DIGITAL CADASTRAL DATABASES: THE AUSTRALIAN EXPERIENCE

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ABSTRACT

Countries in the world that have maintained some form of cadastral mapping are now proceeding to a full digital representation of these cadastral maps with the ultimate aim of having country wide coverage at an accuracy level consistent with current technology in Geographic Information Systems (GIS) and surveying. GIS have shown the economic and information benefits of integrating the data sets and functions of the mapping, land titling and land management institutions. Also in each of these countries the current status and future directions of digital cadastral databases (DCDB) in any jurisdiction depends very much on the historical origin of the cadastral systems and the land related institutional structures (or current restructuring). In contrast to the varied paths to the present digital cadastral maps of any country the current problems and required solutions are surprisingly similar world wide.

This paper focuses on the current problems and solutions strategies for state DCDBs within Australian with particular focus on the Australian states of Victoria and New South Wales (NSW). A brief explanation of the origin of state DCDBs in Australia is followed by an overview of the information flow in the cadastral systems to contextualise the current issues and strategies for the update and upgrade of the Australian state DCDBs.

1. INTRODUCTION

In contrast to the small to medium scale topographic data sets, DCDBs are very dynamic since they are tied to daily changes in the cadastral framework through the subdivision and the land titling processes. A very significant feature of the Australian digital cadastre is its full digital coverage across all the states of Australia. Each state in Australia maintains its own state DCDB and for a number of historical, political and economic reasons each has developed DCDBs that have a number of significant differences and similarities. In general the DCDB of each of the Australian states is a digital spatial database which has been derived from paper maps, it gives a graphical representation of the cadastral fabric and plays no technical or legal role in cadastral surveying or the land titling process. At present the digital cadastral database of the whole of Australia is a one time compilation of discrete and disparate data sets of each Australian states (PSMA, 1996).

The processes for updating and upgrading DCDBs are gaining considerable attention world-wide as GIS users recognise the importance of the currency, quality and content of the DCDB that underpins their GIS application. The problems that face each of the individual Australian states to satisfy both small and national GIS customers and the improvement strategies being discussed and adopted are not unlike those faced world wide by custodians of digital cadastres.
2. THE DEVELOPMENT OF STATE DCDB's IN AUSTRALIA

In Australia the activities that relate to the capture and maintenance of a complete state digital cadastre have been the responsibility of a number of different state government bodies. The Departments of Surveyors General administered the Crown land as well as managing the surveying infrastructure and topographic mapping. State Land Surveyors Boards maintained the quality assurance function for cadastral surveys. The Land Titles Offices (LTO) for each state has had the responsibility for the titles and deeds associated with all freehold lands and have usually been responsible for examining cadastral survey plans of these lands. Land Titles Offices have specifically only ever been concerned with individual land transactions with the result that the Australian states lacked a complete cadastral map which could be used for land administration purposes (Williamson, Chan and Effenberg, 1997).

The large digital mapping data sets have their origin in the early to mid 1980’s. The typical technique for establishing computerised cadastral maps or state DCDBs has been to fit the best available cadastral survey plans together onto a topographic base map using control surveys and physical features as control in a graphic ‘rubber sheeting’ technique. In rural areas the source maps were generally at a scale of 1:25000, while the metropolitan areas were sourced from paper map scales ranging from 1:5000 down to 1:200. In urban areas, field surveys and survey control have been used to a much greater extent with typical scales being usually 1:500-4,000. The resulting paper cadastral map base was then digitised to establish the DCDB.

The derivation of DCDBs from paper cadastral maps means that cadastral boundaries are represented at a graphical accuracy. Large variations in the accuracy of the graphical coordinates of boundaries are possible with the accuracy of the scaled boundary coordinates in most Australian state and territory systems being about ˜1 mm at map scale (eg. ˜2.5 m at a map scale of 1:2,500).

Most digital cadastral maps in urban areas were initially prepared by utility authorities responsible for water, sewerage and drainage. Melbourne Water Corporation (Victoria) and Sydney Water Corporation (NSW) originally captured and managed their state’s metropolitan cadastral map. These represented a large portion of the land parcels in the states of Victoria and NSW; collectively these two states have by far the majority of legal land parcels in Australia (Wan and Williamson 1995).

