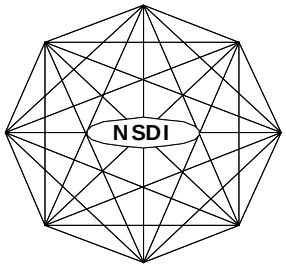


National Spatial Data Infrastructure

# SDTS CADD Profile - Public Review Draft

## FGDC Facilities Working Group

August 1997

Federal Geographic Data Committee
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Department of Housing and Urban Development • Department of the Interior • Department of State
Department of Transportation • Environmental Protection AgencyFederal Emergency Management Agency • Library of Congress
National Aeronautics and Space Administration • National Archives and Records Administration
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# 1. Introduction

An SDTS profile is defined as a limited subset of the Spatial Data Transfer Standard, designed for use with a specific type of data. Specific choices are made for encoding possibilities not addressed, left optional, or left with numerous choices within the SDTS Standard.

## *1.1 Objective*

Computer Aided Design and Drafting software poses a special challenge to the current profiles of the SDTS standard. These programs allow for several types of elements that are not considered "normal" for Geographic Information Systems. But CADD software makes up a large portion of the GIS marketplace. In particular, the use of 3 dimensional elements and complex curves are fairly common to CADD software, but not to the rest of the GIS market.

### *1.1.1 Data Supported*

The data supported by this profile is 2 Dimensional vector data, or 3 dimensional vector data where the 3rd dimension is the "height" of the object. This data may or may not have topology. Excluded are raster data, and 2 dimensional transfers already represented by another profile.

## *1.2 Scope and Definition*

The Computer Aided Design and Drafting Profile (CADD) contains specifications for an SDTS profile for use with vector-based geographic data as represented in CADD software. The purpose of this profile is to

facilitate the translation of this data between CADD packages without loss of data, and support the translation of this data between CADD and mainstream GIS packages.

## 1.3 Conformance

### 1.3.1 Transfer Conformance

In order to conform to this CADD Profile, an SDTS transfer shall:

(a) contain all mandatory spatial objects, modules, fields, and subfields as specified in this profile.

(b) conform to all requirements of Parts 1, 2, and 3 of SDTS unless they conflict with this profile.

(c) conform to all restrictions of SDTS Parts 1, 2, and 3, as specified in this profile.

(d) be formatted in compliance with ANSI/ISO 8211.

(e) follow all module and file naming conventions of this profile.

(f) adhere to all other requirements of this profile.

### 1.3.2 Encoder Conformance

In order to conform to this CADD Profile, an SDTS encoder shall:

(a) be able to be directed to generate only SDTS CADD transfers which conform to this specification.

(b) convert spatial objects in the input system (both CADD and GIS) to appropriate SDTS spatial objects.

(c) convert attribute data stored in the input system (such as in a data base) to SDTS Attribute Primary and Attribute Secondary modules (or provide a reasonable alternative for retrieving these values).

(d) correctly maintain linkages between spatial objects and attributes.

### *1.3.3 Decoder Conformance*

(a) be able to interpret CADD Profile transfers which conform to section 1.2.1.

(b) be able to decode any module required or permitted by this profile.

(c) be able to decode any spatial object permitted by this transfer.

(d) be able to convert any Attribute Primary or Attribute Secondary module and convert it to a format usable by the output system.

(e) correctly maintain linkages between spatial objects and Attribute Primary records.

(f) be able to ignore modules, fields, and subfields that are optional, or not currently defined.

(g) be able to recover if an error is encountered in a particular record, field, or subfield in the SDTS transfer.

(h) report to a file or device all errors encountered during a transfer, along with severity.

## *1.4 Changes to SDTS Standard Requirements*

In cases where this profile conflicts with any portion of the SDTS Standard, the requirements of this profile shall be met.

## 1.5 Applicability

Software developers should use this standard to develop encoders and decoders for CADD data transfers. Data providers should use this standard to create and verify valid SDTS CADD data sets.

