Mapping Specification for DWG/DXF (MSD)

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Abstract: The ESRI Mapping Specification for DWG/DXF (MSD) is a method of coding information in a DWG or DXF file to define GIS feature classes with non-geometric attribution, and the definition of a geospatial coordinate system recognized by ESRI's *ArcGIS* software. The specification utilizes standard DWG/DXF data structures to define schema, store data, and define a geospatial coordinate system.

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Introduction

The ESRI Mapping Specification for DWG (MSD) is a standard for coding information in a DWG or DXF file to define GIS feature classes with non-geometric attribution, and the definition of a geospatial coordinate system. Feature classes and the coordinate system defined in a DWG or DXF file using this specification are recognized by ESRI's ArcGIS software as read-only GIS feature classes.

The MSD is designed to allow developers and computer-aided design (CAD) software users to store, edit and share GIS content in a DWG or DXF file. This document defines CAD data storage structures that must remain consistent with each implementation. For the remainder of this document DWG refers to both the DWG and DXF formats.

The MSD complies with the Autodesk Registered Developer Symbol (RDS) standard. All root-level entries in the Named Object Dictionary use the prefix ESRI_ to prevent namespace conflicts with other applications. Developers are permitted to use the ESRI_ prefix as defined in this standard to create an MSD-formatted DWG.

MSD-compliant applications can be implemented with AutoLISP™, Visual Lisp™, the ObjectARX™ programming environment using C++, C#, and VB .NET, and OpenDWG® toolkits. In the ancillary documents you will find example source code used to implement MSD in a variety of development environments. These documents assume the reader has a working knowledge of reading and writing to the DWG and or DXF format.

The DWG format is an open standard used for storing and sharing CAD data. Originally developed by Autodesk as a proprietary format for its AutoCAD products, it is widely used in many engineering related organizations. The US and other government contracts often explicitly require that drawing data be stored and delivered in DWG format.

The Open Design Alliance (ODA) is a non-profit organization funded by dues from its members. The ODA offers OpenDWG, which does not replace the DWG file format but is instead compatible with the DWG file format. The ODA is committed to maintaining compatibility between the DWGdirect libraries and the DWG file format. The aim of the ODA is to provide its membership libraries that read and write CAD files, such as DWG and DGN, or other formats where appropriate. More information regarding ODA can be found at www.opendesign.com.

For CAD/GIS Administrators

The ESRI Mapping Specification for DWG (MSD) is an open-source framework for software developers based entirely on the standard DWG/DXF format. It is a non-proprietary specification that defines standardized programming structures and methods for embedding GIS schema, attribute data and a coordinate system into a DWG or DXF file.

MSD-compliant DWG files allow organizations to share GIS content between internal and external stakeholders that also adopt MSD. MSD-compliant schema and data can be added to existing drawings without altering existing CAD geometry. A well planned implementation can improve CAD/GIS interoperability with minimal disruption to existing workflows.

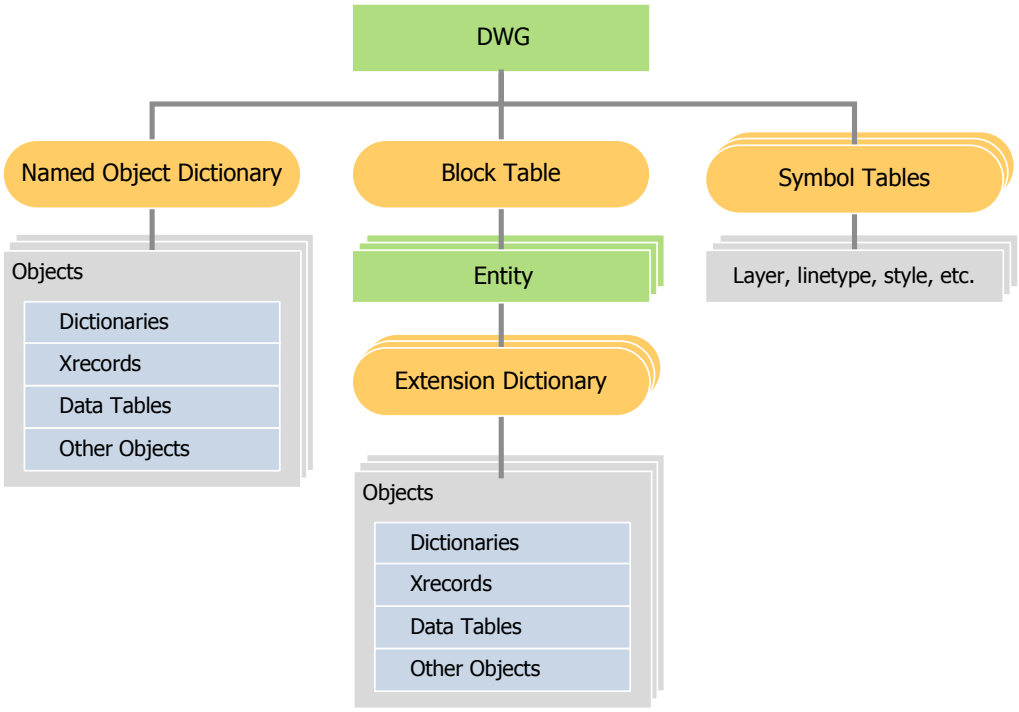
A DWG application implementing MSD enables CAD users to create feature classes with attribution while at the same time allowing them to define the members of a feature class within a CAD context such as layer(s), line style(s), and color. This can be especially beneficial for mixed GIS and CAD workflows where MSD can be used to leverage existing CAD standards to produce organized CAD feature classes that are useful to ArcGIS users.

