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Information Technology – Geographic Information Framework Data Content Standard

Part 0: Base document

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Foreword

Geographic information, also known as geospatial information, both underlies and is the subject of much of the political, economic, environmental, and security activities of the United States. In recognition of this, the United States Office of Management and Budget issued Circular A-16 (revised 2002), which established the Federal Geographic Data Committee (FGDC) as a coordinating organization.

Work on this standard started under the Geospatial One-Stop e-Government initiative. The standard was developed with the support of the member agencies and organizations of the FGDC and aids in fulfilling a primary objective of the National Spatial Data Infrastructure (NSDI), that is, creation of common geographic base data for seven critical data themes. The seven core data themes are considered framework data of critical importance to the spatial data infrastructure.

The increasing need to coordinate collection of new data, identify applicability of existing data, and exchange data at the national level led to the submission of this standard to the ANSI process to become an American National Standard. The national standard contained in this document and its parts was sponsored by Technical Committee L1, Geographic Information Systems, of the InterNational Committee for Information Technology Standards (INCITS), an ANSI-accredited standards development organization.

As the Geographic Information Framework Data Content Standard was developed using public funds, the U.S. Government will be free to publish and distribute its contents to the public, as provided through the Freedom of Information Act (FOIA), Part 5 United States Code, Section 552, as amended by Public Law No. 104-231, “Electronic Freedom of Information Act Amendments of 1996”.

Introduction

The Geographic Information Framework Data Content Standard establishes common data requirements for the exchange of National Spatial Data Infrastructure (NSDI) framework data. The purpose of the standard is to decrease the costs of acquiring, exchanging, and maintaining framework data for creators and users through establishment of a minimal set of data content elements and a common means of describing data content.

The standard addresses seven core themes that are considered framework data of critical importance to the spatial data infrastructure of the Nation: cadastral data, digital orthoimagery, elevation data, geodetic control data, governmental unit boundary data, hydrographic feature data, and transportation network data. It provides a data content and high level Unified Modeling Language (UML) description for each data theme. The standard is divided into eight parts, one for each of the seven data themes and a base document containing information common to two or more themes.

The Framework Data Content Standard will improve and promote the efficient data exchange among local, Tribal, State, Federal, and other governmental entities, as well as with the private sector and academic communities. The private sector, specifically software developers, data creators, and vendors, will benefit by developing tools that exploit data based on the standard. While use of the standard will decrease the costs of acquiring and exchanging framework data for creators and users through the common means of describing data content, other benefits will occur, such as improved operational efficiency.

Framework Data Content Standard – Base document

1 Scope

1.1 Scope of whole standard

This Geographic Information Framework Data Content Standard provides interrelated thematic standards in seven data areas: cadastral, digital orthoimagery, elevation, geodetic control, governmental unit boundaries and other geographic area boundaries, hydrography, and transportation.[1] The parts for each of the seven themes and this Base Document specify a minimal level of data content that data producers, consumers, and vendors shall use for the description and interchange of those data, including through Web services.

The standard does not specify a particular structure for the interchange of data. Further, data producers and users may structure framework data in any format for their own internal use. The standard does not modify an organization's internal business processes or how the organization holds data, except for the requirement that a minimal level of data content is present.

1.2 Scope of the Base Document

This Base Document provides:

- A high-level view of the seven framework data themes
- An overall integrating Unified Modeling Language (UML) model that is supplemented by detail in the part for each data theme
- Terminology and other information common to two or more themes

1.3 Overview scope of other parts

1.3.1 Cadastral

Cadastral data describe the geographic extent of past, current, and future right, title, and interest in real property, including above, surface, and below ground and water, and the conceptual structure to support the description of that geographic extent.

1.3.2 Digital orthoimagery

Digital orthoimages are georeferenced images of the Earth's surface for which image object displacement caused by sensor orientation, sensor distortions, and terrain relief has been removed. Digital orthoimages have the geometric characteristics of a map and image qualities of a photograph.

1.3.3 Elevation

1.3.3.1 Elevation data – models

Elevation data may be modeled in various forms, such as in an evenly spaced grid or as irregularly spaced points (triangulated irregular network, hypsography, or mass points).

1.3.3.2 Elevation data – terrestrial

Terrestrial (land) elevation data contain georeferenced digital representations of terrestrial surfaces, natural or manmade, which describe vertical positions above or below a datum. The terrestrial data, in its various forms, support the elevation theme of the framework data.

[1] This standard expands on framework data descriptions given in the 1997 publication, Framework Introduction and Guide, by the Federal Geographic Data Committee, Washington, DC.

1.3.3.3 Elevation data – bathymetric

Bathymetric data comprise depths below sea level. These data support the Nation's critical nautical charting program and are used to create electronic navigational charts. Bathymetric data support the elevation theme of the framework data.

1.3.4 Geodetic control

Geodetic control provides a common, consistent, and accurate reference system for establishing coordinates for all geographic data. NSDI framework data may use geodetic control to accurately register spatial data. The fundamental geodetic control for the United States is provided through the National Spatial Reference System (NSRS) managed by the National Oceanic and Atmospheric Administration (NOAA).

1.3.5 Governmental unit boundaries

The data theme for governmental unit boundaries and other geographic area boundaries establishes the content requirements for the collection and interchange of governmental unit and other legal entity boundary data to facilitate the maintenance and use of that information. This part identifies terminology, encoding schema, and the data components required for describing the governmental unit or other legal entity and its boundary, along with the metadata needed for boundary data exchange.

1.3.6 Hydrography

This data theme includes surface water features such as lakes, ponds, streams or rivers, canals, oceans, and shorelines. Each hydrographic feature is assigned a permanent feature identification code and may also be identified by a feature name. Spatial positions of features are described as lines, points, and polygons. Network connectivity, direction of flow, and a linear reference system are also described.

1.3.7 Transportation

Transportation data are used to model the geographic locations, interconnectedness, and characteristics of the transportation system. The transportation system includes both physical and non-physical components representing all modes of travel that allow the movement of freight and people between locations.

Sub-themes representing the physical components of the transportation infrastructure include airport facilities, waterways, roads, railroads, and transit.

2 Conformance

Each thematic part of the Framework Data Content Standard includes a data dictionary based on the conceptual schema presented in that part. To conform to the standard, a thematic dataset shall satisfy the requirements of the data dictionary for that theme. It shall include a value for each mandatory element, and a value for each conditional element for which the condition is true. It may contain values for any optional element. The data type of each value shall be that specified for the element in the data dictionary and the value shall lie within the domain specified for the element.

3 Normative references

Annex A lists normative references to standards that affect two or more parts of the Framework Data Content Standard. Informative references applicable to two or more parts are listed in Anex D. References applicable to a single data theme are reported in the respective theme part of the standard.