## 1.6 Related Standards

The SDTS Topological Vector Profile was used as a starting point for this profile, and both are based upon Parts 1-3 of the SDTS standard.

## 1.7 Standards development procedures

This standard was developed as a modification of the SDTS Topological Vector Profile in order to support CADD data. CADD developers and software vendors participated in a study to determine the scope of the standard and then integrated into this profile.

## 1.8 Maintenance authority

The Department of Defense, U.S. Army Corps of Engineers maintains the SDTS CADD Profile for the Federal Geographic Data Committee with support from the Tri-Service CADD/GIS Technology Center. All general questions and comments concerning this standard should be addressed to:

**U. S. Army Corps of Engineers**
**General Engineering Branch**
**20 Massachusetts Avenue, NW**
**Washington, DC 20314-1000**

All technical question and comments pertaining to this standard should be directed to:

**Tri-Service CADD/GIS Technology Center**
**ATTN: CEWES-IM-DA**
**3909 Halls Ferry Road**
**Vickburg, MS 39180-6199**

# 2.0 Spatial Data Concepts

## *2.1 Spatial Objects*

The following table indicates which spatial objects are required, optional, or not permitted for this profile.

| Object Representation Code | Required | Optional | Not Permitted |
|---|---|---|---|
| NP - Node | | x | |
| NL - Label Node | | x | |
| NE - Entity Node | x | | |
| NA - Area Node | | x | |
| NO - Planar Node | | x | |
| NN - Network Node | | x | |
| LQ - Link | | x | |
| LS - String | | x | |
| LE - Complete Chain | x | | |
| LL - Area Chain | | x | |
| LW, LY- Network Chain | | x | |
| AC - Circular Arc | | x | |
| AE - Elliptical Arc | | x | |
| AU - Uniform B-Spline | | x | |
| AB - Piecewise Bezier | | x | |
| RM - Ring with Mixed Composition | | x | |
| RS - Ring composed of Line Strings | | x | |
| RU - Ring composed of Chains | | x | |
| RA - Ring composed of Arcs | | x | |
| PG - G-polygon | | x | |
| PC - GT-polygon | | x | |
| PR - GT-Polygon | | x | |
| PU - Universe Polygon | | x | |
| PW - Universe Polygon | x | | |
| PV - Void Polygon | | x | |
| PX - Void Polygon | | x | |
| GI, GJ, GK, GM - Raster Objects | | | x |
| FF - Composite | | x | |

The minimal transfer that conforms to this profile will consist of one universe polygon.

### *2.1.1 New Entities*

This profile requires a minimum of two new entities to express infinite lines. They are described below as an extension to the Line Module definition:

**Unbound Line (LU) /Line Directed (LD)**

| FIELD NAME | SUBFIELD NAME | FIELD/SUB FIELD DESCRIPTION | TYPE | DOMAIN | DOMAIN DESCRIPTION | SDTS MNEMONIC |
|---|---|---|---|---|---|---|
| Line (P) | | | | | | LINE |
| | Module Name | A unique identifier for the module. | A | Alphanum | Name shall begin with an alphabetic character other than SPACE. | MODN |
| | Record ID | Line object record identifier. | I | Integer | Unsigned integer. With Module Name shall form unique ID within the file set. | RCID |
| | Object Representation | Representation code for the object. | A | LU<br>LD | Line, Unbound<br>Line, Directed | OBRP |
| Attribute ID | | Foreign identifier for Attribute Primary module record. | | | | ATID |

| | | | | | | |
|---|---|---|---|---|---|---|
| Spatial Address | | Spatial address of line point. The order of the instances of this field indicates the construction of the line in terms of vertices. The last point is the direction that goes to infinity for type LD. | | | | SADR |
| Composite ID | | Foreign identifier of Composite module record which includes this line | | | | CPID |

## *2.2 Layers and (or) Partitions*

Data are represented as all of the elements necessary to transfer one or more 2 or 3 dimensional manifold.

