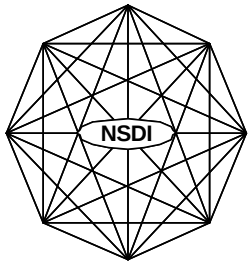
FGDC-STD-002.7-2000




National Spatial Data Infrastructure

# Spatial Data Transfer Standard (SDTS)
# Part 7: CADD Profile

FGDC Facilities Working Group
Federal Geographic Data Committee

March 2000

Federal Geographic Data Committee
Department of Agriculture Department of Commerce Department of Defense Department of Energy
Department of Housing and Urban Development Department of the Interior Department of State
Department of Transportation Environmental Protection Agency
Federal Emergency Management Agency Library of Congress
National Aeronautics and Space Administration National Archives and Records Administration
Tennessee Valley Authority

## Federal Geographic Data Committee

Established by Office of Management and Budget Circular A-16, the Federal Geographic Data Committee (FGDC) promotes the coordinated development, use, sharing, and dissemination of geographic data.

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## 7.1 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 that are not addressed, left optional, or left with numerous choices within the SDTS Standard.

### 7.1.1 Objective

This SDTS Computer Aided Design and Drafting (CADD) Profile supports exchange of geospatial data contained within CADD systems with other geoprocessing systems. CADD software makes up a large portion of the Geographic Information Systems (GIS) marketplace. CADD software allows for several types of elements, in particular, the use of three-dimensional elements and complex curves that are not commonly used by GIS. This profile allows the representation of two- and three-dimensional geographic vector data from CADD packages to be transferred via the SDTS standard.

### 7.1.2 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.

This profile supports two-dimensional vector data and three-dimensional vector data, where the third dimension is the "height" of the object. These data may or may not have topology. This profile does not support raster data or two-dimensional transfers already represented by another profile.

### 7.1.3 Applicability

This SDTS CADD Profile is applicable for use of exchange of geospatial CADD data with other geoprocessing systems (e.g. CADD and GIS). Software developers should use this standard to develop encoders and decoders for CADD geographic data transfers. Data providers should use this standard to create and verify valid SDTS CADD geographic data sets.

### 7.1.4 Related and Referenced Standards

The SDTS Part 4: Topological Vector Profile was used as a starting point for the SDTS CADD profile. The following standards constitute provisions of the CADD Profile by specific reference within the text of the CADD Profile:

SDTS Part 1: Logical Specifications
SDTS Part 2: Spatial Features
SDTS Part 3: ISO 8211 Encoding
SDTS Part 4: Topological Vector Profile
ANSI NCITS 320-1998:Spatial Data Transfer Standards (SDTS).
ISO 8211-1984 Data Descriptive File for Information Interchange

### 7.1.5 Standards development procedures

The participants directly involved in the development of this CADD Profile were: Applied Software Technologies, Inc., members of the CADD/GIS Technology Center, and members of the FGDC Facilities Working Group. Dave Horner, CADD/GIS Technology Center, coordinated development of the SDTS CADD profile. Donald W. and Lori A. MacVittie, Application Software Technologies, Inc. (AZTECH), compiled and drafted this Standard.

This standard was developed as a modification of the SDTS Topological Vector Profile in order to support geospatial CADD data. The GIS Solutions Group at AZTECH, working with the CADD/GIS Technology Center, merged the input contained in several reports that documented the interests of CADD developers and software vendors (e.g., Intergraph, Bentley, and Autodesk) in CADD-related spatial data exchange. That input was then integrated into this profile

### 7.1.6 Maintenance authority

The Department of Defense, U.S. Army Corps of Engineers maintains the SDTS CADD Profile with support form r the Federal Geographic Data Committee and 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 questions and comments pertaining to this standard should be directed to:

CADD/GIS Technology Center
ATTN: CEWES-IM-DA
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

## 7.2 Spatial Data Concepts

### 7.2.1 Spatial Objects

Table 1 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 | |

Table 7-1 Spatial Objects.

7.2.1.1 Entities

This profile requires a minimum of two new entities to express infinite lines. They are described as extensions to the Line Module definition: Unbound 2.1.1.1 Line (LU) /Line Directed (LD) inTable 2.

| 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 |
| 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 |

Table 7-2 Line (LU)/Line Directed

7.2.2 Layers and (or) Partitions

Data are represented as all of the elements necessary to transfer one or more two-dimensional or three-dimensional manifold. More than one layer may be included in a single transfer.

## 7.3 General Specification (The Transfer Model)

7.3.1 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 two other valid character Object Representation codes "LU" and "LD" are defined in Section 2.1. The last two characters of the module name may be defined 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 have the same name 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.

7.3.2 Order of Records, Fields, and Subfields within Modules

(a) Records within modules shall be ordered by Record ID in ascending order. 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.

