# THE SPATIAL DATA TRANSFER STANDARD

## Guide for Technical Managers

*A concise, comprehensive guide to the SDTS for technical managers in spatial data user organizations and software development groups involved in SDTS use or implementation*

Prepared under direction of the Federal Systems Integration and Management Center and the SDTS Task Force

SDTS
Spatial Data Transfer Standard

# Contents

# Acknowledgments

This document has been prepared, under contract, by PlanGraphics, Inc., in association with PRC, Inc. Work has been carried out under the direction of the Federal Systems Management and Integration Center (FEDSIM) and staff of the SDTS Task Force of the U.S. Geological Survey (USGS).

FEDSIM would like to acknowledge the following individuals who played an important role in the preparation of this document:

Project Team:

- Peter L. Croswell, PlanGraphics, Inc.
- Angela Jennings, PlanGraphics, Inc.
- Woodson Smith, PlanGraphics, Inc.
- Pat Edelen, PlanGraphics, Inc.
- Richard Hogan, USGS
- Robin Fegeas, USGS
- Bill Hill, USGS
- William Tolar, USGS
- J. B. Hanson, USGS
- Janette Cascio, USGS
- John Szemraj, USGS
- Bill Janssen, PRC
- Chris Wren, FEDSIM Project Manager

Peer Reviewers:

- Phyllis Altheide, USGS
- Kevin Backe, U.S. Army Topographic Engineering Center
- Michael Bauer, American Digital Cartography
- Penny Capps, U.S. Army Corps of Engineers
- David Edwards, Clark County, Nevada
- Barbara Frey, U.S. Bureau of Census
- Chuck Gross, NOAA
- Bill Johnson, New York State Department of Transportation
- Gary Kuell, NOAA Coastal Services Center
- Roger Livingston, Washington County, Oregon
- David Schaub, GTAC, MRJ Inc.

# Preface: Using This Guide

## Overview

This handbook provides a technical explanation of the Spatial Data Transfer Standard (SDTS) and offers information of value to technically oriented individuals who will be implementing SDTS. The materials in this handbook and its appendices are designed to summarize important SDTS topics and to augment the SDTS specification itself.

For more effective use of this handbook, please note that italicized words are defined in the Glossary at the end of this guide.

## Intended Audience

This guide will help you if you are:

- In a **management position in a federal agency** in charge of implementing the federal SDTS mandate (FIPS 173), or if you are involved in furthering your agency's role in managing, collecting, or dispersing spatial data.
- A **department or division manager in a data creator or user organization** that will or may use SDTS as a means for accepting spatial data from outside organizations, or for distributing data to other groups.
- A **Geographic Information System (GIS) or Automated Mapping System (AM) manager** in any organization.
- A **technical manager in a software company** that will be developing software for SDTS implementation.
- A **technical staff person who requires an overview** of the organization, content, and format of SDTS.
- A **senior or non-technical manager who would like to gain a more detailed understanding** of SDTS, beyond that which is provided in the *Senior Management Overview* document.

This guide is meant to provide a solid understanding of the format, content, and status of the SDTS so that it may be used wisely. It assumes that the reader understands the nature of spatial data and is familiar with GIS and database software used to manage the data. This guide is not intended to provide technical information required for the development of SDTS translation software or profiles—that is the role of a companion document, the *SDTS Handbook for Technical Staff*.

# Introduction

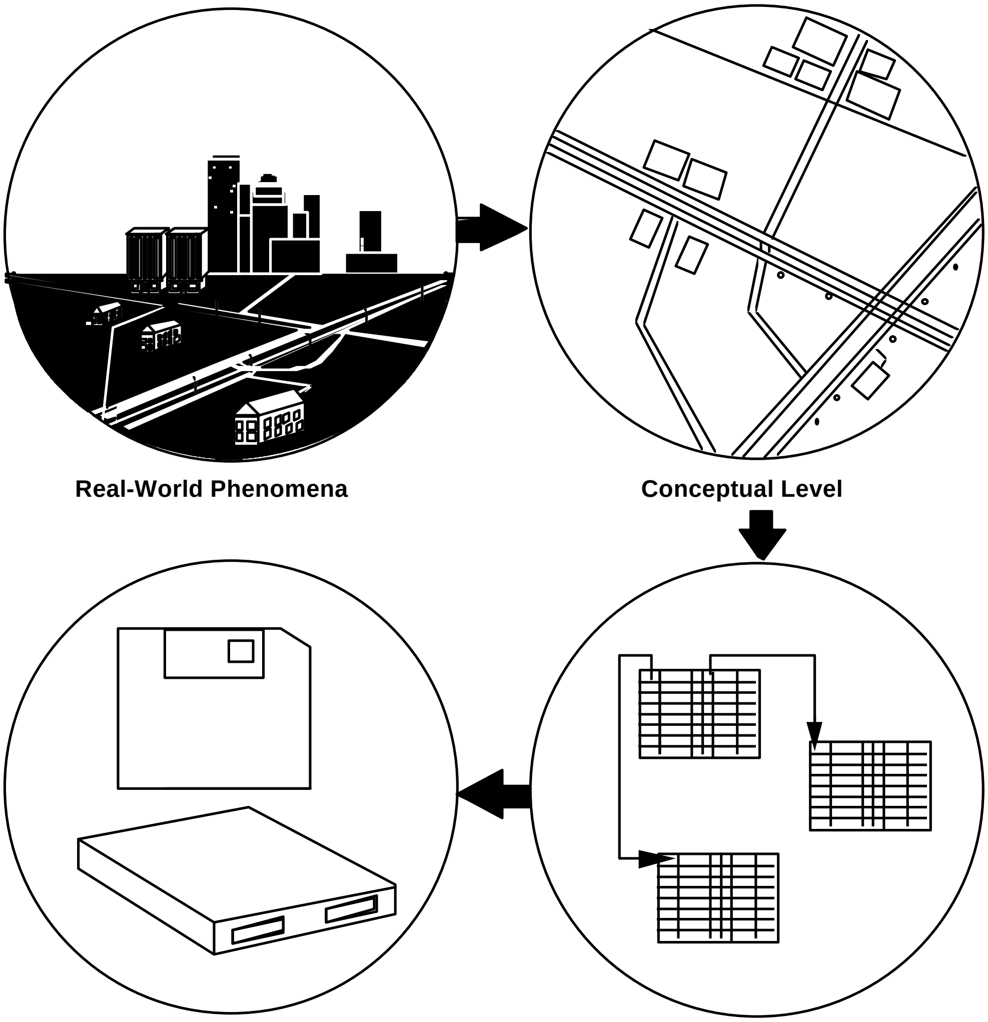
## What is SDTS?

The Spatial Data Transfer Standard (SDTS) provides a practical and effective vehicle for the exchange of spatial data between different computing platforms. It is designed specifically as a format for the **transfer** of spatial data—not for direct use of the data. By addressing all aspects of spatial data, SDTS is comprehensive in nature—effectively avoiding pitfalls of other transfer formats that have been used in the past. After years of development and testing, SDTS is now ready for use.

SDTS was ratified by the National Institute of Standards and Technology (NIST) as a Federal Information Processing Standard (FIPS 173) in 1992. Compliance with FIPS 173 by federal agencies became mandatory in 1994. Many federal agencies, most notably the U.S. Geological Survey (USGS), U.S. Census Bureau, and Army Corps of Engineers, are producing and distributing spatial data in SDTS format.

As described in more detail in this guide, the full SDTS specification creates a framework for spatial data transfer by defining different "levels," from the real world to the physical encoding of the data (see Figure 1). The **conceptual level** describes a way to represent real-world entities, including their geometric and topological characteristics and relationships. The **logical level** presents a data model for identifying and encoding information for an SDTS transfer. SDTS also defines the **physical level** with rules and specific formats for encoding data on a medium of choice (e.g., magnetic tape).

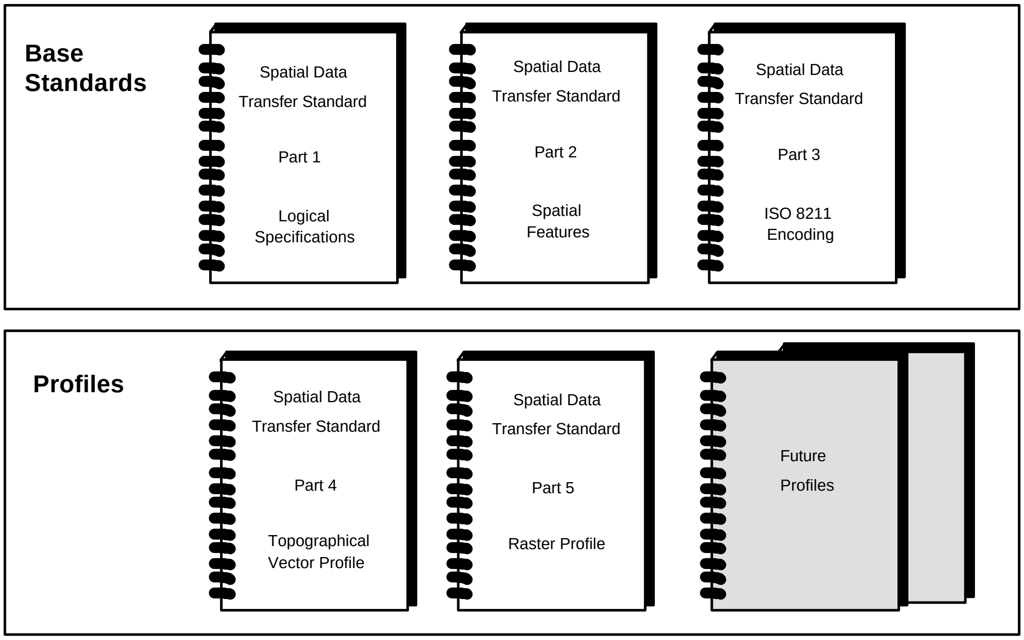
**Figure 1: Foundation for SDTS Transfer**




## Overview of the Content and Format of SDTS

The SDTS specification currently consists of five parts. They describe the underlying conceptual model explained above, and they specify in detail how spatial data should be structured for exchange with any system for which translation software has been developed. As shown in Figure 2, the SDTS specification is organized into the *base specification* and multiple profiles, each of which defines specific rules and formats for applying SDTS to the exchange of particular types of data. The base specification and the current profiles—the *Topological Vector Profile* (TVP) and the *Raster Profile* (RP)—address all elements of spatial data transfer.