4 Maintenance authority

4.1 Level of responsibility

The FGDC is the responsible organization for coordinating work on all parts of the Geographic Information Framework Data Content Standard and is directly responsible for the development and maintenance of the Base Document. The development and maintenance authority for each of the other parts is provided in the maintenance authority section of the respective part.

The FGDC shall be the sole organization responsible for direct coordination with the InterNational Committee for Information Technology Standards (INCITS) concerning any maintenance or any other requirements mandated by INCITS or ANSI affecting any part of the standard.

4.2 Contact information

Address questions concerning this part of the standard to:

Federal Geographic Data Committee Secretariat
c/o U.S. Geological Survey
590 National Center
Reston, Virginia 20192 USA

Telephone: (703) 648-5514
Facsimile: (703) 648-5755
Internet (electronic mail): gdc@fgdc.gov
WWW Home Page: http://fgdc.gov

5 Terms and definitions

Definitions applicable to the Base Document part or common to two or more parts of the standard are listed below. Terms specific to a theme shall be defined in that theme. Terms and definitions common only to multiple transportation parts are listed in the Transportation Base (Part 7). Users are advised to consult these documents for a complete set of definitions.

5.1
accuracy

closeness of agreement between a test result and the accepted reference value [ISO 3534]

NOTE Accepted reference value can be a standard or an accepted [true] value. Accuracy is related to the quality of a result, and is distinguished from precision, which relates to the quality of the operation by which the result is obtained.

5.2
application schema

conceptual schema for data required by one or more applications [ISO 19101]

5.3
boundary

set that represents the limit of an entity [ISO 19107]

5.4
conceptual model

model that defines the concepts of a **universe of discourse** [ISO 19101]

5.5
conceptual schema

formal description of a **conceptual model** [ISO 19101]

5.6
contiguous

sharing a common **point** or portion of a **boundary**

5.7
contour

line connecting **points** of equal **elevation**

5.8
contour interval

difference in **elevation** between **contours**

5.9
control

high-accuracy **geospatial data** associated with a collection of well-defined ground **points**, usually given as **coordinate** data

5.10
coordinate

one of a sequence of n numbers designating the position of a **point** in n-dimensional space [ISO 19111]

5.11
curve

1-dimensional geometric primitive, representing the continuous image of a line [ISO 19107]

5.12
data content standard

standard that specifies what information is contained within a geospatial **dataset** and provides an **application schema**

5.13
dataset

identifiable collection of data [ISO 19104]

5.14
datum

parameter or set of parameters that serve as a reference or basis for the calculation of other parameters [ISO 19111]

5.15
discrete grid

rectangular array of **points** spaced at a uniform sampling interval in x and y directions relative to a common origin

NOTE A discrete grid represents the value of the surface only at the grid points or elevation posts of the grid, rather than the value of the cell area surrounding each grid point.

5.16
elevation

distance measured upward along a plumb line to a **point** from the **geoid**

5.17
ellipsoid

surface formed by the rotation of an ellipse about a main axis [ISO 19111]

NOTE In ISO 19111, ellipsoids are always oblate, meaning that the axis of rotation is always the minor axis.

5.18
ellipsoid height
h

distance of a **point** from the **ellipsoid** measured along the perpendicular from the **ellipsoid** to this **point** [ISO 19111]

5.19
feature

abstraction of real world phenomena [ISO 19101]

5.20
feature attribute

characteristic of a **feature** [ISO 19101]

5.21
feature delineation

criteria or rules for defining the limits of a **feature** and how it will be represented geometrically in a **dataset**

5.22
feature type

category of real world phenomena with common properties [ISO 19126]

5.23
framework data

collection of basic geospatial data upon which users may collect, register, or integrate **geospatial data**

NOTE Thematic categories comprising framework data include geodetic control, digital orthoimagery, elevation, transportation, hydrography, governmental unit boundaries, and cadastral [FGDC, 1997].

5.24
Framework Data Content Standard

data content standard specifying a level of information content and service adequate for data exchange for **framework data** themes

5.25
geoid

level **surface** which best fits mean sea level either locally or globally [ISO 19111]

NOTE “Level surface” means an equipotential surface of the Earth’s gravity field that is everywhere perpendicular to the direction of gravity.

5.26
geoid height
N

difference between an **ellipsoid height** and an **orthometric height**

5.27
geometry

shape and geographic location of a **feature**

5.28
geospatial data
spatial data
geographic data

data with implicit or explicit reference to a location relative to the Earth [ISO 19109]

NOTE These data may be derived from, among other things, remote sensing, mapping, or surveying technologies.

5.29
government

organized entity that has elected officials and the ability to raise revenues and has sufficient discretion in the management of its own affairs to distinguish it as separate from the administrative structure of any other government

5.30
governmental unit

geographic area with legally defined boundaries established under Federal, Tribal, State, or local law, and with the authority to elect or appoint officials and raise revenues through taxes

EXAMPLES American Indian Reservation, City, School District, Village

5.31
grid point

point located at the intersection of two or more **curves** in a grid [ISO 19123]

5.32
landmark

point or area of interest

5.33
legal area

geographic unit with legally defined **boundaries** established under Federal, State, Tribal or local law as a **governmental unit** or as an area for the administration of a governmental function [ANSI INCITS 31-1988 (R2002)]

NOTE Legal area encompasses both governmental unit and legal entity, and includes cadastral units.

5.34
linear reference method
LRM

scheme used to measure a location along or beside a linear feature as the distance from the beginning of that **feature** or from a reference **point** on that **feature** and measured along (and optionally laterally offset from) the linear feature

5.35
linear reference model

part of a model that defines the manner of describing locations along linear entities used to specify the extent or applicability of values of attributes along segments or paths or the linearly referenced locations of feature events

5.36
linear reference system

one or more **linear reference methods** and associated rules and protocols governing the application of the **linear reference methods**

5.37
metadata

data about data [ISO 19115]

5.38
namespace

name assigned to a set of identifiers, each of which is certified by some person, organization, or entity to be unique within the set

NOTE Namespace may be applied to features packaged in different types of exchanges, such as those for an individual dataset, a business use, or a framework theme, as needed to ensure the uniqueness of the identifiers.

5.39
orthometric height
H

distance measured along the plumb line between the **geoid** and a **point** on the Earth's surface, taken positive upward from the **geoid** [adapted from National Geodetic Survey, 2001]

5.40
point

0-dimensional geometric primitive representing a position [ISO 19107]

5.41
polygon

bounded **surface**

NOTE Usage is general, unless explicitly stated in other parts of this standard.

