Technology for Cadastral Applications

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SUMMARY

As technology has improved, the expectations for cadastral applications have grown. Land management software is not longer simply a map creation application. New data sources, new data input methods; more sophisticated data editing, management and publishing capabilities have all lead to a significantly more complex view of the very nature of cadastral applications.

This paper reviews the main areas of concerns facing land management professionals and looks at available technologies that are required to maximize the value and effectiveness of cadastral applications.

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A Few Definitions

When we discuss cadastral applications, several terms need clarification, since they shed light on both the expectations of the applications and the uses of the information being created and managed. Commonly used terms include:

Geography – *Geographic* Information Systems

Geospatial – Open *Geospatial* Consortium

Geometry – *Geometric* Precision

Engineering – *Engineering* Accuracy

Mapping – Cadastral *Mapping*

Each of these terms has a specific connotation regarding the data, the use of the information, the accuracy of the digital representations, and the way the data is managed. GIS is primarily concerned with creating a model of the geography of an area. Associated attributes are only as accurate as the map data itself, at least from a positional perspective. The term Geospatial is now being used throughout the industry to represent a broader range of spatial applications – traditional GIS, some engineering applications, and even data that is related to spatial location and spatial relationships.

We often hear about geometric precision or engineering accuracy when discussing both cadastral and infrastructure applications. Drilling down into real-life, infrastructure or public works projects requires a greater element of accuracy that most traditional mapping applications simply can't provide.

Finally, the term mapping, and specifically cadastral mapping is used to describe both cartographic applications as well as the highly technical discipline of creating, editing and maintaining the land base data associated with the cadastre.

Though some of these terms have been used interchangeably, each one is a distinct and very specialized application of geospatial technology.

Cadastral Issues

Precision and Accuracy – the GIS / Engineering Divide

When it comes to precision and accuracy, there seems to be a significant divide between GIS and Engineering applications.

Traditional GIS is concerned mainly with generalization or approximation of the represented geographies. The interpretation of data leads to maps that, in general, depict relative rather than absolute location, proximity, shape, and size. In fact, even the data creation techniques tend to be approximations. Digitizing, warping of data to fit an existing land base, and other

techniques tend to reduce the quality of the data, particularly with regards to accuracy and precision. The application of these techniques is often uncontrolled and leads to increased inconsistency in the data itself.

Finally, traditional GIS and mapping applications are primarily two-dimensional approximations of real life features. Most applications find it difficult to represent 3-D information, complex or compound shapes or customized representations that might be outside of the pre-defined GIS data schema.

Engineering applications, on the other hand, tend to stress geometric accuracy and often are concerned with not only location, but also measurement of the geometries. Engineering concentrates on quantifying the mapped information – how big, how far, how high, how deep, etc. This emphasis on accurately depicting the measured attributes of a feature indicates that engineering platforms offer a better approach to cadastral applications. The resultant accuracy will yield more accurate base maps, upon which all other analysis, design and map creation activities can rely.

Cadastral mapping then is really an extension of the engineering disciplines used for years in the design of the world's infrastructure. Cadastral applications are both geometric and geodetic disciplines that are created to provide an accurate spatial representation of a part of the earth's surface. The cadastre must provide a precise, measured record of the land and therefore must rely on highly precise and accurate tools for the creation, maintenance and presentation of the information. This includes both the traditional surveying accuracy found in typical cadastral applications and also the depiction of the data in three dimensions, to more closely model the real world.

Data Acquisition

Data creation and edition techniques have provided the land management professional with many new tools to create a more accurate land base. The joining of GPS technology with traditional land surveying techniques offers a richer and more accurate fabric for the cadastre. New remote sensing techniques – LIDAR and others – offer a new data creation methodology. The creation of 3D models based on data clouds and other methods offer the cadastral mapping applications more data on which to base their representations. The data is more accurate and can be integrated with the traditionally more accurate engineering design applications to yield a more complete and more flexible data set.

The new data acquisition capabilities mean that the very meaning of a cadastre is changing. More accurate data and the inclusion of 3D data mean that the land information system is now more of a model of the real world, complete with associated features, infrastructure components, and design drawings. Cadastre is now much more than simply 2D lot line maps.