**Figure 2: SDTS Specification Format**




Each part is summarized below.

**Part 1—Logical Specifications**
Part 1 consists of three main sections which explain the SDTS conceptual model and SDTS spatial object types, components of a data quality report, and the layout of SDTS modules that contain all needed information for a spatial data transfer compliant with SDTS. This part of SDTS addresses the conceptual and logical levels shown in Figure 1.

**Part 2—Spatial Features**
Part 2 of SDTS further addresses the logical level of Figure 1. It contains a catalogue of spatial features and associated attributes. This part addresses a need for definition of common spatial feature terms to ensure greater compatibility in data transfers. The current version of Part 2 is limited to small- and medium-scale spatial features commonly used on topographic quadrangle maps and hydrographic charts.

**Part 3—ISO 8211 Encoding**
This part of SDTS addresses the physical level of Figure 1. It explains the use of an international standard for physical data encoding (ISO 8211, also known as FIPS 123) to transfer SDTS on a physical medium (e.g., disk) or through communication lines.

**Part 4—Topological Vector Profile**
The *Topological Vector Profile* (TVP) is the first of a potential series of SDTS profiles, each of which define how the SDTS *base specification* (Parts 1, 2, and 3) must be implemented for a particular type of data. The TVP limits options and identifies specific

requirements for SDTS transfers of data sets consisting of topologically structured area and linear spatial features.

**Part 5—Raster Profile**

The *Raster Profile* presents requirements for the formatting and transfer of data in raster or gridded form. A final draft of the Raster Profile is complete, but formal approval under FIPS 173 has not yet occurred.

# Benefits of SDTS

## Need for an Improved Spatial Data Transfer Mechanism

Spatial data has been recognized as critical to the operation of most government agencies and many private companies.

The need for increased sharing of spatial information was the reason for the creation of the Federal Geographic Data Committee (FGDC), a coordinating body with representation from all federal agencies that are significant generators or users of spatial data.

More recently, the need for a national program of spatial data sharing with participation from governments at all levels and the private sector resulted in the 1994 Executive Order establishing the National Spatial Data Infrastructure (NSDI) program.

Greater sharing of spatial data makes sense because it encourages

- Consistency in data generation and use
- Reduction in redundancy in data compilation
- Re-use of previously generated data.

It has been estimated that federal agencies spend more than $4 billion annually in the collection and generation of spatial data. This amount may be multiplied many times when the activities of state and local governments, utility companies, and many other spatial data generating organizations are taken into account. SDTS is a mechanism that can ensure better use of this spatial data and help to eliminate the costs of redundant data generation.

## Challenges in Spatial Data Exchange

As illustrated in Figure 3, many characteristics of spatial databases must be taken into account in a fully effective transfer process:

- *Geographic information system* and *automated mapping* software packages use different **proprietary structures** for storing graphic data. As a result, batch restructuring of data is necessary if it is transferred to and used with another software package.

- Spatial databases represent *spatial features* in terms of their *geometry* (graphic representation) as well as their **topological relationships**, which explicitly define the connectivity and adjacency of features.

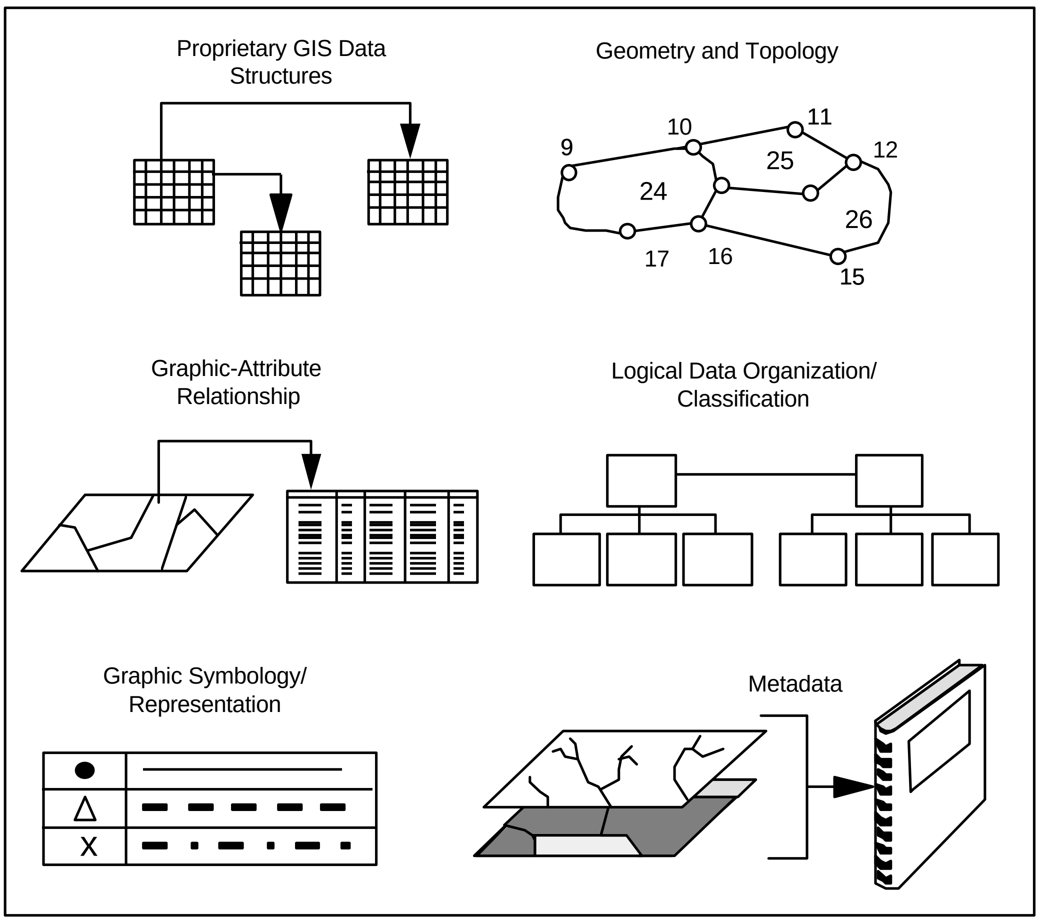
- Spatial databases store not only the graphic representations of features but **non-graphic attributes** associated with those features. These attributes should be included in a data transfer and their link with specific *spatial features* should be maintained.

- Spatial databases are built using specific approaches for **grouping and classifying** *spatial features* and attributes.

- GISs and *automated mapping* software packages allow for the selection of specific symbology (e.g., line styles, point symbols) for the **graphic display of spatial features**

- It is becoming a standard practice of GIS user organizations to build and maintain metadatabases that contain information about the content, quality, and characteristics of a spatial database.

**Figure 3: Fundamental Issues in Spatial Data Transfer**

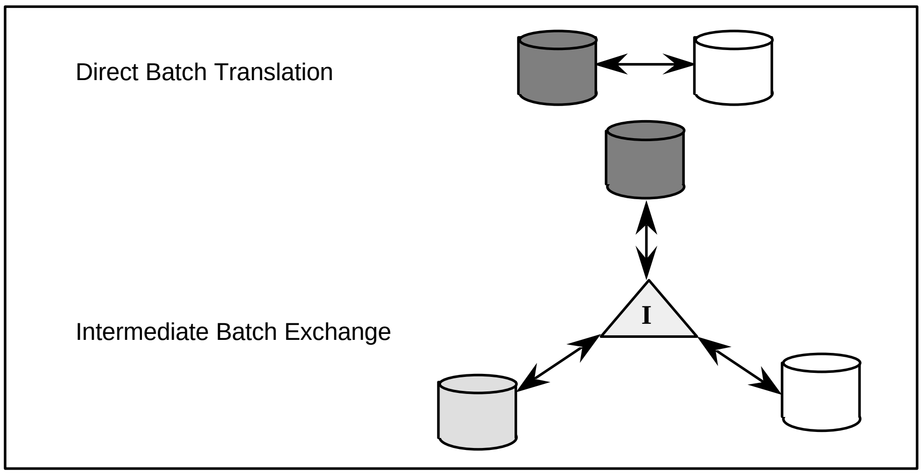


A complete and fully effective spatial data transfer mechanism should provide for the encoding and exchange of all of these characteristics and components of spatial databases among disparate computing platforms. SDTS has been designed to accomplish this goal without loss or corruption of data in the transfer process.

### Approaches to Spatial Data Transfer

Two basic approaches, illustrated in Figure 4, have been used to exchange spatial data between different computer systems. The data may be translated from its initial system format to the destination system format directly, **or** an intermediate exchange format may be used.

**Figure 4: Approaches to Exchanging Spatial Data**




While direct translation may be useful in some cases, the intermediate exchange approach, which SDTS supports, is much more efficient. It reduces software development costs, since only one set of encoding and decoding software is necessary. At the same time, maintenance of translation software also becomes simpler, since only one set of changes must be made when vendor software or data structures are revised.

# SDTS—Its Past, Present, and Future

## SDTS Development Timeline

A brief timeline of major SDTS milestones is presented in Figure 5. This timeline shows that the development of SDTS dates to the 1982 formation of the National Committee for Digital Cartographic Data Standards (NCDCDS) sponsored by the American Congress on Surveying and Mapping (ACSM). SDTS development received a boost in 1983 with the formation of the Federal Interagency Coordinating

Committee on Digital Cartography (FICCDC) with a goal of setting standards and encouraging greater sharing of spatial data among federal agencies.