More than one layer may be included in a single transfer.

# 3 General Specification (The Transfer Model)

## *3.1 Standard Module Names*

SDTS Computer Aided Design and Drafting Profile module names (the unique module name of each individual module) shall be standardized, and consist of four characters. For modules carrying spatial objects, the module name shall begin with the same two characters as the object representation code for the objects (use “PC for modules with “PC”, “PX”, and “PW” objects and use “FF” for composite objects (including block/cell modules). The other valid two character Object Representation codes are defined in Section 2.1, Spatial Data Concepts, Spatial Objects. The last two characters of the module name are free to distinguish different modules/files. Attribute Primary and Secondary modules shall be named “Axxx” and “Bxxx” respectively (where x is any number 0-9 or any upper case letter A-Z).

Non-object modules shall be named the same as the primary module field mnemonic (ISO 8211 Tag):

| | |
|---|---|
| IDEN | Identification |
| CATD | Catalog/Directory |
| CATX | Catalog/Cross Reference |
| CATS | Catalog/Spatial Domain |
| SCUR | Security |
| IREF | Internal Spatial Reference |
| XREF | External Spatial Reference |
| SPDM | Spatial Domain |
| DDDF | Data Dictionary/Definition |
| DDOM | Data Dictionary/Domain |
| DDSH | Data Dictionary/Schema |
| STAT | Statistics |

| | |
|---|---|
| DQHL | Data Quality/Lineage |
| DQPA | Data Quality/Positional Accuracy |
| DQAA | Data Quality/Attribute Accuracy |
| DQLC | Data Quality/Logical Consistency |
| DQCG | Data Quality/Completeness |

More than one module of the following types may exist:

| | |
|---|---|
| SCUR | Security |
| IREF | Internal Spatial Reference |
| SPDM | Spatial Domain |
| DDDF | Data Dictionary/Definition |
| DDOM | Data Dictionary/Domain |
| DDSH | Data Dictionary/Schema |
| DQHL | Data Quality/Lineage |
| DQPA | Data Quality/Positional Accuracy |
| DQAA | Data Quality/Attribute Accuracy |
| DQLC | Data Quality/Logical Consistency |
| DQCG | Data Quality/Completeness |

If more than one of any of these modules exists in a transfer, the last letter shall be changed to a digit to differentiate the file names.

## *3.2 Order of Records, Fields, and Subfields within Modules*

(a) Records within modules shall be ordered in ascending order, by Record ID. The actual Record ID values need not start at “1”, and may arbitrarily skip integers.

(b) The subfields within fields and fields within records shall be ordered as in the SDTS module specification layout tables in Part 1, Section 5.

## 3.3 Spatial Address (Coordinate) Format

### 3.3.1 Internal Representation of Spatial Addresses

The internal representation of X, Y, and Z coordinates shall be as 32-bit signed implicit fixed point binary numbers ("BI32" SDTS type). Signed integers are to be represented in "two's complement" big-endian format. Note that use of the FIPS 123 library (public domain) will allow the reading and writing of these numbers in the correct format on a variety of platforms.

### 3.3.2 Restrictions on X, Y, and Z Subfields

The X subfield of spatial addresses shall only be used to transfer longitude and easting values. The Y subfield shall only be used to transfer latitude or northing values. The Z subfield of spatial addresses shall only be used to transfer altitude information, in inches above sea level.

## 3.4 Null, Unused, and Unknown Values

When a transfer has fixed length subfields (e.g. to carry attribute data linked to the various objects), then special consideration must be given to handling Null values. The SDTS default option for implementing nulls is not feasible in this case. When appropriate, the following text shall be encoded in the comment subfield of a Logical Consistency module record, and implemented:

When a subfield, either user-defined in Attribute Primary and Attribute Secondary module records, or in other SDTS module records, is implemented as fixed-length, the following null scheme is used: (a) when information to be encoded in the subfield is known to be undefined, then the subfield is valued by the string “Undefined”; (b) when the information is known in the source data set, but not used in the translation to SDTS, then the subfield is valued by the phrase “Not Applied”; (c) when the information to be encoded is relevant, but unknown or missing from the source data, the subfield is valued by the string “Unknown”.

