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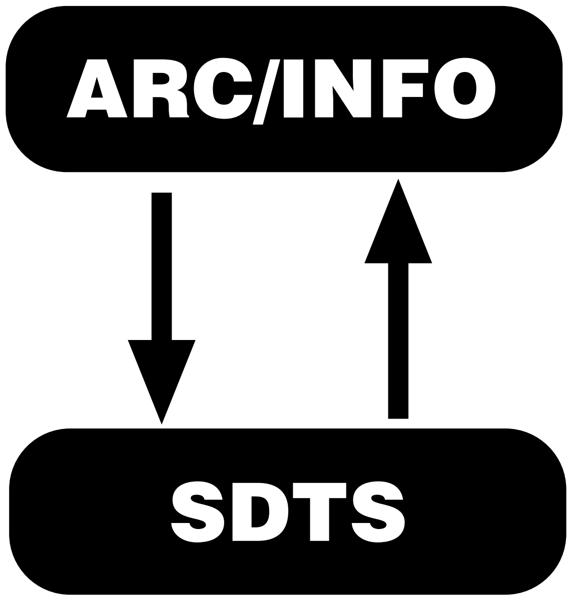

SDTS

Supporting the Spatial Data Transfer Standard in ARC/INFO®

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SDTS: Supporting the Spatial Data Transfer Standard in ARC/INFO

An ESRI White Paper

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SDTS: Supporting the Spatial Data Transfer Standard in ARC/INFO

Introduction

This white paper is meant to provide a base of information that you should have when considering using Spatial Data Transfer Standard (SDTS) data products with Environmental Systems Research Institute, Inc. (ESRI), ARC/INFO® software. It has been broken up into two main sections:

- ***The Spatial Data Transfer Standard.*** Understanding the SDTS helps to explain what to expect when using SDTS data products in ARC/INFO. The SDTS is complex and this white paper is not meant to restate the FIPS-173 but rather to provide a general use perspective. For a detailed understanding of SDTS, you should obtain a copy of FIPS-173.

- ***The Spatial Data Transfer Standard in ARC/INFO.*** This section walks you step by step through the conversion process. Conversion issues are presented and an attempt is made to define the type of complex database structures a user of SDTS data products can expect to encounter during the conversion process.

Also included is an appendix, Background and General Information, which provides general information about data standards and their relative importance in the geographic information system (GIS) community and touches on why data transfer standards have become so complex and comprehensive, requiring a more developed understanding of the data products they transport.

The Spatial Data Transfer Standard

The Spatial Data Transfer Standard is a Federal Information Processing Standard (FIPS) developed to accommodate different data models, preserve feature relationships of even the most complex database designs, and provide a mechanism to transfer on-line data dictionaries and metadata for certification and fitness for use.

Goals of the SDTS

The goals of the SDTS, as defined by the SDTS in FIPS-173, include

- Encode in a standard format.
- Provide machine and media independence.
- Accompany the data with their description.
- Preserve all meaning and relationships of the data.
- Keep both files and records to an appropriate maximum length.

SDTS and the National Spatial Data Infrastructure

The Federal Geographic Data Committee (FGDC) is responsible for the National Spatial Data Infrastructure (NSDI), a federal crackdown on the costly duplication of spatial data management activities abundant at every level of government. The NSDI consists of individuals of coordinating agencies, both federal and nonfederal, that will generate or use a national spatial data resource, the technology that will support its use, and the framework that will define and standardize it.

While new standards are being developed for data content, data model, and reference systems in support of a national data set, the NSDI is promoting the use of existing data standards including those already approved by the FGDC for data transfer and metadata storage.

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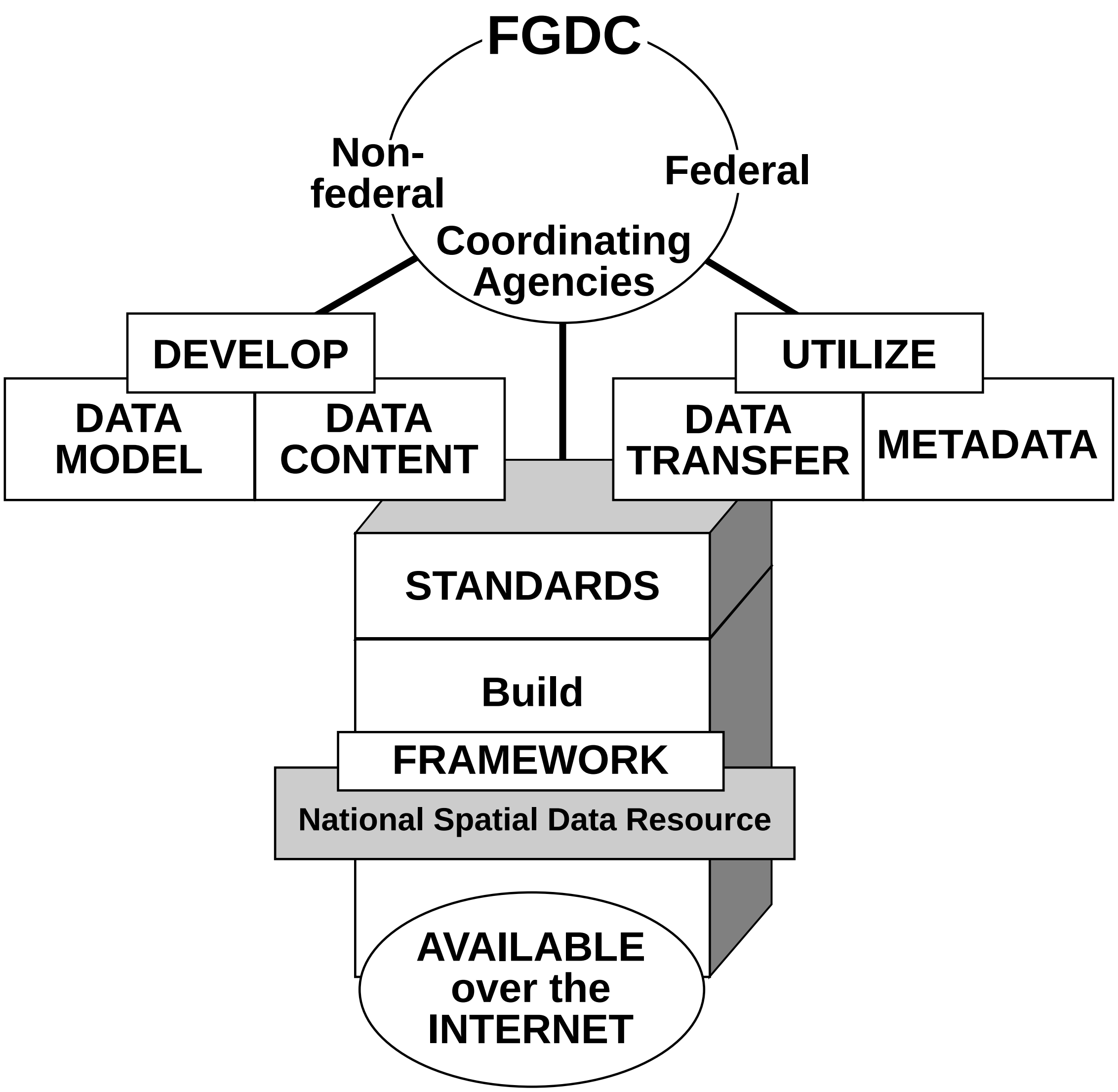

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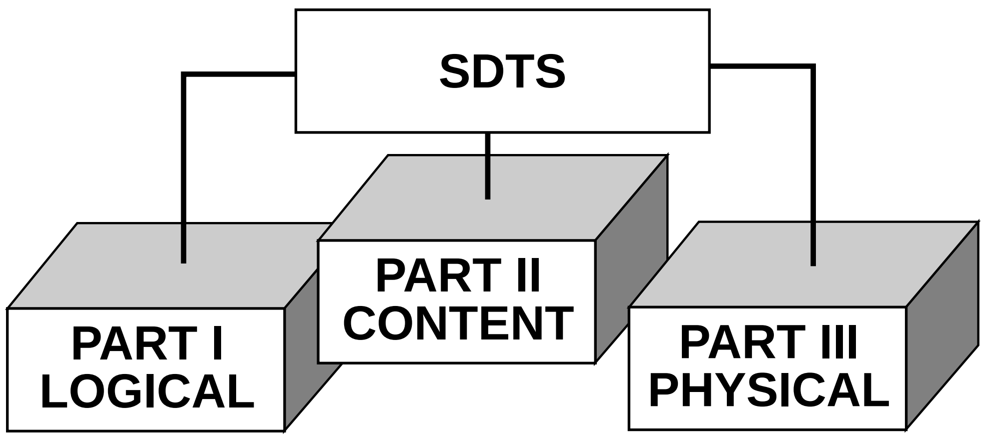
Providing a national spatial information resource current and accessible over the Internet is not just an ambitious dream, it is an executive order, issued to accelerate its accomplishment and ensure all nonfederal agencies cooperate with the FGDC to make it a reality.

The SDTS is the only transfer standard approved to support the growth of the NSDI. It is flexible, extendable, modular, and developed in the spirit of an "open GIS." It contains a living registry of defined spatial objects and entity terms, extensive documented metadata, and a well organized and structured on-line data dictionary.

