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Geografisk information – Metadata – implementering med XML-schema (ISO/TS 19139:2007)

Geographic information – Metadata – XML schema implementation (ISO/TS 19139:2007)

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CEN ISO/TS 19139

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Geographic information - Metadata - XML schema implementation (ISO/TS 19139:2007)

Information géographique - Métadonnées - Implémentation de schémas XML (ISO/TS 19139:2007)

Geoinformation - Metadaten - XML-Schema-Implementierung (ISO/TS 19139:2007)

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Foreword

The text of ISO/TS 19139:2007 has been prepared by Technical Committee ISO/TC 211 “Geographic information/Geomatics” of the International Organization for Standardization (ISO) and has been taken over as CEN ISO/TS 19139:2009 by Technical Committee CEN/TC 287 “Geographic Information” the secretariat of which is held by NEN.

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Endorsement notice

The text of ISO/TS 19139:2007 has been approved by CEN as a CEN ISO/TS 19139:2009 without any modification.

Introduction

The importance of metadata describing digital geographic data is explained in detail in the text of ISO 19115. ISO 19115 provides a structure for describing digital geographic data by defining metadata elements and establishing a common set of metadata terminology, definitions and extension procedures. ISO 19115 is abstract in that it provides a worldwide view of metadata relative to geographic information, but no encoding.

Since ISO 19115 does not provide any encoding, the actual implementation of geographic information metadata could vary based on the interpretation of metadata producers. In an attempt to facilitate the standardization of implementations, this comprehensive metadata implementation specification provides a definitive, rule-based encoding for applying ISO 19115. This Technical Specification provides Extensible Markup Language (XML) schemas that are meant to enhance interoperability by providing a common specification for describing, validating and exchanging metadata about geographic datasets, dataset series, individual geographic features, feature attributes, feature types, feature properties, etc.

ISO 19115 defines general-purpose metadata in the field of geographic information. More detailed metadata for geographic data types and geographic services are defined in other ISO 19100 series standards and user extensions (ISO 19115). This Technical Specification is also intended to define implementation guidelines for general-purpose metadata. Where necessary, interpretations of some other ISO 19100 series standards are incorporated.

ISO 19118 describes the requirements for creating encoding rules based on UML schemas and the XML-based encoding rules as well as providing an introduction to XML. This Technical Specification utilizes the encoding rules defined in ISO 19118 and provides the specific details of their application with regard to deriving XML schema for the UML models in ISO 19115.

Geographic information — Metadata — XML schema implementation

1 Scope

This Technical Specification defines Geographic MetaData XML (gmd) encoding, an XML schema implementation derived from ISO 19115.

2 Conformance

Conformance with this Technical Specification shall be checked using all the relevant tests specified in Annex A. The framework, concepts, and methodology for testing, and the criteria to be achieved to claim conformance are specified in ISO 19105.

3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 639-2, *Codes for the representation of names of languages — Part 2: Alpha-3 code*

ISO 3166 (all parts), *Codes for the representation of names of countries and their subdivisions*

ISO 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO/IEC 10646, *Information technology — Universal Multiple-Octet Coded Character Set (UCS)*

ISO/TS 19103, *Geographic information — Conceptual schema language*

ISO 19105, *Geographic information — Conformance and testing*

ISO 19107, *Geographic information — Spatial schema*

ISO 19108, *Geographic information — Temporal schema*

ISO 19109, *Geographic information — Rules for application schema*

ISO 19110, *Geographic information — Methodology for feature cataloguing*

ISO 19111:—[1)], *Geographic information — Spatial referencing by coordinates*

ISO 19115:2003, *Geographic information — Metadata*

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1) To be published. (Revision of ISO 19111:2003)

ISO 19115:2003/Cor. 1:2006, *Geographic information — Metadata — Technical Corrigendum 1*

ISO 19117, *Geographic information — Portrayal*

ISO 19118:2005, *Geographic information — Encoding*

ISO 19136:—[2)], *Geographic information — Geography Markup Language (GML)*

W3C XMLName, *Namespaces in XML. W3C Recommendation* (14 January 1999)

W3C XMLSchema-1, *XML Schema Part 1: Structures. W3C Recommendation* (2 May 2001)

W3C XMLSchema-2, *XML Schema Part 2: Datatypes. W3C Recommendation* (2 May 2001)

W3C XML, *Extensible Markup Language (XML) 1.0 (Second Edition), W3C Recommendation* (6 October 2000)

W3C XLink, *XML Linking Language (XLink) Version 1.0. W3C Recommendation* (27 June 2001)

4 Terms and definitions

For the purposes of this Technical Specification, the following terms and definitions apply.