7.3.3 Spatial Address (Coordinate) Format

7.3.3.1 Internal Representation of Spatial Addresses

The internal representation of X, Y, and Z coordinates shall be 32-bit signed implicit fixed point binary numbers ("BI32" SDTS type). Signed integers shall be represented in "two's complement" big-endian format. Note that use of the ISO 8211 library (public domain) will allow reading and writing of these numbers in the correct format on a variety of platforms.

7.3.3.2 Restrictions on X, Y, and Z Subfields

The X subfield of spatial addresses shall only be used to transfer longitude or 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.

7.3.4 Null, Unused, and Unknown Values

When a transfer has fixed length subfields (e.g. to carry attribute data linked to 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.

7.3.5 Attribute Usage

All agencies shall use established FIPS codes where applicable, such as FIPS PUB 6-4, Counties and Equivalent Entities Codes or FIPS PUB 10-4, Countries, Dependencies, Areas of Special Sovereignty and their Principal Administrative Division.

7.3.6 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.

### 7.4 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. Restrictions on field/subfield values are noted for each module. The order of coverage follows that of Part 1, Section 5, Transfer Module Specification, of SDTS.

Table 3 contains the inclusion/exclusion, and cardinality rules for each module. 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. The meaning of lowercase letters or dots in the module name are explained in SDTS Part4, Section 4.1, Standard Module Names, of SDTS.

| **Module Type** | **Name** | **Min. No.** | **Max. No.** |
|---|---|---|---|
| *Global Information* | *Modules ( see also Part 1* | *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/Schema | DDSh | 1 | n |
| Data Quality/Lineage | DQHL | 1 | 1 |
| Data Quality/Positional Accuracy | DQPA | 1 | 1 |
| Data Quality/Attribute Accuracy | DQAA | 1 | 1 |
| Data Quality/Logical Consistency | DQLC | 1 | 1 |
| Data Quality/Completeness | DQCG | 1 | 1 |

| **Module Type** | **Name** | **Min. No.** | **Max. No.** |
|---|---|---|---|
| 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 |
| 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 |

Table 7-3 Module Rules

7.4.1 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 data dictionary. It is recommended that there be 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 data dictionary. It is recommended that there be only one of the following global modules:

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.

7.4.2 Attribute Modules (see also SDTS Part 1, Section 5.4, Attribute Modules)

(a) There is no restriction on 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 between objects and Attribute Primary module records is not one-to-one or one-to-many, the encoder is required to identify the modules involved in the Catalog/Cross Reference module record by placing the characters “JJ” into the first two characters of the comment subfield.

7.4.3 Composite Module (see also SDTS 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 so that the first point ( start node of “F” chains and end node of “B” chains) of each chain following the first chain 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 features such as one-way roads and drains.

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

7.4.4.1 Universe Polygon (see SDTS 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”.

7.4.4.2 Void Polygons (see SDTS 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”.

7.4.4.3 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.

7.4.4.4 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.

7.4.4.5 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.

7.4.5 Graphic Representation Modules

These modules may be optionally included in a transfer. Encoders and decoders are required to support graphic representation module that conform to this profile.

7.4.6 Module Restrictions/Requirements: Identification Module (see also Part 1, Section 5.2.1, Table 10 Identification)

7.4.6.1 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 MARCH, 2000"

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.

7.4.7 Module Restrictions/Requirements: Internal Spatial Reference

The spatial address X component label subfield is restricted to "LONGITUDE" when the spatial reference system is geographic, "EASTING" when the external spatial reference system is UTM/UPS or SPCS, or "OTHER" when the external spatial reference system is not geographically based. Similarly, the spatial address Y component level subfield is restricted to "LATITUDE" when the spatial reference system is geographic, "NORTHING" when the external spatial reference system is UTM/UPS or SPCS, or "OTHER" when the external spatial reference system is not geographically based. The Z subfield shall be used only for altitude measured in inches above sea level.

7.4.8 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.

7.4.9 Module Restrictions/Requirements: Catalog/Directory

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

(a) the Volume subfield shall only be used to describe a Uniform Resource Locator (URL) address.
(b) the File subfield shall include only a file name meeting the requirements of Section 6.5.

7.4.10 Module Restrictions/Requirements: Data Dictionary/ Schema

The Entity Authority and Attribute Authority subfields shall contain "SDTS-USA" when Part 2 of ANSI NCITS 320-1998 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.

7.4.11 Module Restrictions/Requirements: Data Dictionary/ Domain

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

7.4.12 Module Restrictions/Requirements: Data Dictionary/ Definition

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

## 7.5 Conformance

7.5.1 Transfer Conformance

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

(a) consist of at least one universe polygon.

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

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

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

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

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

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

7.5.2 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.

7.5.3 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.

## 7.6 References

American National Standards Institute (ANSI). National Committee for Information Technology Standards (NCITS). *Spatial Data Transfer Standard, Parts 1-3*. (ANSI NCITS 320:1998). NCITS Secretariat, Washington DC (1998).

