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A Proposed Architecture for Distributed and Version-Based Geospatial Data Sharing

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Introduction

- Realizing e-government:
  - Developing systems to facilitate spatial data sharing
- land administration:
  - Collaboration of variety of organizations due to variety of activities
- adapting these various activities:
  - sharing their data by utilizing appropriate frameworks and technologies
- Sharing spatial data:
  - legal rules and technical tools

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Realizing e-government

In this research:

- a new spatial database architecture is proposed to utilize, update and analyze spatial data in a shared environment.
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- The proposed model supports versioning of data and provides two level of quality control when an update introduced to data.
  - ✓ Business level quality control
  - ✓ Technical level quality control

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What is the Concept of Spatial Data Sharing ?

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- Sharing of spatial data involves more than simple data exchange. In order to facilitate the spatial data sharing, spatial stakeholders require dealing with many issues including data integration, representation and updating

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- Before the 90s: Organizations purchased geographic information systems with a native, spatial data model
  - ✓ Data sharing between organizations with different GIS vendor systems was limited to data converters, transfer standards, and later open file formats. Sharing spatial data with other core business applications was rarely achieved
- Gradually: GIS models evolved into Geo-relational structures, where related attribute data could be stored in a relational database that was linked to the file-based spatial features.
  - ✓ In this model supporting large data layers required the use of complex tiling structures to maintain performance, and sharing spatial information with other core business applications was still not possible
- After 90s : new technologies emerged that enabled spatial data to be stored in relational databases supporting large, non-tiled, continuous data layers.
  - ✓ These Geo-relational databases (also referred to as spatial databases) could be embedded within core business applications where the sharing of spatial features became possible

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Shared map updating as one of the requirements in Spatial Data Sharing

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- One of the most challenging issues in multi-unit organizations is to provide updated spatial information between their different sections.
- There are often two methods used.
  - ✓ In the first method changes applied to spatial information in specific times by a technical division.
  - ✓ In the second method, changes applied by users during their daily activities named "incremental and shared spatial data updating". The most advantage of this method is that the most updated data are available in real-time.

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Incremental and Shared Spatial Data Updating

- There are four steps for incremental and shared data updating:
  - ✓ Migrating from file based maps to spatial databases
  - ✓ Distribute spatial information between different divisions
  - ✓ Provide spatial data updating tools to users
  - ✓ Provide quality control mechanisms

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Architecture Specifications

- In previous file based map usage, each user has a distinct version of data and is not aware of the changes applied by other users unless they get a copy.
- Spatial databases provide a suitable platform to distribute maps between different users.
- In spatial database systems different users access to same map from different locations using different access level.
- Some users have editing permissions to some layers which are accessible for just viewing by other users.
- Updating tools play a very important role in this method.
  - ✓ Users should use the same tools as they worked with in the file based method. This means that the architecture must let CAD software to be used for editing.
  - ✓ As data are accessible in a shared environment, the edits by one user must be accepted by others. This makes the quality control very important steps.

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Versioning is a key feature in shared spatial updating

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- Versioning is a mechanism that enables concurrent multiuser spatial data editing in spatial database systems.
- It uses a concurrency data-locking model, which means no locks are applied to features and rows during the editing process.
- This mechanism provides support for many users creating and maintaining large amounts of GIS data in a central location.
- In many cases, multiple users need to edit the same data at the same time. In other words, they require concurrent multiuser geodatabase editing.
- Conceptually, a version represents an alternative, independent and persistent view of the database. It supports multiple concurrent editors and does not duplicate the data. A version references a specific state of the database.
- Versioning make it possible to distribute spatial data between different divisions and at the same time let us to control the quality and the correctness of the edits applied by different users. The last one can be done by comparing versions related to different users.

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Our Architecture for Shared Spatial Data Updating