4.1
namespace
collection of names, identified by a URI reference, that are used in XML documents as element names and attribute names

[W3C XML]

4.2
package
general purpose mechanism for organizing elements into groups

[ISO/TS 19103, definition 4.2.22]

EXAMPLE Identification information; Metadata entity set information; Constraint information.

4.3
realization
semantic relationship between classifiers, wherein one classifier specifies a contract that another classifier guarantees to carry out

[Booch 1999]

4.4
polymorphism
characteristic of being able to assign a different meaning or usage to something in different contexts – specifically, to allow an entity such as a variable, a function, or an object to have more than one form

NOTE There are several different kinds of polymorphism.

[http://searchsmallbizit.techtarget.com]

2) To be published.

5 Symbols and abbreviated terms

5.1 Acronyms

UML	Unified Modelling Language
XCT	XML Class Type
XCPT	XML Class Property Type
XCGE	XML Class Global Element
XML	Extensible Markup Language
XPath	XML Path Language
XSD	XML Schema Definition
XSL	Extensible Style Language
XSLT	XSL Transformation

5.2 Namespace abbreviations

In the lists below, the item on the left describes the common namespace prefix used to describe the elements in the namespace. The second item is an English description of the namespace prefix, and the item in parenthesis is the URI of the actual namespace. These URIs do not correspond necessarily to an effective location of the schemas.

This first list corresponds to the namespaces defined by this Technical Specification.

gco	Geographic Common extensible markup language	(http://www.isotc211.org/2005/gco)
gmd	Geographic MetaData extensible markup language	(http://www.isotc211.org/2005/gmd)
gmx	Geographic Metadata XML Schema	(http://www.isotc211.org/2005/gmx)
gss	Geographic Spatial Schema extensible markup language	(http://www.isotc211.org/2005/gss)
gsr	Geographic Spatial Referencing extensible markup language	(http://www.isotc211.org/2005/gsr)
gts	Geographic Temporal Schema extensible markup language	(http://www.isotc211.org/2005/gts)

This second list corresponds to external namespaces used by this Technical Specification.

gml	Geography Markup Language	(use the GML namespace URI stated in ISO 19136)
xlink	XML Linking Language	(use the XLINK namespace URI stated in the W3C XLink recommendation)
xs	W3C XML base schemas	(use the XML schema namespace URI stated in the W3C XMLSchema-1 and W3C XMLSchema-2 recommendations)

5.3 UML model relationships

The diagrams that appear in this Technical Specification are presented using the Unified Modelling Language (UML) as the conceptual schema language as defined in ISO/TS 19103. ISO 19115:2003, Figure 2, also displays the UML notation that is used to describe the metadata. In addition to the UML described in ISO/TS 19103 and shown in ISO 19115, this Technical Specification uses the notation shown in Figure 1.

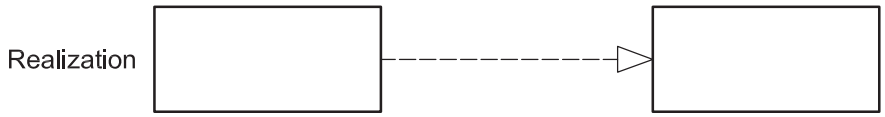

Figure 1 — UML Notation for Realization

The class that is the source of the connection (shown on the left in Figure 1) is guaranteed to carry out (or implement) the specification of the class at the destination of the connection (shown on the right in Figure 1).

5.4 UML model stereotypes

A UML stereotype is an extension mechanism for existing UML concepts (see ISO 19115). In addition to the stereotypes already defined in ISO 19115 for describing metadata, this Technical Specification defines stereotypes necessary for a rules-based encoding into XML schema.