The mid 1980’s through to early 1990’s saw the capture of a digital cadastre become the key mandate for each of the Australian states (Mooney and Grant, 1997). For Victoria and NSW the cadastral data sets of the water boards for the cities of Melbourne and Sydney became the basis for each state’s mandated state DCDB. The DCDBs were therefore both state and metropolitan focused, with each state generating somewhat different cadastral data sets in response to individual state priorities. As a result there are broad disparities in the quality and content of Australia’s current digital cadastral map base.

3. MAINTENANCE OF the CADAstral DATA SET

The dataflow for the incremental update of the DCDB starts with the surveyor whose deposited plans of subdivision must ultimately be correctly incorporated into the state’s DCDB and eventually these changes need to be distributed to the customers of the DCDB. Figure 1 depicts what is essentially the insertion of a digital cadastral database maintenance process into what is currently a paper based transfer of cadastral plans to the LTO by the surveyor and from the LTO to the custodian of the state DCDB’s.

This post land registration model relies on the fact Land Titles Offices will capture all activity which will impact on the cadastral fabric and its attributes. Most states in Australia maintain a DCDB that is current within 5 to 10 working days of the plan being registered (OGDC, 1995 and PSMA, 1996).
3.1 Data transfers to DCDBs

The surveyor is increasingly able to offer both greater accuracy for his plans and to offer them in a digital format. Some utilities require that subdivisions of greater than say 10 parcels must be submitted in digital form. It is this submitted plan in whatever format it is required to be, that is eventually used to update the each states DCDB.

To ensure the integrity and completeness of the DCDB other data sources such as government gazettes, parish plans, etc, are consulted to capture all boundary data. Some states quote up to 40% of current cadastral update activity is outside the current subdivision process (PSMA, 1996). While the cadastral activity that is not required to pass through the LTO is generally easily identified, it is often difficult to capture the related survey data.

The model clearly indicates that to include the proposed or prebuilt subdivision plan information in the DCDB would require that the information be sourced at planning stage from either the surveyor, the councils or a utility. Victoria with its close association with the metropolitan water utility, has a proposed layer for its metropolitan jurisdiction, complete with digital lodgement of subdivisions of greater than ten lots.

3.2 Data Transfers from DCDB

The custodians of the DCDB have been able to offer customers a complete copy of the DCDB in a number of digital, vendor specific and specific standard formats for some years. The DCDB is usually held in a tile or file based format and the distribution in this block format is also currently possible. The frequency of the update delivery is also flexible but in the absence of a proposed layer, customers must take account of the time required for deposited plan to complete the LTO approval registration process.

The distribution of cadastral updates to the utilities is very much on an individual contractual arrangement. At one end of the spectrum a national utility requesting multi state coverage requires a third party to join the data sets from a number of states. In contrast for the Victorian Metropolitan DCDB, updates are able to be delivered to Melbourne Water, on a weekly basis, a bulk replacement of any of the 2,800 predefined tiles that have changed (Hesse and Jacoby, 1995).

4. UPDATE of state DCDB

Since the initial capture phase, the task of updating the state DCDBs to ensure that all new legal subdivisonal activity is recorded and that the existing DCDB is complete, has occupied a majority of the resources of the custodians of the state DCDBs (Effenberg and Williamson, 1996).

The general method for the spatial update is to enter an image of the survey plan graphics using coordinate geometry techniques. This survey accurate graphics may or may not be stored for future upgrade purposes. Survey information is then distorted within DCDB's accuracy in this area to minimise alterations to existing cadastre. The majority of update tasks for each state, that originate from the subdivision process, are for one and two lot subdivisions (OGDC, 1995 & LIC, 1996).

