A SURVEY OF STANDARDS FOR THE EXCHANGE OF DIGITAL GEO-REFERENCED INFORMATION

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ABSTRACT

A number of countries and international organizations are developing standards for the exchange of digital geographically referenced information. This paper provides a survey of some of these standards and highlights the problems associated with moves towards establishing a single, international standard for the exchange of digital geo-referenced information.

INTRODUCTION

This paper is a survey of some of the standards developed for the exchange of digital geographically referenced (geo-referenced) information, in particular, those for North America, the International Hydrographic Organization and South Africa. Similar standards have been, and are being, developed in other countries, so this survey is not comprehensive.

Geo-referenced information consists of all information referring to the human-environment system and which can be localized in space and time. Exchanging digital geo-referenced information is complex, due to the divergent nature of geo-referenced information (for example, topographical, cadastral, hydrographical, geological and social statistical information), the various forms of the digital data (vector, raster and non-spatial, as well as the topological and other relationships within the data), the disparity with which different users and systems view the data and the sheer volume of data involved. For more details on the nature of, and problems associated with digital geo-referenced information and the exchange thereof, see Clarke et al (1987).

NORTH AMERICA

The Development of the American Standard

In January 1982 the National Committee for Digital Cartographic Data Standards (NCDCDS) was formed under the auspices of the American Congress on Surveying and Mapping (ACSM), in response to a formal request for proposals issued by the United States Geological Survey (USGS) (DCDSTF, 1988). The NCDCDS consisted of a steering committee and four working groups, which investigated:

- Data Organization;
- Data Quality;
- Cartographic Features; and
- Terms and Definitions. This fourth working group was disbanded in 1985 as it was felt that terms and definitions should be investigated within context by the remaining three working groups.

Up to May 1987 NCDCDS produced nine reports, all entitled 'Issues in digital cartographic data standards'. Perhaps the most important of these are reports number six (Moellering, 1985), which presents their interim proposed standard and contains an excellent discussion on data quality; number seven (Moellering, 1986), which describes the testing of the standard and contains examples of comprehensive reports on data quality, their interim proposed standard feature and attribute definitions; and number eight (Moellering, 1987) which was their final proposal.

The NCDCDS's most significant contributions were in identifying the issues that such exchange standards should address and in providing a comprehensive model for data quality (albeit not a quantifiable and encodable one). The NCDCDS also provided a comprehensive list of features and attributes, with their definitions and their alternative names (aliases, or as they prefer, included

terms) — 200 different features, with 1 134 alternative names and 301 attributes.

In April 1983 the Federal Interagency Coordinating Committee on Digital Cartography (FICCDC) was created by the Office of Management and Budget to eliminate duplication and waste in the development of Federal digital cartographic data bases and to coordinate digital cartographic activities within the Federal government in the United States of America. The FICCDC formed a Standards Working Group (SWG) to develop digital cartographic data standards within the Federal Government. A data exchange format was identified as the SWG's first priority, followed by common standards for the content and accuracy of Federal digital cartographic data bases (DCDSTF, 1988).

The SWG worked in parallel with the NCDCDS and there was cooperation between the two groups — in fact, some members served on both. Their proposed standard was called the Federal Geographic Exchange Format (FICCDC, 1986).

In March 1987 the Digital Cartographic Data Standards Task Force (DCDSTF) was formed by the USGS to resolve the differences and merge the draft proposed standards of the NCDCDS and SWG of the FICCDC (DCDSTF, 1988). This was done, and in January 1988 the Proposed Standard for Digital Cartographic Data was released (DCDSTF, 1988). The proposed standard is known as the Spatial Data Transfer Specification (SDTS) and it resembles closely the NCDCDS proposal.

Once the standard has been tested stringently, it will be submitted to the American National Bureau of Standards as a possible Federal Information Processing Standard (FIPS) publication.

The Structure Of The American Standard

The Spatial Data Transfer Specification (SDTS) is designed to cater for digital cartographic data. It uses ISO 8211 (ISO, 1985) as the base for the transfer of data — the data are organized according to SDTS and encoded according to ISO 8211. The standard has a comprehensive and well defined classification and attribute scheme, which is confined to those features found on general nautical charts and topographical maps. The user may use additional feature classes, as long as they are defined in the data dictionary. The classification is of the linear list type and the attributes are defined across all feature classes.

The standard caters for a wide range of spatial attributes (termed cartographic objects) and the topologies of adjacency (left and right areas on chains), coincidence (spatial attributes shared by more than one feature) and exclusion (regions wholly contained by area features, but not forming a part of that feature).

The standard allows data sets to extend over multiple volumes. The standard also allows the use of either a relational or hierarchical form for exchanging vector data and has a form for exchanging raster data.

INTERNATIONAL HYDROGRAPHIC ORGANIZATION

The Development Of The IHO Standard

In 1983 the International Hydrographic Organization (IHO) created the Committee on the Exchange of Digital Data (CEDD). Its 15 member countries were: Australia, Canada, Cuba, France, Germany, Greece, India, Italy, Japan, New Zealand, South Africa, Spain, United Kingdom, United States of America (as the chairman) and Yugoslavia. The task of creating the standard was delegated to the North American Work Group (NAWG), which consisted of delegates from various organizations in Canada and the United States (CEDD, 1986a).