The elements of the UML diagrams depicted in Clause 9 can carry stereotypes specifying an XML implementation. Those stereotypes are carried by classes representing XML elements or XML types, UML attributes, UML links (realizations or dependencies) and UML packages.

In this Technical Specification the following stereotypes of classes are used.

a) <<xs:choice>>: the class represents an implementation type encoded as an XML choice block. Each property of the class is implemented as an element of the choice.

b) <<xs:complexType>>: the class represents an implementation type encoded as an XML complex type.

c) <<xs:element>>: the class represents an XML global element.

d) <<xs:simpleType>>: the class represents an implementation type encoded as an XML simple type.

e) <<xs:simpleContent>>: the class represents an implementation type encoded as an XML complex type with simple content.

In this Technical Specification the following stereotypes of attributes are used.

f) <<xs:attribute>>: the property is encoded as an XML attribute.

g) <<xs:element>>: the property is encoded as an XML element with a name and a type (<xs:element name=”propertyName” type=”propertyType”/>)

h) <<pattern>>: this stereotype only applies to XML simple types derived from built-in XML types. A property with the stereotype <<pattern>> restricts the range of a built-in simple type.

i) <<XCGE>>: the property is encoded as a reference to an XML global element (<xs:element ref=”XCGE”/>).

In this Technical Specification the following stereotypes of links are used.

j) <<XCT>>: (carried by realization relationships). The XCT of the abstract concept to implement is substituted by the specified external implementation.

k) <<XCGE>>: (carried by realization relationships). The XCGE of the abstract concept to implement is substituted by the specified external implementation.

l) <<XCPT>>: (carried by realization relationships). The XCPT of the abstract concept to implement is substituted by the specified external implementation.

m) <<implement>>: (carried by dependency relationships). The source represents an XML schema implementing the abstract concepts defined in the target.

n) <<include>>: (carried by dependency relationships). The source and the target represent XML schemas. The source includes (<xs:include … />) the target.

o) <<import>>: (carried by dependency relationships). The source and the target represent sets of XML objects grouped within the same namespace. The source imports (<xs:import … />) the target.

In this Technical Specification the following stereotypes of packages are used.

p) <<xmlSchema>>: The package represents an XML schema.

q) <<xmlNamespace>>: The package represents a set of XML objects grouped within the same namespace.

6 Requirements

6.1 Introduction to gmd

Geographic metadata is represented in ISO 19115 as a set of UML packages containing one or more UML classes. ISO 19115 provides a universal, encoding-independent view of geographic information metadata. This Technical Specification provides a universal implementation of ISO 19115 through an XML schema encoding that conforms to the rules described in ISO 19118.

While the details of XML namespaces are not included in this Technical Specification, the contents of several namespaces are defined here. A namespace is really a collection of names which can be used in XML documents as element or attribute names. The namespace is used to identify the names with a particular schema. A namespace is a URI, and the ones utilized in this Technical Specification are listed in 5.2. A URI is often cumbersome for reading, writing and including in human discussion, so this Technical Specification will more often refer to common namespace prefixes when identifying particulars about the contents of a namespace. The primary namespace defined in this Technical Specification is http://www.isotc211.org/2005/gmd and the namespace prefix is **gmd** which stands for ***G****eographic* ***M****eta****D****ata extensible markup language*.

XML schema offers many alternatives for structuring information for exchange. ISO 19118 defines a set of encoding rules for transforming a UML conceptual schema from the ISO 19100 series of documents into an XML schema. Even within the pared down limitations of ISO 19118, there are still choices for the creation of specific XML schemas. Clauses 7, 8 and 9 describe the details of encoding the ISO 19115 UML conceptual schema and the UML models depicted in the respective ISO 19100 series of International Standards listed in Clause 3, into a set of XML schemas. A description of geographic ISO/TS 19139 XML resources and examples of metadata instance documents are included in Annexes C and D.

Before delving into the details of the encoding it is important to understand why certain encoding rules are utilized in the development of gmd. Gaining an understanding of the rules will make the capabilities, limitations and best-practice use of gmd clear. Some of the major goals for gmd were interoperability with other ISO 19100 series specifications, predictability, extensibility and usability. Further details of these goals are described in 6.2 to 6.8.

