CADASTRAL SURVEY DATA TRANSFER

for the Cadastral Spatial Referencing System

GEORGE BAITCH

Registered Surveyor
Land Information Centre
Dept Conservation & Land Management

ABOUT THE AUTHOR

GEORGE BAITCH is presently the Manager of Cadastral Development, Land Information Centre, Bathurst.

He studied at the University of New South Wales for the Bachelor of Surveying. He started his association with the then Department of Lands in 1971 when he earned a part-time traineeship. He graduated and became registered in 1976. Then he commenced work with the Department of Mines.

In 1980, George rejoined the Department of Lands as a Staff Surveyor in the Narrandera field office of the Crown Lands Office. In March 1982, he was appointed the Senior Surveyor.

In May 1986, he was engaged by the Central Mapping Authority on an exchange program as the coordinator of the State Survey System Review. In 1988, he took up his present position.

He completed a degree in business on public administration at the Charles Sturt University - Riverina in 1990.

George has been on the Staff Surveyors Association committee since 1982.

Abstract

This paper describes a method for translating surveyed information in digital form and the reasons for its development. This translator was specifically prepared to populate the cadastral spatial referencing system (CSRS). It is an enhancement of an earlier translator modified in response to feedback received from the industry.

The paper will show that the translator will enable the surveyor to transmit any information without much added effort. The paper will describe the underlying philosophy behind the translator design and give an outline of its structure. Examples of the translator are provided and show that is even possible to emulate the current plan based system of survey information recording.

Introduction

The buzz word of the 1990s is the information superhighway. This superhighway will allow the transmission of information in digital form to anyone across the nation and even overseas. All without leaving home or office.

It has been agreed that the most efficient method of accessing land based information is by spatial referencing. It is now necessary to enhance the accessibility, communication systems and use of this data. The challenge of the next decade is to involve the land information industry in this superhighway. It is necessary to create a national network linking databases and their users in the spatial data industry.

This communication is in existence in other industry sectors, such as the banking and financial industry. Surveyors and land information scientists have not as yet been able to transmit their digital data in an use-friendly and efficient manner. As a result, real estate agents, land-use planners, environmental scientists and many others will benefit from the implementation of such an infrastructure.

A whole new value-added industry will emerge with market opportunities that are beyond the cadastral surveyor's wildest dreams.

Spatial Industry Development

Phase 1: In the 1960's there was a genuine effort to develop a new system for managing spatial data. During this period we saw the first use of computers in surveying and mapping. We also saw the first efforts in automating land records.

This phase was led by non-commercial interests, such as government bodies or members of the profession or the public itself. It was not technologically driven. There was a broad vision of the information society that resulted in the creation of a system that would enable land issues to be resolved and citizens to participate in land use decisions.

It was during this period that in government and university laboratories the first geographical information systems (GIS) software was developed. GIS would enable the integration of land related information.

Phase 2: Broad vision characterised the first phase of land information systems development. Whereas the second phase, from 1975 to now, was dominated by proprietary interests, a vendor driven market and bureaucratic replication.

During this phase many commercial GIS, surveying packages and digital mapping systems developed. Governments at all levels invested heavily in database development. Industry bought up in hardware and software both to compete commercially and to remain relevant to their clients.

What happened however was that the vendors took over the agenda and created a culture of competition, oversell, and fierce customer loyalty. Conferences during this period were dominated by how to create GIS rather than asking why.

No organisation wanted to be left out. So as a result, many bureaucracies simply automated established activities, not realising the benefits of the technology. Accordingly, during this phase, rather than devolving power to the people through this technology, it became centralised.

Phase 3: Now that these GISs and their attendant databases have been created, some semblance of sanity can return to the spatial data industry. The emphasis is again shifting from the technology to the information and its use.

Now that the technology is commonplace, even the information itself is becoming less important and the extracting and communicating knowledge is the issue of the phase three.

This period that has only recently commenced is dominated by integration of applications. Databases will be linked through distributed spatial information networks.

Today, spatial information is a multibillion dollar industry, but most of these dollars are spent on data collection, management and technologies within government. To foster industry growth in the future, two components are required:

* a national strategy for the interconnection of spatial databases, and
* a mechanism by which spatial data can be transmitted from supplier to user.

This paper describes the development an internationally compliant transfer mechanism. It is hoped that the Land Information Centre can take a lead in the implementation of this transfer mechanism nationally and the development of a national strategy for land data access.