5.42
positional accuracy

accuracy of a **coordinate** value in a specified reference system

5.43
precision

measure of the repeatability of a set of measurements [ISO 19116]

5.44
resolution

measure of the minimum difference in a value that can be detected or represented

5.45
slope

rate of change of **elevation** with respect to **curve** length [ISO 19133]

EXAMPLE A rise of 4 meters over a distance of 100 meters describes a 2.3° or 4% slope.

5.46
surface

2-dimensional geometric primitive, locally representing a continuous image of a region of a plane [ISO 19107]

5.47
topological relationship

spatial condition or characteristic required for creating and maintaining the internal topology of a database (or file)

5.48
universe of discourse

view of the real or hypothetical world that includes everything of interest [ISO 19101]

6 Symbols, abbreviated terms, and notations

The following symbols, abbreviations, and notations are applicable to this part or common to two or more parts of the standard. Symbols, abbreviations, and notations common to only multiple transportation parts are listed in the Transportation Base (Part 7).

2D – 2-dimensional

ANSI – American National Standards Institute

FGDC – Federal Geographic Data Committee

GIS – Geographic Information System

GML – Geography Markup Language

GPS – Global Positioning System

ID – Identifier

IEC – International Electrotechnical Commission

INCITS – InterNational Committee for Information Technology Standards

ISO – International Organization for Standardization

LRM – Linear Reference Method

LRS – Linear Reference System

MAT – Modeling Advisory Team

NAD83 – North American Datum of 1983

NGS – National Geodetic Survey

NOAA – National Oceanic and Atmospheric Administration

NSDI – National Spatial Data Infrastructure

NSRS – National Spatial Reference System

OGC – Open Geospatial Consortium, Inc.

UML – Unified Modeling Language

URI – Uniform Resource Identifier

USGS – United States Geological Survey

WGS84 – World Geodetic System of 1984

XML – Extensible Markup Language [W3C]

7 Requirements

7.1 Unified Modeling Language (UML) model

A data model expressed in UML is provided in each theme part in one of the following ways:

- Incorporated in the body text in each section that needs it
- Incorporated in the body text in a UML model-only section
- Incorporated in a normative annex and referenced in the body text
- Incorporated in the body text, but only at a high level or in a general way with detailed data components of the model presented in a normative annex

The use of UML class diagrams in the Framework Data Content Standard is an application-neutral approach to depict the inherent description of and relationships among data entities. These diagrams should neither be interpreted as requiring object-oriented implementation – methods or interfaces are not typically shown on these data classes – nor should they be interpreted as representing tables in relational databases. Instead, the UML classes should be used as the basis for translation to and from internal organization data stores and applications. UML modeling environments typically support conversion of logical UML models into implementations in various programming environments through rule-based transforms.

7.2 Dependence on ISO 19100 series of geographic information standards

The Framework Data Content Standard is dependent on structures and concepts from several standards in the ISO 19100 series of geographic information standards, as shown in Figure 1. Full titles for these standards are found in Annex A. The digital orthoimagery and elevation data parts also are dependent on ISO 19123. Data standards for certain transportation modes are dependent on ISO 19133. All parts have dependencies on ISO 19107, ISO 19108, ISO 19109, ISO 19111, and ISO 19115.

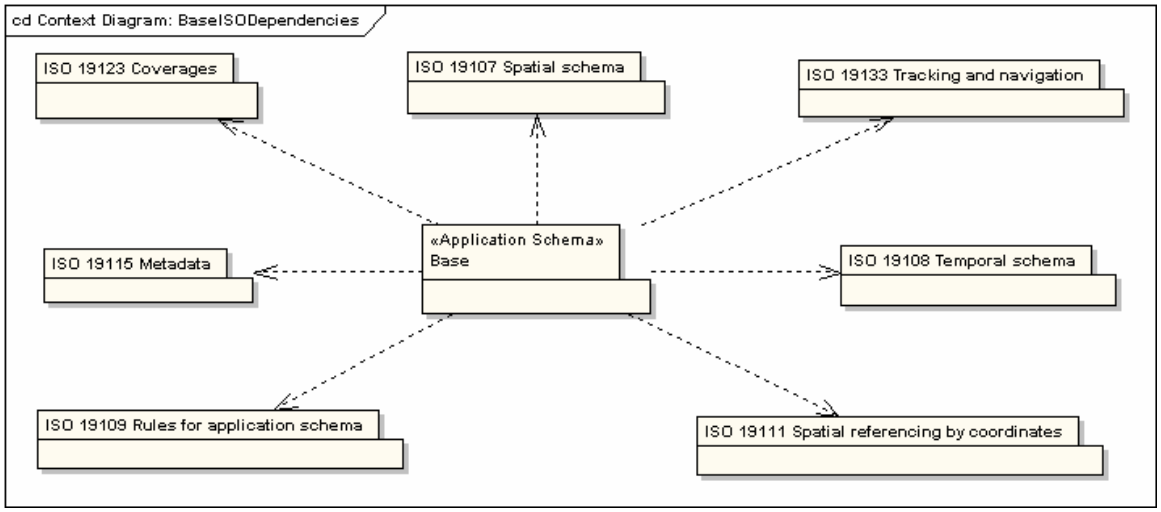


Figure 1 – Framework base dependencies on ISO series of geographic information standards

7.3 Application schema

Each of the thematic Framework Data Content Standard parts includes an integrated application schema expressed in the Unified Modeling Language (UML) according to ISO 19109, Geographic information – Rules for application schema, and its normative references. The application schema specifies, as appropriate, the feature types, attribute types, attribute domain, feature relationships, spatial representation, data organization, and metadata that define the information content of a dataset.

The UML models included in the parts of the standard describe the common content and structures that can be exchanged between members of the geospatial community. The use of UML and abstract modeling concepts allows the standard to be technology independent but permits current and future implementation cases to be derived from the UML model.

Whenever possible, the standard references abstract UML object types from the ISO 19100 series of standards and OGC specifications. Specialization of these classes of objects allows each theme to inherit properties and behaviors and ensure their propagation when transformed into an encoding such as XML.

UML concepts and notation are described in Annex B.

7.4 Data dictionary

7.4.1 General requirements

Each of the thematic Framework Data Content Standard parts contains, as appropriate, documentation of all features, attributes, and relationships and their definitions. A data dictionary table describes the characteristics of the UML model diagrams.