Understanding SDTS

SDTS is not an exchange format. It is a standard or set of guidelines that, if strictly adhered to, will describe and preserve your database design and its underlying data model. The SDTS is made up of three main parts that describe the logical, conceptual, and physical structure of the different GIS data models.



Part I—Logical Representation

Part I deals with the logical representation of all data objects used to describe different data models. It provides guidelines for each object, how they are organized, named, and structured. The data objects include spatial objects, nonspatial objects, and composite feature objects.

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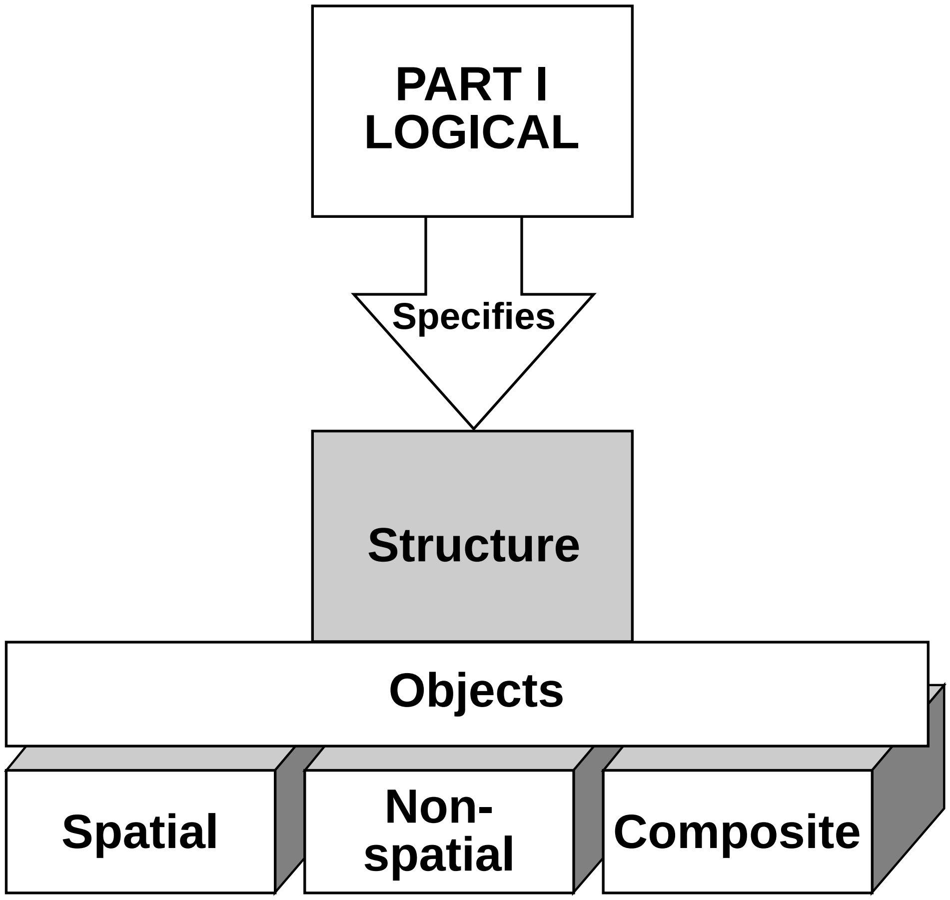

Part II—Data Content

Part II of the SDTS provides data content standards for spatial features, for both entities and attributes, in two data categories: topological and hydrographic. These were the only categories of features defined at the time the SDTS was approved. While the documentation only includes those features in these two categories, their definitions are stored on-line in a spatial register that is updated as new categories and features are identified and defined. Existing FIPS standards are used wherever possible.

While the documented content standards are reviewed and updated every five years in accordance with the Federal Information Processing Standard, the on-line spatial register is continually being updated.

Part I provides the guidelines for attribute and entities not defined by the content standards of Part II.

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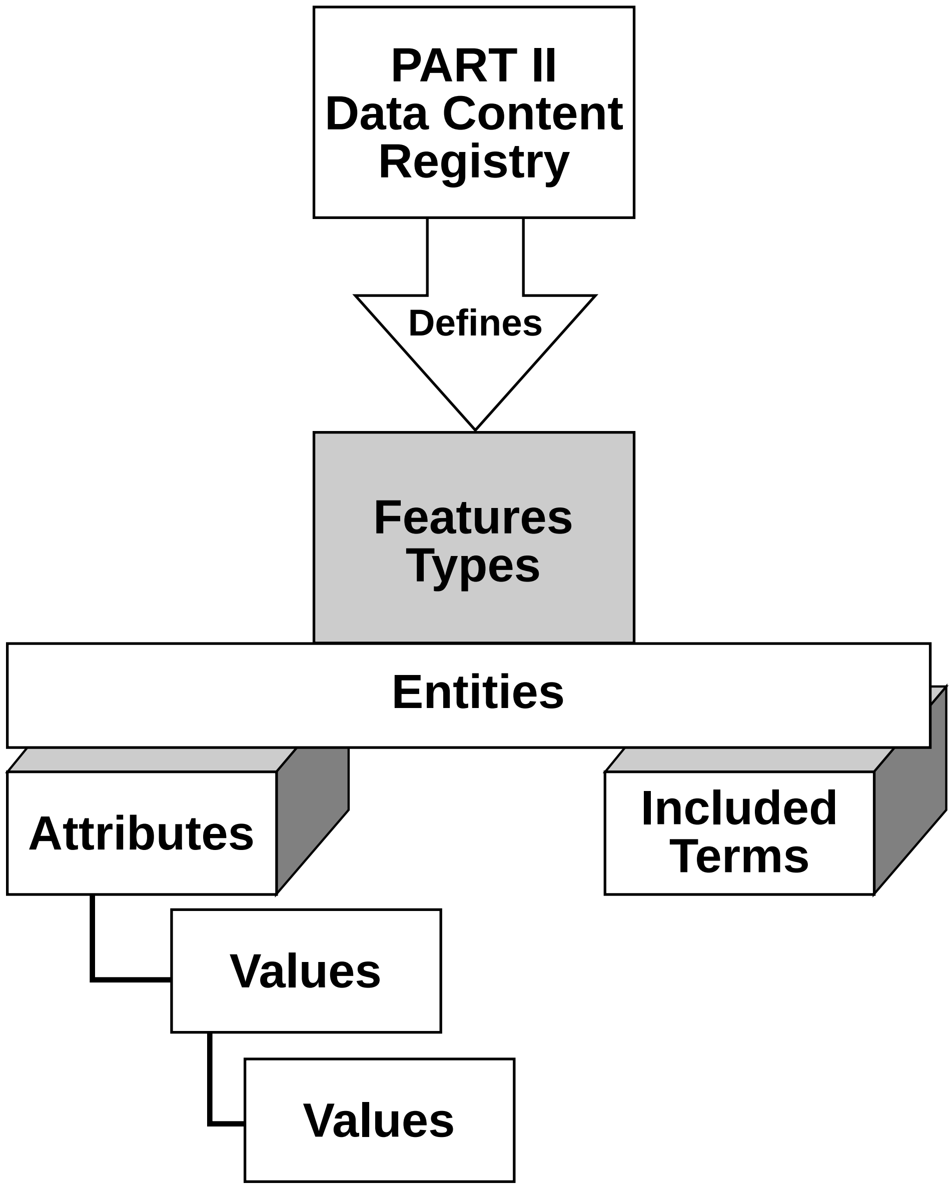

Anyone may request modifications to existing or additions of new terms and definitions of Part II. Proposed changes may be submitted to the U.S. Geological Survey (USGS) SDTS task force, where it will be considered for approval by members of a technical review board.

Part III—Physical Structure

Part III specifies the physical storage of the transfer using the ISO 8211 international standard for information interchange. The standard itself is embedded into the SDTS to ensure that data can be transferred to any computing environment. The USGS has developed and makes available a public domain software function library to assist in encoding and decoding SDTS data in ISO 8211 format.

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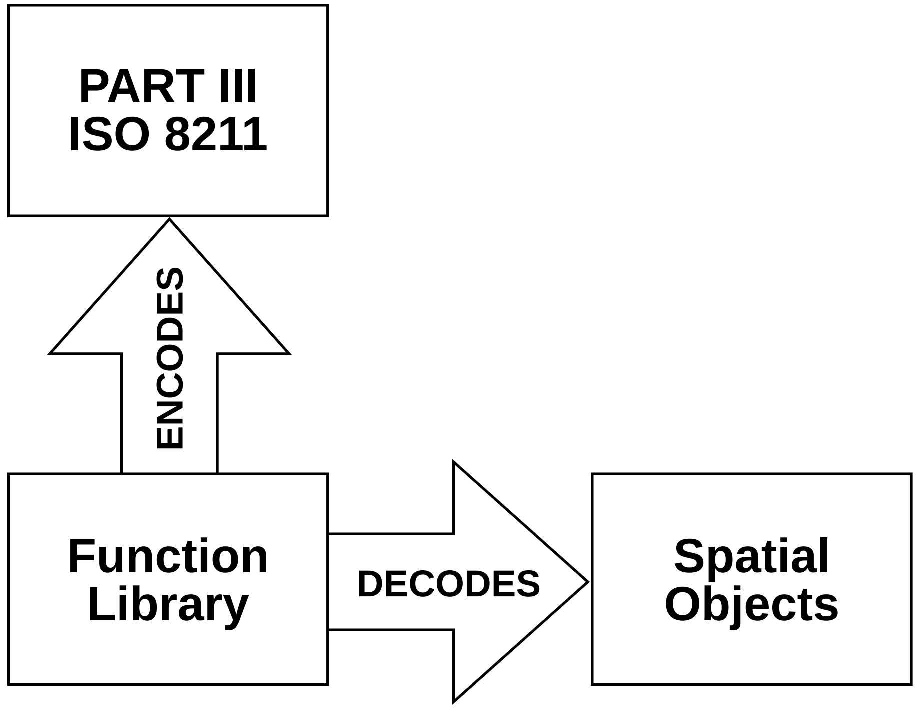

SDTS Profiles

While SDTS provides many options and restrictions for several very different data models, it is not intended that all options be used at once by any given spatial data set, but rather that the options be limited to only those needed to support its particular data model. This subset of options, once identified, is submitted for approval as its own FIPS and, once approved, is added as a new part to the SDTS as an SDTS profile.

