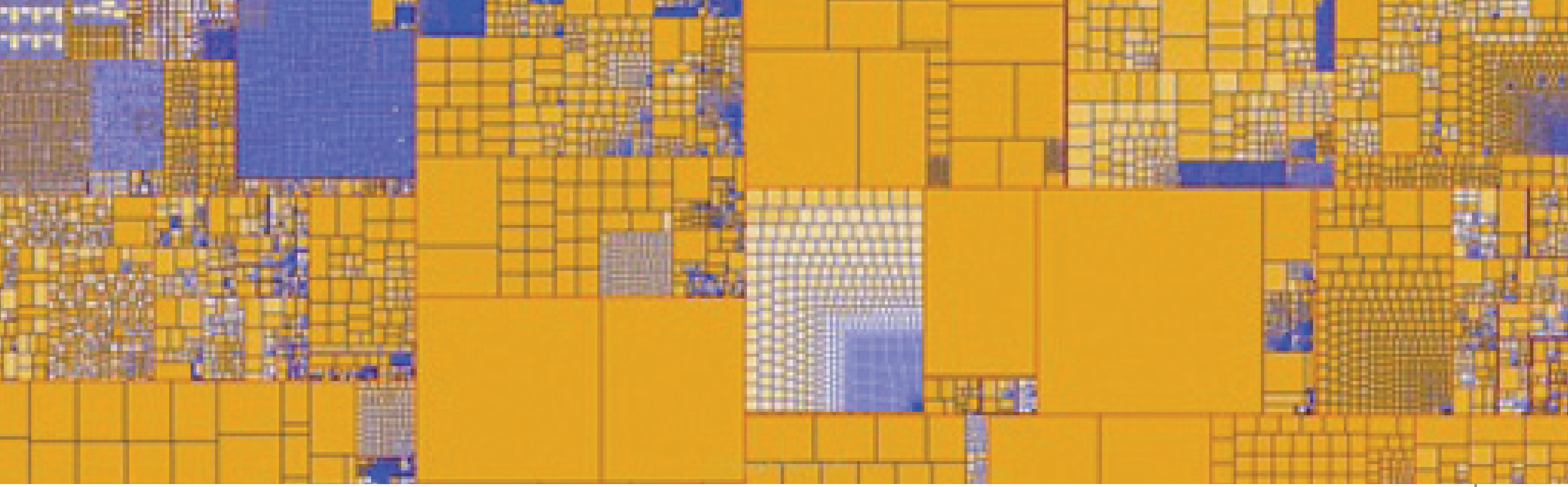
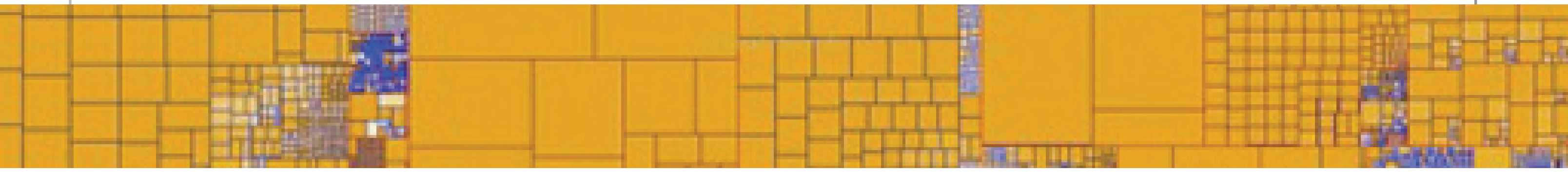


Digital Parcels Go Geospatial

A lesson in the Cadastre, Boundaries and the Parcel Fabric



BY DR. BRADY FOUST

For nearly every project associated with right of way, accurate documentation of property rights and land boundaries is essential. With more than 144 million parcels estimated in the United States, accessing and using this essential information can be challenging, even for small projects.

For companies and organizations that must plan across multiple parcels and geographies, a geospatial approach can improve accuracy while streamlining a variety of the processes required.

Maintaining Documentation

An official register that documents legal data for millions of parcels is known as a cadastre. Cadastres are used by many nations around the world to document land ownership, some in conjunction with other records, such as a title register. The cadastre serves as an official register of the value, extent, and ownership of land for taxation purposes and commonly includes ownership details, tenure, precise location, dimensions and value of individual parcels. It serves as the fundamental source of data in disputes and lawsuits between landowners.

To document the boundaries of land ownership, cadastral surveys are used and can be comprised of different elements, including documentation, diagrams, sketches, plans/plats, charts and maps. In addition to the legal documentation that forms proof of ownership, the survey includes the precise location of the property described in words, the exact dimensions and sometimes a description of land use.