Beginning with ArcGIS 9.3, ESRI supports MSD-compliant CAD datasets. The ArcGIS Geoprocessing tool EXPORT TO CAD (ArcInfo license only) generates MSD-compliant feature class schema, attributed entities and a coordinate system. This is non-graphical GIS content that requires ArcGIS for AutoCAD or MSD-compliant open-source programming to view or manipulate the data. ArcGIS for AutoCAD is available for download at www.ESRI.com.

Understanding the DWG Format

This section is a general overview of the DWG objects and data structures. This information applies to all DWG files and is not exclusive to the MSD.

The DWG Database



The DWG file is a database comprised of entities and objects. Entities are the objects with graphical representations such as lines, text, and arcs. They are owned by the block table. The graphical properties associated with entities such as layer, linetype and style are owned by separate symbol tables.

Dictionaries are non-graphical container objects that can be defined to store custom data. They accept a variety of other objects such as xrecords, data tables and even other dictionaries in nested form. The Named Object Dictionary (NOD) is the parent dictionary that owns all other dictionaries. The DWG automatically creates the NOD.

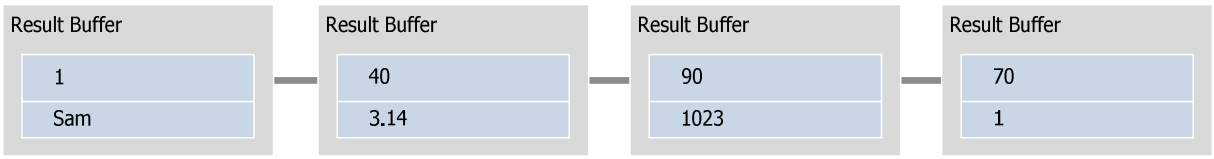
The extension dictionary is used to link arbitrary DWG database objects to entities or other DWG database objects. It stores the handle of a dictionary in the definition of the object or entity. The data is duplicated any time an entity is copied and travels with the entity when inserted into other drawings.

Xrecords are used to store arbitrary non-graphical data and are similar to xdata. They are constructed with DXF group codes in the dotted-pair format. They are owned by other objects and can store up to 2GB of information.

Manipulating data in a DWG

Result buffers are used to access data stored in DWG objects and entities. They can be combined in linked lists for handling objects and entities that contain a variety of data types. They are comprised of two elements: an association code and a value, respectively. The association code is a DXF group code that also specifies the value's data type. DWG implements ranges of DXF codes reserved for specific uses.

The following figure shows the result buffer format of an entity containing a string (1), a real (40) number, an Int32 (90) number, and an Int16 (70) number:



A selection set filter list is used to create a selection set. It is an array of associated dotted-pairs, each comprised of two elements: an association code and a value, respectively. The DXF code specifies the filter type (e.g. for layer names) and the value's data type. The value specifies the property. Filter lists can specify multiple properties such as object type, object name, and layer name. They can be combined in nested form to select multiple entities and a variety of properties. The following example could be used to select all block inserts named MyBlock on layer XYZ:

((0 . "Insert") (2 . "MyBlock") (8 . "XYZ"))

String-value properties such as layer names and line types can be combined as a single string separated with commas to create an OR condition. The following example could be used to select all Point entities on layers ABC *or* XYZ and of line types ByLayer *or* Center:

((0 . "Point") (8 . "ABC", "XYZ") (6 . "ByLayer", "Center"))