Since 1982, many experts from government, academic institutions, and the private sector have participated in SDTS development. Detailed preparation began in 1987 with the creation of the Digital Cartographic Data Standards Task Force (DCDSTF). This group, which was led by USGS, included many individuals and organizations. In 1988, a specification, “Proposed Standards on Digital Cartographic Data,” was completed by the DCDSTF. This specification was the basis for SDTS. SDTS development and support have been coordinated by the SDTS Task Force in the National Mapping Division of USGS. Many years of work have culminated in a sound and practical vehicle for the transfer of spatial data.

**Figure 5: Important Dates in SDTS Development**

| | Milestone | SDTS Development Phase |
|---|---|---|
| 1982 | NCDCDS Formed | **Building the Foundation** |
| 1983 | FICCDC Formed | |
| 1987 | DCDSTF Formed | |
| 1988 | Proposed Standards on Digital Cartographic Data | **Base Standards Development/ Approval** |
| 1990 | Draft SDTS | |
| 1991 | SDTS Submitted to NIST | |
| 1992 | Base SDTS Approved as FIPS 173 | |
| 1993 | SDTS TVP Approved for FIPS 173 | **Refinement/ Profile Development** |
| 1994 | Mandatory SDTS Compliance by Federal Agencies | |
| 1995 | SDTS Draft Raster Profile Prepared | |
| | • Program Coordination | |
| | • Industry Adoption | |
| | • Certification | |
| | • Continued Refinement/Profile Development | |

## Future Development and Refinement

Activities of the SDTS Task Force and NIST continue in the areas of formal approval of the *Raster Profile* as Part 5 of SDTS, establishing procedures for SDTS *conformance testing*, and other SDTS support initiatives.

## Relationships with Other Standards Activities

SDTS is one of several formal standards initiatives that are aimed at providing flexible approaches for the exchange of digital spatial data. Bodies at the national and international level are sponsoring standards development programs that impact spatial data content and format. The nature of formal standards setting by these organizations provides for input from a broad community of interested parties and for coordination between different standards organizations. SDTS has been developed in coordination with related standards initiatives of these other national and international bodies.

One important SDTS-related standard is the FGDC-sponsored *Content Standard for Digital Spatial Metadata*. This standard was intended to provide a consistent framework for a comprehensive set of metadata describing a spatial data set. This FGDC standard has metadata elements arranged into the following categories: a) spatial data organization information, b) data quality information, c) spatial reference information, d) entity and attribute information, e) distribution information, and f) metadata reference information. This FGDC standard defines the content of a metadatabase with recommendations for mandatory and optional items. It is not meant to prescribe a specific format for storage or transfer of metadata. Since it is an approved FGDC standard, federal agencies are required to use it for documenting new spatial data being provided as part of the National Spatial Data Clearinghouse Program.

SDTS was one of the sources used to prepare the FGDC metadata standard, and therefore similarities exist between some of the FGDC modules and fields and the elements in the FGDC content standard. However, there is not a direct logical or functional relationship between these standards. Much of the information in a metadatabase that fully complies with the FGDC standard could be used in an SDTS transfer, but there is no direct relationship or formal “logical mapping” between them. The table in Appendix A indicates the general relationship between the components of these two standards.

While a direct functional link between the FGDC standard and SDTS might be desirable for many users, the evolution of these standards has not resulted in such a direct relationship at this time. Organizations, particularly at the federal level, that produce spatial information may need to establish internal procedures to comply with each of these standards.

# SDTS Base Specification

## SDTS Part 1: Logical Specifications

Part 1 of SDTS explains a *conceptual model* that serves as a foundation for SDTS and a logical format for data translation. Part 1 also defines the content and format that are needed to transfer information about the quality of the spatial data.

### SDTS Spatial Data Model (Conceptual Level)

Data transfer through SDTS is based on a *conceptual model* of spatial data that defines the characteristics of *objects*—the building blocks for a digital representation of a spatial entity like a river, building, utility line, or water well. Objects within SDTS may be *simple objects* (the most basic representative elements like points or line segments) or *aggregate objects* (which combine multiple simple objects into a larger whole, e.g., a data layer).

The spatial model defines both the *geometry* (graphic depiction) and the *topology* (connectivity and spatial relationships) of map features as shown in Figure 6. These map features may be graphically represented as points (zero-dimensional vector objects), as lines (one-dimensional vector objects), as areas (two-dimensional vector objects), or in gridded or raster form. Figure 7 illustrates how spatial entities may be represented as zero-, one-, or two-dimensional objects.

**Figure 6: Geometry vs. Topology**

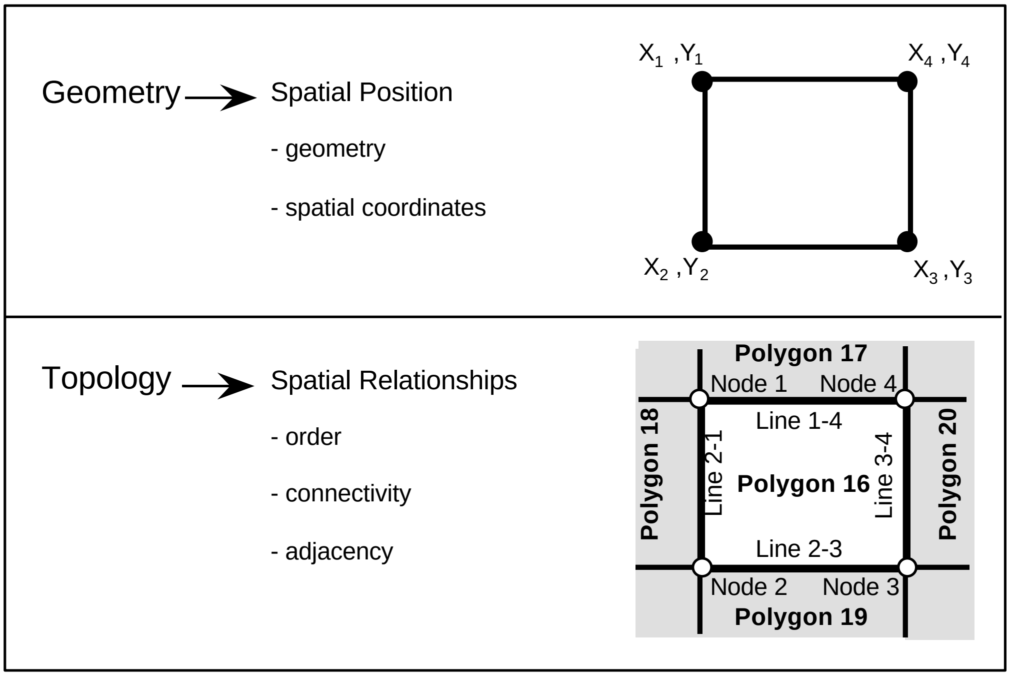



**Figure 7: Map Feature Representations**

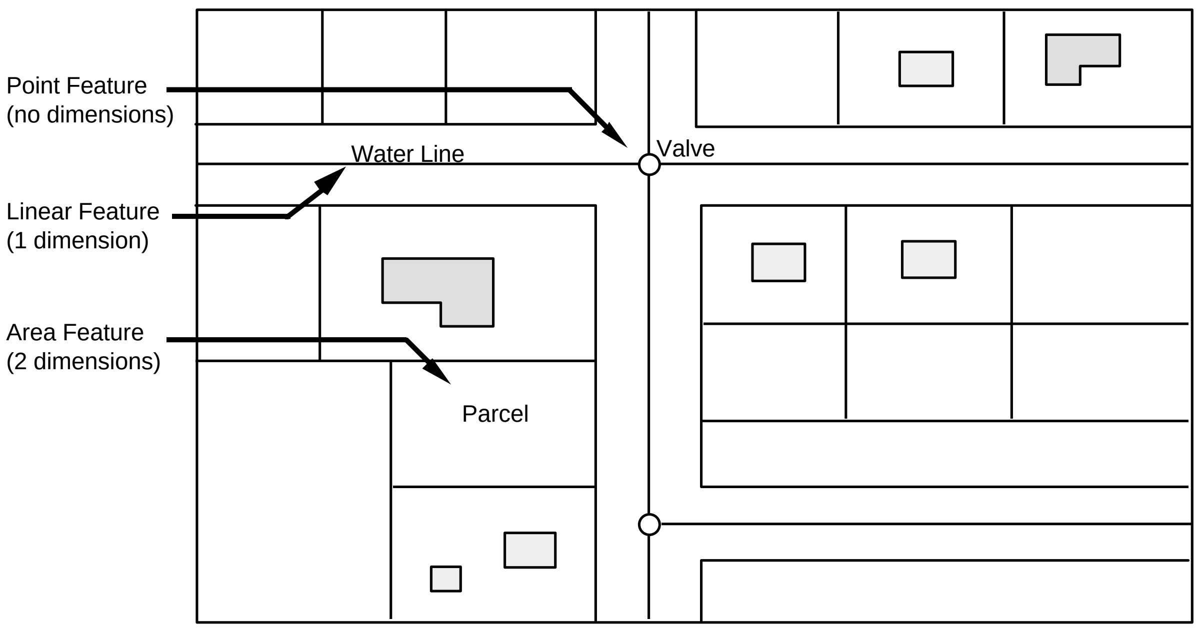



Table 1 identifies the different simple object types included in the SDTS conceptual model. Depending upon the particular type of data and requirements of particular users, a map feature could be digitally represented by "geometry only" objects **or** "geometry-topology" objects. For instance, using the example in Figure 7, a water valve could be represented as a point (geometry-only) object or as a node (geometry-topology) object if it is being treated as part of a linear topological network of the water distribution system. Whether or not a map feature is represented by geometry only or by topological representation depends in part on the software being used and on the specific applications of the user.