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National Institute of Standards and Technology (NIST). Federal Information Processing Standards (FIPS) Standard for *Countries, Dependencies, Areas Of Special Sovereignty, And Their Principal Administrative Divisions,* (FIPS Publication 10-4), National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA (April, 1995).

**Appendix 7-A (Informative) 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 new SDTS line type with a start-point and a direction.
2. Line Unbound (LU) is new SDTS line type with two points indicating an unbound line.

The following tables depict the CADD Types represented in the profile

| ***Name*** | ***Type*** | ***Description*** | ***Structure*** |
|---|---|---|---|
| Nodes | | | |
| Point | POINT | Zero dimensional geometric location | XYZ location of point |
| Lines | | | |
| Line | LINE | Linear segment defined by two points. | XYZ location of start and end vertices. |
| Open Polyline without bulge | POLYLINE | Linear segment defined by two or more points. | XYZ list of all vertices. |
| Open Polyline with bulge | POLYLINE | Linear segment defined by two or more points with at least one set of points representing a circular arc that is part of the line. | List of points, with arc points marked as a “bulge”. The point after the one marked as the bulge is the end point. ¼ the angle of the arc being traced is inserted after the end point. |
| Ray | RAY | Linear line defined by a start point and a direction. | Start Node, and one point on the line. |
| Non-segmented Line | XLINE | Linear definition of an unending line. | Two points on the line. |

| *Name* | *Type* | *Description* | *Structure* |
|---|---|---|---|
| Text | | | |
| Attribute | ATTRIB | A (sometimes variable) text string that is used to label blocks. | XYZ coordinates to insert text at , the text height (in units), the character prompt for the variable part, skew angle, text style, and justification. |
| Text | TEXT | A label point | XYZ coordinates to insert text at, text height in units, rotation angle (in radians), horizontal and vertical alignment, and attachment point. |

| *Name* | *Type* | *Description* | *Structure* |
|---|---|---|---|
| Polygons | | | |
| Closed Polyline, with or without bulge | POLYLINE | Closed segment defined by two or more points, some points may represent a circular arc that is part of the polygon. | List of points, with arc points marked as a “bulge”. The point after the one marked as the bulge is the end point. ¼ the angle of the arc being traced is inserted after the end point. |
| Arcs | | | |
| Circle | CIRCLE | A circular arc defined by center point and radius. | XYZ coordinates of the center, and the radius. |
| Arc | ARC | A circular arc defined by center point, radius, start and end angles. | XYZ coordinates of the center, the radius, the start and end angles (in radians). |
| Ellipse | ELLIPSE | A geometric ellipse. | XYZ coordinates of the center, the primary radius, the secondary radius, the rotation angle, the start angle, and the end angle (all in radians). |
| Spline | SPLINE | Bspline definition. Applies to open, closed, rational, non-rational, periodic, non-periodic, Planar, linear, and non-planar or non-linear splines. | Header describes spline represented, followed by number of knots, number of control points, numbers of fit points. Finally, knot values, control points, weight |

| *Name* | *Type* | *Description* | *Structure* |
|---|---|---|---|
| Composites | | | |
| Block | INSERT | Series of objects that together create a symbol or other oft-used object. (usually stored in another file). | Insertion point, rotation angle, x,y, and z scaling factors, column and row counts, column and row spacing. |
| Multi-Line | MLINE | Multiple lines described as a single polyline that is drawn multiple times. | Multi-line style (string), scaling factor, number of vertices, and a vertex list comprised of entries in the form: (Vertex, segment Params) |
| Multi-line Text | MTEXT | Text that is on more than one line. | The string, in 256 byte chunks. Then the text style name (string), the XYZ insertion point, the X and Y Axis vectors, and the width of the bounding box. Finally, the attachment point and the drawing direction. |

| *Name* | *Type* | *Description* | *Structure* |
|---|---|---|---|
| 3 Dimensional Entities | | | |
| Solid, 3-D Face, Trace | SOLID 3DFACE TRACE | Define one polygon in a 3D surface. For solid it defines a face of a solid object, for face it defines a face of an object that contains holes, and for trace it defines the face of an object as a wireframe. | All have 4 points (three mandatory) that define the boundaries and plane of this element. 3D face also has information to help determine if this face is hidden. |
| Non-Graphic Representations | | | |
| Line Type | LTYPE | Defines the style of line to draw. These are stored as an array. | Name(String), total length of this line style, number of dash length items, array of dash lengths, scale, rotation angle (in radians), XYZ offsets, and optional STYLE name or SHAPE name(meaning line type is defined in that style record). |
| Font Definition | | Defines how a font is drawn. | Style Name(string), Text height, width as a fraction of height, oblique angle (italics), mirrored text info, font file name. |