TECHNICAL SPECIFICATION

ISO/TS 19130-3

First edition

Geographic information — Imagery sensor models for geopositioning —

Part 3: Implementation schema

PROOF/ÉPREUVE

Reference number
ISO/TS 19130-3:2021(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*.

A list of all parts in the ISO 19130 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Vast amounts of data from imaging systems have been collected, processed and distributed by government mapping and remote sensing agencies and commercial data vendors. Additional processing is often needed to make these data useful in the extraction of further geographic information. Geopositioning, which determines the ground coordinates of an object from image coordinates, is a fundamental step in the extraction process. Because of the diversity of sensor types and the lack of a common sensor model standard, data from different producers may contain different parametric information, lack parameters required to describe the sensor that produces the data, or lack ancillary information necessary for geopositioning. A separate software package must often be developed to deal with data from individual sensors or data producers. Standard sensor models and geolocation metadata allow agencies or vendors to develop generalized software products that are applicable to data from multiple data producers or multiple sensors. With such standards, producers can describe the geolocation information of their data in the same way, thus promoting the interoperability of data between application systems and facilitating data exchange and integration.

ISO and OGC have independently defined relevant specifications to standardize the description of sensor models, though a fundamental difference exists between them.

ISO 19130-1 provided a location model and metadata relevant to all sensors. It included metadata specific to whiskbroom, pushbroom and frame sensors, and some metadata for synthetic aperture radar (SAR) sensors. In addition, it provided metadata for functional fit geopositioning. ISO/TS 19130-2 extended the specification of the set of metadata elements required for geolocation by providing physical sensor models for light detection and ranging (LIDAR) and sound navigation and ranging (SONAR), and it presented a more detailed set of elements for SAR. It also defined the metadata needed for aerial triangulation of airborne and spaceborne images.

OGC defined interfaces and encodings for sensor devices and data through sensor web enablement (SWE) to enable the sharing of sensor data over the Web. Sensor Model Language (SensorML) is one of the five defined, prototyped and tested implementation standards under SWE activity. Its primary focus is to provide a robust and semantically-tied means to define processes and processing components associated with the measurement and post-measurement transformation of observations. It utilizes the process concept to describe sensors, systems, and processes surrounding observations and measurements. Geolocation is one of those processes.

Since ISO 19130-1 and ISO/TS 19130-2 do not define encoding rules, the actual implementation of image sensor models for geopositioning can vary based on the interpretation of image producers. To facilitate the standardization of implementations, this document utilizes the Extensible Markup Language (XML) schema defined in OGC SensorML to provide XML Schema encodings for the imagery sensor models for geopositioning defined in ISO 19130-1 and ISO/TS 19130-2. It enables both semantic and syntactic interoperability between ISO 19130-1, ISO/TS 19130-2 and OGC SensorML.

Geographic information — Imagery sensor models for geopositioning —

Part 3: Implementation schema

1 Scope

This document defines the XML Schema implementation of imagery sensor geopositioning models defined in ISO 19130-1 and ISO/TS 19130-2. It applies XML Schema inheritance and extension based on the OGC SensorML and OGC SWE Common Data Model.

Instead of introducing an XML Schema based on the UML models defined in ISO 19130-1 and ISO/TS 19130-2, it leverages the existing OGC SensorML by first introducing a semantic mapping from the model elements defined in ISO 19130-1 and ISO/TS 19130-2 to OGC SensorML, and then defining the detailed schema inheritance and extensions based on OGC SensorML to fully support encoding of the imagery sensor models for geopositioning defined in ISO 19130-1 and ISO/TS 19130-2.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 19103, *Geographic information — Conceptual schema language*

ISO 19111, *Geographic information — Referencing by coordinates*

ISO 19115-1, *Geographic information — Metadata — Part 1: Fundamentals*

ISO 19115-2, *Geographic information — Metadata — Part 2: Extensions acquisition and processing*

ISO 19123, *Geographic information — Schema for coverage geometry and functions*

ISO 19123-1, *Geographic information — Schema for coverage geometry and functions — Part 1: Fundamentals*

ISO 19130-1, *Geographic information — Imagery sensor models for geopositioning — Part 1: Fundamentals*

ISO/TS 19130-2, *Geographic information — Imagery sensor models for geopositioning — Part 2: SAR, InSAR, lidar and sonar*

ISO 19157, *Geographic information — Data quality*

ISO/TS 19163-1, *Geographic information — Content components and encoding rules for imagery and gridded data — Part 1: Content model*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
document
<XML> well-formed data object

Note 1 to entry: Text of the note.