**Table 1: SDTS Simple Objects**

| | SDTS Simple Objects | |
|---|---|---|
| **Feature Types** | **Geometry Only** | **Geometry/Topology** |
| Point Features (Zero-dimensional) | Point (includes subtypes of Entity, Area, and Label Points) | Node (Planar or Network) |
| Linear Features (One-dimensional) | Line String, Arc, G-Ring | Link, Chain, GT-Ring |
| Area Features (Two-dimensional) | G-Ring[1], G-Polygon | GT-Polygon, Universe Polygon, Void Polygon |
| Raster Surfaces (Two-dimensional) | Pixel, Grid Cell, Labeled Grid Cell[2] | N/A |
| Raster Surfaces (Three-dimensional) | Voxel[2], Labeled Voxel[2] | N/A |

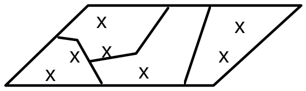
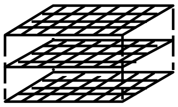
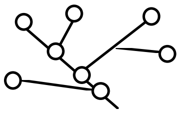
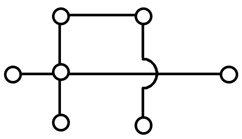
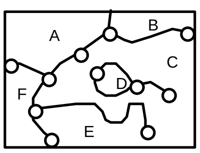
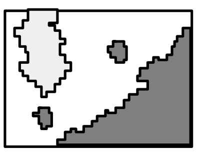
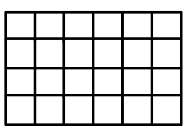
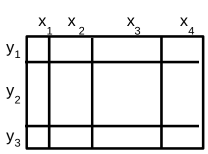
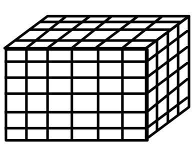
[1] The G-Ring does not formally represent the area inside the closed linear boundary, but in non-topologically based graphics software, it can be used to represent area features.

[2] These new object types are not part of the 1992 version of SDTS, but will be included in the next version of the standard, expected to be issued by NIST in late 1996 or 1997.

Several types of *aggregate objects* are defined by SDTS because they are effective in providing a context for use of *simple objects* in a data transfer. With simple objects as the building blocks, aggregate objects denote collections of simple objects that represent real-world phenomena and, therefore, they provide a basis for defining a specific data transfer. For example, the aggregate object, planar graph, may represent a road network that is concisely defined in terms of its component simple objects, thereby facilitating a consistent data transfer. Aggregate objects are explained in Table 2.

The *composite object* is a specially-defined object type that is any aggregation of simple objects or other composite objects. This object type is useful because it allows the flexibility to define an object for transfer that consists of any collection of other objects.

### Table 2: Aggregate Spatial Objects

| | | |
|---|---|---|
|  | **Layer** | General term describing a collection of instances (occurrences) of spatial features in a single theme |
|  | **Raster** | One or more overlapping layers for the same grid, labeled grid, voxel space, or other raster data |
|  | **Planar Graph** | Linear objects inter-connected on a two-dimensional surface with a node at each intersection (e.g., a topologically structured stream network or street network) |
|  | **Network** | A graph of linear objects inter-connected topologically, which, when projected onto a two-dimensional surface, allow multiple nodes at a single location or no nodes at intersection points (e.g., a gas distribution pipeline with overlapping pipes in three-dimensional space) |
|   | **Two-Dimensional Manifold** | A planar graph and its associated polygons which totally exhaust a surface (e.g., land cover map, parcel map) |
|  | **Digital Image** | Two-dimensional array of regularly spaced pixels (e.g., unclassified satellite image, digital orthophotograph) |
|  | **Grid** | Matrix of cells forming a mesh with repeating pattern (e.g., grid map, digital terrain model) |
|   | **Labeled Grid**[1] | A two-dimensional set of labeled grid cells [1] forming an irregular rectangular pattern; each labeled grid cell is identified by a spatial label |
|  | **Voxel Space, Labeled Voxel Space**[1] | Three-dimensional grids in which each voxel represents a three-dimensional volumetric unit (the three-dimensional equivalent to the grid or labeled grid) |

[1] Labeled Grid, Voxel Space, and Labeled Voxel Space are not part of the 1992 version of SDTS but are expected to be included in the next version of the standard.

## Spatial Data Quality

Information about the quality of spatial data provides a basis for decisions on the appropriateness of data for specific applications. Part 1 of SDTS specifies a format for storing information about *data quality* and for creating a *data quality report* to accompany a spatial data set when it is transferred via SDTS. This data quality report provides for "truth in labeling" about the data set. When it is available for a particular data set, the information about data quality described in Table 3 should be included in an SDTS transfer.

**Table 3: Categories of Data Quality**

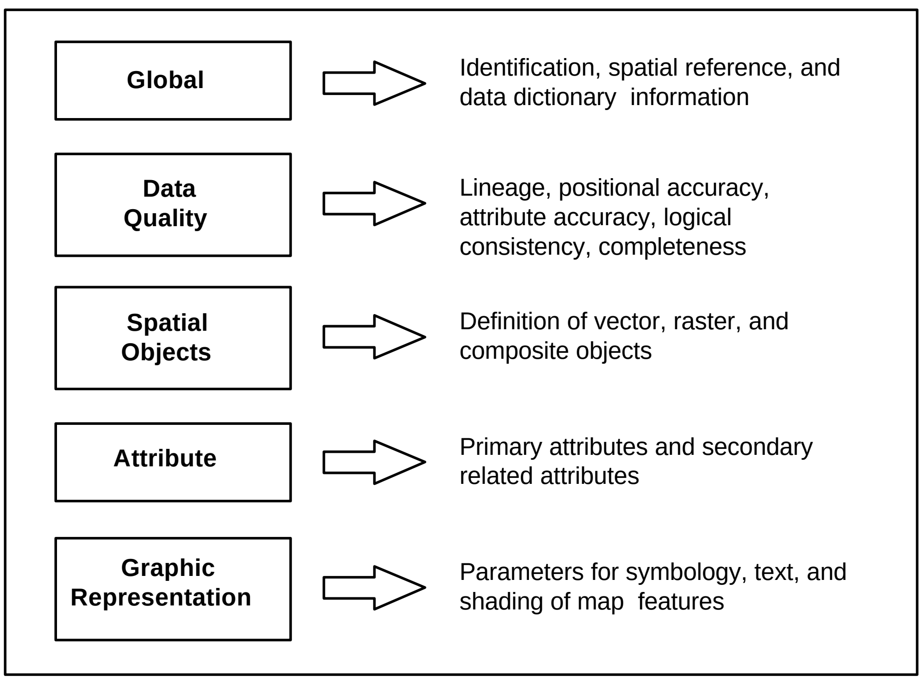
| Data Quality Category | Explanation | Example |
|---|---|---|
| **Lineage** | Information on sources, update activity with dates, and processing steps that have transformed the data. | A reporting of photogrammetric compilation methods and sources and ancillary sources for topographic quadrangle production. |
| **Positional Accuracy** | Information about how closely coordinate values of map features match their true location. Based on reference to latitude/longitude or another external coordinate reference system using any of several means to deductively estimate or rigorously test accuracy. | a) Geodetic control report documenting the horizontal and vertical accuracy of control points, or<br>b) Statement of horizontal accuracy (maximum circular margin of error) for a large-scale planimetric map based on independent checks on a selected sample of features. |
| **Attribute Accuracy** | Information on the error in the values of attribute data elements included in a transfer. The error may be based on deductive estimates or actual tests. | a) Error levels expressed as a percentage of primary attributes such as parcel number, owner name, deed reference, etc., associated with parcels on a tax map, or<br>b) Level of misclassification of defined areas on a land cover map. |
| **Logical Consistency** | An indication of the graphic quality and topological integrity of a digital map. | a) Report on problems in graphic connectivity and closure (overshoots, gaps, etc.) for a parcel or soil map, or<br>b) Report on the topological integrity of a water utility map modeling the water network. |
| **Completeness** | Information about selection criteria for inclusion of map features, minimum thresholds in map compilation (minimum area or width), and the exhaustiveness of features mapped. | a) Selection criteria for planimetric mapping indicating inclusion of all buildings and structures above X sq. feet in size, or<br>b) Minimum mapping unit sizes for soil mapping, or<br>c) Expected percentage of manholes mapped from aerial photography relative to the number of manholes that actually exist. |

It should be the responsibility of the organization that collects or manages spatial data to maintain appropriate information on *data quality* to satisfy the specifications for an SDTS *data quality report*. Comprehensive procedures to record and track this data quality information are not in place in many organizations, although they are becoming standard in most federal agencies and other government organizations that have established serious GIS or mapping programs. Although data quality information may not always be available, SDTS encoding and decoding routines must have the capability to capture and extract the data quality report. This is not an extremely complex task since much of the data quality information is in text report form.

## General Transfer Specification (Logical Level)

Part 1 also includes the logical format for an SDTS transfer. This logical format defines the content and basic format of a series of *modules*, each of which contains a specific category of information for the SDTS data transfer. Figure 8 shows the five major categories of modules into which a total of 34 individual SDTS modules are grouped.