The Logical Consistency module with the above text shall be associated to applicable modules through the Catalog/Cross Reference module.

## *3.5 Attribute Usage*

All agencies shall use established FIPS codes where applicable, such as FIPS PUB 6-4 (31 August 1990) Counties and Equivalent Entities Codes or FIPS PUB 10-3 (9 February 1984) Countries, Dependencies, Areas of Special Sovereignty and their Principal Administrative Division.

## *3.6 Minimum Transfer*

(a) For objects particular to one “Layer”, there shall be:
exactly one Polygon module for simple object types PC, PW, and PX
exactly one Chain module for simple object type LE
exactly one Point-Node module for simple object type NE
zero or one of all other allowed modules.

# 4 Transfer Module Specification

This section addresses the module level restrictions as they apply to a transfer. Certain requirements of Part 1 are repeated here for clarity. Following the module level restrictions/requirements, any restrictions on field/subfield values are noted for each module. The order of coverage follows that of Part 1, Section 5.

The following table contains the inclusion/exclusion, and cardinality rules for each module. The standardized modules names are included, along with the minimum number of occurrences of the module type. A lowercase "n" indicates that the upper limit is user defined. Any lowercase letters or dots in the module name has the meaning explained in Section 4, Standard Module Names.

| **Module Type** | **Name** | **Min. No.** | **Max. No.** |
|---|---|---|---|
| *Global Information* | *Modules ( see also Part1* | *Section 5.2, Global* | *Information Modules.* |
| Identification | IDEN | 1 | 1 |
| Catalog/Directory | CATD | 1 | 1 |
| Catalog/Cross-Reference | CATX | 1 | 1 |
| Catalog/Spatial Domain | CATS | 0 | 0 |
| Security | SCUr | 0 | n |
| Internal Spatial Reference | IREf | 1 | n |
| External Spatial Reference | XREF | 1 | 1 |
| Registration | .. | 0 | 0 |
| Spatial Domain | SPDm | 0 | n |
| Data Dictionary/Domain | DDOm | 1 | n |



| | | | |
|---|---|---|---|
| Data Dictionary/Definition | DDDf | 0 | n |
| Data Dictionary/Definition | DDDf | 0 | n |
| Data Dictionary/Schema | DDSh | 1 | n |

| | | | |
|---|---|---|---|
| Transfer Statistics | STAT | 1 | 1 |
| Composite Module | FF.. | 0 | n |
| *Attribute Modules ( see* | *also Part1, Section 5.4,* | *Attribute Modules )* | |
| Attribute Primary | A… | 0 | n |
| Attribute Secondary | B… | 0 | n |
| *Vector Modules ( see also* | *Part 1, Section 5.6,* | *Vector Modules )* | |
| Point-Node | NE.. | 1 | n |
| | NO.., NA..,NL..,NP.., | | |
| | NN.. | 0 | n |
| Line | LE.. | 1 | n |
| | LQ..,LS..,LW..,LY..LD.., | | |
| | LU.. | 0 | n |
| Arc | AC..,AE.. | 0 | n |
| Ring | RM..,RS..,RU..,RA.. | 0 | n |
| Polygon | PW.. | 1 | n |
| | PG..,PR..,PU.., PC.. | 0 | n |
| *Raster Modules* | .. | 0 | 0 |
| *Graphic Representation* | *Modules* | | |
| Text Represenation | TEXT | 0 | n |
| Color | COLX | 0 | n |
| Font | FONT | 0 | n |
| Area Fill | AFIL | 0 | n |
| Symbol Representation | SYMB | 0 | n |



| | | | |
|---|---|---|---|
| Line Representation | LNRP | 0 | n |

## 4.1 Global Information Modules

(a) For each SDTS transfer data set that does not reference an external SDTS data dictionary, there must be at least one and it is recommended that there by only one of each of the following global modules:

