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## NEW TRENDS IN TECHNOLOGY, AND THEIR APPLICATIONS: DIGITAL DATABASES, GEOGRAPHICAL AND LAND INFORMATION SYSTEMS

## Implementing the Spatial Data Transfer Standard

Paper submitted by the United States of America**

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** Prepared by Kathryn C. Wortman, U.S. Geological Survey.

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**INTRODUCTION**

Recent advances in geographic information system (GIS) technology and digital cartography have increased the demand for digital spatial data. Unfortunately, the diversity of existing hardware and software and the lack of data exchange standards have inhibited the transfer of spatial data between data producers and data users. The Spatial Data Transfer Standard (SDTS), or Federal Information Processing Standard (FIPS) 173, was designed to facilitate data transfer between dissimilar spatial data bases. Implementation of the SDTS will increase access to and sharing of spatial data, will reduce the cost of developing data bases, and will improve the quality and integrity of spatial data and related documentation. In addition, the SDTS will reduce duplication of effort in data production and maintenance and will make a national spatial data infrastructure feasible.

**STATUS**

In April 1991, after nearly 10 years of development and testing, the SDTS was issued by the National Institute for Standards and Technology (NIST) as a proposed FIPS. Following a 90-day formal public review and comment period, the Technical Review Board (TRB) overseeing the development of the SDTS met to review the comments. The document was then edited according to decisions made by the TRB. The edited SDTS was sent to the Department of Commerce for processing as a FIPS in February 1992; approval was granted on July 29, 1992. The SDTS implementation was effective February 15, 1993; use of the standard was mandatory for Federal agencies 1 year from this date -- February 15, 1994.

The SDTS, or FIPS 173, will serve as the spatial data transfer mechanism for all Federal agencies and will be available for use by State and local governments, the private sector, and research and academic organizations. The success of any standard, such as the SDTS, depends on its acceptance by the user community. Therefore, the U.S. Geological Survey (USGS), as the designated SDTS maintenance authority, is committed to providing support to the greatest extent possible to increase access to and use of the standard.

**SUPPORT FOR USE OF SDTS**

The USGS has identified several activities to promote acceptance and use of the SDTS. An SDTS Task Force was established to coordinate these activities within the USGS and throughout the spatial data community. These activities include: overall program coordination, NIST support, profile development, software development, training, education, and marketing activities, and SDTS Spatial Features Register development.

**Program Coordination**

Program coordination involves developing support activities within the USGS, facilitating similar activities outside the USGS, and interfacing with related standards development activities in the spatial data community, both nationally and internationally. The USGS is actively working with the Federal community, through the Federal Geographic Data Committee (FGDC), to foster

support for SDTS implementation. Coordination with the FGDC working groups and subcommittees is focused on such activities as profile development, metadata definition, and feature and attribute data dictionary definition. The USGS is also working with many professional societies (e.g., Association of American Geographers (AAG), American Congress on Surveying and Mapping (ACSM), Automated Mapping/Facilities Management (AM/FM), American Society for Photogrammetry and Remote Sensing (ASPRS), the Institute for Land Information (ILI), and the Urban and Regional Information Systems Association (URISA)), the National Academy of Sciences Mapping Sciences Committee, and research organizations to encourage use of the SDTS for data exchange. Special interest groups, such as the Intelligent Vehicle Highway Systems America, are working with the USGS to define strategies to implement the SDTS within their systems and throughout their user community. The USGS is also supporting the U.S. Army Corps of Engineers Construction Engineering Research Laboratory in developing an SDTS interface to the Geographic Resources Analysis Support System (GRASS). The GRASS is a GIS that is used by a variety of public and private agencies. Lastly, many States are actively involved in GIS standardization activities, including the implementation of the SDTS as the mechanism for data exchange, standardizing data documentation, and standardizing feature and attribute terms and definitions.

The USGS is coordinating with other data standardization activities in the United States, most notably within the Defense Department, the National Ocean Service (NOS) within the National Oceanic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA). The Defense Department's Defense Mapping Agency (DMA) represents the United States on the Digital Geographic Information Working Group (DGIWG), an ad-hoc group made up of member countries from the North Atlantic Treaty Organization (NATO). NATO adopts the DGIWG standards recommendations. The DGIWG recently developed the Digital Geographic Information Exchange Standard (DIGEST) for its user community. NOS supports the use the of DX-90 standard for International Hydrographic Organization data applications. NASA supports the use of the Hierarchical Data Format (HDF) as the exchange format for the products to be created by the Earth Observing System Data and Information System program. The USGS is involved in efforts with the DMA, NOS, and NASA to harmonize the SDTS with the DIGEST, the DX-90, and the HDF, respectively, to ensure compatibility between these standards.

**NIST Support**

This activity is required for the continued maintenance and growth of the SDTS. When the SDTS was approved as a FIPS, it entered a 5-year maintenance cycle, at the end of which it will be possible to modify the standard to meet the changing demands of the user community. Because of its modular design, the SDTS can be changed and expanded as the requirements for its use change. Also, the American National Standards Institute (ANSI) recently formed a GIS Technical Committee, known as X3L1. X3L1 will work to adopt the SDTS as an ANSI standard. The ANSI approval of the SDTS will broaden acceptance and use of the standard within the United States and will serve to represent the SDTS in international standardization activities, most notably within the International Standards Organization (ISO).