Reason for Digital Data Transfer Standard

A draft transfer has been prepared as the basis for discussion from members of the survey profession. They will supply measurement based cadastral survey data in a digital transfer format. Feedback from all participants involved in the development of the transfer is essential for the success of its implementation.

Other public organisations have prepared specifications for the transfer of survey data or for the transfer of the drafted image of cadastral surveys. They have all had significant shortcomings. This standard will not be dependent on any proprietary product and thus not liable to version changes. No other public organisation's format will have the same industry wide ramifications. Therefore this is an attempt to provide a flexible and user friendly format that will meet the needs of all parties involved in the transfer of measurement based information.

This specification is intended to be as flexible as possible. It has attempted to separate content from format. The format specified in this standard will allow amendment of contents without amendment to the translator.

This document specifies the items that are proposed to be transferred in the Cadastral Survey Data Transfer to enable the loading of data into the Cadastral Spatial Referencing System (CSRS).

Why Digital Data Transfer?

Currently the Land Titles Office (LTO) holds around 900,000 deposited plans in its records. These plans are stored at present in hardcopy, on microfiche and on optical disk. Plans are being deposited at a rate exceeding 12,000 per year.

Once a cadastral survey plan, designed to be registered, has been completed, many copies must be distributed to many government authorities. Within the Department of Conservation and Land Management (CaLM), survey plans, once deposited, are forwarded onto the Land Information Centre (LIC) for the purpose of updating the Digital Cadastral Data Base (DCDB).

Whilst the DCDB has many uses to the profession it can not deliver cadastral based survey data. Land Titles Office holds deposited plans (DP) that contain surveyed information in picture form. An intelligent system, however, would improve access to the LTO's plans as well as increasing the speed and efficiency of searching survey information.

An intelligent system for cadastral plan storage and retrieval has two major requirements:

(i) It must contain all the data currently available on all Deposited Plans (DPs); and

(ii) It must store and be able to retrieve all information spatially and temporally.

Another feature that such a system should provide is the ability to carry out a search directly from the LTO client's offices rather than through the cumbersome procedures currently in use. It is obvious that such a facility is a long term objective, but the longer it is left, the longer it will inevitably take to create the future.

The third and most important criterion to the profession is that such a system ought, at the very least, be revenue neutral to the individual members of the profession, *if not revenue positive* to them. To achieve this an intelligent system must make use of the facilities available in a modern and progressive survey firm and make use of existing systems.

In a series of questionnaires carried out at the "Control Your Future" Workshops it was established that 74% of firms prepare their DPs or planning work using a survey computer (CAD) package. It then becomes feasible to make use of these facilities presently available in most survey offices.

The Cadastral Spatial Referencing System (CSRS) is such an intelligent system. Currently in its final development phase it will provide a searchable cadastral fabric. Data to sustain the CSRS will be obtained further upstream in the development process, ultimately leading to reduced costs for the client of the surveyor by reducing the number of downstream operations needed in the registration process.

The Cadastral Spatial Referencing System

The CSRS has been developed to accept measurement based information derived from land surveys. This will eventually give rise to the creation of a survey database that will assist in the creation or re-establishment of land boundaries.

A pilot of the CSRS was developed to demonstrate the functionality of the proposed system, prove that functionality, identify available data items and determine the inquiries that could be made by the identified users. A working prototype was produced which has achieved this objective and was demonstrated at last year's conference.

The scope of the project is now to consider the following issues:

Survey Data Collection
- data format
- data content
- data structure

Survey Data Management
- data quality
- data integrity
- auditable editing

Survey Data Integration
- import/export to existing systems
- client data formats

At the completion of this project the Land Information Centre (LIC) will have the capability to build a database of cadastral surveys; construct and maintain a continuous parcel fabric from these surveys; as well as display and inquire upon the survey database and the continuous parcel fabric.

What Form for Digital Data Transfer?

To make use of existing survey office systems it was considered appropriate that the CSRS could be updated directly from the surveyors' own computer software. To do this it was considered necessary to create a Survey Data Transfer (SDT) mechanism. The SDT transfer being considered in the light of data format, content and structure.

When the project team sought a format that was acceptable to the clients and the international GIS community. The Spatial Data Transfer Standard (SDTS) was prepared by a world wide network of GIS experts to provide a solution to the problem of transferring the full range of spatial data. SDTS has now been accepted as an Australian and New Zealand standard (AS/NZS 4270).