The Public Land Survey System (PLSS) is the cadastral survey used in the United States, while Canada uses the Dominion Land Survey. Both cadastral surveys are described in relation to principal meridian and baselines. Surveyed areas are divided into townships, which are further divided into sections. Describing a PLSS cadastre might read something like, "The 40-acre parcel consisting of the NE¼ of the SW¼ of Township 2 North, Range 3 West of a given principal meridian and parallel."

The most important cadastre in the U.S. is the fabric of parcels created and maintained by state, county and local taxing authorities. A fabric of parcels is another term for the dataset that contains the legal extents of each taxable property address, as well as the non-taxable parcels, such as parks and other publically-owned land.

Geospatial Parcel Fabric

With millions of parcels to access, a parcel fabric stores a continuous surface of connected parcels, also known as a parcel network. Parcels in a fabric are defined by polygon, line and point features. A series of boundary lines store dimensions as attributes, and these should ideally match recorded dimensions on the record or survey or plan.

The fabric concept initiated the development of a common land data model that integrates the world of surveying with Geographic Information Systems (GIS). This concept is fundamental to preserving the accuracy and quality of survey data and providing methodology to maintain the integrity of the PLSS coordinates. A common land data model and a set of GIS tools unifies the worlds of surveying and GIS, and this is fundamental for improving the accuracy and quality of the data. The end result is standardized land descriptions and cadastral data that can be used by anyone, anywhere.

A geospatial approach means that the cadastre is stored and maintained in an electronic format, with the boundaries of the fabric in the form of a digital map. The information is stored in an associated database. Given that paper maps are difficult to store, index and retrieve, the efficiencies obtained are significant.

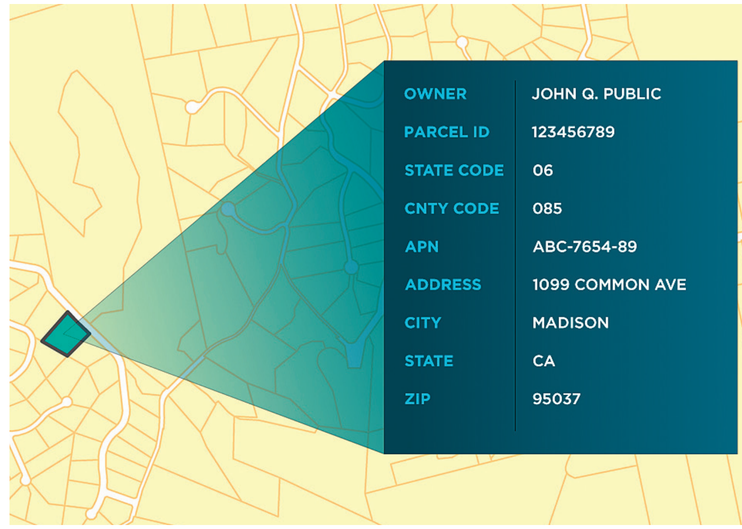
A number of geospatial companies in the U.S. have extracted, converted and normalized 50-70 million parcels from government sources. As one of the leading providers of information, analytics and business services, CoreLogic has created and maintains the largest geospatial database of parcels in the U.S., recently passing 131 million parcels.

Right of Way Applications

In addition to using the parcel fabric for natural resource management, it has become increasingly used for large scale planning for highways, power lines, pipelines and other projects that cut across or affect numerous parcels. The parcel fabric is essential for right of way and easement planning and implementation. It is also used to improve geocoding, the process of finding associated geographic coordinates that can be mapped and entered into GIS systems.

For example, a power line company might need to store 50,000 scanned map images over a particular area. Although the legal descriptions might be correct, paper maps often lack accuracy, and it is difficult to maintain them so that they fit together spatially. While it takes considerable skill in the field to find specific parcels, this

Figure 1: Single Parcel Data



activity has been greatly simplified by the introduction of electronic maps and Global Positioning System (GPS) technology. Companies can leverage the parcel database to manage encroachments and ensure compliance with environmental and other federal, state and local regulations. Using GPS can also help in supporting civil engineering teams in determining access points for ingress and egress of right of way, as well as performing budget and cost analysis years before acquisition.

A digital map can represent millions of parcels and their associated data in a single entity. Users can easily see how the pieces fit together and have the ability to pan and zoom to any area with ease. Figure 1 shows an example of the parcel fabric with the data associated with a single parcel.

Removing the Geospatial Errors

In a legal sense, the parcel fabric is seamless since parcels cannot overlap and there are no gaps or overlaps when the fabric passes from one county to another. Most digital parcel maps are created by digitizing paper maps from a single tax authority and are therefore subject to considerable geospatial error. Fortunately, modern GIS technology provides robust tools to correct these errors.

