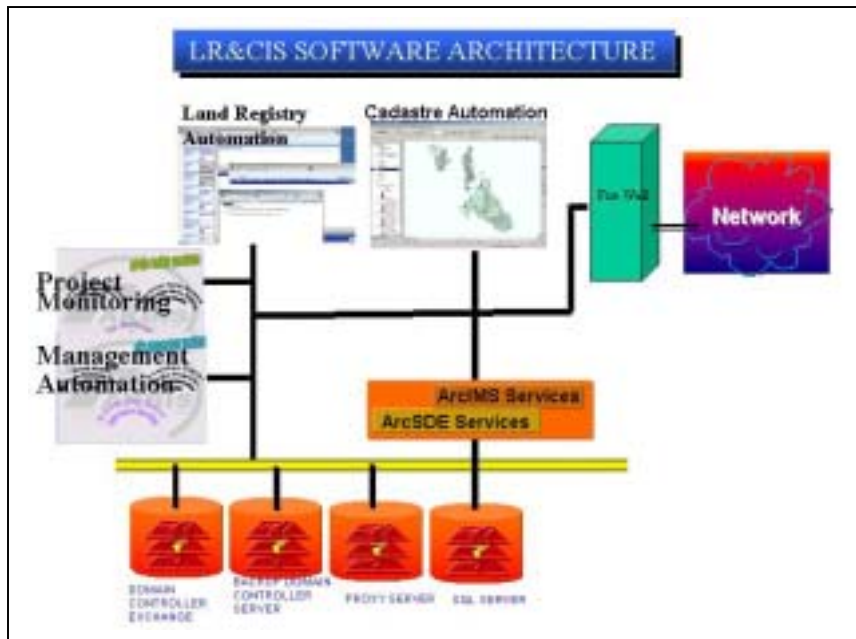
- Getting citizen application / checking documents
- Determination of related parcels / calculation fee
- Getting related data from central geodatabase (creating a version, creating a personalDB via checking out)
- Doing process
- Controlling and checking each step
- Preparation the registration data and form
- Creating a data security report (Modified parcels and their modification type (add, delete, edit))
- Preparation of formal documents for the Land Registry
- Submitting formal sketch and documents to the Land Registry
- Registration process at the Land Registry site
- Getting the approval message from Land Registry
- Finishing the Process (Ending Version)



Figure_7: Cadastral Automation System

1.4. Software Architecture

In the project there are two main application software packages namely Land Registry and Cadastral Application Software packages are developed. On the other hand Project Monitoring Software, Office Automation Software, User Support Services are developed which are running with main software packages (Figure_8). This paper focused on the Cadastral Application software package.



Figure_8: Software Architecture

In the project some base software are used. They are presented below;

- ArcObject library is used for developing custom application.
- ArcSDE is used for;
 - managing and maintain cadastral geodatabase in the SQL/Server RDBMS
 - providing multiuser editing
 - providing version support for each cadastral process
- ArcMap is used for providing user Interface, selection tools, displaying and vieweing data, snapping tools, page layout viewing.
- ArcCatalog is used for define geodatabase schema and design
- SQL Server for RDBMS
- Active Directory for user privileges
- Share Point Server (help desk document for regulations)

1.4.1. The tools used in the software development

- COM+ for software development technology
- Rational Rose for system modeling
- Delphi for Land Registry Coding
- Visual Basic for Cadastre Coding
- Visual C ++ for Cadastre coding

- VBScript for ArcMap customization
- Document X for coding documentation

1.4.2. The tools used in design and build up GeoDatabase

- MS Visio for system modeling
- ArcCatalog is used for define geodatabase schema and design

1.4.3. The Capabilities of Cadastral Application Software

The Cadastral Application Software is developed for the daily procedures of the Cadastral Survey Directorates are designed fully in compliance with the applicable regulations. Every procedure is controlling by a background – edited mechanism, the error risk of the official is minimizing, the system is warning the user in case of improper procedures.