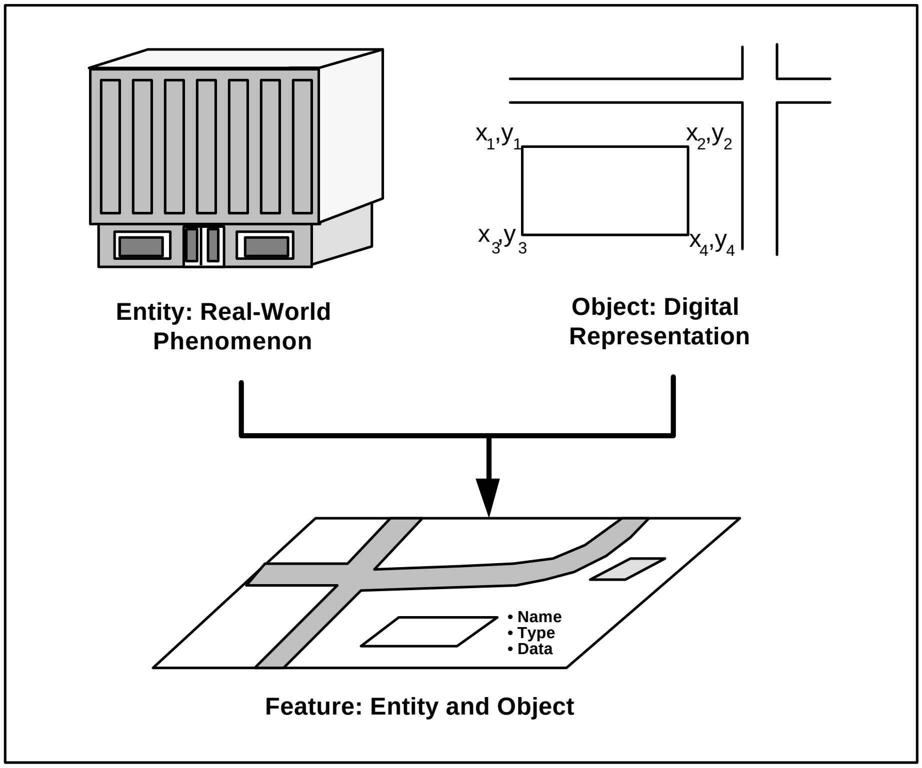
**Figure 8: Categories of SDTS Transfer Modules**



# SDTS Part 2: Spatial Features

The SDTS defines a spatial *entity* as a specific "real world phenomenon," which could be a physical feature or an occurrence that can be located geographically. An *object* in SDTS is used as a digital representation (geometry and/or topology) of the entity. SDTS defines the term *spatial feature* as the combination of the concepts of entity and object (as shown in Figure 9). The terms entity and spatial feature are often used synonymously; but to be totally consistent with the SDTS model, spatial feature should be used to refer to an entity, represented in digital form, with its geometry, topological relationships, and attributes.

**Figure 9: SDTS Conceptual Model Entities, Objects, Features**




Different organizations often apply different names and methods of classification to spatial entities. For instance, does the entity name "road" differ from "street" or "highway," or does it include these terms as particular types of "roads?" The resulting need for interpretation can inhibit effective sharing of data.

Part 2 of the SDTS *base specification* identifies a standard set of *entity types* to provide a consistent basis for transferring spatial information among organizations. These entity types have been designed with the following intent:

- Each entity type is mutually exclusive
- Standard names are assigned to entity types
- No specific hierarchy or classification system is pre-defined.

While SDTS does not define any specific hierarchy or classification scheme for these entity types, it is understood that some type of hierarchical classification is often required by data users and that these classification schemes may vary from user to user. By defining *entity types* to be independent, users may accept data from SDTS transfers in a consistent manner and apply specific classification schemes that meet their needs.

Table 4 provides some examples of *entity types* in SDTS Part 2. Part 2 includes names and definitions of a finite set of entity types, along with a set of standard attributes and, where applicable, *included terms* that are encompassed by the entity type.

**Table 4: Examples of Entity Types in SDTS Part 2**

| | Example of Entity Types | |
|---|---|---|
| | **Road** | **Mine** |
| **Attributes** | Name<br>Surface Type<br>Number of Lanes | Name<br>Mineral Content<br>Size |
| **Included Terms** | Highway<br>Street<br>Thoroughfare | Quarry<br>Excavation<br>Gravel Pit |

The current version of SDTS Part 2 focuses on types of entities useful in topographic base mapping and hydrographic charting. There is no defined limit to the number of spatial entities that may be included in Part 2 of SDTS. Efforts underway by the Federal Geographic Data Committee (FGDC) and other groups will result in an expansion, in future versions, in the number of *entity types* included in Part 2. The FGDC is defining formal procedures for making revisions to Part 2.

# SDTS Part 3: ISO 8211 Data Encoding (Physical Level)

## Introduction

*ISO 8211* is a recognized standard for encoding digital information on storage media or for transmitting it electronically. It provides a standard means for arranging information in a transfer so that it can be accepted and decoded easily. ISO 8211 was first defined by the ISO. The American National Standards Institute (ANSI), and the National Institute of Standards and Technology, have recognized it as a formal standard, known as FIPS 123. ISO 8211 and SDTS are two different standards, but SDTS uses ISO 8211 because it is an internationally accepted general-purpose standard for physical transfer of data.

Part 3 of SDTS describes how *ISO 8211* is used to encode SDTS transfers. Familiarity with ISO 8211 is required before reading Part 3 of SDTS. In brief, Part 3 provides the following:

- Directions for “mapping” the SDTS logical module structure to the ISO 8211 physical format
- Arrangement of records for ISO 8211 compliance
- Record and field naming
- Arrangement of records in the transfer
- Implementation with different types of media.

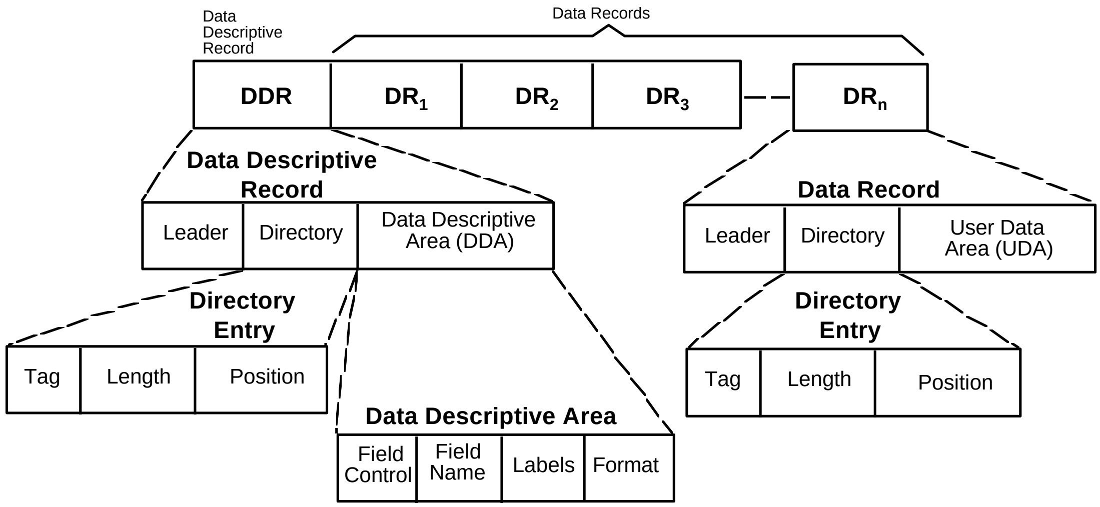
## Overview of ISO 8211 Structure

An *ISO 8211* file is called a *Data Descriptive File* (DDF) (see Figure 10). It consists of two types of records. The Data Descriptive Record (DDR) contains the structure and description of data. The Data Record (DR) contains the actual data. There is always one DDR in a file, and one or more DRs.

Records consist of one or more fields. A *field* can be thought of as having two components—its description and structure contained in the DDR and its data contained in the DR. Fields consist of one or more subfields.*Subfields* are the basic elements of data.

Figure 10 shows the general structure of DDRs.

**Figure 10: Structure of the ISO 8211 Data Descriptive File**




**Description of Fields and Subfields in ISO Fields and Subfields in ISO 8211 Files**

**Data Descriptive Record (DDR):**Contains information on the structure and format of data in the ISO 8211 data descriptive file (DDF)

**Data Record (DR):**Contains the actual data in the SDTS transfer

**Leader**: Always 24 characters describing the remainder of the DDR or DR

**Directory:** Repeating sub-fields identifying a unique tag, length in bytes, and position of each field in the DDR or DR

**Data Descriptive Area:**Includes fields which describe the format and characteristics of fields in the DDR

**User Data Area:**Fields of the DR which contain the actual SDTS data to be transferred

**Tag:** A unique identifying mnemonic for fields in the DDF

**Length:** Length, in bytes, for fields in the DDF

**Position:** Location of a DDF field relative to the start of the DDR or DR

# SDTS Profiles

## Overview

Actual use of SDTS for transferring spatial data is carried out through its profiles. A *profile* is intended to provide specific rules for applying the SDTS base specification to a particular type of spatial data. A profile can be considered a subset of the SDTS specification that defines the following:

- Restrictions and requirements for use of specific spatial object types
- Restrictions and requirements for use of SDTS modules, including rules for choosing among options present in the base specification
- Module naming and file naming conventions
- Use of ISO 8211 encoding specifications, including allowable options to be used.

One profile, the *Topological Vector Profile* (TVP), has been formally approved by NIST as part of FIPS 173. The TVP is Part 4 of the SDTS specification. Another profile, the *Raster Profile* (RP), which is Part 5 of SDTS, has been prepared in draft form by the SDTS Task Force with considerable outside review and comment. It has not been submitted to or formally approved by NIST, so it currently is not part of the FIPS 173 mandate.

These two profiles, summarized in Table 5, address much of the spatial information used by organizations today that are operating geographic information systems or image processing systems.