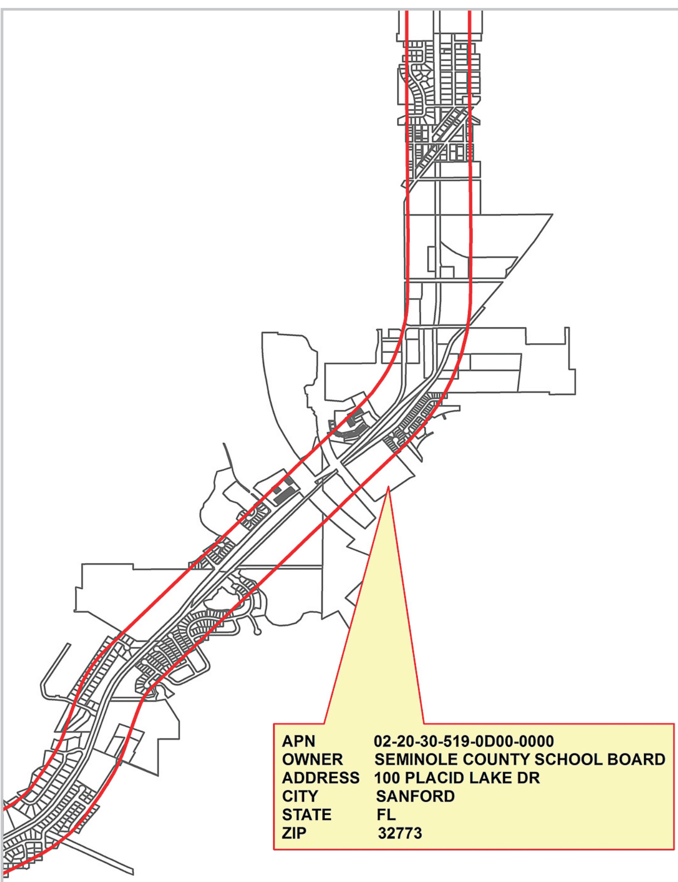
There are four common corrections, which include topological creation, geospatial rectification, geospatial operations and versioning/updating.

1) **Topological Creation:** GIS processes work to create a seamless topology from digital vectors. For example, two adjacent parcels are often digitized as two separate entities so that each has a separate boundary. In reality, there can be only a single boundary so changes in the boundary of one must automatically be reflected in the other. This is especially true at the boundaries of counties or states. GIS technology cleans these and other topological errors to produce a single seamless fabric.

2) **Geospatial Rectification:** Conversion from paper to a digital format does not necessarily ensure spatial accuracy. Land surveyors who represent the final, legal authority for spatial accuracy begin each survey from a known location on the surface of the earth. The transition from a paper map to a digital format does not always preserve an acceptable level of accuracy, so the digital maps must be georectified. This process can shift the parcel fabric to congruency with known control points, such as triangulation points, section corners or other common survey markers.

3) **Geospatial Operations:** Having the cadastre in a digital format makes geospatial operations possible. Spatial selection lets you select all parcels that touch or fall within a certain distance of a planned pipeline or highway corridor, for example. The resulting data set is then subject to mathematical operations, such as calculating the total area or a count of owners. A corridor area can be automatically calculated for estimating the right of way needs, while terrain analysis calculates the elevation, slope and aspect of a given parcel or part when combined with underlying elevation layers. A spatial overlay function calculates the location of a parcel in relation to other underlying layers, such as roads and streets, environmentally sensitive areas, rivers and lakes, industrial plants and other areas of interest.

Figure 2: Geospatial Operations



Source: CoreLogic as of July 2012

4) **Versioning and Updating:** The creation of a single geospatial database that can be shared with all authorized users along typical GIS operations means that changes, deletions and additions can be shared almost instantly with all users over any geographic area. This would be extremely costly and laborious with paper maps and documents.

In Figure 2, several kinds of geospatial operations are shown. The GIS created a corridor of a specified width along a centerline drawn by planners based on a number of criteria. The system then selected all parcels from the larger fabric that touched the corridor polygon. This greatly reduces the number of parcel polygons for planners to consider. Next, all publically owned parcels were returned by a simple query to the associated database to create a smaller dataset for additional analysis. Data about one such parcel is shown in the figure.

The combination of large digital parcel datasets and robust GIS operations to enhance, analyze, and manipulate geospatial data, means that the parcel fabric has important uses that extend beyond property taxation.

Efficiencies Gained for Power Line Projects

For many pipeline and power line companies, GIS joined with digital parcel datasets has become an important force multiplier resulting in more efficient operations and lower costs when planning routes and conducting other right of way related processes. For example, companies often plan routes based on environmental considerations including elevation, slope, environmental sensitivity, flood zones, taxation areas, cemeteries, schools and hospitals. Furthermore, they often consider several different routes, each with a different set of positive and negative attributes. The parcel layer adds another element to the planning process. GIS can provide automated estimates of potential right of way costs and impacts from the assessed value of each parcel crossed by the corridor, and additionally, the amount of land affected.