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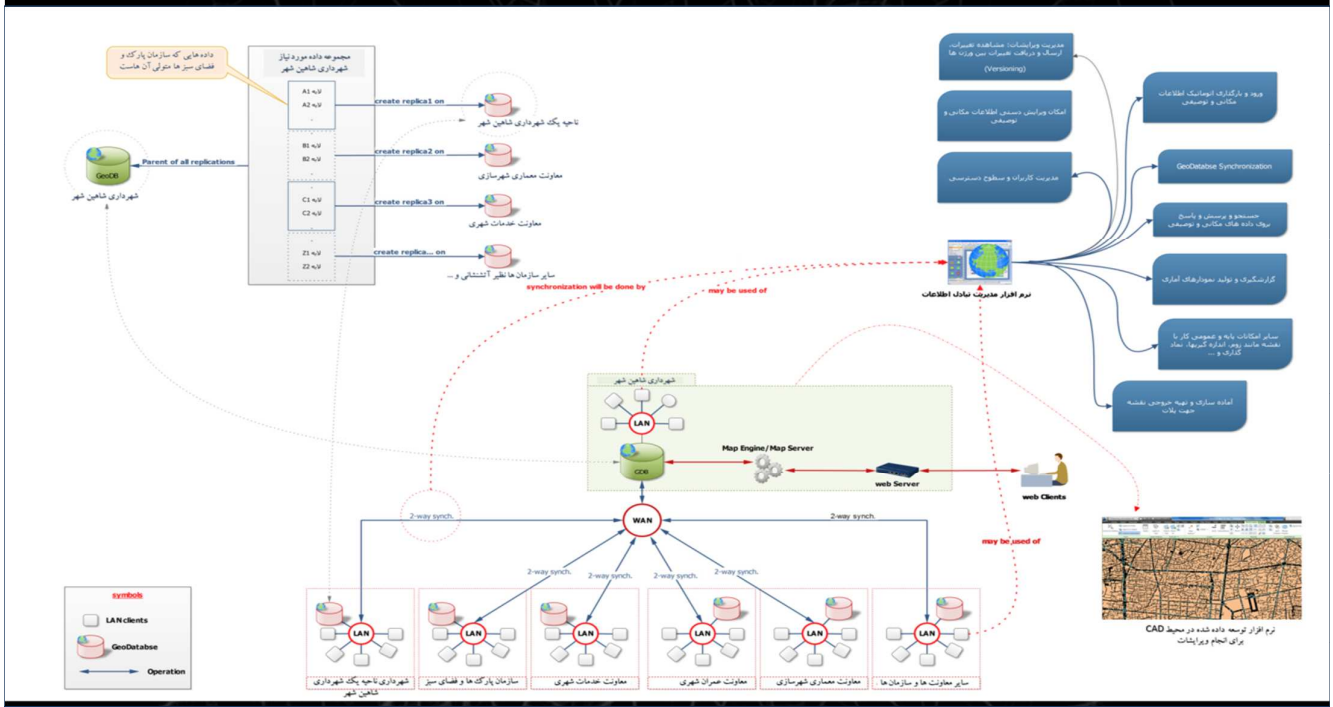

A central database is used to store spatial data seamlessly. There are a number of distributed databases replicated from this central database. These databases are located in different divisions in which users connected to and edit, observe or analyses related data. Each user has his/her own version. Any modifications applied to data from each user just affect the related version.

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Quality Controls

Two levels of quality control are designed to assure the validity and the correctness of modifications.

- ✓ The first level is business level, in which edits are investigated to be correct from a business point of view.
- ✓ The second level is technical level in which all edits are checked to assure that are geometrically and logically true

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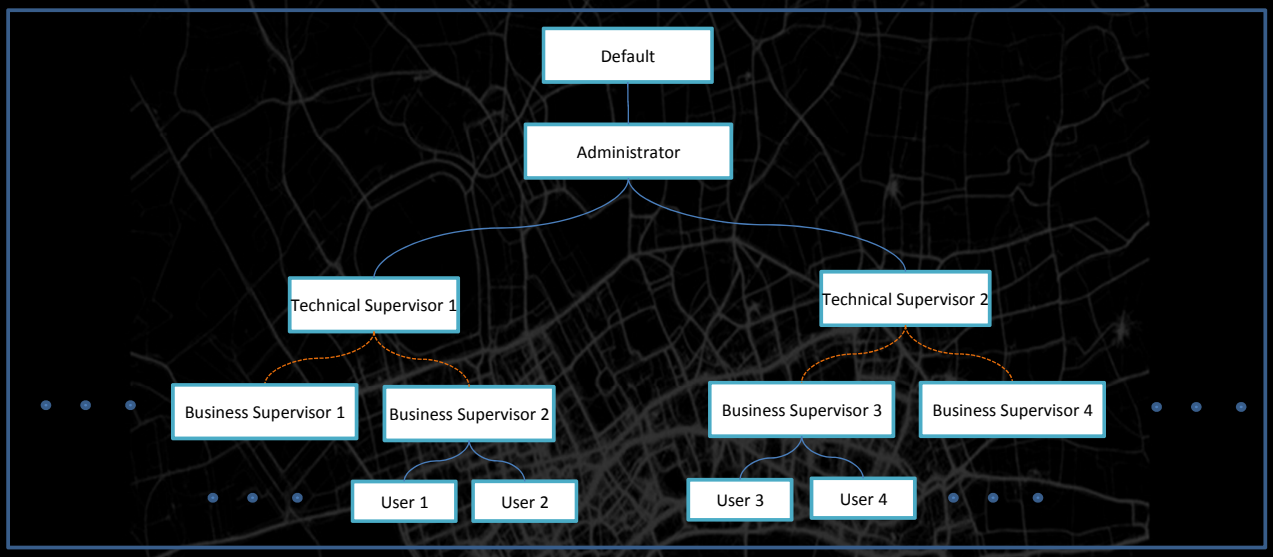