The most critical problem that the CEDD had to face was the disparate levels of sophistication of the intended user countries. The most sophisticated required full topology and the ability to perform real time updates of the electronic chart, while the most naive required a graphics standard — they would merely reproduce the paper chart from the data, and not perform any analysis on the data.

During the third quarter of 1985, NAWG distributed a test data set of their proposed format. At the next CEDD meeting on 9 December 1985, only South Africa was able to produce a chart plotted from the data, one that had been produced at the Centre for Advanced Computing and Decision Support. This dispelled the doubts of the CEDD that the proposed format might be too complex for the smaller hydrographic offices to handle (CEDD, 1986a).

The proposed format of the CEDD (CEDD, 1986b) was released in November 1986.

The Structure Of The IHO Standard

The IHO standard, the Format for the Exchange of Digital Hydrographic Data, is designed to cater for hydrographic information. It has a fixed format throughout. When a field has no value, blanks are inserted. Attribute values have fixed positions (placements) within the attribute lists of the features. However, the fixed placement is different for each feature class. Most of the attributes have enumerated values (numeric codes representing fixed textual descriptions). The values of numeric attributes are either restricted to 999 values, or have enumerated values representing ranges.

A fixed, three level hierarchy is used for the classification. The standard has a comprehensive list of features, attributes and attribute values—the Feature Attribute Coding Standard (FACS). For obvious reasons, the classification is confined generally to those features found on nautical charts. No definitions of the features or attributes are given in the lists.

The standard allows for encoding information on the quality of the data, and for encoding global information. It also caters for both spaghetti data and 'chain-node' data (data with topology), and chart-dependent and -independent data. The topology they cater for is that of shared segments. In the standard, there is an explanation of the advantages of using chain-node data.

The standard does not cater for multi-reel volumes (data sets on more than one magnetic tape).

The standard caters for vector data but not raster data.

SOUTH AFRICA

The Development Of The South African Standard

In April 1986 a joint project was established by the Centre for Advanced Computing and Decision Support of CSIR and the Chief Directorate of Surveys and Mapping (CDSM) to draw up proposals for a national standard for the exchange of digital geo-referenced information. The project was funded mainly by the National Programme for Remote Sensing (NPRS) of CSIR's Foundation for Research Development (Cooper, 1988).

In March 1987 a draft exchange standard (Clarke et al, 1987a) was distributed for comment and in September 1987 the project terminated when the final version of the standard (Clarke et al, 1987b) was released to the public. The project team recommended that the NPRS ask the chairman of the State Inter-departmental Coordinating Committee for Land Information Systems to establish a sub-committee to maintain and coordinate the use of the exchange standard (Clarke et al, 1987c). The National Exchange Standard Committee (NESC) was established early in 1988.

The maintenance committee has prepared a questionnaire (NESC, 1988) on the availability of digital geo-referenced information in South Africa, and is in the process of correcting and updating the exchange standard. The second edition of the standard will be published by NESC in two volumes (the standard itself and a user manual), during 1989.

The exchange standard has been favourably reviewed in the International Journal of Geographical Information Systems (Lane, 1988).

The Structure Of The South African Standard

The South African standard for the exchange of digital geo-referenced information attempts to cater for *all* forms of geo-referenced information, and not just cadastral or topographic information. It is based on a relational model, which allows it to be modular and thus easy to expand to cater for new concepts. In addition, when creating a data set for exchange, a user need only use those parts of the standard that are relevant for the data being exchanged.

The standard has a free format and allows for the use of binary or ASCII data, and of delimiters between fields or explicit field lengths for each field.

The standard includes an incomplete list of features and attributes. No definitions of the features or attributes are given. A variable-level hierarchy is used for the classification, though any classification or attribute scheme may be used with the standard. A mechanism is provided for exchanging the definition and structure of a classification scheme and/or attribute scheme within the set of data being exchanged.

The standard allows information on the quality of the data to be exchanged as free text embedded within the data.

The standard caters for node, chain, arc, region and matrix spatial attributes, and point, line, area

and raster features, as well as compound features, which are those that consist of other features. It caters explicitly for the topologies of coincidence and exclusion. Adjacency is conveyed implicitly by regions sharing a common chain.

While the standard is meant to be used on any physical exchange medium, only the use of nine-track magnetic tape is described. The standard allows data sets to extend over many volumes (tapes).

The standard caters for both vector and raster data.

CONCLUSIONS

A number of countries and international organizations have prepared standards for the exchange of digital geo-referenced information, and more are in the process of development. To date, no standard is tested fully and accepted widely by its target community. However, this should change in the short term. Only after such standards are accepted and all the relevant issues understood and addressed, can one look forward to a single, international standard for the exchange of digital geo-referenced information.

The International Cartographic Association (ICA) has established a Working Group on Digital Cartographic Data Exchange Standards. Its initial goals include:

- the exchange of information and reports by ICA member countries concerning the development of digital cartographic data exchange standards;
- the collection and distribution with the Working Group copies of all standards published in ICA countries;
- that of serving as a focal point of information concerning digital cartographic data exchange developments throughout the world, and
- identifying research needs that arise from the standards process (H. Moellering, personal communication, 1989).

Significantly, the Working Group's initial goals do not include the drafting of a single, international standard.

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