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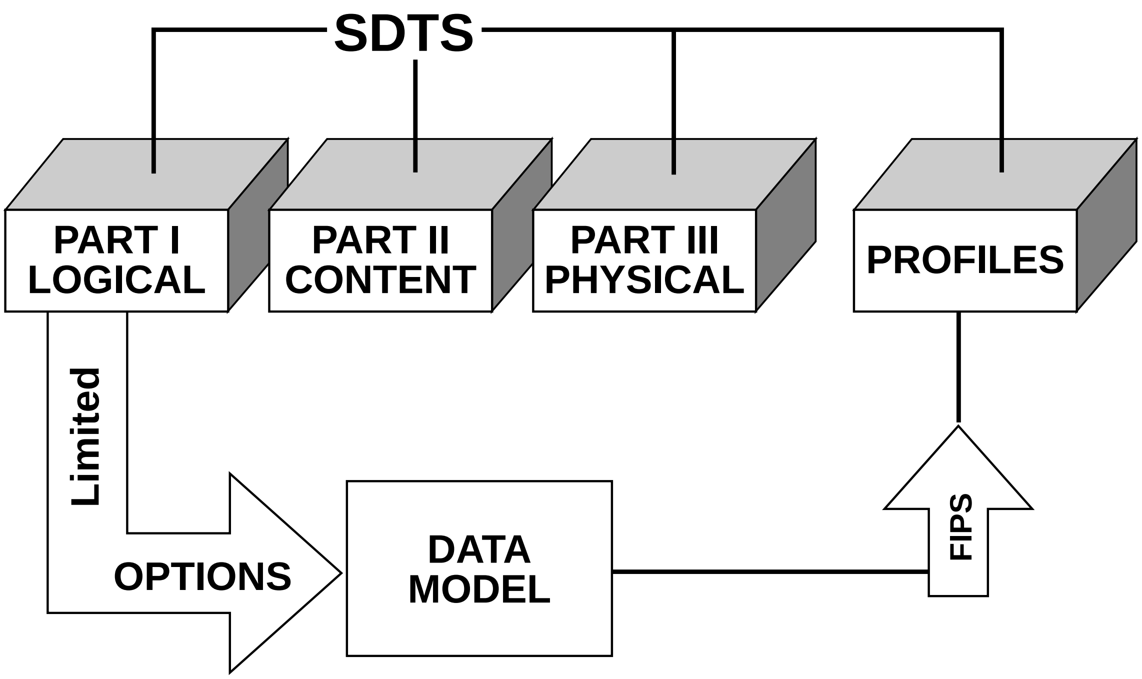
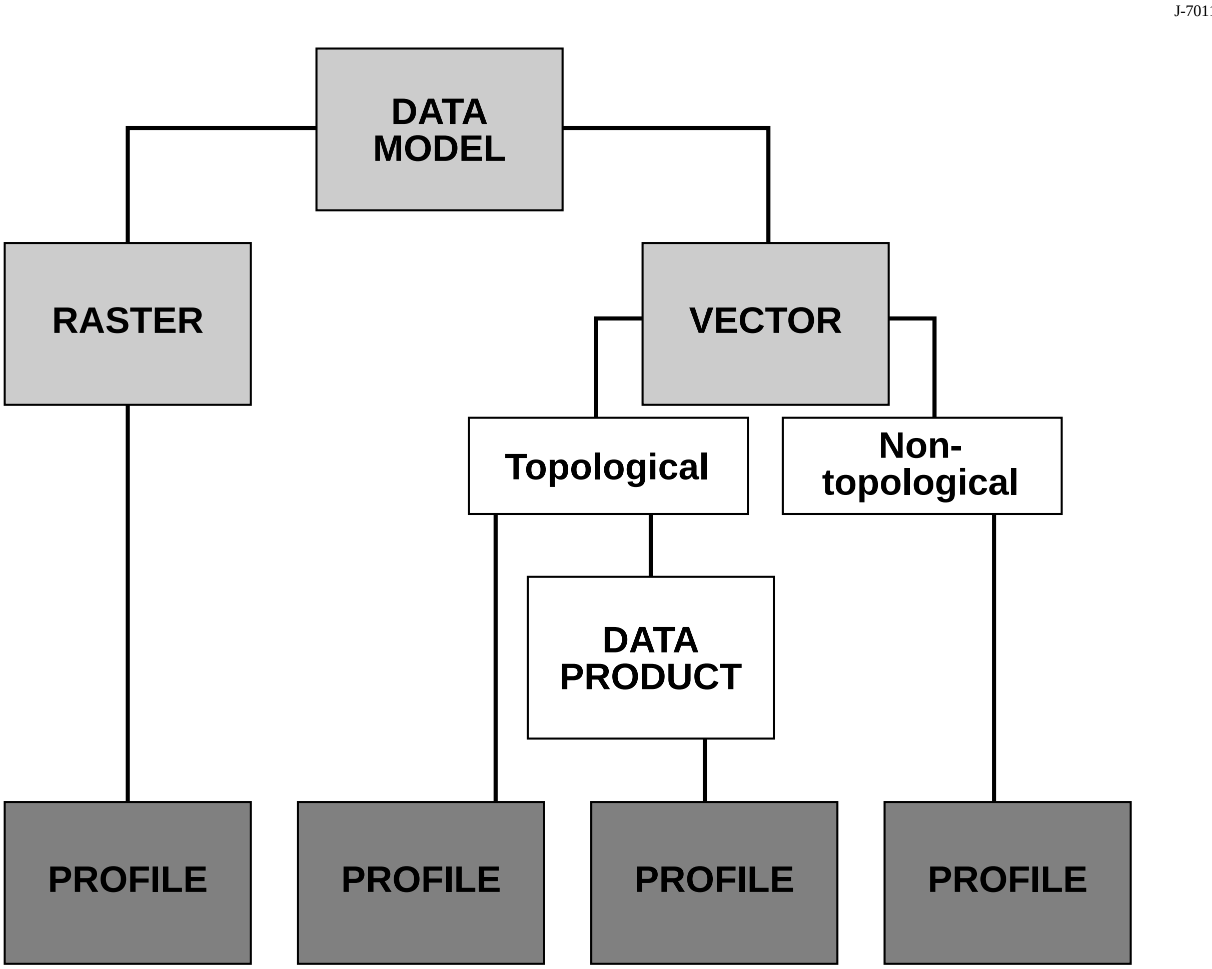


What Is the Basis for Profiles?

The primary basis for subdividing the SDTS into profiles is the data model. The two predominantly used GIS data models are raster and vector. This division is necessary because each data model employs an entirely different set of spatial objects. The vector data model is further divided into topological and nontopological data models because each requires a different subset of options of the SDTS.

In some cases, a data product will require restrictions, modifications, or extensions that may not be allowed by any existing profile for any data model. In this case, a new profile can be created. By allowing the additions of profiles, the standard can grow and expand to accommodate specific requirements not already addressed by the SDTS.



Current Profile Status

The first profile to be identified and approved is the Topological Vector Profile (TVP) for vector data with full and explicit topology. The next in line is a raster profile for image and gridded data. Under consideration are vector profiles for network/transportation data, for nontopological nautical chart and hydrographic data, and for CAD data.

Part IV—The Topological Vector Profile

Part IV of the SDTS standard is the TVP, the first and only profile currently approved as a Federal Information Processing Standard, and the only profile supported by ARC/INFO Version 7.xx.

TVP is to be used with geographic data or data that describe "real-world" features rather than a symbolized map graphic. The features have more than an identifying color or symbology but have definitions, attributes, and relationships to other "real-world" features.

Because the TVP will not support the different levels of topology that ARC/INFO allows, it will be necessary to create polygon topology for line coverages before exporting, and point data will require an accompanying polygon coverage with at least

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one area feature. A single transfer cannot contain multiple profiles, which means different geo_datasets must always be transferred separately.