6.2 Rule-based

This XML schema implementation is a rule-based encoding built from the UML models in the ISO 19100 series of International Standards as required by ISO 19118. Using this methodology achieves a couple of the goals mentioned in 6.1. First, the resulting gmd schemas are based directly on other ISO 19100 series International Standards and therefore increase the chance for interoperability. Second, the resulting schema is predictable since any class, attribute, association, etc. is encoded just as other UML elements of the same type are encoded.

Although not discussed in detail in this Technical Specification, having a rule-based encoding also allows the XML schemas to be generated in an automated or semi-automated fashion.

6.3 Quality

Quality in terms of the XML schema implementation implies simple XML schemas as well as the human readability of the XML files. The structural complexity of the ISO 19100 series, particularly ISO 19115, implies that it is not possible to provide simple XML schemas for geographic metadata. But the encoding rules are defined so that a user can directly create and/or understand the content of an XML instance document using the UML models in ISO 19115 as a basis. Additionally, an implementer can determine the XML schema implementation of the UML models in ISO 19115 by knowing the encoding rules.

Another aspect to the quality of gmd is completeness. This Technical Specification encodes the entire UML model from ISO 19115 without regard to a particular usage for gmd or a particular application schema that will utilize gmd.

6.4 Web implementations

One of the goals stated in 6.1 is usability. Usability, as it pertains to the design of gmd, focuses on the exchange of geographic metadata with the understanding that this will often happen in a web-like environment. While there is no restraint against creating geographic metadata instance documents based on gmd which never transfer across a network, there are many aspects to the design that are intended to aid internet and web-like transfer of data.

6.5 Use of external XML implementations

Another design principle that aids interoperability and usability is the use of existing XML schemas. If an XML schema standard already exists that encodes a part of the ISO 19100 series pertaining to geographic metadata then it is advantageous to incorporate that XML schema standard into gmd. If gmd uses the external XML schema directly, then interoperability is enhanced. It is also likely that software already exists that can process instance documents that conform to the external XML. Furthermore, if the external schema is well designed it might be more efficient than XML schema generated from a series of encoding rules and this might help achieve the goal of usability.

While using an implementation that already exists has some important advantages, the external XML schemas should not violate the primary design principles of gmd. For example, if an external XML schema implements part of the ISO 19100 series but does so in a cumbersome, unusable manner then it is not incorporated into gmd. Additionally, if an external XML schema does not readily meet the requirements stated in 6.6 for multilingual support then it is not incorporated into gmd.

6.6 Multilingual support

Cultural and linguistic adaptability is a basic requirement for any textual metadata elements. In Annex J of ISO 19115:2003, there is an informative discussion of multilingual textual metadata elements. In order to enhance the chances for interoperability of implementations it is important that a normative mechanism for multilingual support be included in this Technical Specification. The details of multilingual support are described in 7.3 and 9.8.6 but for the sake of understanding the design of gmd it is important to understand that special consideration is given to this requirement. The specific mechanisms used to achieve this goal are polymorphism and codelist registers. Polymorphism is introduced in 6.7 and codelist registers are described in 7.4.4.4.

It is also important to understand that the multilingual support that exists in W3C XML is not sufficient for the expression of geographic metadata. In W3C XML, “A special attribute named xml:lang may be inserted in documents to specify the language used in the contents and attribute values of any element in an XML document [W3C XML]”. If a particular element can only occur once based on the encoding rules discussed in Clause 8 then the technique of using the special xml:lang attribute to indicate the language does not allow for the specification of the same element in two or more languages.

6.7 Polymorphism

The term polymorphism is formally defined in Clause 4. In general terms, polymorphism means the ability to assume different forms. In terms of this Technical Specification, the first obvious use for polymorphism is for providing cultural and linguistic adaptability. This allows implementers to provide geographic metadata in one or more languages without violating any cardinal rules defined in ISO 19115. Polymorphism provides more than just support for multiple languages. It also allows user communities to better refine geographic metadata to meet their organizational needs. For example, ISO 19115 contains an *individualName* attribute of type *CharacterString* in the *CI_ResponsibleParty* class, but within an organization individuals may be described in a more compartmentalized form (e.g. by first, middle and last names). Polymorphism allows implementers to extend the more general format of *individualName* within their namespaces while still fully utilizing gmd and still providing usable and understandable instance documents for users outside of their organization. The characteristics of gmd that allow for polymorphism primarily derive from the property type encodings described in 8.4.