different versions have a hierarchical structure. User's versions are at the bottom of the hierarchy. When a user modifies an object, business supervisor can check them by comparing his/her version with the version of the related user. If the changes are valid from a business point of view then the changes will be transfered from user's version to the business supervisor version. Afterwards, technical supervisor can check the changes to assure that changes are applied correctly and GIS ready rules are observed. If this two level of quality control passed, all the changes will be transfered upward to the administrator version. Finally, the versions of different users will be synchronized with transferring changes downward from administrator version to all other users.

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Implementation

- To illustrate the application of the model in a real world problem, we implement it in the Municipality of Shahinshahr city in the central part of Iran
  - ✓ The data were collected by the Municipality in digital format at the scale of 1:2000, totaling 20 sq. km. of area

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- The framework for incremental and shared spatial data updating is developed as a client server GIS tool. Two packeges are developed for supervisors and editors.
  - ✓ The first one developed as a stand alone system using VB.net and ESRI Engine Core.
  - ✓ The second one developed using C++ as an extension of Autocad Map 3D software.

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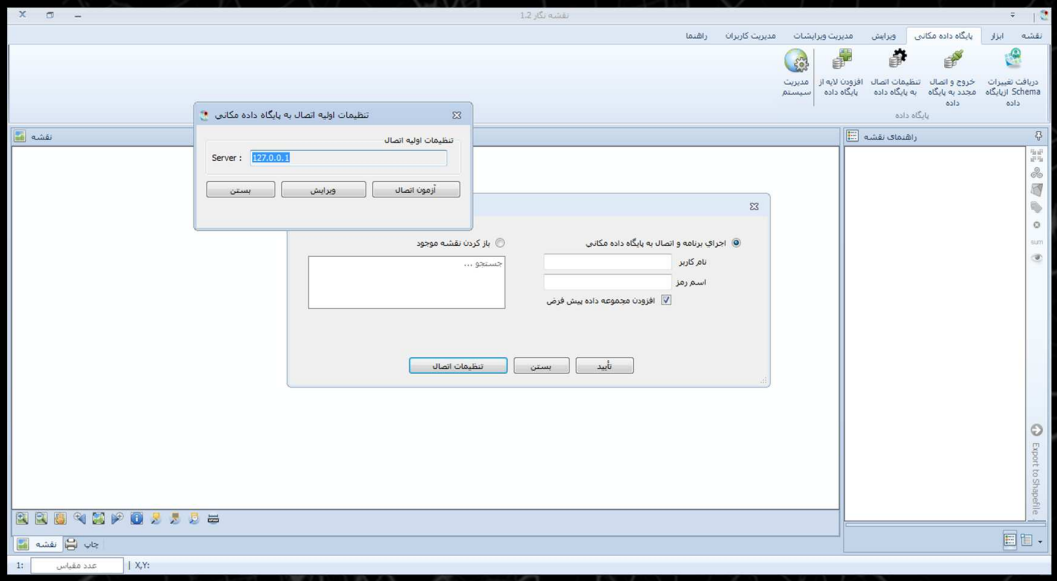
Administration and Quality Control Package



the supervisors's system starts providing user with a wizard that enabling him/her to walk through some settings regarding connections to the server