One of CoreLogic's utility customers recently demonstrated significant cost savings and efficiencies using the parcel fabric in planning a major transmission line through an urban area. The transmission line was projected to run along a multi-lane thoroughfare with a majority of the structures designed to be sited in or near the state highway right of way.

In the past, the company would have purchased a ten foot right of way along the highway corridor, resulting in acquisition costs of over $4 million for a route just over a mile in length. The parcel layer facilitated an engineering decision to leverage survey grade data and restrict the acquisition to structure footprints. The GIS environment and the parcel dataset enabled the company to quickly project cost savings of more than $3 million. In terms of using high precision parcel data for right of way acquisition, this project was a great success.

Time and Cost Savings for Pipeline Projects

A major pipeline company used CoreLogic's digital parcel fabric in hopes of saving time and money. The pipeline company would often begin planning with a corridor of 300 feet or wider to establish a final route with a much smaller width. But before survey teams take the field, permission from the correct landowners must be obtained. Letters and phone calls are an integral part of the process, and any delay in the process can slow down the entire project. With paper maps and physical visits, the process traditionally took six to eight weeks. However, the availability of a digital parcel fabric and the associated owner data reduced this time to less than one day in most cases, as mailing lists and letters could be generated automatically using GIS spatial selection processes along a corridor center line.

In the past, survey crews faced a confusing array of information when they received permission data through printed lists. Now the pipeline company provides parcel maps with a corridor overlay that has color coded parcels: green for permission granted, yellow for notification before proceeding, and red for no permission. Clicking on a yellow parcel, for example, presents vital information, such as the need for 24-hour notice before proceeding, a telephone number for access and mail notification of dates before proceeding.

Pipeline companies also maintain line lists that contain parcel/ownership information along their right of way. The parcels must be listed in order of their distance from a certain point and in the direction of the flow of the pipeline. The direction of the flow also provides a left/right description of the parcel. The line list also assigns each parcel a unique identification based on these metrics. Such a list is difficult to create with paper maps, but greatly simplified with digital parcels and GIS.

Eliminating delays in the early stage of the process—delays that can span months in many cases—has other advantages as well. For example, surveying or construction may be curtailed for environmental impact reasons such as for a migratory bird habitat or a particular blooming season for plants. Delays in survey permissions and right of way land acquisition in the spring may suspend construction for an entire year because winter weather sets in before construction can begin. These kinds of delays can significantly hold up an entire project.

Once initial surveys are completed, company engineers can begin planning an exact route. Using the parcel fabric, they can access any layer, such as wetlands, to see how the route fits within both land ownership and environmental and terrain conditions. The route may be moved to follow property divisions rather than cutting directly through individual parcels. The process gives the company a much better initial route.

"Companies can leverage the parcel database to manage encroachments and ensure compliance..."

When construction begins, GIS maps of right of way acquisition prove invaluable in keeping the process moving. Crews can work along the corridor where the right of way has been secured, and fill in the missing segments as the acquisition process proceeds. Furthermore, construction managers can view any given parcel and determine what was promised to the landowner, such as fences requiring repair, seeds to restore vegetation, or roads and driveways requiring repair. This greatly reduces the confusion inherent in any complicated project.

Even after a pipeline project is completed, the digital parcel fabric continues to provide efficiencies. Pipelines must be inspected every seven years by sending an electronically laden "pig" down the line to search for anomalies. Reported problems may necessitate excavating a section of pipe for inspection followed by potential repair or replacement. Instant access to land ownership speeds up and simplifies the permission process for land access, and if the purchase of extra workspace is required, knowing immediately who owns what is extremely important to avoid delays in getting the pipeline operational.

Conclusion

The various processes involved with right of way projects can be cumbersome, full of moving parts, and can result in considerable time constraints and deadlines. History and current land development procedures illustrate that a complete and precise cadastre is absolutely essential to all elements of the right of way process—from initial conceptualization and planning to legal document closing. The creation and consolidation of a digital parcel fabric and the associated GIS technology to access, enhance and analyze such electronic data can make the right of way process easier, faster and more cost-effective for the companies that use it.

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Brady serves as an independent Consulting Geographer to CoreLogic Spatial Solutions specializing in GIS applications for insurance, oil and gas, utilities and governments. He has more than 40 years of experience in theoretical and applied research in retail site location, insurance and tax geospatial solutions, and the design and implementation of large spatial databases. Brady is also Professor Emeritus of Geography at the University of Wisconsin-Eau Claire.