The data dictionary (see Table 1) is structured as follows:

- Each UML model class equates to a data dictionary entity
- Each UML model class attribute equates to a data dictionary element
- Each UML model role name equates to a data dictionary element
- The shaded rows define entities
- The entities and elements within the data dictionary are defined by six attributes based on those specified in ISO/IEC 11179-3 for the description of data element concepts, that is, data elements without representation

Table 1 – Data dictionary table format

Line	Name/Role Name	Definition	Obligation/Condition	Maximum Occurrence	Data Type	Domain
1						
2						
3						

7.4.2 Name/Role name

The name/role name is a label assigned to a data dictionary entity or to a data dictionary element.

The class name begins with an upper case letter. Spaces do not appear in an entity name: instead, multiple words are concatenated, with each word starting with a capital letter (example: XnnnYmmm). Entity names are unique within a data theme.

Element names start with a lower case letter. Spaces do not appear in an element name: instead, multiple words are concatenated, with subsequent words starting with a capital letter (example: xnnnYmmm). Element names are unique within an entity. Combinations of the entity and element names (example: Dataset.name) are therefore unique within a data theme.

Role names are used to identify the roles of the classes at the ends of a model association and are preceded by the term “Role name” followed by a colon to distinguish them from other types of data dictionary elements.

7.4.3 Definition

The definition is the entity or element description.

7.4.4 Obligation/Condition

7.4.4.1 General

Used only in rows that contain elements, Obligation/Condition is a descriptor indicating whether the element shall always be populated (that is, contain a value or values) or sometimes will be populated for every instance of its owning entity. If the element is a role name, then the obligation/condition shall apply to the element indicated by the Data Type. This descriptor may have the following values: M (mandatory), C (conditional), or O (optional).

7.4.4.2 Mandatory (M)

Mandatory (M) indicates that the entity or element shall be populated.

7.4.4.3 Conditional (C)

Conditional (C) specifies an electronically manageable condition under which at least one entity or element is mandatory. “Conditional” is used for one of the three following possibilities:

- Expressing a choice between two or more options. At least one option is mandatory and must be populated
- Populating an entity or element if another element has been populated
- Populating an element if a specific value for another element has been populated. To facilitate reading by humans, the specific value is used in plain text (for example, “C/not defined by encoding?”). However, the code shall be used to verify the condition in electronic user interface

If the answer to the condition is positive, then the entity or the element shall be populated.

7.4.4.4 Optional (O)

The entity or the element may be populated. Optional (O) entities and optional elements have been defined to provide a guide to those looking to fully document their data. (Use of this common set of defined elements will help promote interoperability among framework data users and producers.) Optional entities may have mandatory elements. If the optional entity is used, the mandatory elements shall be used. If an optional entity is not used, the elements contained within that entity (including mandatory elements) will also not be used.

7.4.5 Maximum occurrence

Used only in rows that contain elements, maximum occurrence specifies the maximum number of instances the element may have. Single occurrences are shown by “1”; unconstrained number of instances are represented by an asterisk “*”. Fixed number occurrences, other than one, are allowed and will be represented by the corresponding number (that is, “2”, “3” …and so on). If the element is a role name, then the maximum occurrence shall apply to the element indicated by the Data Type.

679 #### 7.4.6 Data type

680 Specifies a set of distinct values for representing the elements (example: integer, real,
681 CharacterString, DateTime, and Boolean). The data type attribute is also used to define
682 stereotypes for entities and entity names for elements which are role names. These data types
683 are generic types that do not infer an implementation.

684 #### 7.4.7 Domain

685 For an entity, the domain indicates line numbers covered by the elements of that entity in the
686 table.

687 For an element, the domain specifies the values allowed. "Unrestricted" indicates that no
688 restrictions are placed on the data type of the element. Code lists provide a list of potential
689 values, although additional values can be used. Enumerations provide a non-extensible list of
690 potential values.

691 ### 7.5 Metadata

692 #### 7.5.1 Requirement for metadata

693 All datasets shall have metadata that conforms to at least the minimal set of mandatory elements
694 of either ISO 19115, Geographic Information – Metadata, or FGDC-STD-001-1998, Content
695 Standard for Digital Geospatial Metadata (revised June 1988). However, more extensive
696 metadata should be provided.

697 #### 7.5.2 Associating metadata entry with data transfer

698 The mechanism used to associate a structured metadata entry with a data transfer is not explicitly
699 declared in the Framework Data Content Standard due to possible complex dependencies on
700 either the structure of FGDC or ISO metadata being used. It is the intention of the standard to
701 logically insert the appropriately structured metadata from either standard wherever the class
702 attribute "metadata" occurs. The implementation of this capability may be specified in the
703 implementation annexes as referenced to external metadata schemas in the appropriate
704 implementation or programming environment.

705 ### 7.6 Model integration

706 The dependencies among the models specified in the thematic parts of the standard are shown in
707 Figure 2. In Figure 2, the parenthetical text (from Transportation) means that there is a UML
708 package called "Transportation" in which all transportation constructs reside, including
709 Transportation Base.