The SDTS Transfer

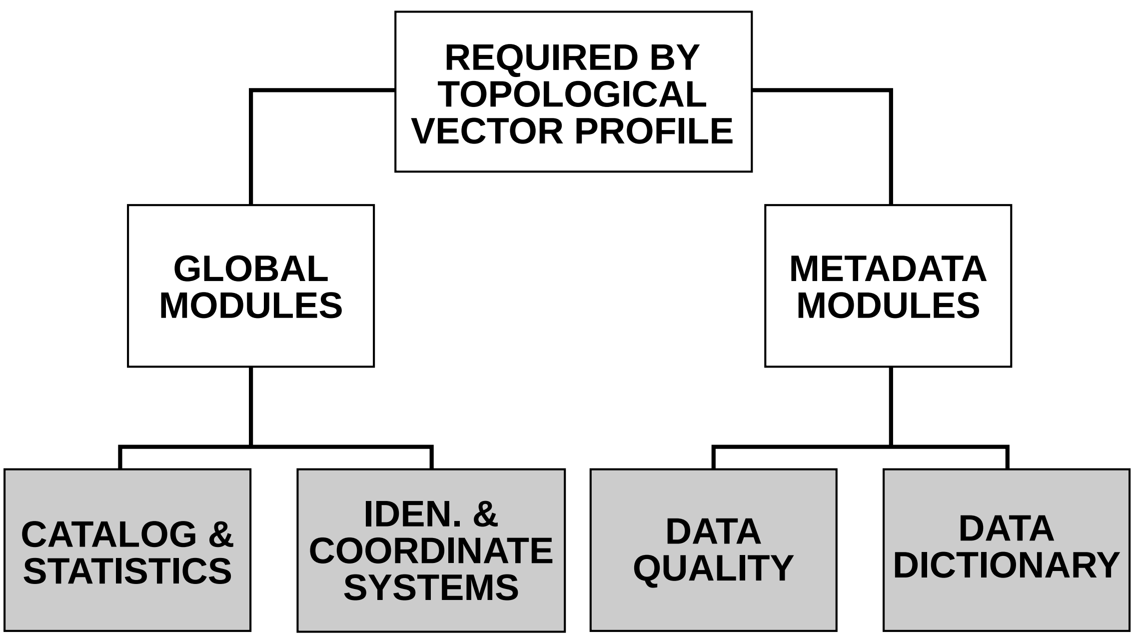
An SDTS transfer is made up of a set of files usually contained in a single directory. Every file in the transfer must have the same four-character alphanumeric prefix. Files belonging to the same transfer are identified using this prefix.

The main logical storage unit in an SDTS transfer is the module. There is usually one module per file and one file per module.

The file's name is an indication of the module it contains. Exceptions are allowed, but by convention files are named using the four-character mnemonic module name concatenated with the four-character file prefix. The .DDF extension is used to identify it as an ISO 8211 Data Descriptive File. File names are always 8.3-compliant and entirely in upper case. Module and file are used interchangeably to refer to the same thing (i.e., files in a transfer directory starting with the prefix AWTX will have a file named AWTXIDEN.DDF that contains the Identification module named IDEN).

Required Modules

The SDTS/TVP has certain mandatory modules that catalog and give statistical information about the transfer, identify the data set, and provide a means to convey metadata information for different levels of data abstraction: data set, theme, entity, feature, and attribute.



The modules that make up both global and metadata module categories must be present in all SDTS/TVP transfers.

Global Modules

The global modules provide detailed information about the transfer. All modules are

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cataloged and cross referenced. The relationship of one module to another is established. The global modules state the profile used, the name and geographic areas the data set covers, and the degree to which the transfer conforms to different aspects of the profile. The transfer coordinate systems, both external and internal, are specified as well.

Catalog and Statistics

Four modules provide a catalog directory of all modules and their relationship to other modules in the transfer and also give statistical information about their physical size.

Catalog Directory (CATD)

This module provides a complete listing of all modules in the transfer.

Catalog Cross Reference (CATX)

This module gives the relationship one module may have with another. If a transfer contains more than one data set, multiple volumes for the same module are linked together in this module.

Catalog Spatial Domain (CATS)

This module establishes hierarchical relationships of modules to geographic area, theme, and aggregated spatial and nonspatial objects.

Statistics (STAT)

This module lists the number of records for each module and the number of data coordinates for each spatial object module.

Identification and Coordinate Systems

Four modules provide transfer and data set identification, the spatial reference systems, and the spatial domain of the data set.

Identification (IDEN)

This module identifies the data set and gives the version of the SDTS and profile used at the time the transfer was generated. A transfer containing multiple data sets will have multiple identification records.

Item Name	**IDEN Field Descriptions**	**ARC/INFO Example**
STID	The title for the standard to which this transfer conforms	SPATIAL DATA TRANSFER STANDARD
STVS	Version date of the standard	1992 AUGUST 28
DOCU	FIPS publication number	FIPS PUB 173—1992
PRID	Title for the profile to which this standard conforms	SDTS TOPOLOGICAL VECTOR PROFILE
PRVS	Version and date of the profile	VERSION 1.0 JUNE 10, 1994
PDOC	FIPS publication number of the profile	FIPS 123-1 PART 4
TITL	Overall title or name that applies to all data content of the transfer	covername
DAST	Description of internal data structure	ARC/INFO
MPDT	Date of the real-world information representing the data	
DCDT	Creation date, processing history date stamp	19950307
SCAL	Indication of scale denominator for map display	
COMT	Additional comments. If data set uses an external data dictionary, it must state that here.	omitted
FFYN	Flag to indicate if transfer contains composite objects	Y

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Item Name	IDEN Field Descriptions	ARC/INFO Example
VGYN	Flag to indicate if transfer contains vector geometry	Y
GTYN	Flag to indicate if transfer contains topological relationships	Y
RCYN	Flag to indicate if transfer contains raster or image data	N
EXSP	Code to indicate if one of three recommended projections are used. 1 = Y, 2 = Other, 3 = Unknown	1
FTLV	Code to indicate level of conformance	4

External Spatial Reference (XREF)

This module contains the coordinate system or map projection and vertical datum for all the data or data sets in the transfer. This information is stored in the coverage projection parameter file.

Item Name	XREF Field Descriptions	ARC/INFO Example
COMT	Comment	
RDOC	Source of reference for external system	
RSNM	Reference system name	UTM
HDAT	Horizontal datum	NAS
ZONE	Zone number	10

Allowable TVP Coordinate Systems

SDTS has several different external referencing system options, but the Topological Vector Profile will allow only the following projections or coordinate systems:

- GEO—Geographic (Latitude and Longitude)
- SPCS—State Plane Coordinate System (Meters)
- UTM—Universal Transverse Mercator (Meters)
- UPS—Universal Polar Stereographic (Meters)

The coordinate systems SPCS, UTM, and UPS have a known relationship to longitude and latitude values, are interconvertible on a point-by-point basis, and are widely used by federal and state survey and mapping agencies.

Internal Spatial Reference (IREF)

This module provides scaling and transformation parameters to convert stored coordinates to the ground coordinate system of the external spatial reference module.

Item Name	IREF Field Descriptions	ARC/INFO Example
COMT	Comment	
SATP	Spatial Address Type	2-TYPLE
XLBL	Spatial Address X Component Label	EASTING
YLBL	Spatial Address Y Component Label	NORTHING
HFMT	Horizontal Component Format	B132
SFAX	Scale Factor X	0.01
SFAY	Scale Factor Y	0.1

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Item Name	**IDEN Field Descriptions**	**ARC/INFO Example**
XORG	X Origin	0.0
YORG	Y Origin	0.0
XHRS	X Component of Horizontal Resolution	0.0
YHRS	Y Component of Horizontal Resolution	0.0

A transfer usually only contains one data set but may contain a number of data sets. All data sets in a transfer must have the same external reference system, but each data set may have different internal coordinates with a different set of scaling factors and transformation parameters to restore them to the same ground coordinates of the external system.

Spatial Domain (SPDM)

This module specifies a boundary within which all the data coordinates fall (e.g., a map quadrangle may be specified by the latitude and longitude values of its neatline). This module is optional.

Metadata Modules

Metadata are important information about the data set. They will help determine if the data set is suitable for the needs of an individual or organization, provided they are detailed enough to accurately represent the content of the database. The required metadata defined within the SDTS provide information with which report utilities can help assess the data to determine their fitness for use and give users some measure of confidence about the data.

Data Quality

There are five data quality modules in the SDTS. These modules are basically free-form narrative descriptions without strict guidelines for their representation.

SDTS requires that data quality information be provided not only for the data sets but also for themes, coverages, and individual feature and spatial objects where this information is known and is different from the overall quality of the data set, but SDTS does not provide specifics on how this is to be achieved.

While the textual reporting style is easy to read, it is difficult to interpret, store, and quantitatively compare, as it will almost always differ from transfer to transfer. This is one area in SDTS that could be strengthened.

There can be anywhere from a few lines of text to volumes of textual information included in each data quality report. This can be stored in single or multiple records or linked via the catalog modules or by pointing to records in other modules. These pointers point to records that can give further information about the data quality record or to the feature or spatial object that the data quality record describes.

Data Quality Lineage (DQHL)

This module should provide a description of different data sources and methods employed to build or create the database. This should also include any transformation information or control points used for data registration or correction as well as update and processing histories and conflation procedures.

Data Quality Positional

Statements made about the positional accuracy may be based on deductive tests, control

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Accuracy (DQPA) procedures, graphic inspection, and by comparing against a source of known accuracy.

Data Quality Attribute Accuracy (DQAA) Statements made about the attribute accuracy may be based on deductive tests, control procedures, graphic inspection, and by comparing against a source of known accuracy.

Data Quality Logical Consistency (DQLC) Consistency reports should include documented tests or software used to test the fidelity of encoded relationships. Things tested would include valid intersections, duplicate or coincident features, polygon closure, and features that are too close or too small for reported tolerances.

Data Quality Completeness (DQCG) The degree to which the database exhausts the universal set of various features. If the database uses a standard such as FIPS for coding features, then any deviations from that standard, either by inclusion or exclusion, should be reported.