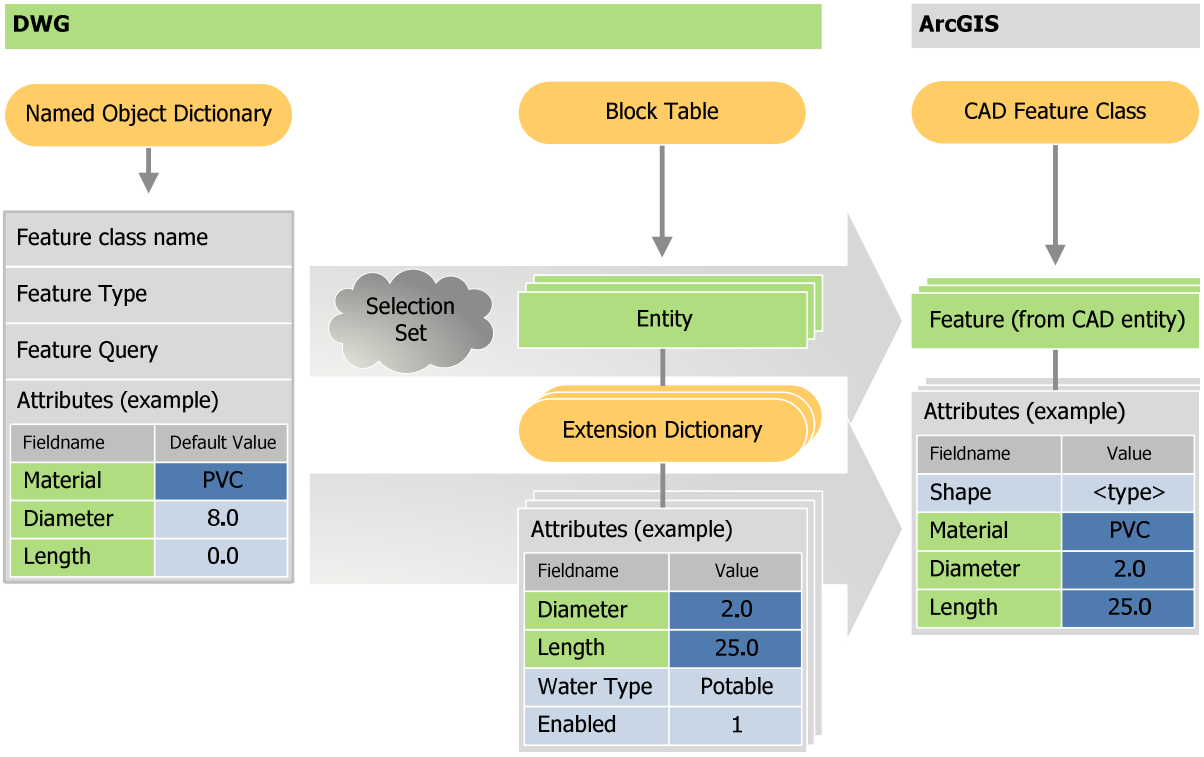
DXF Codes for common filters:

Code	Filter Type
0	Object type (string) - such as "*Point*", "*Line*", "*Circle*" and so on.
2	Object name (string) - the table given name such as "*MyBlock*".
6	Line type (string) – such as "*ByLayer*", "*Center*", "*Continuous*" and so on.
8	Layer name (string) - such as "*ABC*", or "*XYZ*".
60	Object visibility (integer) - 0=visible, 1=invisible.
62	Color number (integer) - numeric index values from 0 to 256. 0 = ByBlock, 256 = ByLayer.

For a complete list of DXF type codes and discussion of selection set filter lists refer to the AutoCAD Customization Guide, or the documentation provide with the ObjectARX™ SDK, or OpenDWG® toolkits.

The MSD Feature Class

This section expands the DWG database diagram to show conceptually how the MSD feature class is organized in the DWG database and the relationships between key components. Examples of attribute values are included to demonstrate how ArcGIS interprets the entity attributes with respect to the schema fieldnames and default values.



The MSD feature class schema is stored in the Named Object Dictionary. Each feature class is defined with a name, a GIS feature type, a CAD entity filter query, and non-graphical attribute fieldnames with default values.

The Feature Type specifies the CAD entity types in GIS terms such as point, polyline, polygon, multipatch, or annotation. It defines the selection set to include multiple DWG entities that qualify as a single GIS feature type. For example, a GIS polyline feature type will include DWG entities such as lines, arcs, circles, ellipses etc.