710

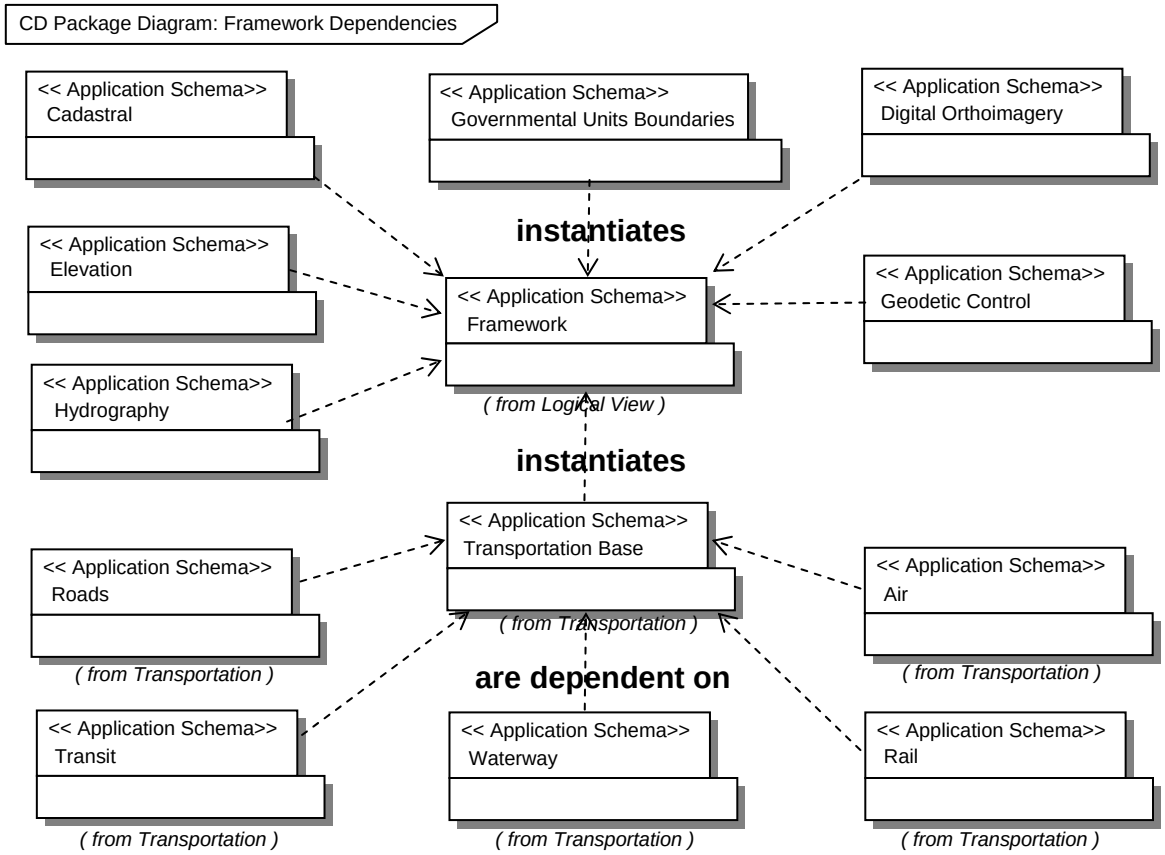


Figure 2 – Dependencies among the models specified in the thematic parts

7.7 Establishment of identifiers

Every UML class that represents a feature type includes attributes for identifier and an optional identifier authority[2]. This construct can be used to distinguish between similar values in different datasets. Policies may be developed within a community for assigning namespaces and permanent identifiers to features and expressing equivalencies among features that have been assigned different namespaces and, therefore, different identifiers, which may be permanent. If there is no standard way to create and manage identifiers, users may develop their own schema and include its description in the dataset metadata.

7.8 Framework feature model and common classes

7.8.1 Introduction

The Framework Data Content Standard organizes information using the ISO General Feature Model [ISO 19109]. Features are abstractions of real-world phenomena or man-made constructs that typically have a persistent or assigned identity, such as a name or code, a location represented by a formalized geometry, and a set of other properties and relationships.

Each framework theme, represented by a part in the standard, documents one or more formal feature types using a logical information model (attributes, associations, conditionality) represented as class diagrams in UML. All feature types (see darker shaded classes in Figure 3) are denoted in UML using the stereotype <<Feature>>. All features in every part of the standard

[2] Commonly known as “namespace”.

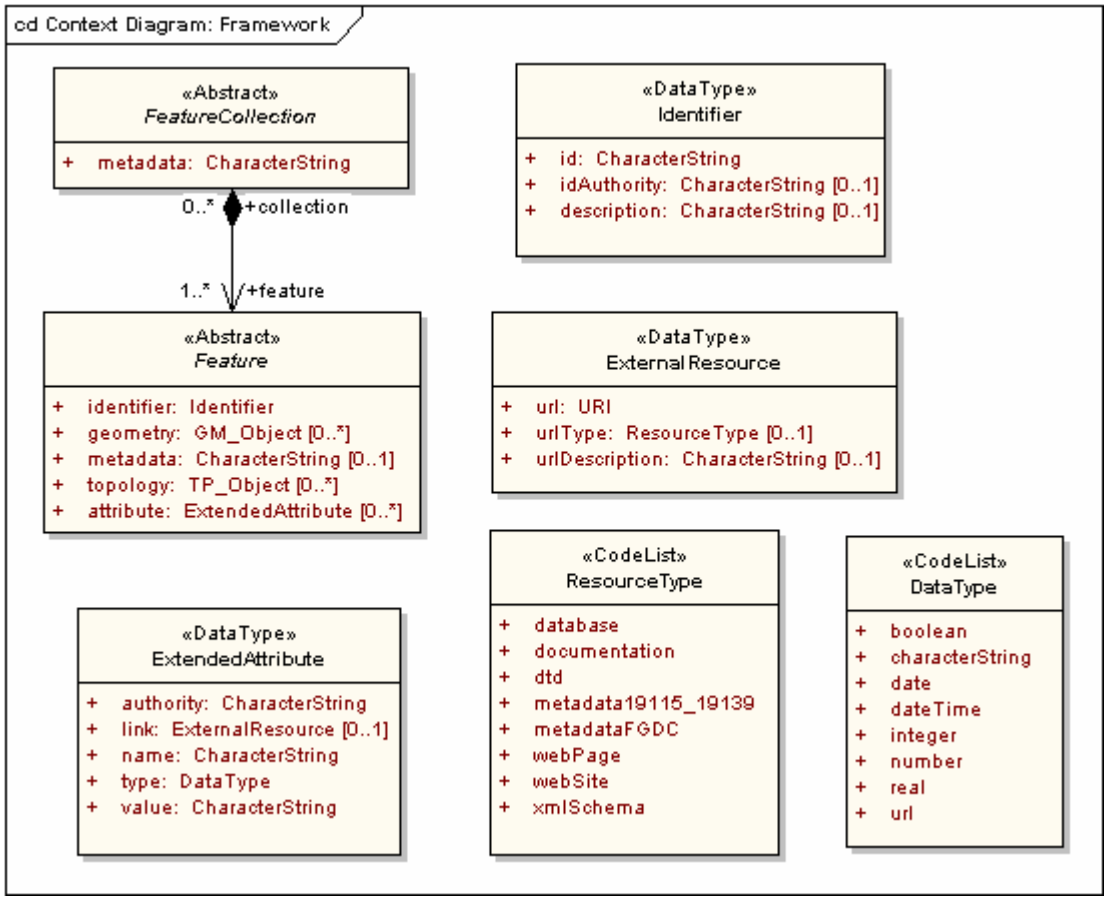
732 are subclasses of this common framework Feature and thus inherit its properties as shown in the
733 diagram. Except for identifier, all properties are optional and most of them are repeatable.

734 All classes stereotyped as <<Feature>> implement the Abstract class named "Feature" in the
735 Base and inherit all of its properties. Likewise, any class stereotyped as <<FeatureCollection>>
736 implements the Abstract class of the same name in the Base and inherits its property of
737 "metadata". Inheritance is also shown through an italicized parent classname in the upper right
738 corner of the child class.

739 The Framework Data Content Standard supports the transfer of geographic data from one party
740 to another. A group of features, known as a feature collection, would define a transfer. Metadata
741 may be associated with the contents of the transfer, as is done now with FGDC “dataset-level”
742 metadata. This feature collection may include features from one or more thematic parts of the
743 standard, depending on the application and its requirements.