Data Dictionary/Domain ( DDOM )

Data Dictionary/Schema ( DDSH )

For each SDTS transfer data set that does not reference an external SDTS data dictionary and that does not have level 1 feature conformance with Part 2, there must be at least one and it is recommended that there by only one of the following global module:

Data Dictionary/Definition ( DDDF )

(b) A common set of Data Dictionary/Definition and Data Dictionary/Domain modules may be used for an entire series of files to be distributed. This Data Dictionary may be made available separately; and it need not be duplicated within each SDTS transfer. If the SDTS data dictionary is separate from the individual SDTS transfer data set, then it shall be uniquely identified and referenced by the individual SDTS transfer data set.

## 4.2 Attribute Modules

( see also Part 1, Section 4.5, Attribute Modules )

(a) There is no restriction on the relationships between objects and Attribute Primary module records: the relationship may be one-to-one, one-to-many, many-to-one or many-to-many. If the relationship is not one-to-one or one-to-many, the encoder is required to alert decoders to

this fact in the Catalog/Cross Reference module record the modules involved. This shall be done by placing the characters “JJ” into the first two characters of the comment subfield.

## 4.3 Composite Module

( see also Part 1, Section 5.5, Composite Module )

(a) Composite objects may optionally not have a list of component objects.

(b) Chains comprising a continuous linear composite object may be ordered. Each Chain ID in the list of components may have an “F” ( for forward ) or “B” ( for backward ) in the Foreign ID Usage Modifier subfield ( see Part I, Section 5.1.2, Foreign Identifiers ). The list of chain Foreign Ids may be ordered such that: the first point ( start node of “F” chains and end node of “B” chains) of each chain following the first in the list, shall be equivalent to the last point ( end node of “F” chains and start node of “B” chains ) of the previous chain in the list ). The ordering and forward/backward chain usage modifiers are included to allow the transfer of directional information for composite objects representing such things as one-way roads and drains.

## 4.4 Vector Modules

( see also Part 1, Section 5.6, Vector Modules )

### 4.4.1 Universe Polygon

( see Part 1 definition 2.3.3.3.1 )

A universe polygon ( object representation code “PW”) is mandatory. Its Record ID subfield shall be encoded with “1”. Attributes of the universe polygon, if any, shall have null values ( see below for specifications for implementing null values.) The Ring ID field is not permitted for universe polygons with an object representation code of “PW”.

### *4.4.2 Void Polygons*

( see Part 1 definition 2.3.3.3.2 )

Other GT-Polygons may be included with attribution similar to the universe polygon: these void polygons shall be coded with a “PX” object representation. The Ring ID field is not permitted for void polygons with an object representation code of “PX”.

### *4.4.3 Attribute Primary Reference*

Object records may reference zero, one or more attribute primary records except for area points ( “NA” object representation code) which shall always reference zero attribute primary records. Attribute primary references for area points should instead be contained in the surrounding GT-polygon spatial object record.

### *4.4.4 Number of Object Types Within a Single Module*

A single module shall contain only records of a single object type ( indicated by appropriate object representation code), with the technical exception that modules carrying “PC” ( GT-polygon ) records may also contain a “PW” ( universe polygon) and “PX” ( void polygon ) records.

### 4.4.5 Label Points

The Attribute Primary Foreign ID ( PAID ) field is mandatory for the “NL” object representation code. This field references the record and the label of the attribute to be annotated. This field shall reference an attribute record in either an Attribute Primary module or an Attribute Secondary module.

## 4.5 Graphic Representation Modules

These modules may be optionally included in a transfer. Encoders and decoders are required to support these module types to be conforming to this profile.

## 4. 6 Module Restrictions/Requirements: Identification Module

( see also Part 1, Section 5.2.1, Table 10 Identification )

### 4.6.1 Profile Identification

Each transfer encoded per these specifications shall have:

“SDTS COMPUTER AIDED DESIGN AND DRAFTING PROFILE”

as the value of the Profile Identification subfield of the Identification module primary field.