Data Dictionary The modules of the data dictionary provide a means to define the structure and meaning of all non-SDTS entities and attributes (i.e., those terms and definitions not included in the data content standard of Part II or on-line in the spatial features register).

Data Dictionary Definition (DDDF) This module provides a full descriptive definition of all non-SDTS entity or attribute labels referenced by the data domain module. If the Entity or Attribute label is not defined by Part II or the spatial features register, then the authority is not SDTS and must be defined in this module. If the authority is another FIPS, then the FIPSPUB number is cited.

Item Name	**DDDF Field Descriptions**	**ARC/INFO Example**
EORA	Entity or Attribute	ATT
EALB	Entity/Attribute Label	SHPEROID
SRCE	Source	ARC/INFO Data Management
DFIN	Definition	Spheroid Name
AUTH	Attribute Authority	ESRI
ADSC	Attribute Authority Description	Environmental Systems Research Institute, Inc.
EORA	Entity or Attribute	ATT
EALB	Entity/Attribute Label	IDTIC
SRCE	Source	ARC/INFO Data Management
DFIN	Definition	The User-ID for each tic
AUTH	Attribute Authority	ESRI
ADSC	Attribute Authority Description	Environmental Systems Research Institute, Inc.
EORA	Entity or Attribute	ATT
EALB	Entity/Attribute Label	cover_name_ID
SRCE	Source	ARC/INFO Data Management

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Item Name	DDDF Field Descriptions	ARC/INFO Example
DFIN	Definition	Feature subclass User-ID: A number assigned to each feature by the user. It can be used to relate additional attribute information to the feature.
AUTH	Attribute Authority	ESRI
ADSC	Attribute Authority Description	Environmental Systems Research Institute, Inc.

Data Dictionary Domain (DDOM)

This module specifies attributes and their associated value domains and serves to attach domain definitions to domain values. Each record shall specify a measurement unit, provide a definition, or reference a published source of definitions.

Item Name	DDOM Field Descriptions	ARC/INFO Example
ATLB	Attribute Label	SPHEROID
AUTH	Attribute Authority	ESRI
ATYP	Attribute Domain Type	ALPHANUM
ADVF	Attribute Domain Value Format	A
ADMU	Attribute Domain Measurement Unit	blank
RAVA	Range or Value	VALUE
DVAL	Domain Value	blank
DVDF	Domain Value Definition	blank
ATLB	Attribute Label	IDTIC
AUTH	Attribute Authority	ESRI
ATYP	Attribute Domain Type	INTEGER
ADVF	Attribute Domain Value Format	1
ADMU	Attribute Domain Measurement Unit	blank
RAVA	Range or Value	VALUE
DVAL	Domain Value	blank
DVDF	Domain Value Definition	blank
RAVA	Range or Value	VALUE
DVAL	Domain Value	blank
DVDF	Domain Value Definition	blank

Data Dictionary Schema (DDSH)

This module provides detailed table and item definitions including units of measurement and maximum field lengths.

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Item Name	DDSH Field Descriptions	ARC/INFO Example
NAME	Module Name	AXRF
TYPE	Module Type	ATPR
ETLB	Entity Label	blank
EUTH	Entity Authority	blank
ATLB	Attribute Label	SPHEROID
AUTH	Attribute Authority	ESRI
FMT	Format	A
UNIT	Unit of Measurement	blank
MXLN	Maximum Subfield Length	20
KEY	Key	NOKEY
NAME	Name	APNP
TYPE	Type	ATPR
ETLB	Entity Label	blank
EUTH	Entity Authority	blank
ATLB	Attribute Label	IDTIC
AUTH	Attribute Authority	ESRI
FMT	Format	1
UNIT	Unit of Measurement	blank
MXLN	Maximum Subfield Length	6
KEY	Key	NOKEY

External Master Data Dictionary Modules

The external master data dictionary directory, or masterdd, stores data dictionary modules that are shared by more than one transfer. The modules are named differently and stored in a separate directory than the transfer modules.

Six modules make up the masterdd, which include shared data dictionary information, identification, catalog, and data quality information. The data quality, catalog, and identification modules are only concerned with the master data dictionary and do not replace similar modules in the transfers.

- MIDE—Masterdd Identification
- MIDR—Masterdd Catalog Directory
- MDEF—Data Dictionary Definition
- MDOM—Data Dictionary Domain
- MQHL—Masterdd Data Quality Lineage
- MQLC—Masterdd Data Quality Logical Completeness

Spatial Object Modules

The TVP requires polygon topology. Required spatial objects include nodes, lines, and polygons. Optional spatial objects may include label points, entity points, and area points. Spatial objects are organized by type into individual modules. One module will contain all spatial objects of a given type for a given geographic area or partition of data.

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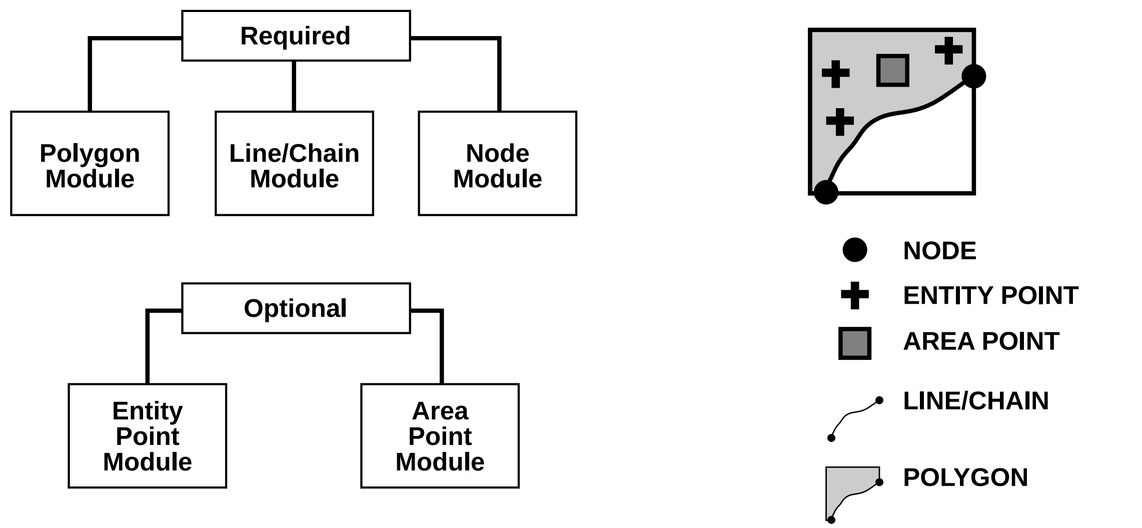
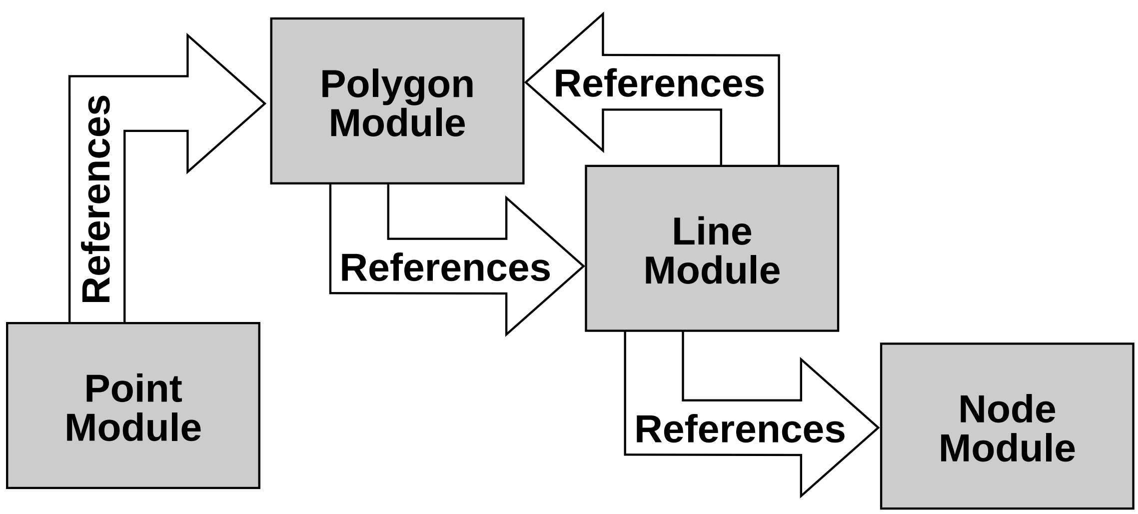


Spatial Object Relationships

Spatial objects build on other spatial objects. A node module contains coordinates for nodes. The line module contains coordinates for each linear chain, pointers locating the start and end nodes in the node module, and pointers to the left and right areas of each chain in the polygon module. The polygon module references chain records in the line module that make up the polygon and does not directly store any coordinates.



Aggregated Spatial Objects

The concept of building or aggregating objects is threaded throughout the SDTS. A single data partition representing a given horizontal partition of the earth's surface is composed of a polygon module, a line module, and a node module (with optional point modules) and collectively makes up an aggregated spatial object. The aggregated spatial object is what we would call a coverage in ARC/INFO.