6.8 Rules for application schema

ISO 19109 defines the rules for application schema and is comprised of two categories of models that are related to metadata:

— **a General Feature Model** that determines the particular way metadata and quality elements relate to geographic features;

— **two interchange models**: the traditional data transfer model and the interoperability model, each of them implying an interrelation of the metadata with its resources.

With regards to the ISO 19109 General Feature Model, the following specific types of attribute can be defined for a feature type:

— metadata attributes (as instances of GF_MetadataAttributeType) whose data type is MD_Metadata or one of its subclasses;

— quality attributes (as instances of GF_QualitiyAttributeType) whose data type is DQ_Element or one of its subclasses.

The use of geographic metadata XML schema in the context of these rules for application schema basically consists of the use of the XML schema definitions corresponding to the metadata and quality attribute data types. The use of XML schema definitions when encoding feature types using ISO 19136 is described in 9.9.2.

With regards to the ISO 19109 interchange models, the *interoperability* model is based on data interchange by transactions and is designed for a large number of transactions involving simple interchange. In contrast, the *transfer model* is designed for a lesser number of transactions with large amounts of well-organized data. The ISO 19115 metadata conceptual schema and this Technical Specification are clearly designed to be a starting point for providing more coherent transfer of geospatial data among and within user communities (i.e. *transfer model*).

Additionally, it is important to understand that the *interoperability* model applies to the interaction between the user application and a service provider, and that the interaction is fully determined by the service interface. While the service interface may not *require* the use of a specific schema, the adoption of the geographic metadata XML schema within an information-sharing community is highly recommended when applicable. Interoperable interchanges by transfer needs to go further in terms of standardization. This is the purpose of the “Extensions for metadata-based transfers of geospatial information” presented in 7.4.

7 Extensions to the UML models in the ISO 19100 series of International Standards

7.1 Introduction to extensions

It has already been stated that ISO 19115 provides an internationally-accepted, encoding-independent view of geographic information metadata and that this Technical Specification provides a worldwide implementation of ISO 19115 through an XML schema encoding. Before delving into the specifics of the encoding it is important to recognise that once a specific implementation technology is identified there may be some specific extensions required for the ISO 19100 series UML models. The purpose of these extensions may vary but they are mainly intended to support the requirements stated in Clause 6. An extension might be created to facilitate interoperability, ease of use, web-like environments, etc. The UML diagrams shown throughout Clause 7 are the extensions identified to support an XML schema encoding of ISO 19115 and its related ISO 19100 series of International Standards.

7.2 Extensions specific to the web environment

There are several extensions of the CharacterString class from ISO/TS 19103 that are necessary to add convenience when working with XML documents. These extensions are specific to the World Wide Web environment where XML documents are typically processed. Figure 2 defines the metadata required to describe elements specific to working in a web environment. The data dictionary for this diagram is located in B.2.1.

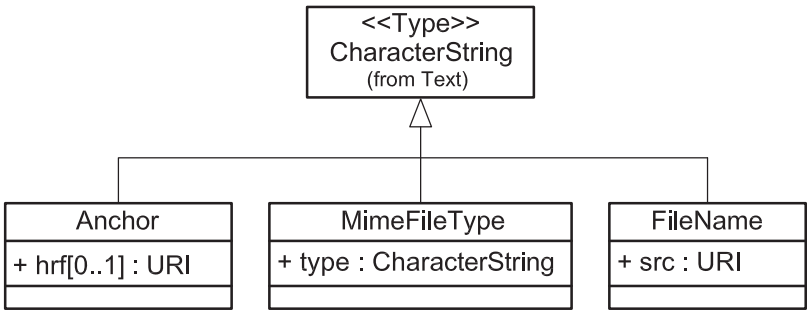

Figure 2 — Extensions to support web environments

The Anchor class is needed to support hyper-linking capabilities and to ensure a web-like implementation of ISO 19115's RS_Identifier and MD_Identifier classes. Because Anchor is a subclass of CharacterString, the *code* attribute of RS_Identifier and MD_Identifier can be implemented by instantiating Anchor and thus provide a reference to the place where the information related to the code is available.