744 Table 2 represents the information from Figure 3 in data dictionary format.

745



746

747 **Figure 3 – The conceptual framework feature model and common classes**

748

749

Table 2 – Description of common UML classes

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
1	FeatureCollection	Aggregation of all features being transferred			<<Abstract>>	LInes 2-3
2	metadata	Structured or unstructured metadata as defined by the community of practice	M	1	CharacterString	May be text or structured metadata fragment or URI
3	Role name: feature	Features in the feature collection	M	*	<<Abstract>> Feature	Unrestricted
4	Feature	Abstraction of a real world phenomenon			<<Abstract>>	Lines 5-10
5	identifier	Label that uniquely identifies a feature, unique within the transfer	M	1	<<DataType>> Identifier	Unrestricted
6	geometry	Geometric representation of the feature	O	*	<<Type>> GM_Object	Defined in ISO 19107
7	metadata	Structured or unstructured metadata as defined by the community of practice	O	1	CharacterString	May be text or structured metadata fragment or URI
8	topology	Connectivity between one feature and another	O	*	<<Type>> TP_Object	Defined in ISO 19107
9	attribute	Producer-defined attribute for inclusion in transfer	O	*	<<DataType>> ExtendedAttribute	Unrestricted
10	Role name: collection	Collection of which this feature is a part	O	*	<<Abstract>> FeatureCollection	Unrestricted
11	Identifier	Construct to group an identifier with an authority and a description			<<DataType>>	Lines 12-14
12	id	Identification value (ID)	M	1	CharacterString	Unrestricted
13	idAuthority	Name of the issuing authority for the identifier	O	1	CharacterString	Unrestricted

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
14	description	Description or qualification of the identification value within the namespace of the authority	O	1	CharacterString	Unrestricted
15	ExtendedAttribute	Property that permits the identification and transport of an unofficial feature attribute			<<DataType>>	Lines 16-20
16	authority	Name of the organization responsible for the naming of this attribute	M	1	CharacterString	Unrestricted
17	link	Identification of an external resource that provides documentation of this attribute	O	1	<<DataType>> ExternalResource	Unrestricted
18	name	Name of the attribute being transferred	M	1	CharacterString	Unrestricted
19	type	Data type of the attribute being transferred	M	1	<<CodeList>> DataType	Unrestricted
20	value	Value of the attribute being transferred	M	1	CharacterString	Constrained by the valid companion data type
21	ExternalResource	Qualified link to a network accessible object			<<DataType>>	Lines 22-24
22	url	Network accessible resource in the form of a Uniform Resource Locator (URL) or valid Uniform Resource Identifier (URI)	M	1	URI	Unrestricted
23	urlType	Classification of the information content referenced by the URL	O	1	<<CodeList>> ResourceType	Unrestricted
24	urlDescription	Additional characteristics of the URL for advice or display	O	1	CharacterString	Unrestricted

The extensibility mechanism shown in Figure 3 (ExtendedAttribute) allows for the description and transfer of additional ad hoc data content without requiring changes or extensions to the data schema. This repeatable structure may carry one or more additional attributes and their values for use in peer-to-peer transfer of unofficial feature properties. Any feature class may incorporate this reference to the ExtendedAttribute class. The link property of ExtendedAttribute expands to a triplet of elements associated with a Uniform Resource Locator (URL) for external documentation. Some ResourceTypes are shown as a code list to characterize the information content found at the referenced URL. For Transportation parts of this standard, events provide an alternative method of extending attributes when their values are not necessarily constant for the entire length of a feature.

7.8.2 Code lists

7.8.2.1 ResourceType code list

ResourceType is a CodeList of values for the attribute urlType.

Table 3 – CodeList for ResourceType

Name	Definition
database	Collection of records where each record has the same structure of data elements
documentationB	Resource file that describes usage of referenced URL
dtd	Schema expressed via a set of declarations written in Document Type Definition (DTD) language
metadata19115_19139	Metadata records formatted using structure from ISO 19115, Geographic information – Metadata, and ISO 19139, Geographic information – Metadata - XML schema implementation
metadataFGDC	Metadata records formatted using structure from a version of the FGDC Content Standard for Digital Geospatial Metadata
webPage	Resource on the World Wide Web usually in Hypertext Markup Language (HTML) format
webSite	Collection of Web pages that common to a particular domain name or subdomain on the World Wide Web
xmlSchema	Schema expressed using a version of the XML Schema World Wide Web Consortium (W3C) Recommendation

7.8.2.2 DataType code list

DataType is a CodeList of values for the attribute dataType.

Table 4 – CodeList for DataType

Name	Definition
boolean	True or False
characterString	A CharacterString is an arbitrary-length sequence of characters including accents and special characters from repertoire of one of the adopted character sets
date	Values for year, month, and day

Name	Definition
dateTime	A combination of year, month, and day and hour, minute, and second
integer	Any member of the set of positive whole numbers, negative whole numbers and zero
number	One of a series of symbols of unique meaning in a fixed order which may be derived by counting
real	Real numbers are all numbers that can be written as a possibly never repeating decimal fraction
url	Network accessible resource in the form of a Uniform Resource Identifier (URI)

8 Encoding of framework data content

To support data exchange, the parts of the Framework Data Content Standard may include informative annexes that provide guidance to implementers on the transformation of the UML information content into a specific encoding environment. These annexes not only document the context and environment of implementation and validation schema for the information content unique to a part of the standard, but also may include encoding or schema representation of heterogeneous collections of features from multiple themes. Because the standard includes a single UML model of all themes that are exposed progressively through a series of limited diagrams in the context of a theme, it represents an integrated set of classes for all framework data.

Annex A
(normative)
Normative references

A.1 General

This annex lists normative standards that support two or more parts of the Framework Data Content Standard. Individual theme parts shall list references applicable to the particular theme. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

ANSI and ISO standards may be purchased through the ANSI eStandards Store at http://webstore.ansi.org/ansidocstore/default.asp, accessed October 2006. FGDC standards may be downloaded at no cost from the web addresses listed with each FGDC standard referenced in section A.4.

A.2 ISO 19100 series of Geographic information standards

ISO 19107:2003, Geographic information – Spatial schema

ISO 19108:2002, Geographic information – Temporal schema

ISO 19109:2005, Geographic information – Rules for application schema

ISO 19111:2003, Geographic information – Spatial referencing by coordinates

ISO 19115:2003, Geographic information – Metadata

ISO 19123:2005, Geographic information – Schema for coverage geometry and functions

ISO 19133:2005, Geographic information – Location based services – Tracking and navigation

A.3 Other ISO/IEC standards

ISO 19501:2005, Information technology – Open distributed processing – Unified Modeling Language (UML), Version 1.4.2

ISO/IEC 11179-3:2003, Information technology – Information technology - Metadata registries (MDR) - Part 3: Registry metamodel and basic attributes

A.4 FGDC standards

FGDC-STD-001-1998, Content standard for digital geospatial metadata, Version 2.0, http://www.fgdc.gov/standards/projects/FGDC-standards-projects/metadata/base-metadata/index_html, accessed October 2006

Annex B
(informative)
UML notation

B.1 Introduction

This annex provides a description of UML notation as used in the UML diagrams in the Framework Data Content Standard.