Aggregated objects can be further aggregated horizontally into data layers, which are aggregated into a single map area or data set. These hierarchical relationships are stored in

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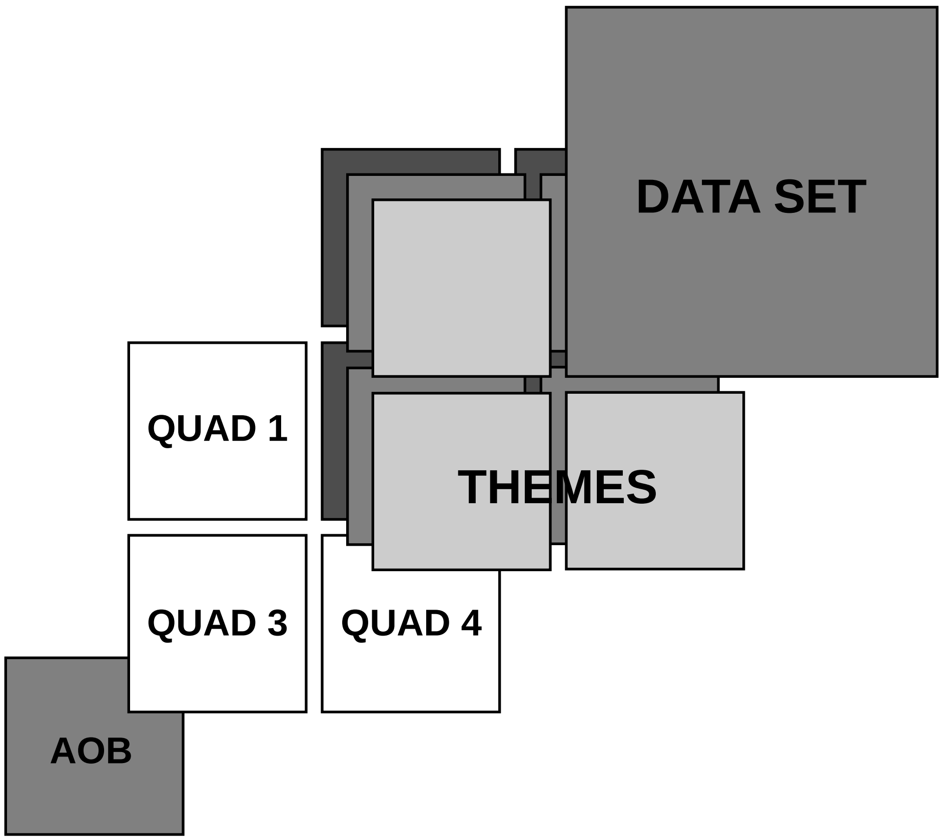
the Catalog Spatial Domain (CATS) module. Both spatial and nonspatial objects are linked by association to other higher level objects.

All primitive spatial object modules belonging to the same aggregated object will reference the same aggregated object (AOB). All AOBs belonging to the same theme will reference the same theme; all themes belonging to the same data set will use the same data set reference.



A data set may contain only one AOB and hierarchical relationships can be the result of aggregating nonspatial attribute modules.

Composite Objects

Another way to aggregate spatial features is by grouping together objects that represent a single entity or feature. This type of aggregation is done through spatial composite modules. These modules contain pointers to spatial objects in other modules. A composite object may contain different types of objects (i.e., a waterway feature may contain line and polygon objects, representing rivers, streams, and lakes).

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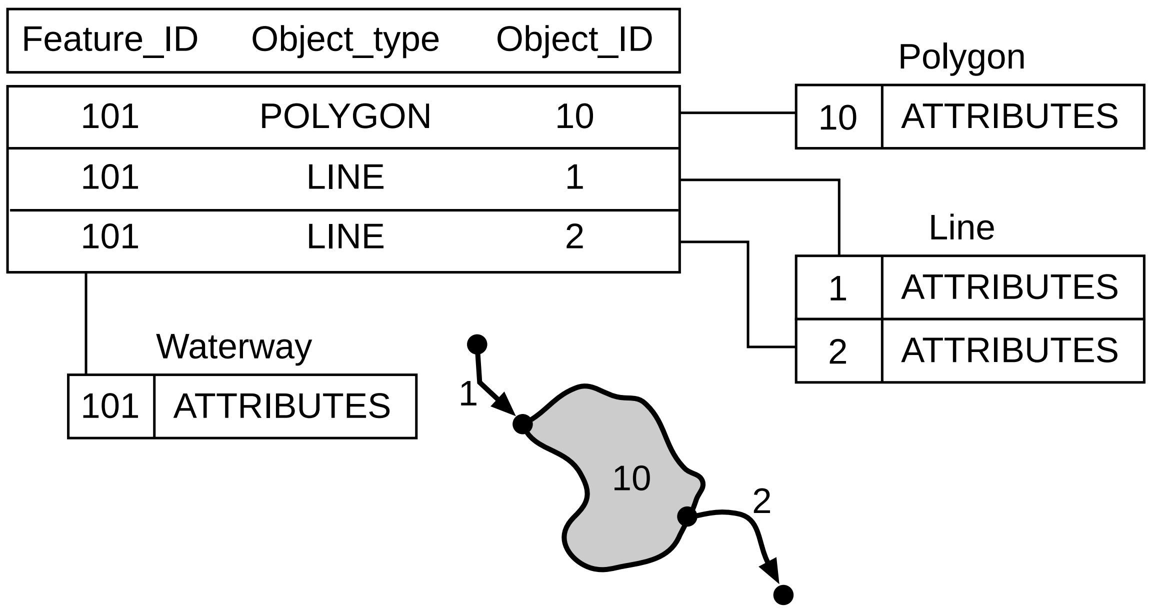

Composite objects can reference other composite objects. Composite objects can have attributes, and their component spatial objects can have attributes. This concept is used by feature-based systems where more complex phenomena are built from simpler ones.

Composite Modules in TIGER Data

The TIGER/SDTS TVP transfer contains a single data partition of fully integrated area features that represent different data layers. TIGER data define boundaries of over thirty different geographic entities, many of which overlap or participate in multiple areas.

The Bureau of the Census (BOC) uses the concept of a Geographic Tabulation Unit Base (GTUB) where areas sharing a unique set of attributes are grouped together and stored as a single feature. These GTUBs are then combined in different ways into larger areas that represent different administrative and political boundaries. This concept of aggregated features built into the BOC TIGER system is well represented in SDTS using spatial composite modules.

Attribute Modules

Attribute modules store tabular data with row and column information. There are two types of attribute modules, primary and secondary.

Primary attribute modules are referenced directly by other SDTS objects, either spatial or nonspatial, using pointers. Secondary attribute modules are not referenced directly by any objects but by item or relational join similar to a lookup table of values that further describes attributes in other modules.

The Spatial Data Transfer Standard in ARC/INFO

This section describes in technical terms the process of using SDTS data with ARC/INFO. There are two SDTS report utility commands in ARC/INFO:

- SDTSLIST lists the contents of any SDTS module in a readable ASCII format.

- SDTSINFO lists information about the data set contained in the identification and spatial reference modules and lists the names of all aggregated spatial objects (referred to as layers).

There are two conversion commands in ARC/INFO:

- SDTSIMPORT converts global, metadata, and attribute modules and converts the spatial modules of one AOB into one ARC/INFO coverage. SDTSIMPORT must be run once for every AOB in the TVP transfer.

- SDTSEXPORT converts a single cover and all attribute tables with the same cover prefix to a set of transfer files in SDTS/TVP format. It will create default mandatory modules if none exist.

IMPORTing

Step 1: Run SDTSLIST

If the data dictionary files are contained within the transfer they will convert automatically when you convert each AOB. Unfortunately, this means the data dictionary files are duplicated each time for each AOB. If the data dictionary is external to the transfer, this duplication can be avoided by converting once and then renaming the directory so it will not be used again in the conversion.

If the data dictionary is external to the transfer, there will be a statement to that effect stored in the comment field of the IDEN module. This is required by the SDTS.

```
Usage: SDTSLIST <SDTS_module>
SDTSLIST Austin/AWTXIDEN.DDF
COMT = This transfer requires an external data dictionary
from U.S.  Geological Survey, authority code USGS/NMD,
version 0.12.See the Data Quality: Lineage Report for an
explanation of this prototype DLG-E Product.
```

NOTE: In this example, the <SDTS_module>, AWTXIDEN.DDF, is located under the transfer directory Austin.

Step 2: Locate the masterdd

The master data dictionary directory containing the files for the external data dictionary must be named "masterdd" and located at the same level as the transfer directory. This is the only place that SDTSIMPORT will look. If it exists, it will be used in the conversion, otherwise no data dictionary will be converted.

List contents of directory to ensure external data dictionary is named "masterdd" and located at the same directory level.

```
Austin    masterdd
```

SDTSIMPORT will not look anywhere else for the data dictionary files.

Step 3:   Run SDTSINFO

```
Usage: SDTSINFO <in_transfer_prefix>
SDTSINFO Austin/AWTX
```

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```
IDENTIFICATION
  Standard Identification: SPATIAL DATA TRANSFER STANDARD
Profile Identification. . SDTS TOPOLOGICAL VECTOR PROFILE
Tile. . . . . . . . . . .  Austin West, TX
Number of layers 3
  Surface1
  Surface2
  Surface3
```

This transfer contains three aggregated objects named surface1, surface2, and surface3. The SDTSIMPORT commands will need to be executed once for each of the three AOBs or layers.

NOTE: In this example, the transfer prefix, AWTX, includes the name of the transfer directory Austin. Path names are also allowed.

Step 4: Run SDTSIMPORT

Use the point cover option to store entity points. If an AOB has points they will be stored in this optional coverage. If not, SDTSIMPORT will continue and will issue a message that no point features were converted.