4.2 Issues

The currency of each state DCDBs with registered plans is not presently reflected in the supply of updates to customers, while negotiable, the supply of updates to individual customers is typically six or twelve months. The custodians of the DCDB are not on the planning referral list and indeed with 177 councils in NSW and 70 odd in Victoria the information flow would be overwhelming, particularly when planning iterations are taken into account. In the absence of planning data within the DCDB (proposed layer, lodged layer, prebuilt layer) many customers
such as councils and utilities, who are on the planning referral list, maintain their own portions of the DCDB and use updates from the custodian as a check on their own maintenance procedures.

In regard to planning data the concern by councils and utilities is twofold; one, as they already have the data well before the custodians of the DCDB it is easier to enter it at that time for planning purposes, and two, they are able to consider any changes to the cadastral fabric and its impact on the spatial components of their assets. This association of assets to the cadastral is a very real problem for the users of the DCDB, particularly if shifts to the cadastral boundaries occur. The result is that there are a number of large portions of each state’s DCDB whose maintenance is duplicated, but state custodians however have the responsibility to maintain the state’s entire cadastral.

The custodians of the DCDB offer customers a complete or ‘refresh’ copy of the DCDB for their area of interest. The DCDBs are also usually held in a tile or file based format and the distribution in this block format is obviously possible. Customers are increasingly requesting incremental delivery of updates for extents and frequencies of their own choosing and with internet technology, the possibility of delivering the cadastral product in more flexible ways.

Pricing is always an issue, especially in the current climate where government authorities must operate on a commercial footing. In addition to paying for the supply of updates, customers of the DCDB are also supporting a very viable industry that customizes and converts DCDB’s to their specific software platform and data structure.

4.2 Improvement Strategies

In recognition of the dual role of councils and utilities as both customers and originators of the cadastral data (see figure 1) the custodians of the DCDB are maintaining or are moving to capture a proposed plan of subdivision as part of the DCDB data model. This is a clear recognition of the fact that once the subdivision plans have been registered at the LTO, the planning authorities have already utilised or incorporated the data. It is seen that the lack of this information is the main cause for the fragmentation and duplication of the state DCDBs. If this cadastral planning information can be supplied in a timely and economical method then a more homogeneous state cadastral can be achieved.

The presence of a planning cadastral data in the cadastral model assumes that the survey planning information can be quickly accessed by the custodians of the DCDB and that this information is accessible to the DCDB customers within a time period of about 24 hours. Digital lodgement is seen as one solution to make the surveyors information more accessible and also to minimise the number of times the cadastral subdivision survey information is printed to hard copy and again entered into another computer system.

NSW and to a lesser extent Victoria have implemented the concept of mirror sites for either internal customers or specific customer research projects. Here an external database site has all of the cadastral updates for a day applied as an overnight batch process. While this is efficient for a small number of sites who maintain similar or predetermined hardware and software, it is not a viable total solution state wide. The technology of the internet offers the promise of some real data distribution and collection solutions and a number of projects are under way in Australia in this area.

As the new data models with unique feature identification to point level are implemented, incremental updates become possible but also introduce their own set of problems not the least of which is a transfer standard. Queensland has for some time offered incremental updates on the basis of an ‘xy’ change file in its own specific format (PSMA, 1996)

There is no doubt that the problem of spatial data associativity will remain a major problem until the accuracy of state DCDBs are upgraded to the level demanded by customers with critical
underground assets. In the meantime many of these customers see a business need to update and maintain their own cadastral products.

5. Digital Cadastral UPGRADE

The issues relating to upgrades have their origin in the historical development of the individual digital cadastres but not surprisingly the issues of accuracy, adjustment, topology and cadastral data content are similar world wide.

5.1 Issues

The Australian Capital Territory with a comparatively small cadastre of just over 100,000 parcels, already has a cadastral accurate to ~0.03m having originally developed their DCDB directly from survey information. Other state DCDBs representing the other 10 million or so land polygons would only have some specific portions of their state DCDB approaching this accuracy.

The outlying suburban areas and to some extent the rural areas represent, for all states, the major requirement to upgrade the accuracy of the DCDB where the original capture was from 1:25,000 maps with errors of up to ~25 metres and where the rural areas are now being subdivided for fringe metropolitan housing.