The Feature Query adds an optional property filter to the selection set. This allows for virtually limitless combinations of properties. For example, multiple line styles, layer names, and a color can all be added to the selection set. This permits a single CAD entity to belong to more than one feature class, and new entities to automatically become part of a feature class selection set.

Fieldnames and default values define how the non-spatial attributes will be interpreted by ArcGIS. ArcGIS will include all ESRI feature class fieldnames and default values with the CAD feature class unless a matching ESRI attribute fieldname is attached to the CAD entity's extension dictionary. If a valid and matching fieldname is found in the entity's extension dictionary, then ArcGIS will instead use the entity's attribute value. This allows the user to quickly create and manipulate CAD entities without the need to attach attributes if the default values are sufficient.

Specifications

Coordinate System

Required/Optional	Optional
Parent	Named Object Dictionary
Object type	Xrecord
Name	(3 . "ESRI_PRJ"), string
Value	(1 . <Coordinate System>),string

The coordinate system is used by ArcGIS as a spatial reference and does not influence CAD program behavior. It is a text string in the Well-Known Text (WKT) format analogous to the ESRI PRJ file. PRJ files continue to be supported and will override the internally stored MSD coordinate system. Alternatively this string can now be embedded in the DWG within the NOD and will be honored if no companion .PRJ file is present.

Feature Classes

Required/Optional	Required
Parent	Named Object Dictionary
Object type	Dictionary
Name	(3 . "ESRI_Features"), string
Value	(3 . <feature class name>), dictionary

ESRI_Features is the parent dictionary for all ESRI feature classes.

Feature Class

Required/Optional	Required
Parent	ESRI_Features dictionary
Object type	Dictionary
Name	(3 . <feature class name>), string
Value	(3 . "Feature Query"), xrecord
Value	(3 . "Feature Type"), xrecord
Value	(3 . "ESRI_Attributes"), dictionary

Feature class schema is used by ArcGIS to translate CAD feature classes and filter entity attributes.

Feature Type

Required/Optional	Required
Parent	<feature class name> dictionary
Object type	Xrecord
Name	(3 . "FeatureType")
Value	(1 . <feature type>), string
Valid feature types	Point, Polyline, Polygon, Multipatch, Annotation

The feature type defines the selection set to include multiple DWG entities that qualify as a single GIS feature type. Refer to the ArcGIS Help system for a complete mapping of CAD entities to ArcGIS feature types.

Feature Query

Required/Optional	Optional
Parent	<feature class name> dictionary
Object type	Xrecord
Name	(3 . "Feature Query"), string
Value	(<DXF code> . <property>), varies/unlimited
Valid selection set filters	Consult MSD and DWG documentation

The feature query adds an optional property filter to the feature type selection set. If the feature query is not defined, ArcGIS will include all entities specified by the GIS feature type. It is recommended that the feature type be excluded from the feature query unless a specific application requires this parameter for redundancy.

Caution: Conditional operators are not currently supported by ArcGIS or the openDWG libraries. Alternatively, use comma delimited strings to create the OR condition for string-value properties such as layer names and line types.

Feature Attributes

Required/Optional	Optional
Parent	<feature class name> dictionary
Object type	Dictionary
Name	(3 . "ESRI_Attributes"), string
Value	(3 . <fieldname>), dictionary

ESRI_Attributes is the parent dictionary for all ESRI feature class attributes.

Fields

Required/Optional	Optional
Parent	ESRI_Attributes dictionary
Object type	Xrecord
Name	(3. <fieldname>), string
Value	(<DXF code> . <default value>), xrecord
Valid DXF parameters	1 . string, 40 . real, 70 . int16, 90 . int32
Optional string parameter	(90 . <string length>), integer

Fieldnames and default values define the default CAD feature class attribute values read by ArcGIS.