The FileName class is needed to support explicitly referencing of an external file corresponding to a property containing the name of the file. This is valuable in the case of ISO 19115's MD_BrowseGraphic class with regards to the fileName attribute. A human readable file name might be a useful value for population of this attribute, but the additional src attribute provided by the FileName class can provide a machine-readable absolute path to the location of the file.

The MimeFileType class is needed to support identification of the file type using the mime media type name and subtype name. This is useful in the case of ISO 19115's MD_BrowseGraphic class with regards to the fileType attribute. The value of the fileType attribute might be “JPEG” and the type attribute of the MimeFileType class allows for the machine-readable Mime-type content-type expression such as “image/jpeg”.

7.3 Cultural and linguistic adaptability extensions

7.3.1 Free text

The free text element in the domain of a CharacterString property type in ISO 19115 is intended to support a textual metadata element having multiple instances of the same information in different locales. A locale (identified as PT_Locale) is a combination of language, potentially a country, and a character encoding (i.e. character set) in which localized character strings are expressed. Annex J of ISO 19115:2003, describes this Free Text concept (identified as PT_FreeText) but does not include the conceptual schema to accompany the description. This Technical Specification makes the use of PT_FreeText normatively by providing a conceptual schema in Figure 3 as well as a corresponding data dictionary (see B.2.2).

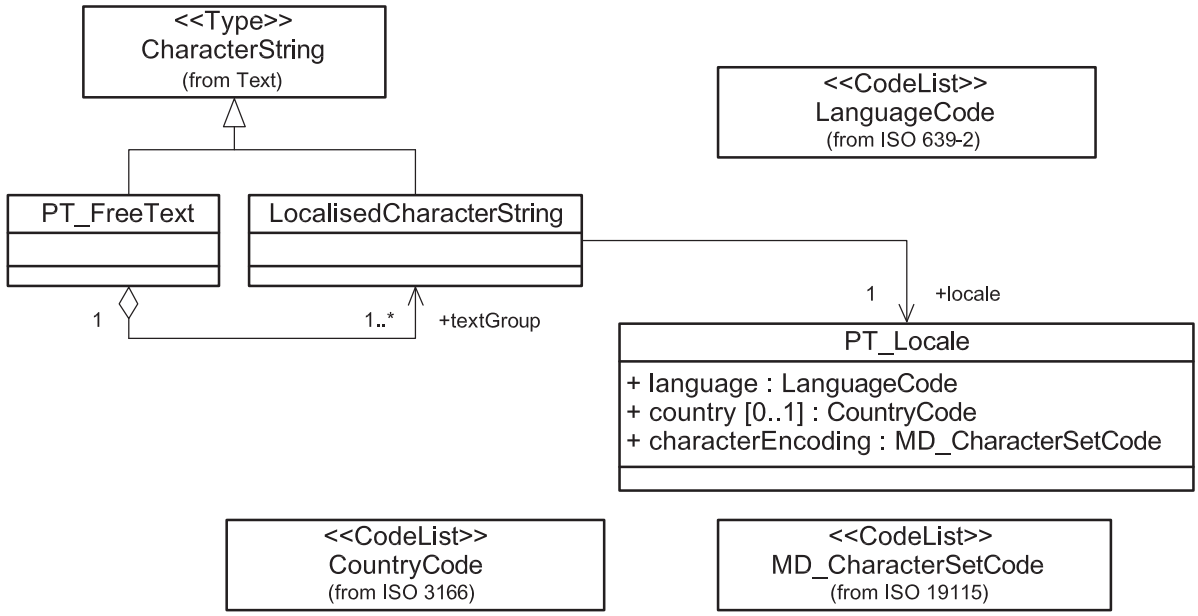

Figure 3 — Free text and localized character string

As a consequence of introducing the Locale concept (PT_Locale), the Group concept (identified as PT_Group) from ISO 19115:2003, Annex J is replaced by the concept of Localised String (identified as LocalisedCharacterString). LocalisedCharacterString is a subtype of CharacterString whose value is expressed in a single locale. An instance of a Free Text consequently is a CharacterString (with its value expressed in a default language and character set that could be defined in an instance of MD_Metadata), which also aggregates a series of Localised Character String translations via the *textGroup* role.