GIS users in Australia are now increasingly demanding greater accuracy. Ten years ago these GIS users were happy with DCDBs having a graphical accuracy (about ~2-4m in urban areas to ~20m or more in rural areas). These same users are now demanding coordinate accuracy of the order of ~0.3m in urban areas. (Williamson and Hunter 1996)

While the surveyor may be able to supply coordinated and digital measurements the current methodology for updating the existing cadastre means that these measurements are lost when the new subdivision is entered and ‘fitted’ to the existing cadastral fabric.

The origin of these state DCDBs from the utilities in the last decade means that a number of issues have or need to be addressed:

- The separate development of DCDBs from the topographic data sets means that they are not aligned with topographic features.
- The CAD origin of the DCDB means a lack of topology.
- The DCDB’s were property rather than parcel based.
- The cadastral contains only boundary information and no building footprints.
- The DCDB does not contain some property attributes considered essential in other cadastral data set such as land use.
- Street addressing is not fully implemented and in rural areas a street addressing program is only now being implemented.

5.2 Improvement Strategies

In the current economic climate the custodians of the DCDBs find it difficult to embark on an upgrade program when the maintenance costs in state of Victoria for instance have been quoted as high as A$14 per parcel (Jacoby, 1996). The state custodians of DCDBs are looking to work with councils and utilities within the state to upgrade the DCDB in areas of mutual interest by incorporating more accurate cadastral data into the current state DCDB.

There are a number of quality assurance, data ownership and pricing issues in this approach especially in an economic climate of cost recovery. While Victoria has totally outsourced the maintenance of the Victorian state DCDB (OGDC, 1995) a decentralised upgrade approach with central or coordination and/or incorporation into the state DCDB may be a very viable future approach.
Some Australian states have already generated survey databases, again often independent of the state DCDB. Digital survey measurements are now being retained by either the newly generated survey databases that are integrated with state DCDB’s or original geometry of the new subdivision in the update process is being retained for the future upgrade of the DCDB. There is also a move for a much wider cadastral reform to include cadastral survey practices and the bringing together of titling and DCDB mapping function (Williamson and Hunter, 1996).

As elsewhere these digital cadastral data sets are being migrated to newer technologies and this affords opportunities to upgrade the DCDBs. Specifically there is a trend both in NSW and Victoria to move to ‘spatial server’ technology to make the spatial data GIS software independent. The migration of these data sets from 1980’s technology allows consideration of the DCDB’s content and redesign of the data models.

Specifically these considerations are:

- The addition of topology to the DCDB.
- Incorporating unique feature identification to point level.
- Moving to both a parcel and property representation to allow easier integration with many other property based data sets which are keyed on street address.
- Inclusion of geometry for building footprints and strata titling.
- Moving to truly seamless spatial databases which do not have underlying file divisions.
- Addition and perhaps deletion of aspatial attributes that reflect the current and future use of the DCDB.

These upgrade strategies are still only on a state by state basis and no standard data model has been adopted to more easily generate national data sets. A move to dual ownership of data sets at state boundaries is one method of beginning to formulate a national capability. The reality is that there are currently eight different cadastral systems in Australia, all with different standards.

In addition there is a real need to agree on meta data for DCDB accuracy. At present the most widely used and consistent meta data about the accuracy of portions of each state DCDB is the original map sheet from which the cadastre was sourced.

6. CONCLUSION

The fact that Australia has a full digital cadastral coverage of its states and territories can not be understated. This Australia wide availability of digital cadastral data has without doubt been a major contributing factor in the growth of GIS in Australia. The liability of this first generation cadastral data set is that there are significant difficulties in the update and upgrade of a graphically accurate digitised DCDB.

The future challenge for the custodians of the state DCDBs is to upgrade the DCDB to a level consistent with current technology and practises. In addition the challenge is to maintain a current and homogeneous cadastral data set for Australia. This will involve considerable utilization of current technology to gather and deliver timely and cost effective updates of the DCDB to fully meet the daily needs the data originators and customers of the state DCDBs.

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