The Survey Data Transfer (SDT) mechanism is compliant with Spatial Data Transfer Standard (SDTS). It adopted some of the SDTS strategies for data transfer. Included are the use of the existing data dictionary for cadastral information, data quality statements, the vector data profile and is based on the coding principles set out in ISO 8211 for digital transfer.

The SDT's design objectives are ease of use, readability, flexibility and extendability. The concepts of which are outlined below.

Ease of Use

The flexible nature of this data transfer format has been developed specifically for its ease of use for both data suppliers and users.

Readability

The transfer data format will be human readable. It is considered that any data transfer standard format must be able to be read by an uninitiated person. It should be possible to present transferred data in such a way that at any point it is possible to determine what the data items represent.

Flexibility

The data definition is in the file itself. This makes for a flexible survey data transfer mechanism as the fields can be changed at any stage. Field types are consequently user definable, fields are thus specified in each file set. Any number of items or field types can be added to the data, simply by adding a label and then matching data input values, enabling any superfluous fields to be discarded.

In the CSRS the flexibility of the SDT is highlighted by the use of aliases. For example fields stored in the CSRS as longitude and latitude are transferred in standard easting and northing format and translated to geographic coordinates.

Extendability

One of the major advantages of the SDT will be the ability to add new and vibrant field and record types to any data sets. As, no doubt, in the future other organisations will desire to make use of the SDT the ability of adding field types, not even yet contemplated, and extracting them will require no change or overhaul of the existing data structures.

Comparison of File Standards

The three file formats considered each had their own advantages and disadvantages. As a consequence a list of desirable features has been drawn up to compare the various pros and cons of the file formats. This list is reproduced below as a performance indicator of the three file format types.

The table below shows that most of the desirable features are to be found in the SDT file format. Two features which this format fails on are commercial availability and independent translators. This however is not seen as problem.

As the need for such files becomes evident the software industry will prepare products which will out of necessity be incorporated into their existing products. There will be little extra cost evident in these products to the end user.

	DXF	NCF	SDT
Simplicity of Structure	✓		✓
Ease of Use	✓		✓
Independence		✓	✓
Control of Standard		✓	✓
Flexibility			✓
Compactness	✓	✓	✓
Readability			✓
Provision for rigorous data cross-checks			✓
Data dictionary compliance			✓
ISO 8211 compliance			✓
Commercial Availability	✓		
Software translators	✓	✓	

Characteristics Of The Survey Data Transfer File

Record Types

Spatial data can have a number of characteristics, not all of which may be present for any particular entity. To ensure that these characteristics are faithfully transferred the survey data transfer (SDT) supports the concepts of record types. Each record type has a particular pre-defined behaviour.

In this version, the only record type to be implemented is the **generic** type. The generic record type simply loads record fields with the supplied data.

Whilst the flexibility exists for any user to define field names and record types, the CSRS has certain field and record names that need to be complied with to enable the smooth transition of information. This in no way limits the flexibility of users to transfer information between other sites, where they are free to use and define their own record and field names.

BASIC STRUCTURE

All data types transferred by the SDT are done so using exactly the same structure and format, whether that data is annotative or constructive. There are no record cards as presented in similar transfer files. The SDT is not hampered in the way other transfer files are by relics of the 1950s and 1960s card reading machines. The format is simple and straight forward:

1. **Key Words**

   Special commands for defining delimiters and special coding parameters.

2. **Data Definition**

   Statement of the record name followed by the field names (equivalent to ISO 8211 Data Descriptive Records (DDR)).

3. **Data Content**

   The actual data entered in accordance with the field definitions (equivalent to ISO 8211 Data Records (DR)).