**Table 5: Profile Summary**

| Profile | Explanation | Example Data Sets |
|---|---|---|
| **Topological Vector Profile** | Designed for transfer of spatial data sets in which vector features are represented with geometry **and** topology. Data sets may contain point, line, and area features that may be defined as a two-dimensional manifold. | • USGS DLG data sets for 1:24K and 1:100K scale topographic maps<br>• U.S. Census Bureau TIGER files |
| **Raster Profile** | Designed for transfer of spatial data sets in which features or images are represented in raster or gridded form. | • USGS DEM and DOQQ |

*Profiles* are designed to allow implementation of SDTS with enough flexibility to take into account some variability in user data formats to avoid a large proliferation of profiles for different data models that are similar in structure. This flexibility is made possible through *core options* and *annex options*. Neither core nor annex options are required by a specific profile. Core options address characteristics of data sets that are considered very important for any transfer, while annex options provide additional supporting information that may enhance a transfer but are not necessarily critical. Core options, when they are used in encoding a data set, must be decoded by decoder software in order for it to conform to SDTS. For example, a number of object types (e.g., NP, NE, NL) are optional for TVP. These are considered core options because when they are included in a transfer, compliant decoding software must be able to translate them. There are no requirements for conforming decoder software to handle annex options in an SDTS transfer.

The SDTS program allows for and encourages the development of new profiles or modifications to existing profiles in cases where existing profiles are not entirely suited to the type of data being transferred or where additional options may enhance a transfer. Some possible new profiles, or profile modifications that have been discussed, are identified in Table 6.

**Table 6: Potential New SDTS Profiles or Modifications to Current Profiles**

| Potential New or Modified Profile | Status |
|---|---|
| **Point Data Profile**<br>**Explanation**: For transfer of data sets consisting of only point features or locations and associated attributes (with optional high precision). | The SDTS Task Force and the Hydrographic Surveys Division of the National Ocean Survey prepared a draft in 1994. The National Geodetic Survey is pursuing FIPS ratification of this profile. This profile will facilitate the FGDC framework initiative for geodetic networks. |
| **Non-topological Vector Profile**<br>**Explanation**: For transfer of features as geometry-only objects which do not require topology. Includes features typical of CAD drawings which represent features parametrically (e.g., arcs). | Suggested as possible profile in 1993, but no specific work was carried out. The Tri-Service CADD/GIS Technology Center (administered by the Army Corps of Engineers in Vicksburg, MS) has initiated a development project. With active participation of the Facilities Working Group of the FGDC and in coordination with the SDTS Task Force and private companies (Intergraph and AutoDesk), development work will likely begin in 1996. No projected completion date exists at this time. |
| **Transportation Network Profile**<br>**Explanation**: For transfer of data sets that define topological linear transportation networks (e.g., road networks) with no area features. | Effort begun in 1993 by Volpe National Transportation Systems Center. Development of profile now in hands of the Transportation Subcommittee of the FGDC. A final draft is complete. This profile provides a model that could be applied to other linear networks. Expected submittal for approval by FGDC Standards Working Group by the end of 1996. |

**Table 6: Potential New SDTS Profiles or Modifications to Current Profiles (continued)**

| Potential New or Modified Profile | Status |
|---|---|
| **Intelligent Transportation Systems (ITS) Profile**<br>**Explanation**: Network profile that meets requirements of private companies developing products for intelligent transportation systems (e.g., vehicle navigation systems). | The vendor consortium, ITS America, began investigating development of a profile in 1993. The Database Subcommittee of ITS America is considering SDTS profile development as it reviews the suitability of other standard formats. There has been some discussion of adapting the Transportation Network Profile (FGDC Transportation Subcommittee) for ITS America requirements. |
| **DX-90 Profile**<br>**Explanation**: To allow transfer of data between SDTS and the DX-90 international standard for hydrographic charts. | The National Ocean Service (NOS) sponsored a project to define DX-90 as a profile of SDTS. The requirements for a Hydrographic Vector Profile (HVP) (similar to TVP) which implements the full topological level of DX-90 have been determined. The HVP is currently unimplemented, but the NOS has a pilot project to create HVP data. Plans for full formalization of HVP are not in place at this time. |
| **DIGEST Profile**<br>**Explanation**: To allow transfer of data between SDTS and the Digital Geographic Exchange Standard (DIGEST), the international standard for spatial data exchange. | In 1993, the Defense Mapping Agency sponsored a study to examine harmonization of SDTS and DIGEST. This resulted in an outline for a DIGEST vector profile (DVP) for DIGEST-A. No formal work for DVP implementation has occurred. |

Neither the SDTS Task Force nor any other organization has a mandated role to develop new SDTS profiles. However, the SDTS Task Force encourages profile development by government or private communities of users. The Task Force will provide information and technical support to any groups interested in profile development. When a new or modified profile is ready for formal approval, the SDTS Task Force will work with the developer and NIST in the FIPS review and approval process.

# FIPS Mandate and Organizational Impact

## Mandated Requirements

SDTS is formally implemented as FIPS 173, which places requirements on federal agencies with the objective of providing an effective basis for spatial data sharing regardless of the specific computer system being used by an agency.

The FIPS program, administered by the National Institute of Standards and Technology (NIST), has been put in place to improve and ensure the efficiency of information systems and their use by federal agencies. FIPS 173 places requirements on federal agencies in computer system procurements and information system development projects. These mandated requirements, which are fully explained in the FIPS 173 publication, are summarized below.

FIPS applies in situations:

- Involving the acquisition and development of applications and a program for transfer of digital spatial data between dissimilar computer systems
- Where the transfer of digital spatial data occurs or is likely to occur within and/or outside of the federal government.

FIPS 173 is not intended to apply in cases where geocoded data files maintained by agencies are not designed to represent geographic or cartographic features; nor does it apply when spatial data is distributed as a product for use with a specific software package.

The wording of this mandate leaves room for some flexibility in interpretation; but, in keeping with the overall objective of the FIPS program, it has the following impact on programs in federal agencies:

- New computer systems designed for mapping and spatial data processing which are being procured by federal agencies should have the capability to encode and decode SDTS data.
- New spatial data collection programs should prepare data in SDTS format if this data is likely to be distributed outside of the agency responsible for the data collection.

Beyond these specific terms, the overall spirit of FIPS 173 may be more broadly conveyed by applying SDTS to some existing systems and spatial databases. Including SDTS encoding/decoding capabilities into existing software packages (particularly when commercial software revisions become available) and providing existing spatial databases for distribution in SDTS format will improve the government's ability to share spatial data. In addition, some federal agencies and other organizations may choose to actively participate in SDTS profile development, which will further encourage spatial data sharing.

While the direct impact of FIPS 173 is on federal agencies, it influences many other organizations, including software firms supplying SDTS compliant products and spatial data users and distributors in all public and private sectors. The importance of the federal government as a spatial data supplier and user, and the growth in sharing of spatial information at all levels of government and among private companies, are driving the wide acceptance of SDTS as a means for data exchange.

## Federal Government Role

NIST is the designated "maintenance authority" with overall responsibility for formal approval, revision, and distribution of the SDTS specification as FIPS 173. The National Mapping Division of USGS has the official role of "maintenance agency." This is a support role which includes technical assistance to agencies implementing SDTS, support in setting up conformance testing, coordination of revision work, training and education, and other support activities. The SDTS Task Force, now based at the National Mapping Division Mid-continent Center in Rolla, Missouri, has been created to coordinate SDTS activities.

# SDTS Implementation

## Implementing an SDTS Program

The best way for a particular organization to implement SDTS depends on what the organization does. SDTS implementation should be considered by any organization that fits one or more of the following roles:

1. **Developer** of GIS or other software that will benefit from SDTS translation routines for transfer of spatial data among different hardware and software environments
2. **Producer or Distributor** of spatial information to groups using multiple computer systems and software
3. **User or Recipient** of spatial data that may be produced on another computer system.

These roles are explained further in Table 7.

**Table 7: Explanation of Roles for SDTS Use**

| Role | Sample Organizations | Use/Impact of SDTS[1] |
|---|---|---|
| **Software Developer** | • GIS software company<br>• DBMS software company<br>• Contracted software developers | • **Building of encoding and decoding translation software**<br>• Design of new SDTS compliant profiles |
| **Producer/Distributor of Spatial Data** | • Federal government agency<br>• State or local government agency<br>• Mapping/Data conversion contractor<br>• Map publishing companies<br>• Value-added data distributor<br>• Other spatial data producers | • **Use of off-the-shelf encoding software**<br>• **Compiling metadata and data quality information for an SDTS transfer**<br>• Design of encoding translation software if not already available off-the-shelf<br>• Design of new SDTS compliant profiles if required |
| **User/Recipient of Spatial Data** | • All government agencies that acquire spatial data from outside sources<br>• Utility companies and private firms that operate GISs<br>• Universities and research institutions<br>• Non-profit organizations | • **Use of off-the-shelf decoding software**<br>• Design of decoding translation software if not already available off-the-shelf<br>• Design of new SDTS compliant profiles if required |

[1]Primary uses and impacts are highlighted in bold print

In essence, Table 7 suggests that software companies have an implied responsibility to design and build translation software (both encoding and decoding) for specific SDTS profiles. This packaged software is used by data developers and data users to package spatial data for distribution and for accepting data for use with a specific software package. In special cases, where a new SDTS profile is called for, software developers may collaborate with data producers and/or users to design and develop it.

## Activity at Federal Level

A number of federal agencies have progressed considerably with SDTS implementation programs. Several agencies have put in place, or will soon put in place, procedures for access to and distribution of spatial data in SDTS format.

Table 8 summarizes key federal SDTS data compilation and distribution programs that are now in place.