Each transfer shall have:

“VERSION 1 AUGUST 4, 1997”

as the value of the Profile Version subfield of the Identification module primary field.

Each transfer shall have:

“SDTS CADD Profile”

as the value of the Profile Document Reference subfield of the Identification module primary field.

## *4.7 Module Restrictions/Requirements: Internal Spatial Reference*

The X subfield of spatial addresses shall be used only for longitude and easting values. The Y subfield shall be used only for latitude and northing. The Z subfield shall be used only for altitude measured in inches above sea level. Therefore, the spatial address X component label subfield is restricted to "LONGITUDE" when the spatial reference system is geographic or "EASTING" when the external spatial reference system is UTM/UPS or SPCS, or "OTHER" when the external spatial reference system is not geographically based.

## *4.8 Module Restrictions/Requirements: External Spatial Reference*

The Reference System Name subfield in the External Spatial Reference Module primary field shall have the value "GEO", "SPCS", "UTM", "UPS", or "OTHER", depending upon the external spatial reference system being used.

## *4.9 Module Restrictions/Requirements: Catalog/Directory*

So that the contents of a transfer are independent of the transfer media, the following restrictions are placed on the primary field of the Catalog/Directory module:

(a) the Volume subfield shall only be used to describe a Uniform Resource Locator (URL) address.

(b) The File subfield shall not include a directory path, only a file name meeting the requirements of Section 6.5.

## 4.10 Module Restrictions/Requirements: Data Dictionary/Schema

The Entity Authority and Attribute Authority subfields shall contain “SDTS-USA” when Part 2 of FIPS 173 is the authority for the definition. When a standard register of entities and attributes of a country other than the United States is the authority, these subfields shall contain “SDTS-“ followed by the three-character ISO 3166 country code. Entity Authority and Attribute Authority may have a maximum length of 8 graphic characters.

## 4.11 Module Restrictions/Requirements: Data Dictionary/Domain

The Attribute Authority subfield may have a maximum length of 8 graphic characters

## 4.12 Module Restrictions/Requirements: Data Dictionary/Definition

The Attribute Authority subfield may have a maximum length of 8 graphic characters

# Appendix A  Sample Mappings.

Attached is a summary of SDTS data type translations for two sample systems:

| ***SDTS Type*** | ***AutoCAD Type*** | ***Intergraph Type*** |
|---|---|---|
| FF (Composite Objects) | Block,  Multi-Line, and Multiline Text | Cell, Shared Cell, Text Node, Complex Shape |
| LS (Line String) | Line, Open Polyline w/o Bulge | Line, Complex Chain |
| *****LD (Line Directed) | Ray | Line with H-bit set in header |
| *****LU (Line Unbound) | Xline | Line with H-bit set in header |
| PG (G-Polygon) | Closed Polyline | Shape |
| AC (Arc Circular) | Circle, Polylines w/Bulge, Arc | Ellipse, Arc (both where Major axis == Minor axis) |
| AE (Arc, Elliptical) | Ellipse | Ellipse |
| AU, AB | Pline with non-zero curve type Spline | B-Spline elements (Pole, Weight, etc.) |
| NP (Point Node) | Points | Point String, Points |
| NE (Entity Node) | Insert | Shared Cell *Instance* |
| NL (Label Node) | Attrib, Text | Text |
| RS (Surface) | 3Dface, 3Dsolid | 3D Surface |
| Line Representation | Line Style | All (Line Style Element of Record Header) |
| Text Representation | Text, M-Text | Text, Text Node |
| Color Representation | Color Table | Color Table |
| Font Representation | Text, M-Text | Text, Text Node |

***Notes:***

1. Line Directed (LD) is a proposed new SDTS line type with a start-point and a direction.
2. Line Unbound (LU) is a proposed new SDTS line type with two points indicating an unbound line.