Entity Attributes

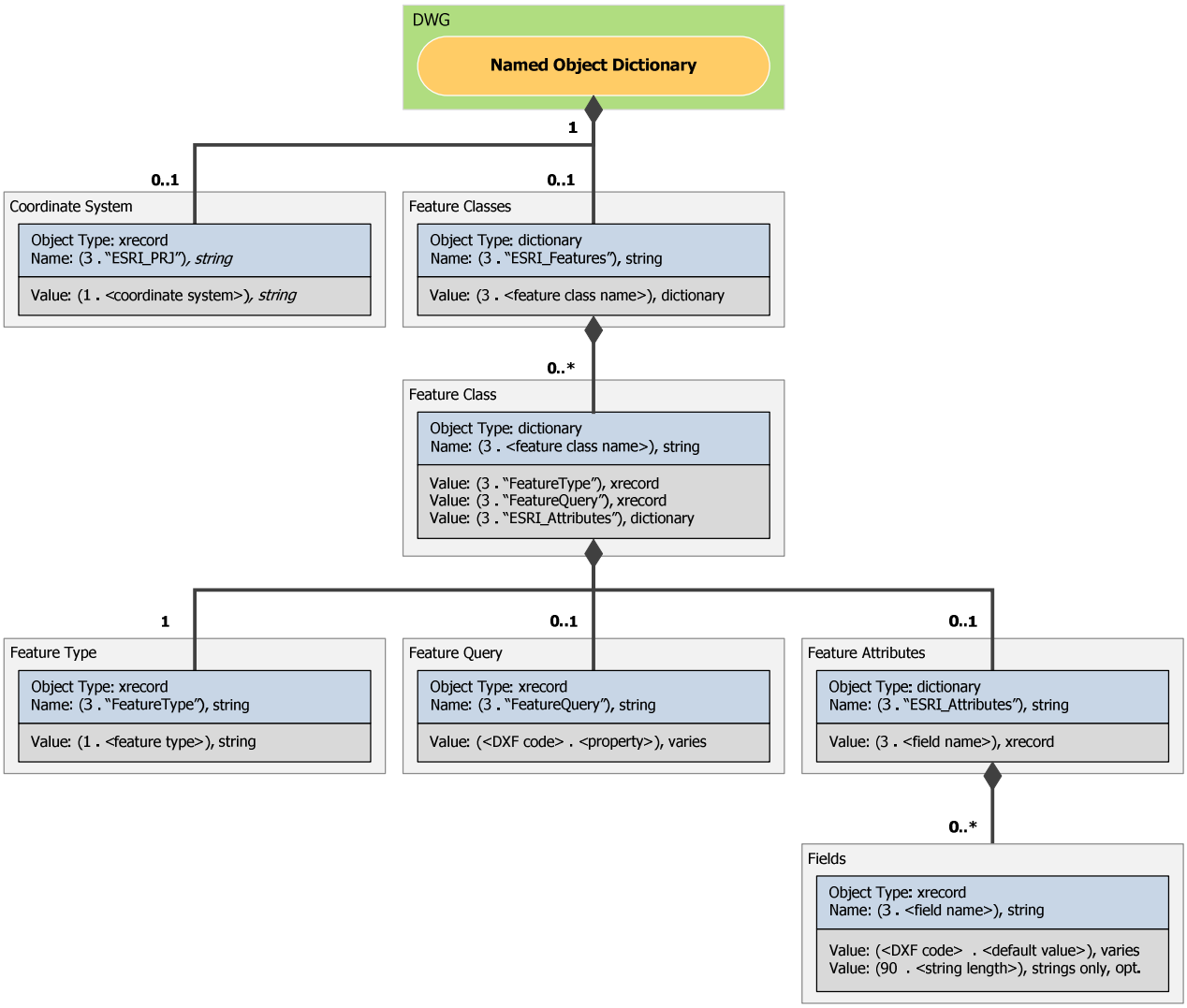
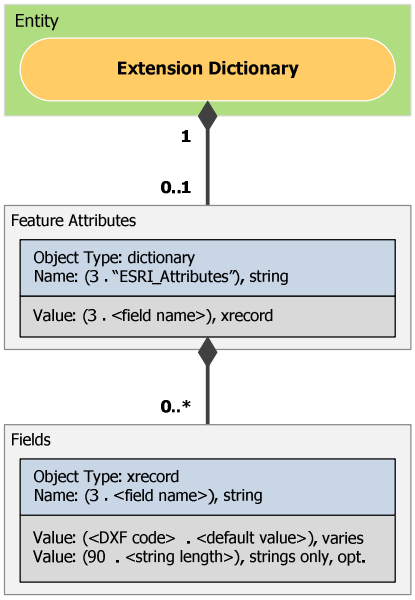
Required/Optional	Optional
Parent	Entity
Object type	Dictionary
Name	(3 . "ESRI_Attributes"), string
Value	(3 . <fieldname>), dictionary

ESRI_Attributes is the parent dictionary for all ESRI feature class attributes.

Entity attributes are used to store field values directly on an entity when the user requires attribute values that differ from the default values defined in the schema. The specification for entity attributes is identical to the specification for attributes defined in the NOD schema. The only difference is they are stored in the entity's extension dictionary. The extension dictionary stores the handle of the ESRI_Attributes dictionary in the definition of the entity.

DWG Class diagrams

Named Object Dictionary



Extension Dictionary