7.3.2 Multilingual metadata sets

An optional but repeatable attribute, locale, presented in Figure 4, was added to the class MD_Metadata of ISO 19115 by corrigendum. This attribute is instantiated if – and only if – the metadata set is multilingual (at least one of the metadata elements is an instance of PT_FreeText or one of its inherited classes).

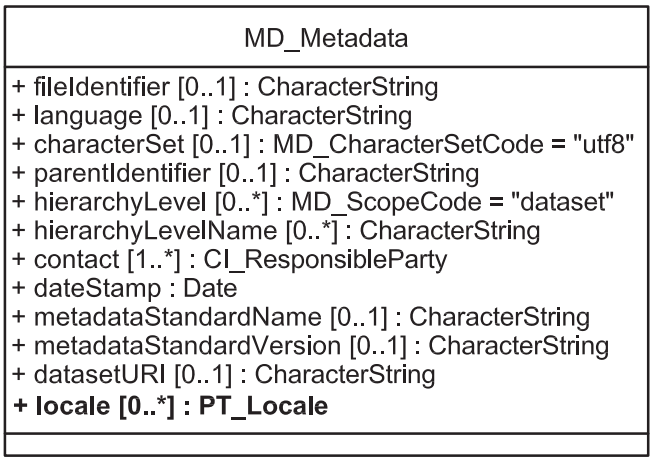

Figure 4 — Attributes of MD_Metadata in the geographic metadata XML schema

7.3.3 Management of localized strings

An instance of free text is composed of default character strings and their translations in different locales through the use of localized strings. This construct implies a distribution of localized strings throughout any given multilingual metadata set. However, a more common way of managing multilingual sets of information consists of grouping the localized strings per their locales. In order to ease the management of localized strings, this Technical Specification describes the concept of locale container (identified as PT_LocaleContainer). A locale container aggregates a set of localized strings related to a given locale (*locale* attribute of PT_LocaleContainer). There is no direct relationship between a locale container and a metadata set except that a locale container may aggregate localized strings of a metadata set.

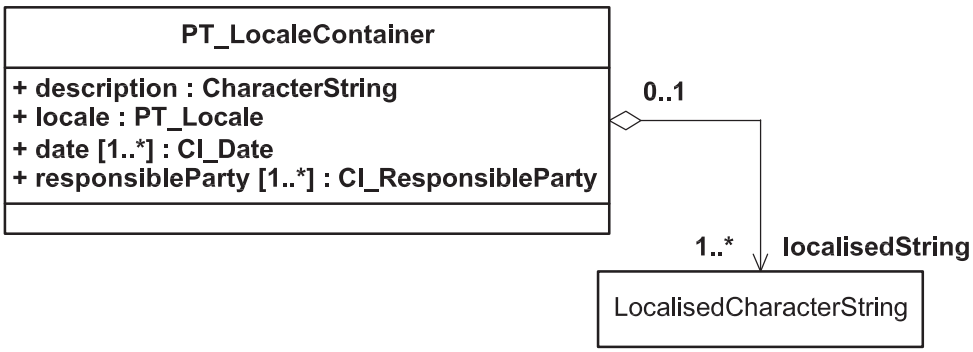

Figure 5 — Translation container

This translation container concept is particularly useful in terms of the XML implementation of ISO 19115, but it is applicable to any other implementation. Indeed, an XML file can only support data expressed in a single character set, which is generally declared in the XML file header. Having all the localized strings stored in a single XML file would limit the use of a single character set such as UTF-8. In order to avoid this,

— the LocalisedCharacterString class is implemented specifically to allow a by-reference containment of the PT_FreeText.textGroup property, and

— the PT_LocaleContainer is the recommended root element to be instantiated in a dedicated XML file.

The localized string related to a given locale can be stored in a corresponding locale container (i.e. XML file) and referenced from the PT_FreeText.textGroup property instances.