It is designed fully in compliance with the applicable regulations. It is mainly include;

- Special data collection tools based on parcel corner points
- Special CAD tools
- Special selection tools
- Customized object inspector
- Creation parcel tool
- Storing and managing survey measurements in database
- Simple measurements tools
- Composite measurements tools
- Computation tools
 - Coordinate calculation from polar and orthogonal measurements
 - Adjustment tools
 - Trigonometric and geometric leveling tools
 - Projection of slope edge measurements
- Special Import and export data tools using National Data Exchange Format based on XML
- Special Sketch tools
 - Generating of application sketch
 - Generating of measurement sketch
 - Generating of block separation sketch
 - Generating of plan copy
 - Generating of block/parcel report
- Storing and managing sketch in database
- Historical query tool
- Mapping tool
 - Finding a sheet name in any scale (from 1:500 to 1: 100K) from given coordinate
 - Finding a sheet name in any scale with getting coordinate from screen
 - Displaying sheet corner coordinate in any scale
 - Creation standard large scale map according to map making regulation
 - Creation dynamic map index in any scale
 - Calculate sheet count given in min and max coordinate in any scale
 - Applying all these process in UTM or Geographic projection
 - UTM to Geographic and reverse conversion

- Cadastral automation tools based on cadastral activities succeeding by both cadastral office and surveyors
 - Storing and managing all process steps in database
 - Establishing Cadastre process
 - Cadastral mapping tools
 - Renovation process
 - Split process with special split tools,
 - Union process,
 - leaving for road and saving from road process
 - Parcelization
 - Nationalization process
 - Aggregation process

2. Conclusions

LR&CIS is a completely Integrated System. At the cadastre side ESRI technology has been used very successfully. At the System Center ArcSDE is managing the cadastral data. At the remote side, Cadastre Application Software package which runs on the ArcEditor is serving all cadastre activities harmonious with Land Registry side. ArcIMS is serving data via internet for external users.

A general evaluation of the Land Registry and Cadastre Information System Project is presented below;

- Since all the data will stored in the central database, data safety shall be ensured, and regular backup of the data shall be possible.
- It will be more easy and faster to access and use data. (Data in the archives will be transferred in computer media, and necessary relations will be established. This way, both the procedures shall be conducted faster)
- It will be possible to prevent damages to the original documents in the archives.
- It will be possible to standardize the activities within the institution by means of the application software has been developed,
- External and internal exchangeability and sharability of the data produced will increase owing to standradization
- Since the data are kept in the center, “ asset investigation procedures ” shall be directly and immediately processed
- Work loads and performances of Directorate staff shall be monitored by both the Director and by top management
- By setting up required safety mechanisms, all citizens will be allowed to access updated data (related with their real estates, to understand title deed procedures and how to carry out them, and to learn amount of taxes and fees, without personally going to Directorates)

- All applications will be based on “procedure”. (Operator, name of the procedure, time of the procedure, stage of the procedure etc will be registered dynamically after the procedure has started.)
- Demands made by courts, municipalities and contractors shall be met accurately and rapidly

It will produce Decision Support functions and reports for the Regional Directorates and the General Directorate by use of such centrally generated information

Turkey has been started to develop and put into applications very large e-government projects. Turkish Land Registry and Cadastre Information system is one of most important part of Turkey’s e-government structure that servers to another state informations systems that has been developing or deploying by other state offices. In near future, system will be deployed to whole Turkey step by step.

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BIOGRAPHICAL NOTES

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Name of Firm: General Directorate of Land Registry and Cadastre

Profession: Having graduated from Karadeniz Techninal University and Yıldız Technical University Faculty of Science Department of Geodesy and Photogrammetry Engineering, completed his PhD at the same department. He has 23 years experience in General Directorate of Land Registry and Cadastre as surveying engineer, has 6 years experience in geodesy, 2 years experience in photogrammetric map production, 2 years experince in local cadastral office, has been working as a section head in department of Phogrammetry and Geodesy for 13 years. Beside that he has worked as a team leader of TAKBİS Project Preparation Phase, was in charge of MERLIS Project and nowadays coordinator of ARIP Project. He is also part time lecturer at Atılım University for 3 years.

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Name of Firm: ISLEM Geographic Information Systems&Engineering Limited

Profession: B.Sc. Degree on Surveying Engineer, M.Sc. Degree GIS science, Ph. Degree on Mapping science, 20 years experience in General Command of Mapping as surveying engineer, 15 years experience in GIS projects as GIS Expert, 1 year experience in INTERGRAPH (Middle East Liaison Office) company as Technical Manager, 3 years experience in ISLEM GIS company as Technical Coordinator, 3 years experience in Turkish Land Registry and Cadastral Information System as Cadastral Project Manager.

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