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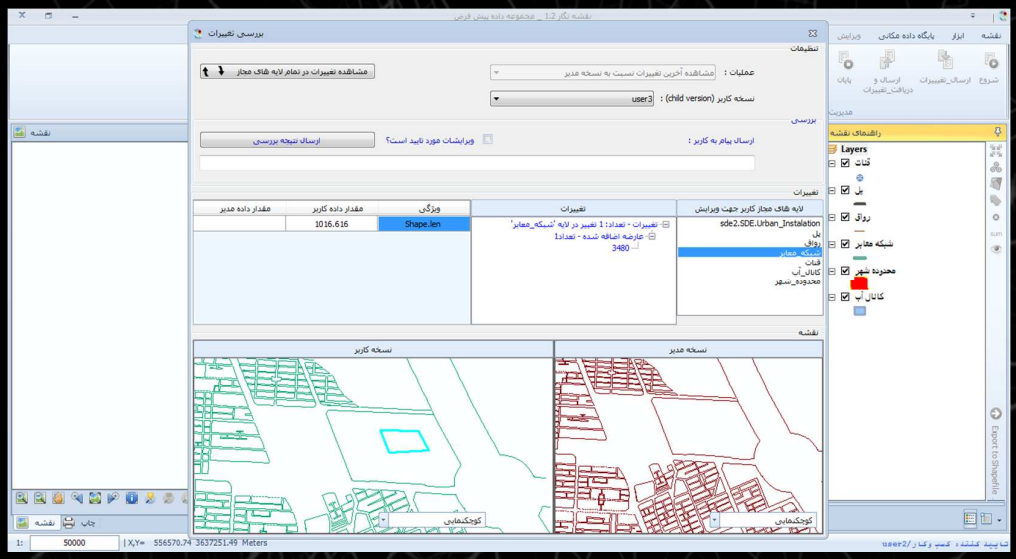
Administration and Quality Control Package



After providing user and password the system lists all the layers user have access where user can use version comparison tools to chekc the edits user have done

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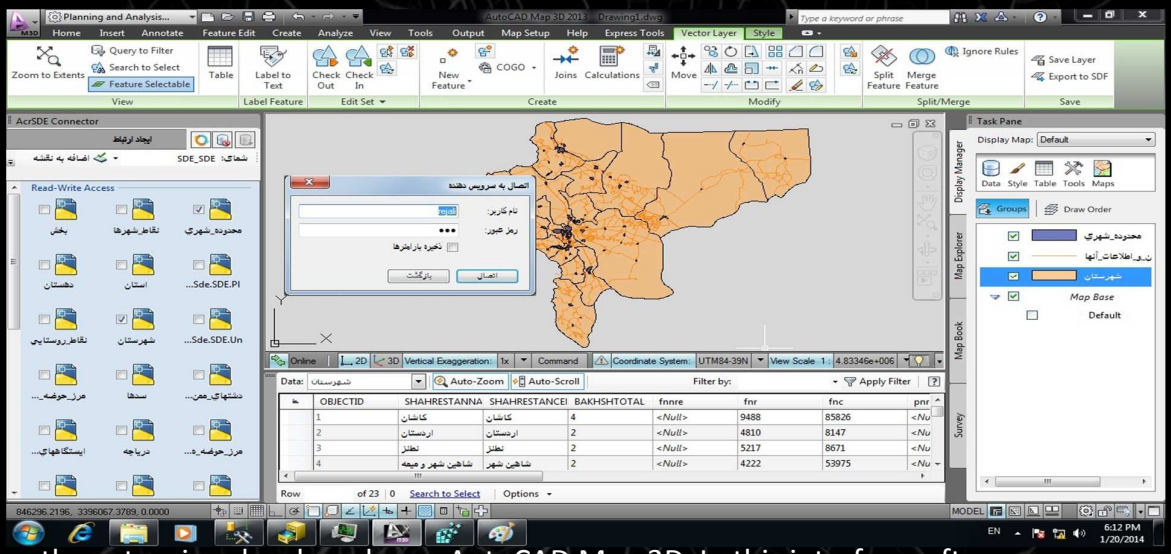
Spatial Data Editing Tools



the extension developed over AutoCAD Map 3D. In this interface, after authentication passed user will have access to the related layers and can observe and/or edit them.

which will be subject to quality controls using previous system

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- The model implemented and tested in municipality of Shahinshahr city in Iran in which illustrates the efficiency and usefulness of the system.
- Implementation of the system as a standalone system for supervisors and an extension for AutoCAD Map 3D simplify the usage of the system which is a critical success factor.

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Shared Spatial Updating

A Key feature for realizing e-government

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