B.2 UML class

B.2.1 UML class notation

B.2.1.1 UML class diagram notation

A UML class (Figure B.1) represents a concept within the system being modeled. It describes a set of objects that share the same attributes, operations, methods, relationships, and semantics. A class is drawn as a solid-outline rectangle with three compartments separated by solid horizontal lines. The top compartment holds the class name and other general properties of the class, including stereotypes; the middle compartment holds a list of attributes; and the bottom compartment holds a list of operations. The attribute and operations compartments may be suppressed to simplify a diagram, however, suppression does not indicate that there are no attributes or operations.

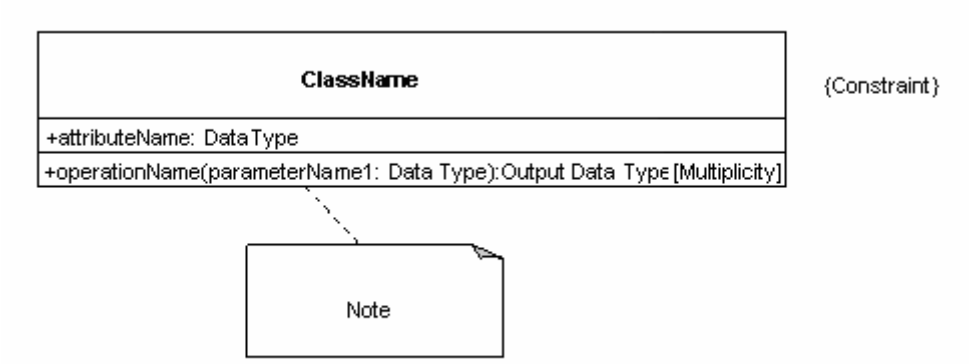


Figure B.1 – UML class

B.2.1.2 Class name format

Class names start with an upper case letter. Spaces do not appear in a class name. Multiple words are concatenated, with each new word starting with a capital letter (for example, XnnnYnnn). Class names are unique within each part of the standard.

B.2.2 Stereotypes

A UML stereotype is an extension mechanism for existing UML concepts. Below are brief descriptions of the stereotypes used in the standard.

<<Abstract>>
class, or other classifier, that cannot be directly instantiated. UML notation for this is to show the name in italics

<<CodeList>>

data type used to describe a more open enumeration. A code list is a flexible enumeration. Code lists are useful for expressing a long list of potential values. Code lists are extensible

NOTE If the elements of the list are completely known, an enumeration should be used. If only likely values of the elements are known, a code list should be used.

<<DataType>>
descriptor of a set of values that lack identity (independent existence and the possibility of side effects). Data types include primitive predefined types and user-defined types. A DataType is thus a class with few or no operations whose primary purpose is to hold the abstract state of another class

<<Enumeration>>
data type in which instances form a list of named literal values. Both the enumeration name and its literal values are declared. Enumeration means a short list of well-understood potential values within a class. Enumerations are not extensible

<<Feature>>
data type used to describe a feature

<<Leaf>>
package that contains definitions, without any sub-packages

<<Union>>
data type consisting of one and only one of several alternatives (listed as member attributes)

B.2.3 Attribute

An attribute represents a characteristic common to all objects of a class. An attribute is specified by a text string that can be parsed into elements that describe the properties of the attribute:

visibility name: type-expression – initial-value [multiplicity]

where:

visibility may be public (indicated by a plus sign “+”) or private (indicated by a minus sign “-“).

name is a character string. The attribute name shall include no blank spaces and shall begin with a lower case letter. Individual words in the name, following the first word, shall begin with an upper case letter. Attribute names are unique within a class, but not throughout the entire data dictionary of the standard. Attribute names are made unique, within an application, by the combination of the class and attribute names (example: Dataset.descripton).

type-expression identifies the data type of the attribute.

initial-value value specifies the default value for the attribute.

multiplicity specifies the number of values that an instance of a class may have for a given attribute (default = 1).

B.2.4 Constraint

A constraint specifies a semantic condition or restriction. A constraint may be written using any formal notation, or a natural language. A constraint is shown as a text string in braces “{}”. It is placed near the element to which it applies. If the notation for an element is a text string, such as an attribute, the constraint string may follow the element text string in braces. A constraint included as an element in a list applies to all subsequent elements in the list, down to the next constraint element or the end of the list.

B.2.5 Note

A note contains textual information. It is shown as a rectangle with a “bent corner” in the upper right corner, attached to zero or more model elements by a dashed line. Notes may be used to contain comments or constraints.

B.3 UML associations

B.3.1 Association

B.3.1.1 Introduction

An association is a semantic relationship between classes that specifies connections between their instances. Figure B.2 shows how associations are represented.

An association is drawn as a solid line connecting class rectangles. An association may have a name, represented as a character string placed near the line, but not close to either end.

If the navigability of an association is not shown by an arrowhead, it is assumed to be navigable in both directions. The end of an association may be adorned with information pertinent to the class at that end, including multiplicity and role name.

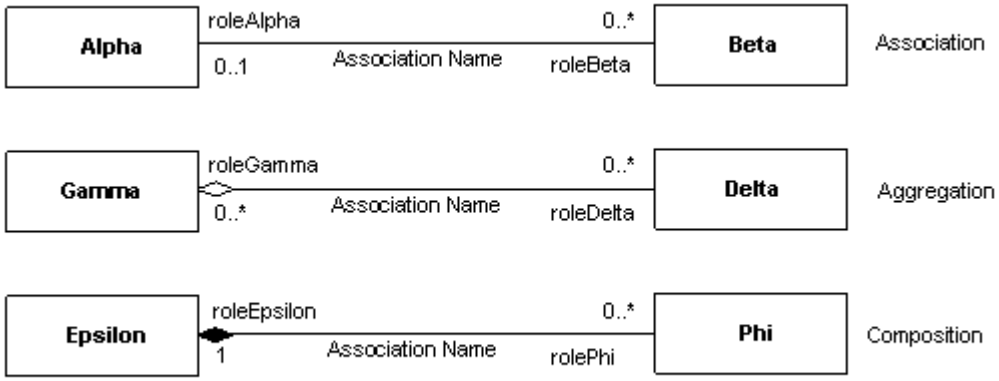


Figure B.2 – UML associations

B.3.1.2 Role name

If an association is navigable in a particular direction shown with an arrowhead in the line, the model shall supply a role name that is appropriate for the role of the target object in relation to the source object. Thus, in a two-way association, two role names shall be supplied.