Data Management

The new complexity of cadastral mapping data raises a new concern for land managers. Different types of data require different data storage, data access and data presentation techniques. When including 3D designs or models in the cadastre, information technology professionals need to ensure that each type of data is handled properly. Associated digital video, remotely sensed information, tabular data that might live outside of the traditional GIS workflow all need to be managed in a way that optimized their use.

Traditional file-base storage or database-centric storage methods alone are not sufficient to ensure that the data remains whole. Each data type rightly should be left in the format that is closest to its native architecture. Design drawings, models, and documents are generally created and stored in files, while attributes, relationships and topology typically are better stored in a RDBMS.

What is really required is a hybrid data management system that allows data to remain true to its nature, but allows the cadastral system to access the information when it is needed. This type of system is combination of high-powered spatial management tools and flexible, engineering-accuracy design and mapping applications. Working in concert, these two traditionally separate data management techniques can offer more flexibility, more accurate modeling and a more precise depiction of the cadastral landscape. This new type of system is really more than simply an enterprise wide system. It creates a Federated Data Management System that offers the best of both worlds when managing, distributing and utilizing the managed data.

Data Publishing

Publishing of cadastral data has likewise changed as the data has changed. The increased accuracy of the data now requires a more accurate map creation methodology. Hard-copy cartographic output must be facilitated by highly accurate platforms that maintain the accuracy of the input data.

Web-based map creation has grown in both importance and in availability. The inclusion of multimedia, associated design data and even 3D models have both increased the richness of the information and put pressure on technology vendors to provide appropriate tools for web distribution of data.

Finally, the digital communication techniques have grown beyond a simple map on the web. The use of 3D PDF, mobile data acquisition and verification, and wireless communication tools have changed the way mapping data is transmitted.

Available Technology

As described above, the technologies available to cadastral mapping applications are most appropriately hybrids of the traditional capabilities.

Desktop applications for GIS's are usually quite good for analysis and simple map creation, but extremely weak when it comes to data entry and data maintenance. Likewise, engineering applications are created for engineers not for mappers. They are highly accurate, but the tools can be cumbersome and difficult to use.

What is required is a combination that offers the power of GIS with the accuracy and precision of an engineering application. By combining the best of both worlds, land management professionals can accurately model the real world, while maintaining the ease of use associated with desktop mapping systems.

Information Management

Information management technology must also be adapted to the new capabilities of cadastres. Simple document management systems fail to understand and manage spatial information. Centralized enterprise systems often restrict access to the information or require that the data itself be normalized to accommodate the database's information-handling capabilities.

Once again a hybrid, Federated system provides the needed tools. To maintain data integrity, the data must remain in its native, most usable form. The data management system needs to be able to catalog, locate and distribute the data when required without changing the nature of the information. This hybrid Federated system can offer spatial data management interfaces designed for mapping applications, while maintaining traditional data management capabilities.

Web-based Technologies

Increases in band width have opened the door to more sophisticated web applications. Map viewing and simple queries are still very popular and widespread throughout the industry. The availability of more sophisticated technologies now offer real-time data modeling and even integrated data editing and data creation capabilities.

The web now acts as both integrator of mapping, engineering and modeling disciplines and as the map update and map creation mechanism for land information systems.

The Future of Cadastral Applications

The information has changed, and the science has changed along with it. Traditional cadastral mapping has expanded to include infrastructure data, 3D models, digital video, remotely sensed data, and other non-traditional information components. The tools used to create, manage and publish the data likewise have changed. New mapping applications are now built on a highly accurate engineering platform that lends itself to the incorporation and use of the newly available, highly precise data.

Cadastral mapping is now a hybrid application that offers significantly more information to the user. It offers a unified view of land information, infrastructure components and three-dimensional views of the real world.

The information management systems have also changed. The newly expanded view of the cadastre has required the data management system to be capable of handling new types of data in new ways. A spatially oriented, Federated data management system allows users to locate data easily, while maintaining the data in its native format. Data integrity and accuracy are maintained, and the information is managed properly and distributed when required.

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