```
SDTSIMPORT <in_transfer_prefix> <out_cover>
{out_point_cover} {layer_name}
```

- Specify first AOB using {layer_name} option.
- Specify an {out_point_cover}—It will be ignored if no points exist for that AOB.

```
Arc: SDTSIMPORT AWTX cov1 cov1_p Surface1
```

Step 5: Rename the masterdd

Before you run SDTSIMPORT again you should rename the masterdd. The data dictionary files are very large—sometimes thousands of records. An identical set of data dictionary tables will be created for every AOB you convert, which generates an incredible amount of duplicate information. To avoid this, rename the masterdd directory and when SDTSIMPORT is run again, it will be unable to locate the masterdd files and will not be able to generate duplicate data dictionary tables. SDTSIMPORT will issue a warning message but will continue to IMPORT.

Output from SDTSIMPORT

The AOB specified by {layer_name} converts to a polygon coverage. An optional point cover may also be generated. Polygon and line topology is built automatically. There is a clean translation from SDTS/TVP spatial objects to ARC/INFO spatial features. Except for the separate point cover, no force fitting or loss of spatial information occurs.

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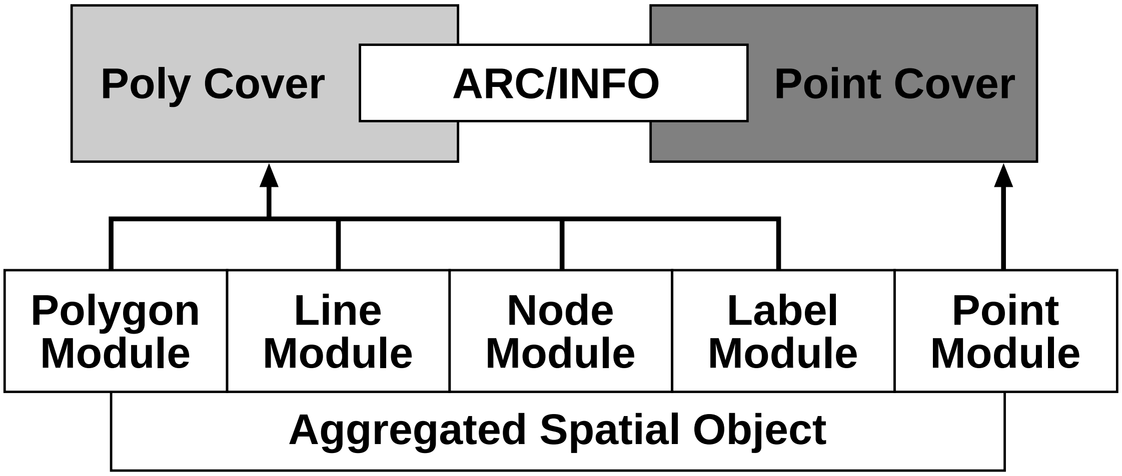

Nonspatial Modules in ARC/INFO

The global, metadata, composite, and attribute modules convert to ARC/INFO attribute tables. The output attribute tables are named cover.module_name. (i.e., the IDEN module, AWTXIDEN.DDF, converts to cover.IDEN). The data dictionary modules can contain lengthy textual information that SDTSIMPORT may need to break into multiple attribute tables. When a data field exceeds 320 characters, SDTSIMPORT splits up the text and stores it as multiple records in a related table. Composite modules that store nonspatial data or mixed feature types also require multiple tables to store the complex relationships.

Global and Metadata Modules

All modules can be listed and the contents viewed by the SDTSLIST command, but most of the information in the global and metadata modules is stored during the conversion.

CATD	Catalog Directory	Not stored
CATS	Catalog Spatial Domain	Not stored
STAT	Statistics	Not stored
MIDE	Masterdd Identification	Not stored
MDIR	Masterdd Catalog Directory	Not stored
MQCG	Masterdd Completeness	Not stored
MQHL	Masterdd Lineage	Not stored
CATX	Catalog Cross-Reference	cover.CATX
IDEN	Identification	cover.IDEN
IREF	Internal Reference	cover.SREF
SPDM	Spatial Domain	cover.SPDM
DQHL	Lineage	cover.DQHL
DQPA	Positional Accuracy	cover.DQPA
DQAA	Attribute Accuracy	cover.DQAA
DQLC	Completeness	cover.DQLC
DDDF	Data Dictionary—Definition	cover.DDDF

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DDDM	Data Dictionary—Domain	cover.DDDM
DDSH	Data Dictionary—Domain	cover.DDSH
MDEF	Masterdd Data Dictionary Definition	cover.DDDF
MDOM	Masterdd Data Dictionary Domain	cover.DDDM
XREF	External Reference	cover PRJ file

Preserving Attribute Relationships in ARC/INFO

We use different methods to preserve object-to-attribute and object-to-object relationships. Some relationships are straightforward and map directly into existing ARC/INFO data structures; others are more complex and require special handling. Composite modules made up of either lines or polygons map easily into ARC/INFO software's existing data structure.

- Composite modules made up of line features convert to route subclasses named cover.RATmodule_name.

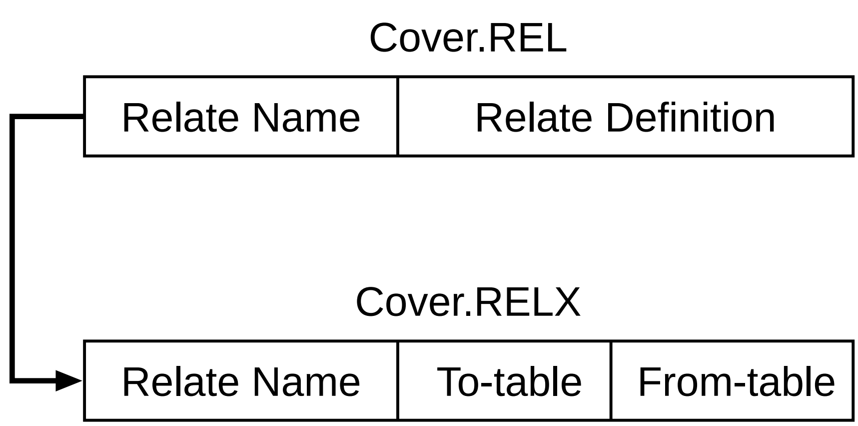
- Composite modules made up of area features convert to region subclasses named cover.PATmodule_name.

More complex attribute relationships found in complex composite modules made up of mixed feature types or compound composite modules composed of other composites require multiple attribute tables and special applications to query, maintain, and edit. This is a topic that will require further discussion as more complex data products become available.

Naming Attribute Tables and Relates

When two tables are related, we define and store the relate definition and we write a relate cross-reference table to identify both the TO_ and FROM_TABLEs intended to be related. In general, all relates are

- Defined
- Stored
- Cross-referenced



J-7011

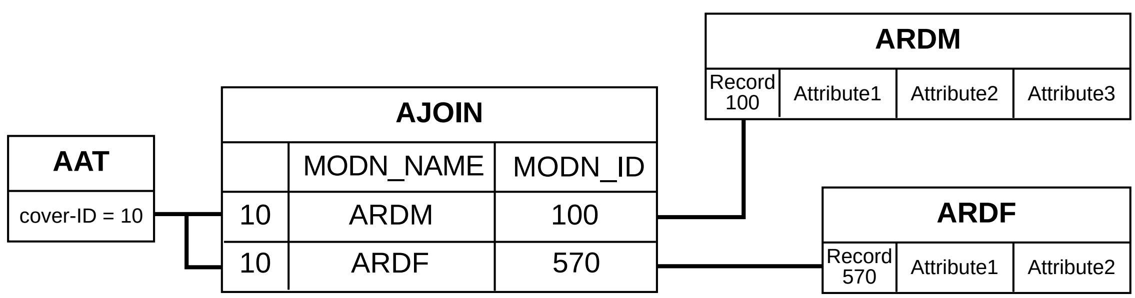
Module name is used to name both attribute table and relates.

RELATION	TO_TABLE	FROM_TABLE
AJOIN	Cover.AJOIN	Cover.AAT
ARDF	Cover.ARDF	Cover.AJOIN
ARDM	Cover.ARDM	Cover.AJOIN

JOIN Table Attributes: One-to-Many

In SDTS, spatial objects can have multiple sets of attributes associated with them. The attributes are not stored directly with the spatial features; instead, spatial objects store pointers to records in the primary attribute modules. A spatial object can point to many primary attribute modules, and different spatial objects can point to different primary attribute modules.

In ARC/INFO we cannot store multiple pointers associated with each feature in the feature attribute table. Instead we must use a join table to store all pointers. By relating the feature attribute table to its associated join table we can step through each record in the join table to access a feature's attributes. The pointers consist of the module name and module ID. The module name is the table identifier (i.e., module ARDM identifies cover.ADRM and the module-ID is the relate item). Cursors provide a way to navigate one-to-many relates in ARC/INFO.



Sample Macro to Display JOIN Table Attributes

Here is a sample macro that shows how to display the contents of each attribute table referenced by the feature attribute's JOIN table using cursors in ARCPLOT.