Role names explain how an object participates in the relationship. A role name adorning an association end specifies behavior of the class at that end with respect to the class at the other end of the association. In Figure B.2, roleAlpha describes the role that the class named Alpha has with respect to the class named Beta.

A role name is represented as a character string. A role name shall include no blank spaces and shall begin with a lower case letter. Individual words in the name, following the first word, shall begin with upper case letters. When placed in a diagram, the role name shall be preceded by a plus sign "+" to indicate that the role name is public.

In a data dictionary table, the word "Role name" followed by a colon should precede the name to distinguish role elements from other elements. In a UML diagram, however, the "Role:" prefix is not used, since the position of a role name identifies it as a role.

B.3.1.3 Multiplicity

Multiplicity specifies the number of instances of a class that may be associated with each instance of a class at the other end of the association. The values shown in Figure B.2 have the following meanings:

- Zero or one instance of Alpha may be associated with each instance of Beta
- Zero or more instances of Beta may be associated with each instance of Alpha

- Zero or more instances of Gamma may be associated with each instance of Delta
- Zero or more instances of Delta may be associated with each instance of Gamma

- One instance of Epsilon may be associated with each instance of Phi
- Zero or more instances of Phi may be associated with each instance of Epsilon

If not shown, the multiplicity is the default value of 1 (one).

B.3.2 Aggregation

An aggregation is an association in which one class (the containee) is a component of the other class (the container). The members of an aggregation can exist independently of the aggregation and can be members of more than one aggregation, if allowed by the multiplicity.

An open diamond on an association end indicates that the class at that end of the association is the container, that is, an aggregate of instances of the class at the other end (see Figure B.2).

B.3.3 Composition

A composition is an association on which the class at one end of the association (the container) is composed of instances of the class at the other end (the containee). Members of a composite cannot exist independently of the composite class, nor can they be members of more than one composite class. If the composite class is deleted, then all of its members are deleted as well.

A filled diamond on an association end indicates that the class at that end of the association is the container, that is, a composite of instances of the class at the other end (see Figure B.2).

B.3.4 Generalization

A generalization is a relationship between a superclass and the subclasses that may be substituted for it. The superclass is the generalized class, while the subclasses are specialization classes. Figure B.3 shows how the generalization relationship is represented. In Figure B.3, Alpha is the superclass, while Beta and Gamma are the subclasses.

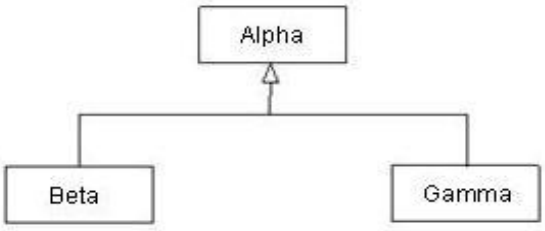


Figure B.3 – UML generalization

ISO/IEC 19501, Information technology – Open distributed processing – Unified Modeling Language (UML), Version 1.4.2 defines generalization as a taxonomic relationship between a more general element and a more specific element. The more specific element is fully consistent with the more general element and contains additional information. Instance of the more specific element may be used anywhere the more general element is allowed. Generalization is shown with a solid line path from the child (the more specific element, such as a subclass) to the parent (the more general element such as a superclass), with a hollow triangle at the end of the path where it meets the more general element.

All attributes, operations, or associations specified for Alpha (that is, appearing in the Alpha class box) are inherited by both the Beta and Gamma. These are not explicitly shown in the class boxes for Beta and Gamma.

Annex C
(informative)
Encoding using Geography Markup Language

C.1 Introduction

This annex describes the implementation of the Framework Data Content Standard using the Geography Markup Language (GML), a specialization of the Extensible Markup Language (XML), for the encoding of geographic information developed by the Open Geospatial Consortium (OGC). The ISO standards project for GML is ISO 19136. It is envisioned that the primary vehicle for the exchange of GML will be through the use of the OGC Web Feature Services (WFS), a query and response protocol for geographic Web services.

C.2 Approach

The representation of the features and related classes defined in the standard were translated directly from the UML models into GML application schemas. XML Schema Document (.xsd) files that facilitate the validation of a framework feature collection expressed in XML incorporating the GML constructs are created in this process.

C.3 Reference for XML encoding

A companion file, ANSI_Framework_Schemas.zip, contains all relevant XML Schema Document files required to validate conformant geographic information for each framework data theme. These schema documents can be used to create, validate, and process geographic information with XML parsing and validation software.

There is a primary schema document for each framework theme. Table C.1 lists the primary schema document name for each theme.

The schema files may require schema fragments from LinearReferenceSystem.xsd and the folders asXML, base, scXML, smil, smXML, ssXML, stXML, and xlink.

Table C.1 – Framework data themes and associated GML schemas

Theme	Schema
Transportation - Air	Air.xsd
Transportation - Base	BaseTransportation.xsd
Cadastral	Cadastral.xsd
Elevation	Elevation.xsd
Base	FrameworkBase.xsd
Geodetic Control	GeodeticControl.xsd
Governmental Unit and Other Geographic Area Boundaries	GovtUnits.xsd
Hydrography	Hydro.xsd
Digital Orthoimagery	Ortho.xsd
Transportation - Rail	Rail.xsd
Transportation - Roads	Roads.xsd

Theme	Schema
Transportation - Transit	Transit.xsd
Transportation - Waterways	Waterways.xsd

C.4 References

See Annex D for GML references.

Annex D
(informative)
Bibliography

The following documents contain provisions that are relevant to two or more parts of the Framework Data Content Standard. References applicable to a single part are reported in the respective part of the standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

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Federal Geographic Data Committee, 1997, Framework introduction and guide, Washington DC, http://www.fgdc.gov/framework/handbook/index_html/?searchterm=Framework%20introduction%20and%20guide, accessed October 2006

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ISO 3534-1:1993, Statistics – Vocabulary and symbols – Part 1: Probability and general statistical terms

ISO 19101:2002, Geographic information – Reference model

ISO/TS 19103:2005, Geographic information – Conceptual schema language

ISO 19104, Geographic information – Terminology (DIS)

ISO 19116:2004, Geographic information – Positioning services

ISO 19126, Geographic information – Profiles for feature data dictionary registers and feature catalogue registers

ISO 19136, Geographic information – Geography Markup Language, (forthcoming)

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