7.4 Extensions for metadata-based transfers of geospatial information

7.4.1 Transfer of datasets and aggregate datasets

Figure 6 reproduces Figure 3 of ISO 19115:2003, focusing on the classes and associations needed for metadata-driven transfers of geospatial information. Datasets (DS_Dataset) may be part of aggregates (DS_Aggregate) which may be subset or superset aggregates. Both aggregates and datasets are linked to one or more sets of metadata elements (MD_Metadata).

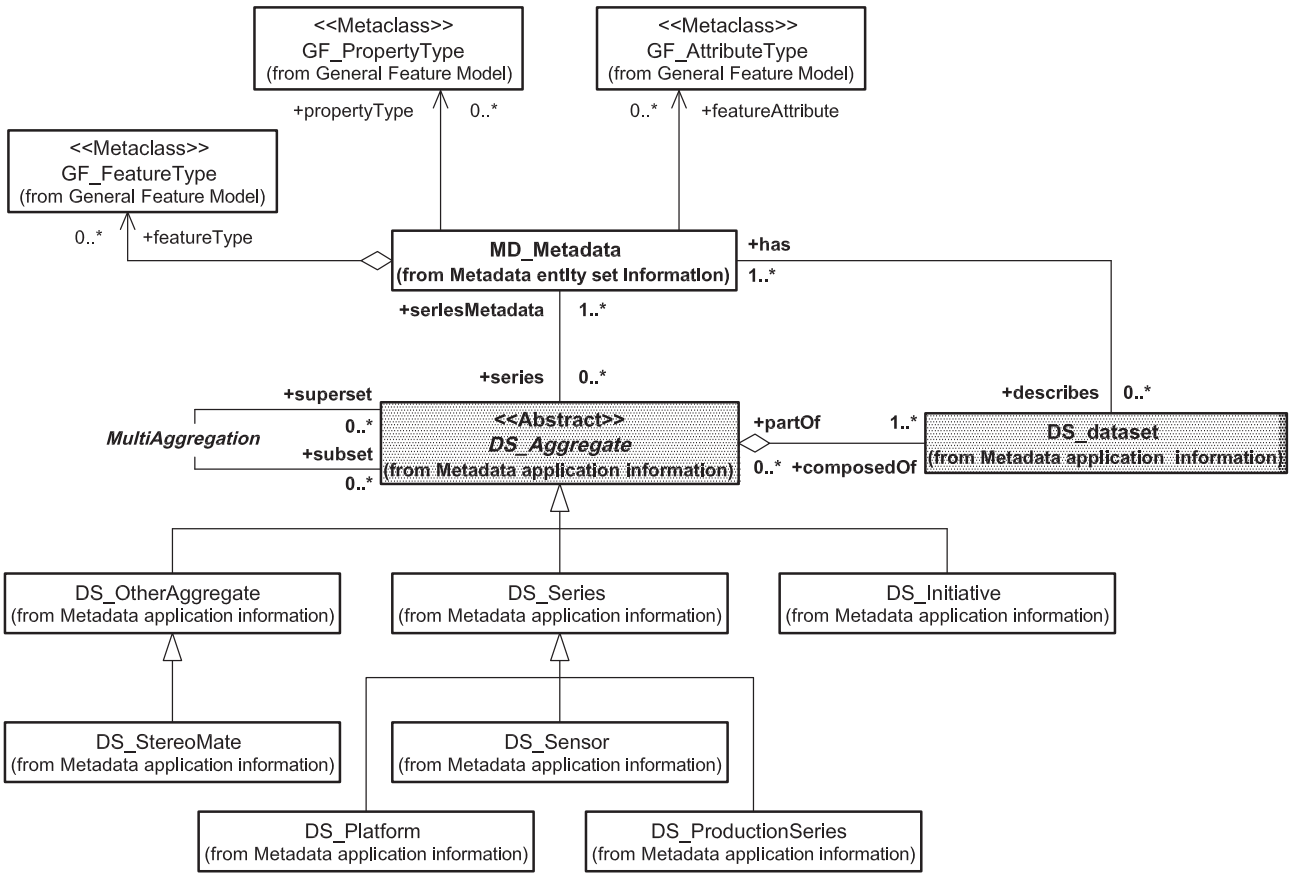

Figure 6 — Datasets, aggregates and their metadata

Metadata-based transfers of geospatial information require the extension of ISO 19115 that is shown in Figure 7.