```
Usage: LISTJOIN <cover> <feature_class>
Arc: &run listjoin TR9 ARC
```

Start of Listing for listjoin.aml

```
&arg cover feat relate

/* AML to list attributes for each feature in the currently
/* selected set using JOIN table generated by SDTSIMPORT when
/* features have more than one set of attributes.
/* cursor rel remove
```

```
/* Determine the name of the JOIN table using feature class

&if %feat% cn arc &then &set join ajoin
&if %feat% cn poly &then &set join pjoin
&if %feat% cn node &then &set join njoin
&if %feat% cn point &then &set join xjoin

/* List JOIN file records for currently selected set

reselect %cover%.%join% info keyfile %cover% %feat% %cover%-
id
&type
list %cover%.%join%
&type

/* Declare and open cursor

cursor rel declare %cover% %feat%
cursor rel open
cursor rel first


/* Step thru each feature in the currently selected set


&do &while %:rel.AML$NEXT%
   &set feature [value :rel.%cover%-id]
   &type
   &type Feature [translate %cover%-id] = %feature%
   &type
   cursor rel relate %join% first

/* Loop thru each related record in JOIN table

&do &while [value :rel.%join%//AML$NEXT]
   &set record := [value :rel.%join%//modn_name]
   &type List [translate %cover%.%record%]
   &call getlist
   cursor rel relate %join% next
&end
   cursor rel next
&end

&return

&routine getlist
/* routine to list all items in related table
/* workaround for problem specifying ^relate
```

```
&set list [listitem %cover%.%record% -info]
&do item &list %list%
    &set val %join%//%record%//%item%
    &type %item% = [value :rel.%val%]
&end
&type
&return

&return
```

Output from listjoin.aml

Sample output from listjoin.aml in ARCPLOT using two line features selected from cover TR9. The selected line features have ID numbers 408 and 409.

```
TR9.AJOIN records : 6 of 3110 selected.

Record             TR9-ID         MODN_NAME         MODN_ID
 418                408             ARDF              383
 419                408             ARDM              137
 420                408             ARDM              138
 421                409             ARDF              384
 422                409             ARDM              139
 423                409             ARDM              140

Feature cursor REL now declared using file
 TR9.aat with Read Only access
Feature cursor REL now opened with
2 reselected records out of 2399
Fetched record 408 for Feature cursor REL

Feature TR9-ID    =  408

List TR9.ARDF
MODN_ID           =  383
ENTITY_LABEL      =  1700201
ARBITRARY_EXT     =
RELATION_TO_GROU  =
VERTICAL_RELATIO  =
OPERATIONAL_STAT  =
ACCESS_RESTRICTI  =
OLD_RAILROAD_GRA  =
WITH_RAILROAD     =
COVERED           =
HISTORICAL        =
LIMITED_ACCESS    =
PHOTOREVISED      =
LANES             =  -9
ROAD_WIDTH        =  -99
BEST_ESTIMATE     =
```

```
List TR9.ARDM
MODN_ID           =  137
ROUTE_NUMBER      =  US 45W
ROUTE_TYPE        =

List TR9.ARDM
MODN_ID           =  138
ROUTE_NUMBER      =  SR 5
ROUTE_TYPE        =

No more related records for relate AJOIN
Fetched record 409 for Feature cursor REL

Feature TR9-ID    =  409

List TR9.ARDF
MODN_ID           =  384
ENTITY_LABEL      =  1700201
ARBITRARY_EXT     =
RELATION_TO_GROU  =
VERTICAL_RELATIO  =
OPERATIONAL_STAT  =
ACCESS_RESTRICTI  =
OLD_RAILROAD_GRA  =
WITH_RAILROAD     =
COVERED           =
HISTORICAL        =
LIMITED_ACCESS    =
PHOTOREVISED      =
LANES             =  -9
ROAD_WIDTH        =  -99
BEST_ESTIMATE     =

List TR9.ARDM
MODN_ID           =  139
ROUTE_NUMBER      =  US 45W
ROUTE_TYPE        =

List TR9.ARDM
MODN_ID           =  140
ROUTE_NUMBER      =  SR 5
ROUTE_TYPE        =

No more related records for relate AJOIN
No more records to fetch for Feature cursor REL
Arcplot: :
```

EXPORTing

SDTSEXPORT will convert a single ARC/INFO coverage to a set of transfer files that are SDTS/TVP-compliant. All attribute tables associated with that coverage will be converted automatically. By this, we mean any INFO table that has been given the same cover name prefix will be translated. All route, region, and annotation subclasses associated with the cover will be converted.

SDTSEXPORT will generate a default set of mandatory modules, but the information contained will be limited to standard ARC/INFO item definitions, tolerances, and log file contents. A more complete source of metadata should be provided.

To create metadata tables and global information tables that you can populate with your own data, use templates generated from SDTSIMPORT. SDTSEXPORT will search for INFO files that have the same name and format output by SDTSIMPORT.

You can run SDTSEXPORT using your coverage, then re-IMPORT to get the tables you want. Purge the records generated by SDTS EXPORT/IMPORT and use COPYINFO to make copies for each coverage you plan to EXPORT to SDTS format and add the information you want.

- Converts only one coverage.
- Converts all attribute tables named cover.
- Checks for valid projection definition.
- Writes default mandatory modules.
- Reads existing tables in correct format with recognizable names.

Converting Point Data with No Polygon Topology

The TVP requires polygon topology and, therefore, a coverage containing point features alone cannot be converted without using a separate polygon cover with a minimum of one area feature. You can create a bounding box in a separate cover and build for polygon topology. The polygon cover must accompany the point cover when you run SDTSEXPORT.

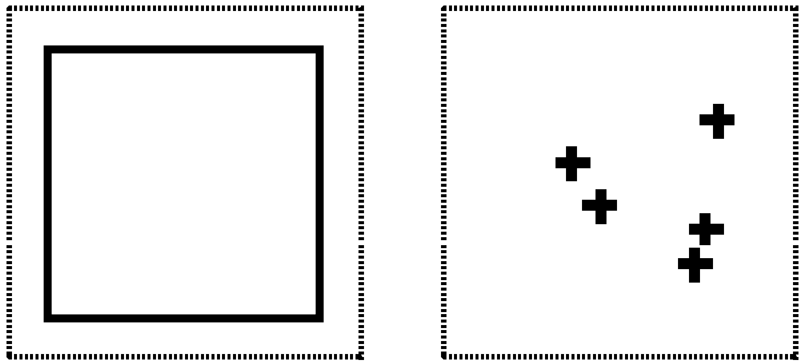
- Build for polygon topology.

- Run SDTSEXPORT using bounding box as <in_cover> and point cover for {in_point_cover}.

```
Usage: SDTSEXPORT <in_cover> <out_transfer_prefix>
{in_point_cover}

Arc:SDTSEXPORT boxcov AWTX pointcov
```

J-7011



boxcov **pointcov**

Note: Meters is the only units allowed by SDTS/TVP, but SDTSEXPORT will take a coverage in STATEPLANE–FEET and automatically convert into the TVP transfer as STATEPLANE–METERS. The internal coordinates in the IREF module will be in meters.

When Is SDTS the Best Choice?

- If you plan to use federal geographic data products
- And you want access to metadata information
- And you want on-line data dictionaries and entity definitions
- And you want feature attribute values and relationships
- And you are willing to invest time and thought into designing an application to view, manage, and edit the database

Or

- If you are producing spatial data products
- That will be exchanged between different environments
- And you want to provide metadata information
- And you want to provide on-line data dictionaries and entity definitions
- And you want to preserve and provide feature attribute definitions, values, and relationships

Appendix—Background and General Information

Agreement in Data Standards

The increased use of GIS technology has created an explosive demand for GIS data and this demand has brought data standards into close focus, the scope of which extends beyond the data themselves to areas governing hardware and software, data collection and management, and data storage and transfer.

Standards are a way for us to collectively agree on issues that help reduce the amount of chaotic ambiguity that results when there is an abundance of data collection activities and a lack of standardized methods for doing them. When we increase our ability to share information, we effectively reduce costs involved in its acquisition.

Standards allow us to communicate with little confusion or misinterpretation. When we are all using the same terminology, we can share information the same way we can share ideas when we speak the same language. One important aspect of standards is standards for data exchange.

Standards for Data Exchange

There is a different data exchange format for every major digital data product distributed outside its native environment, most of which carry only basic spatial information and minimal attributes. Decades have been spent collecting data and organizing them into comprehensive databases. The investment in data is staggering, and the need to disseminate this information is a growing concern that has brought about the development of a very high order of standards for data exchange. Nowhere is this more evident than in the major data producing agencies of the federal government, where the development of a standard way to describe and transfer federal geographic data products has become a government mandate.

Three federal agencies are the responsible maintenance authorities for what has become national and international standards for data exchange.

The U.S. Geological Survey maintains the Spatial Data Transfer Standard, a federal standard used to transfer a variety of federal data products including DLG, TIGER/Line, and GRASS.

The Defense Mapping Agency (DMA) is the U.S. guardian of the international military format DIGEST which has evolved into a family of exchange standards including VPF, a format for direct access and distribution of DMA's Digital Chart of the World data product.

The National Ocean Service is the developing agency for DX90, the international standard for hydrographic and nautical chart data.

Even though each agency worked in open communication and coordinated their efforts with one another, the resulting standards, though similar, branch off in different directions to meet their users' needs. While their goals were the same, the client bases they served were different.

Each of the three standards are large, complicated, and nearly all-encompassing, providing solutions for feature-based, vector, raster, and matrix formats. To date, the harmonization studies have been done and recommendations made as the next step toward unifying these standards into a larger, more comprehensive set of data content and data exchange standards that will adhere to the fundamental guidelines of the SDTS.

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