**Profile Development**

The development of profiles is a key element for the successful implementation of the SDTS. A profile is a clearly defined and limited subset of the standard that is designed for use with a specific type of data. The SDTS contains a full range of capabilities and options designed to handle a wide spectrum of possible geographic and cartographic data structures and content. Because handling this range of options is such a difficult task for encoding and decoding software, the best way to implement the SDTS is to first define a profile with few, if any, options. Software can then be designed to handle just these options. Regardless of which options are specified for a given profile, all profiles will share important common characteristics, particularly in terms of global information or metadata, and physical file encapsulation methods.

The USGS is coordinating the development of profiles with the user community to ensure maximum consistency among all SDTS profiles. The first of these profiles, the Topological Vector Profile (TVP), was tested and reviewed in 1992 to ensure that it supported vector data with planar graph topology. This profile was submitted to the NIST in early 1993 for approval as an amendment to the SDTS; the TVP will be issued as part 4 of the SDTS effective February 15, 1994. At this time, USGS digital line graph (DLG) data will be available from the National Digital Cartographic Data Base in the TVP.

Additional vector profiles are being addressed, such as one for network-only topological data sets useful in transportation and utility systems and one for site and location data sets useful in geology, mining, and exploration systems. The TVP will provide the foundation for future vector profile development; changes will be incorporated when necessary to support the required data structures.

The development of a raster profile began late in 1992; this effort is expected to continue through mid-1994. An official test and demonstration period (June to November 1993) produced an approved core raster profile for the SDTS. The USGS has made an uncompressed digital orthophoto quarter-quad (DOQ) available in the prototype SDTS raster profile. The USGS also plans to make available digital elevation model (DEM), compressed digital orthophoto quad (DOQ), and advanced very high resolution radiometer (AVHRR) data sets in the prototype SDTS raster profile to support additional testing. This raster profile will be completed and forwarded to the NIST for approval as part 5 of the SDTS by mid-1994.

Although this core raster profile developed thus far can support a variety of data sets, additional raster data requirements in the areas of n-dimensional arrays, raster compression, spatial referencing, and color indexing are being addressed and will ultimately expand this core raster profile. These additional requirements will enhance the capabilities of the core raster profile to support the large number of satellite data produced by NASA and NOAA, which are vital for global change research projects supporting environmental monitoring. The raster profile has the potential to support and make a large amount of valuable global spatial data available to a wide range of users.

**Software Development**

The development of software is an integral part of implementation. Software tools, such as encoding, decoding, and display tools, must be developed. The vendor community will assume a large part of this responsibility. The USGS is designing a spatial data transfer processor to support SDTS exchanges of its own digital spatial data, such as DLG's, DEM's, and DOQ's. The USGS has also developed public domain software tools, known as the FIPS 123 Software Library, designed to support the encoding and decoding of logically compliant SDTS data in and out of the required ISO 8211/FIPS 123 physical file implementation. This software is available to the vendor community to support their development of turnkey systems that import and export SDTS data.

The USGS is working with the NIST to define and implement a conformance testing, or certification, program. As part of this activity, the USGS will develop software tools and test data to validate a system's capability to either encode or decode SDTS data sets, based on one of the approved profiles. The USGS and the NIST will work to define a conformance testing plan for each SDTS profile. Each plan will identify test points (what is to be tested) and procedures (how it is to be tested). Test plans, software, and data sets will be made available to vendors so that they may pre-test their translators during system development. Upon request, vendors can have their systems formally tested for SDTS conformance. Systems that pass conformance testing will receive NIST certification.

**Training, Education, and Marketing Activities**

Training, education and marketing activities are needed to increase the knowledge and understanding of the SDTS within the community. The SDTS is a technical specification describing content, structure, and format; it is not an easy document to understand. To address the complexity of the document, user guides are being developed for the standard, the profiles, and the software tools. The USGS will coordinate the development of these user guides over the next few years. In addition, the USGS is developing other training aids, such as PC-based training tutorials and educational video tapes.

Education of the spatial data community and promotion of the SDTS will continue to be supported by the USGS through workshops and other presentations. Presentations on the SDTS and associated activities are planned for the major professional organizations, such as the AAG, the ACSM, the ASPRS, AM/FM International, the ILI, and the URISA. In addition, the USGS, the NIST, and the Standards Working Group of the FGDC plan to sponsor workshops to provide detailed information about the standard and implementation strategies.

**Spatial Features Register**

One part of the SDTS presents a standard model for a spatial features data dictionary, as well as a glossary of terms and definitions for entities and attributes. This entity and attribute glossary provides a foundation for standardizing spatial features. The glossary now contains only a limited set of hydrographic and topographic features. Because this glossary is not complete, conformance is optional in the prototype TVP; however, conformance to the model is mandatory. For the glossary of SDTS to be useful, additional

terms and definitions must be included for other categories of data, such as cadastral, geodetic, and geologic, and the set of hydrographic and topographic features must be expanded. The NIST authorized the USGS to establish an SDTS Spatial Features Register to expand the content of this glossary. The Federal community will contribute information for this register through the data category subcommittees of the FGDC; however, the USGS intends to solicit information from the non-Federal spatial data community as well. A plan to maintain the Spatial Features Register is being developed. Because the register will allow users to update the glossary continuously, this part of the SDTS will evolve over time.

**CONCLUSION**

The Department of Commerce's approval of the SDTS as a FIPS is a major milestone for the spatial data community. Although the USGS is committed to coordinating a wide range of activities designed to promote acceptance of the SDTS, all members of this community must contribute to these efforts to ensure success of the standard. For additional information concerning the SDTS, or FIPS 173, or how to participate in these activities, please contact:

SDTS Task Force
U.S. Geological Survey
526 National Center
Reston, VA 22092
FAX: (703) 648-5542
E-MAIL: sdts@usgs.gov

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