SYNTAX

```
#Survey Dimension                                    # as a comment delimiter

FORMAT survey_dimension                              FORMAT as a keyword
{
from to bearing distance radius dimension_status fcode
}                                                    Whitespace acting as a field delimiter

RECORDS                                              RECORDS as a keyword

{                                                    { acting as an opening data delimiter
200,4,98:30:00,51.820,0,L
4,8,189:05:40,42.670,0,L                             EOL acting as a record delimiter
```

```
8,7,278:02:20,58.520,0,L
7,199,13:04:00,39.630,1819.660,L
199,200,56:07:00,5.405,0,L
4,6,98:30:00,48.430,0,L
}
```

} acting as a closing data delimiter

Delimiters

The Survey Data Transfer (SDT) makes use of delimiters to separate data elements and data fields. The default values are shown in the following table:

DELIMITER TYPE	DEFAULT
COMMENT_DELIMITER	#
RECORD_DELIMITER	EOL
FIELD_DELIMITER	White Space
DATA_DELIMITER	{ }

COMMENT_DELIMITER Allows the user to insert comments at any point in the file. Everything to the right of the comment delimiter up to the end of line (EOL) will not be extracted from the file by the receiving program. The comment delimiter can not be the EOL.

RECORD_DELIMITER Used to define the end of a data record. Even if the specified number of fields have not been read for a record, the record delimiter will cause the translator to start a new record.

FIELD_DELIMITER Used to define the end of the field.

If the default delimiter of whitespace is used and a field contains whitespace, the field value must be quoted with "double quotes".

"Double quotes" are not required if a non-whitespace field delimiter is used.

If, as in the example above, the EOL character is used as the record delimiter and the whitespace is used as the field delimiter, then the EOL character (usually a member of the whitespace set) acts exclusively as the record delimiter.

If the EOL character is used as a field delimiter then the fields of a record are entered on separate lines of the SDT file. Under these circumstances the record delimiter must be other than the EOL character or the whitespace.

DATA_DELIMITER Used to define the beginning and ending of data records. Any keywords that appear inside the data delimiters will be treated as input data.

Delimiter Redefinition

Sometimes the data may contain the default delimiter characters thus making it necessary to change them. The SDT provides a mechanism for doing this by allowing the user to redefine the delimiter values via a keyword statement. The general syntax is the delimiter keyword in upper case followed by a character. White space may be used to separate the keyword and the character. Only the first non-whitespace character after the keyword is considered, other characters up to the EOL are ignored.

For example, to redefine the comment delimiter from the default '#' to an '*' the following syntax is used:-

COMMENT_DELIMITER *

Data delimiters occur in pairs and the only supported character pairs are:- {}, [], (). Only one member of the pair is required in the data delimiter keyword definition. Supplying the other member of the pair has no effect. If a character other than one of those supported is supplied, the default will be used. An example of the use of the data delimiter definition is:-

DATA_DELIMITER (or DATA_DELIMITER ( )

Delimiters must be unique for each of the four types. If a user wishes to specify a delimiter value to be one of those which is a default for another delimiter type, then the other delimiter type must be redefined first. For example if the user wished to re-define the record delimiter to be a '#', they would need to re-define the comment delimiter to be something else first, ie:

COMMENT_DELIMITER ;
RECORD_DELIMITER #

Record Format Statement

The record format statement defines the record name and the fields that are contained within that record type. The general syntax is:-

```
FORMAT <record_name> {<field_name1> <field_name2> ...  <field_nameN>}
```

Where:-

FORMAT	: the keyword which should be written as shown.
<record_name>	: where the name of the record should be placed.
{	: the data delimiter
}	: the end of data delimiter
<field_1> to <field_n>	: the field names.

Valid characters for field and record names are to be [A-Z], [a-z], [0-9], and the underscore (_). A field, however, cannot start with an underscore. A new field will begin with the first valid character encountered inside the data delimiters { }. The field name will end with any non-valid field name character. A maximum length for field names is 256 characters.

Example use of the record format statement.

```
FORMAT survey_point {point_num easting northing elevation description}
```

or

```
FORMAT survey_point
{
point_num, easting, northing, elevation, description
}
```

or

```
FORMAT survey_point
{
point_num
easting northing elevation
description
}
```

Record Statements

The record statements define the actual data records. The general syntax is:-

```
RECORDS
{ <value_1,1> <value_1,2> ...  <value_1,n> <record_delimiter>
  <value_2,1> <value_2,2> ...  <value_2,n> <record_delimiter>
...
<value_m,1> <value_m,2> ...  <value_m,n>
}
```

Where:

RECORD:	: the keyword which should be written as shown
{	: the data delimiter
}	: the end data delimiter
<value_m,n>	: field value n for record value m.

When the field delimiter is whitespace, null values for field need to be treated differently.

Option 1: Use another field delimiter. Thus two field delimiters with nothing between indicates a null value. For example, if the field delimiter was a comma, then ,, would indicate a null value for a field.