**Table 8: Summary of Federal SDTS Data Programs**

| Agency | Status |
|---|---|
| **U.S. Geological Survey—National Mapping Division** | The USGS, as the FIPS 173 maintenance authority, has taken the lead in converting its digital cartographic data holdings to SDTS format. For the next couple of years, the USGS will offer all SDTS formatted data FREE via the Internet.<br><br>Data holdings that use the Topological Vector Profile (TVP), the first profile developed and approved for FIPS 173, are the first to be converted. All available 1:100,000 Digital Line Graph (DLG) files have been converted to SDTS format. This includes national coverage of the hydrography and transportation overlays, and less complete coverage of other layers.<br><br>The 1:2,000,000 DLG data were revised in 1995 and are now available in SDTS format. This includes coverage of the individual conterminous United States for the following categories of data—hydrography, transportation, boundaries, PLSS, and man-made features.<br><br>All existing 1:24,000 DLG data will be available in SDTS format by the end of 1996. These data holdings are being converted during a mass data conversion effort. State coverages will start to appear this summer. Beginning in the Fall of 1996, the USGS will begin routine production and dissemination of geospatial data in SDTS format.<br><br>Once a Raster Profile is available, all USGS data holdings that fit into this profile will be converted, including Digital Elevation Models (DEM), Digital Orthophoto Quadrangles (DOQ), and Digital Raster Graphics (DGR). SDTS DEMs are expected to be released in late 1996.<br><br>The SDTS data currently available can be found at the EROS Data Center (ftp://edcftp.cr.usgs.gov).<br><br>The USGS also has sample datasets available, including DLG-3, DLG-E, GRASS, TIGER, DEM, DOQ, and a multi-spectral image at the Mid-Continent Mapping Center ftp site (ftp://sdts.er.usgs.gov in the pub/sdts directory). |

**Table 8: Summary of Federal SDTS Data Programs (continued)**

| Agency | Status |
|---|---|
| **U.S. Census Bureau** | The Census Bureau has provided a prototype version of the 1990 TIGER data in the SDTS format. The files are available on the Mid-Continent Mapping Center's ftp site (ftp://sdts.er.usgs.gov directory pub/sdts) and have been distributed to the Census Bureau's data centers and to commercial TIGER software vendors.<br>The Census Bureau is capable of providing additional counties from its 1990 Census version of the TIGER data base on request at a cost-reimbursable basis of $150 per partition (Census Bureau partitions approximate counties).<br>When resources become available, the Census Bureau plans to simplify the prototype design based on feedback from the users. The Census Bureau hopes the new version of the TIGER/SDTS files will be available in conjunction with the release of Census 2000 data products. |
| **U.S. Army Corps of Engineers** | The Corps lists SDTS as a mandatory standard in its Engineer Circular 1110-1-83, "Policies, Guidance, and Requirements for Geospatial Data and Systems."<br>The Corps' Waterways Experiment Station has a CD of wetlands data, with Metadata, in SDTS format.<br>The Corps will include SDTS translation in the next release of GRASS. |

# SDTS Translation Software Status

Effective and flexible use of SDTS will rely to a very great extent on the development of easy-to-use software for encoding and decoding SDTS to support the many spatial data formats in use. These formats include those developed by the public sector (e.g., GRASS and DLG), as well as a range of commercially developed formats for CAD, automated mapping, and GIS applications. The federal government and many commercial software vendors have developed SDTS translation software. Table 9 summarizes the status of SDTS translation software development and availability.

**Table 9: Status of SDTS Translator Development**

| Company/ Organization | Topological Vector Profile | Raster Profile | Comments |
|---|---|---|---|
| American Digital Cartography | C | P | Geographic Data Interchange System will allow import and export of many GIS file formats, including SDTS. SDTS-TVP driver available in June, 1996. |
| Applied Geographics, Inc. | P | | Planning translator development. Will most likely be client-driven. |
| Autodesk Corporation | P | | Currently working with third party vendors to add SDTS-TVP translator to software. |

**Table 9: Status of SDTS Translator Development (continued)**

| Company/ Organization | Topological Vector Profile | Raster Profile | Comments |
|---|---|---|---|
| Caliper Corporation | | | Not currently developing any translators. Seriously considering development in the future. |
| ERDAS | A | D | Raster encoder/decoder will be available in August, 1996. |
| Environmental Systems Research Institute (ESRI) | A | | SDTS-TVP import and export functionality currently available in ARC/INFO. |
| Geographic Data Technology | | | No development to date. Any future development will be customer-driven. |
| Graphic Data Systems | D | D | Currently, there is partial support for SDTS-TVP export in GDS; complete support for import and export will be available in 1997. Raster profile format available in GDS v. 5.6 in 1997. |
| Intergraph Corporation | C | | MGE to SDTS. SDTS to MGE. SDTS translator includes a Metadata Editor. |
| MapInfo Corporation | D | | MapInfo to SDTS. SDTS to MapInfo. Available in September, 1996. |
| SAFE Software, Inc. | D | | Translation product is called FME. Will offer bi-directional translation between SDTS and the following—MapInfo MIF/MID, ESRI Shape Files, ESRI Generate/Ungenerate, ESRI SDE, Intergraph/MicroStation Design Files, Intergraph MGE, PAMAP, AutoCAD DWG/DXF, Spatial Archive and Interchange Format (SAIF), ASCII, and others are planned. |
| SHL System House | | | Not currently developing any translators at this time. |
| Smallworld | P | | Looking at translator development for SDTS-TVP. |
| Strategic Mapping | P | | Currently looking at translator development. |
| Unisys Corporation | A | | Complete: SDTS to System 9, System 9 to SDTS, GINA to SDTS, OSNTF to SDTS. In development: SDTS to SpatialWare. |
| USA-CERL (GRASS) | C | | SDTS-TVP translator is developed for GRASS, but not yet certified. There are no near future plans for raster profile development for GRASS. |

A—Translator complete and available; C—Translator complete or near completion; D—Translator in active development; P—Planning for translator development; Blank—Unknown status or no active plans.

# Appendix

# A: General Comparison between the FGDC Content Standards for Geospatial Metadata and SDTS

**Table A-1: General Comparison between the FGDC Content Standards for Geospatial Metadata and SDTS**

| FGDC<br>Content Standard Elements | SDTS<br>Modules |
|---|---|
| **Identification Information** | |
| Citation | Identification |
| Description | Identification |
| Time Period of Content | Identification |
| Status | Data Quality-Lineage |
| Spatial Domain | Spatial Domain |
| Keyword | Catalog/Spatial Domain |
| Access Constraints | Security |
| Use Constraints | Security |
| Point of Contact | READ ME File |
| Browse Graphic | Raster |
| Security Information | Security |
| Native Data Set Information | Data Quality-Lineage |
| Cross Reference | Identification and Data Quality -Lineage |
| **Data Quality and Information** | |
| Attribute Accuracy | Data Quality-Attribute Accuracy |
| Logical Consistency Report | Data Quality-Logical Consistency |
| Completeness Report | Data Quality-Completeness |
| Positional Accuracy | Data Quality-Positional Accuracy |
| Lineage | Data Quality-Lineage |
| Cloud Cover | Completeness |
| **Spatial Data Organization Information** | |
| Indirect Spatial Reference | N/A |
| Direct Spatial Reference Method | Identification |
| Point and Vector Object Information | Vector Modules |
| Raster Object Information | Raster Definition |
| **Spatial Reference Information** | |
| Horizontal Coordinate System Definition | External Spatial Reference |
| Vertical Coordinate System Definition | External Spatial Reference |

**Table A-1: General Comparison between the FGDC Content Standards for Geospatial Metadata and SDTS (continued)**

| FGDC Content Standard Elements | SDTS Modules |
|---|---|
| **Entity and Attribute Information** | |
| Detailed Description | Data Dictionary Modules |
| Overview Description | Identification |
| **Distribution Information** | |
| Distributor | N/A |
| Resource Description | N/A |
| Distribution Liability | N/A |
| Standard Order Process | N/A |
| Custom Order Process | N/A |
| Technical Prerequisites | N/A |
| Available Time Period | N/A |
| **Metadata Reference Information** | |
| Metadata Date | N/A |
| Metadata Review Date | N/A |
| Metadata Future Review Date | N/A |
| Metadata Contact | N/A |
| Metadata Standard Name | N/A |
| Metadata Standard Version | N/A |
| Metadata Time Convention | N/A |
| Metadata Access Constraints | N/A |
| Metadata Use Constraints | N/A |
| Metadata Security Information | N/A |

# Glossary

# Glossary

## A

**aggregate objects** • Specifically defined collections of simple objects that may be used to represent or model real-world spatial entities. For instance, while a simple object (e.g., Chain) may be used to represent a road centerline segment, an aggregate object such as a Planar Graph can be used to represent an entire road network and, thereby, establish a basis for the transfer of a large data set.

**annex option** • An option for inclusion of information in an SDTS transfer that may or may not be exercised in a transfer in order for it to be compliant with a specific SDTS profile. An annex option is always one which may be omitted from encoding or decoding software. This differs from a core option which **must** be addressed by compliant decoding software **if** the information referenced by the option has been included in a transfer.

**automated mapping** • A general class of software or application that concentrates on graphic operations for the entry, update, display, and hard copy production of maps with little capability for the storage or processing of attribute data or for spatial analysis. Some automated mapping system users have applied the capabilities of computer-aided drafting packages for mapping purposes. GIS software packages also include capabilities for automated mapping as well as more advanced functions for attribute processing and analysis.

## B

**base specification** • Parts 1, 2, and 3 of the SDTS specification. This includes the Logical Specifications, Spatial Features, and ISO 8211 Encoding but does not include any SDTS profiles.

## C

**composite object** • A special type of spatial object (SDTS object code FF) which is any aggregation of simple objects or other composite objects. This object type is useful because it allows the flexibility to define an object for transfer that consists of any collection of other objects.

**conformance testing** • The process of formal testing, managed by The National Institute of Standards and Technology, to verify compliance with SDTS. Conformance testing examines defined test points to check for compliance of SDTS transfers (data sets), encoding software, and decoding software.