Option 2: Use the word NULL as the field value. Null is not special to the translator and is treated as a normal data value. It will be passed to the receiving application which is then responsible for interpreting the null value.

NOTE: The system does not count the fields to find the end of a record but uses the record delimiter. Thus if one record does not have the correct number of fields the following records will not be affected.

Example use of the records statement in conjunction with the field_delimiter statement.

FIELD_DELIMITER,

```
RECORDS
{
1,363527.907, 1356198.845, O,PEG
2,363571.951, 1356127.115, O,DH & Ws
}
```

KEY WORDS

In the SDT certain reserved key words tell the translator what to expect next. These words are built in to the translator and have specific predefined functions as outlined in the table below:

KEY WORD	DESCRIPTION
FORMAT	Statement indicating information grouping of field names
RECORDS	Statement indicating data to be entered by the SDT
MODE	Indicates a change in default format for angles and dates
DATE	Indicates that the date mode is about to be changed
ANGLE	Indicates that the angle mode is about to be changed
FIELD_DELIMITER	Indicates that the field delimiter is to be changed
RECORD_DELIMITER	Indicates that the record delimiter is to be changed
COMMENT_DELIMITER	Indicates that the comment delimiter is to be changed
DATA_DELIMITER	Indicates that the data delimiter is to be changed

FIELD TYPES

The SDT will specify certain ANSI standard field types. This is necessary as data received through the translator will in certain instances require identification before being loaded. When data is loaded into a database or needed to be preprocessed it then becomes necessary to identify field types. For example, valid field types are:

CHAR	Alpha numerical character strings
DATE	An expression for date and time
NUMBER	A field for numeric transfer

The CHAR field in definition can contain up to 256 characters, however the field size is often limited in the SDT. Thus a character string could be limited to 40 characters - this would be presented in the specifications as CHAR(40).

The NUMBER numeric field can be broken down into separate components. If the field is presented in the same format as the CHAR(40) ie. NUMBER(10) implies that the field is an integer field. On the contrary, if the NUMBER field does not contain the string limiter then the number is assumed to be of the floating type variety.

It is possible when dealing with transfers for other applications than with the CSRS to define the field type. The default field type will be the CHAR(40) type. Otherwise the field type will be indicated by the field name and field type separated by a colon. For example if a field was to be created called azimuth and was to be defined as an angle the field name would be written as `azimuth:ang`.

The field types and the method for indicating them are shown in the table below. It is emphasised that when the SDT is used in relation to the CSRS or any other predefined database then set defaults are used and definition of field types becomes unnecessary.

FIELD TYPE	CODE	EXAMPLE
CHARACTER	char	`townplanner:char(40)`
DATE	date	`zoned_date:date`
INTEGER	int	`no_of_lots:int`
FLOATING POINT	flpt	`roadwidth:flpt`
ANGLE	ang	`heading:ang`

SDT - Requisite Standards

The American National Standard Code for information Interchange (ANSI) has yet to deal with certain data types which are required by the surveying community. The two which the SDT deals specifically with are "time" and "angle" types. As a consequence the SDT has been designed to accept a variety of input formats for these types using the MODE keyword command.

ANGLES

The SDT will accept three angle input formats, the commands being:

COMMAND	STYLE	INPUT FORMAT
ANGLE MODE DMS	118°13'21.38"	118:13:21.38
ANGLE MODE DEG	118.222606	118.222606
ANGLE MODE RAD	2.063374	2.063374

The SDT default is ANGLE MODE DMS and entered as DDD:MM:SS.ss

If the mode changes in the input of the data then the MODE statement can be inserted between the FORMAT statement and the RECORDS statement of the SDT. If, for example, the text angle is provided in radians then the statement would be made:

```
* Parcels

FORMAT parcel
{
lot_no section_no legal_area EASTING NORTHING elevation text_angle
parcel_descript
}

ANGLE MODE RAD

RECORDS
{
100,0,2442.0,282173.0273,1226440.4460,0,3.141593
101,0,10000,282183.7920,1226384.5245,0,3.141593
}
```

DATE/TIME

The standard date mechanism for computer systems produces an output as:

YYYY:MM:DD HH:MM:SS

The default for the SDT will be:

YYYY:MM:DD eg. 1995:01:29

To change this format the MODE statement can be used, for example:

DATE MODE DD/MM/YY HH/MM/SS.SS

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