**core option** • An option for inclusion of information in an SDTS transfer that may or may not be exercised in a transfer in order for it to be compliant with a specific SDTS profile. Information referenced by core options is considered very important for a specific data transfer. **If** a core option is exercised in the **encoding** of SDTS data, compliant decoding software must be capable of **decoding** the data addressed by the option.

## D

**data quality** • Characteristics of a spatial data set and its individual elements and attributes that are important for its proper use. SDTS defines several modules for transferring such data quality information as lineage, positional accuracy, attribute accuracy, logical consistency, and completeness. In an SDTS transfer, this data quality information may be conveyed through a data quality report.

**data quality report** • A standard description of the quality of a data set, including information about lineage, accuracy, logical consistency and completeness as described in SDTS Part 1, Section 3.

**DCDSTF** • Digital Cartographic Data Standards Task Force.

## E

**entity** • A real-world physical object, incident, or phenomenon that can be described locationally or geographically.

**entity type** • A named set of spatial entities that are formally defined in Part 2 of SDTS. Each entity type (e.g., “road,” “lake,” “tower”) may be considered a spatial feature when it is represented using an SDTS object or objects. Part 2 attempts to define a standard list of entity types for use in an SDTS transfer.

## F

**feature** • Also referred to as “map feature” or “spatial feature.” A feature is the actual definition of an entity when it is represented or modeled using one or several SDTS objects.

**FGDC** • Federal Geographic Data Committee.

**FICCDC** • Federal Interagency Coordinating Committee on Digital Cartography.

**FIPS** • Federal Information Processing Standard. This refers to the set of information processing standards defined and maintained by NIST which are mandated for use by U.S. federal agencies.

## G

**geographic information system (GIS)** • A computer system that stores and links nongraphic attributes or other spatially referenced information to graphic map features. A GIS goes beyond automated mapping by allowing many different information processing and analysis functions.

**geometry** • The graphical qualities of an object as defined by its coordinates in two or three dimensions.

## I

**included term** • A non-standard name by which a defined entity type (in SDTS Part 2) may be referred.

**ISO 8211** • A standard approved by the International Organization for Standardization (ISO) and the American National Standards Institute (ANSI) defining rules for the physical formatting, labeling, and organization of data on storage media or for electronic transmission.

## M

**module** • A defined category of information to be contained in an SDTS transfer. SDTS defines a total of 34 modules covering global information about a transfer, data quality information, definition of spatial objects in a transfer, attribute information, and parameters of graphic representation of the data. Each has a set of related data fields and subfields (with specific logical formats and domains) that hold data in a transfer. The modules, therefore, establish the logical structure for information encoding and decoding in an SDTS transfer.

## N

**NCDCDS** • National Committee for Digital Cartographic Data Standards.

**NIST** • National Institute of Standards and Technology. The U.S. federal government agency charged with establishing standards of all types for use by federal agencies.

## O

**object** • The basic building block for modeling or representing a real-world geographic entity. The definition for a particular object describes the basic geometry (graphics) and topological relationships of the object. SDTS defines simple objects (e.g., Entity Point, Line String, GT-Polygon) and aggregate objects (e.g., Planar Graph, Grid) which are composed of simple objects.

## P

**profile** • A set of rules for actual implementation of SDTS in a specific data transfer. The SDTS Base Specification in Parts 1, 2, and 3 defines the overall model, content, and structure for the transfer of spatial data. A profile defines specifically how SDTS is to be used in a particular case by limiting options and choices that are present in the base specification, thereby, providing a structure for encoding and decoding of data in an SDTS transfer.

## R

**Raster Profile (RP)** • A formal SDTS profile which is in the final stages of development by the SDTS Task Force. It is designed for the transfer of any two-dimensional grid or image data.

## S

**simple object** • A basic element defining certain geometrical and topological qualities that is used as a building block to model or represent a real-world spatial entity.

**spatial feature**• See "feature."

## T

**theme** • A general term describing a related set of spatial entities (e.g., transportation, utility, hydrography, etc.). The theme is not a defined object type in SDTS, but a theme may be defined as equivalent to the aggregate object, "layer."

**Topological Vector Profile (TVP)** • The first formally defined SDTS profile approved as Part 4 of FIPS 173. The TVP is designed for the transfer of topologically structured point, line, and area features, and associated attributes. As a formal profile, the TVP defines a specific way in which SDTS specifications are to be applied by limiting options and identifying specific modules required and how they shall be treated in a data transfer.

**topology** • A characteristic of a spatial data format in which spatial relationships of features such as order, connectivity, and adjacency are explicitly defined.

# Bibliography

# Bibliography


Altheide, Phyllis. “Design of a Spatial Data Transfer Processor.” *Cartography and Geographic Information Systems*, Vol. 19, No. 5 (December, 1992), pp. 311–314.

Altheide, Phyllis. “An Implementation Strategy for SDTS Encoding.” *Cartography and Geographic Information Systems*, Vol. 19, No. 5 (December, 1992), pp. 306–310.

Cascio, Janette. “A Spatial Features Register: Toward Standardization of Spatial Features.” *Cartography and Geographic Information Systems*, Vol. 21, No. 3 (July, 1994), pp. 155–158.

Coleman, David J. and John D. McLaughlin. “Standards for Spatial Information Interchange: A Management Perspective.” *Canadian Institute for Surveying and Mapping Journal*, Vol. 46, No. 2 (1992), pp. 131–141.

Craig, William J., Paul Tessar, and Niaz Ali Khan. “Sharing Graphic Data Files in an Open System Environment.” *URISA Journal*, Vol. 3, No. 1 (Spring, 1991), pp. 20–32.

Croswell, Peter L. “Understanding the Web of Standards Organizations.”*URISA News*, February, 1993, p. 1.

Davis, Beverly A., Jack R. George, and Robert W. Marx. “TIGER/SDTS: Standardizing an Innovation.” *Cartography and Geographic Information Systems*, Vol. 19, No. 5 (December, 1992), pp. 321–327.

Fegeas, Robin G., Janette L. Cascio, and Robert A. Lazar. “An Overview of FIPS 173, The Spatial Data Transfer Standard.” *Cartography and Geographic Information Systems*, Vol. 19, No. 5 (December, 1992), pp. 278–293.

Fernandez-Falcon, Eduardo A., James R. Strittholt, Abdulaziz I. Alobaida, Robert W. Schmidley, John D. Bossler, and J. Paul Ramirez. “A Review of Digital Geographic Information Standards for the State/Local User.” *URISA Journal*, Vol. 5, No. 2 (Fall, 1993), pp. 21–27.

Grady, Richard. “The Lineage of Data in Land and Geographic Information Systems.” *URISA Journal*, Vol. 2, No. 2 (Fall, 1990), pp. 2–6.

Hogan, Richard. “Developing a Spatial Feature Register.” In 1993 Urban and Regional Information Systems Association Conference: Proceedings. Washington, D.C.: URISA, 1993, pp. 117–128.

Hogan, Richard L., Kathryn C. Wortman, Charles A. Roswell, and Walter M. Winn. “Joint Leadership for Spatial Data Standards.” *Cartography and Geographic Information Systems*, Vol. 21, No. 3 (July, 1994), pp. 145–149.

Kindrachuk, Eugene. “Dealing with Spatial Data Exchange Issues.” *GIS World*, June 1992, pp. 76–79.

Kottman, Clifford A. “Some Questions and Answers about Digital Geographic Information Exchange Standards.” Second Edition. Huntsville, Alabama: Intergraph Corporation, 1992.

Kottman, Clifford A. and Barbara P. Buttenfield. “Standards for Spatial Data Use: Similes Improve Our Understanding.” *Cartography and Geographic Information Systems*, Vol. 21, No. 3 (July, 1994), pp. 140–144.

Lazar, Robert. “The SDTS Topological Vector Profile.” *Cartography and Geographic Information Systems*, Vol. 19, No. 5 (December, 1992), pp. 296–299.

Mapping Science Committee. *Toward a Coordinated Spatial Data Infrastructure for the Nation.* Washington, D.C.: National Research Council, National Academy Press, 1993.

Moellering, Harold. “Continuing Research Needs Resulting from the SDTS.” *Cartography and Geographic Information Systems*, Vol. 21, No. 3 (July, 1994), pp. 180–187.

Moyer, D. David and Bernard J. Niemann, Jr. “The Why, What and How of GIS Standards: Issues for Discussion and Resolution.” *URISA Journal,* Vol. 5, No. 2 (Fall, 1993),pp. 28–43.

Musselman, Curtis. “Implementation of SDTS in the Commonwealth of Virginia.” *Cartography and Geographic Information Systems*, Vol. 21, No. 3 (July, 1994), pp. 172–175.

Strand, Eric. “SDTS Masters Object-oriented Implementation.” *GIS World*, April, 1996, pp. 32–34.

Szemraj, John A., Robin G. Fegeas, and Billy R. Tolar. “Profile Development for the Spatial Data Transfer Standard.” *Cartography and Geographic Information Systems*, Vol. 21, No. 3 (July, 1994), pp. 150–154.

Tom, Henry. “The Spatial Data Standard: A Catalyst for Change.” *Cartography and Geographic Information Systems*, Vol. 21, No. 3 (July, 1994), pp. 136–139.

Tosta, N. “GIS Standards.” *GeoInfo Systems,* Vol. 2, No. 9 (October, 1992), pp. 28–31.

Ventura, Steve. “LIS/GIS Standards—an Industry Challenge.” *GIS World,* September, 1993, pp. 42–47.

Wortman, Kathryn C. “Developing Standards for a National Spatial Data Infrastructure.” *Cartography and Geographic Information Systems*, Vol. 21, No. 3 (July, 1994), pp. 132–135.

Wortman, Kathryn. “The Spatial Data Transfer Standard (FIPS 173): A Management Perspective.” *Cartography and Geographic Information Systems*, Vol. 19, No. 5 (December, 1992), pp. 294–295.