[SOURCE: ISO/TS 19157-2:2016, 3.1, modified — Note 1 to entry has been added.]

3.2
image
gridded coverage whose attribute values are a numerical representation of a physical parameter

Note 1 to entry: The physical parameters are the result of measurement by a *sensor* (3.5) or a prediction from a model.

[SOURCE: ISO 19115-2:2019, 3.18]

3.3
imagery
representation of phenomena as *images* (3.2) produced by electronic and/or optical techniques

Note 1 to entry: In this document, it is assumed that the phenomena have been sensed or detected by one or more devices such as radar, cameras, photometers, and infrared and multispectral scanners.

[SOURCE: ISO 19101-2:2018, 3.14]

3.4
namespace
<XML> collection of names, identified by a *URI* (3.7) reference, which are used in XML documents as element names and attribute names (W3C XML Namespaces)

[SOURCE: ISO 19136-1:2020, 3.1.43]

3.5
sensor
element of a measuring system that is directly affected by a phenomenon, body, or substance carrying a quantity to be measured

[SOURCE: ISO/IEC Guide 99:2007, 3.8, modified — EXAMPLE and Note 1 to entry have been removed.]

3.6
sensor model
<geopositioning> mathematical description of the relationship between the three-dimensional object space and the 2D plane of the associated *image* (3.2) produced by a *sensor* (3.5)

[SOURCE: ISO 19130-1:2018, 3.80]

3.7
schema
formal description of a model

Note 1 to entry: In general, a schema is an abstract representation of an object's characteristics and relationship to other objects. An XML schema represents the relationship between the attributes and elements of an XML object.

EXAMPLE A document or a portion of a document.

[SOURCE: ISO 19136-1:2020, 3.1.52]

3.8
schema
<XML> collection of *schema* (3.7) components within the same target *namespace* (3.4)

EXAMPLE Schema components of W3C XML Schema are types, elements, attributes, groups, etc.

[SOURCE: ISO 19136-1:2020, 3.1.53]

3.9
schema document
<XML> XML document containing *schema* (3.7) component definitions and declarations

Note 1 to entry: The W3C XML Schema provides an XML interchange format for schema information. A single schema document provides descriptions of components associated with a single XML namespace, but several documents may describe components in the same schema, i.e. the same target namespace.

[SOURCE: ISO 19136-1:2020, 3.1.54]

3.10
Uniform Resource Identifier
URI
unique identifier for a resource, structured in conformance with IETF RFC 2396

Note 1 to entry: The general syntax is <scheme>::<scheme-specific-part>. The hierarchical syntax with a namespace is <scheme>://<authority><path>?<query> — see RFC 2396.

[SOURCE: ISO 19136-1:2020, 3.1.62]

4 Symbols and abbreviated terms

4.1 Abbreviations

SWE Sensor Web Enablement

UML Unified Modeling Language

URI Unique Resource Identifier

XML eXtensible Markup Language

XSD XML Schema Definition

5 Conformance

The framework, concepts and methodology for testing, and the criteria to be achieved to claim conformance, are specified in ISO 19105. An XML Schema implementation of sensor models conforms to this specification if it passes the test modules defined in Annex A.

6 XML Schema requirements class

6.1 Introduction

The normative parts of this document use the W3C XML Schema language to describe the grammar of conformant XML data instances. XML Schema is a rich language with many capabilities and subtleties. While a reader who is unfamiliar with XML Schema may be able to follow the description in a general fashion, this document is not intended to serve as an introduction to XML Schema. To have full understanding of this document requires a reasonable knowledge of XML Schema.

This implementation schema for ISO 19130-1 and ISO/TS 19130-2 is expressed in XML using SensorML classes as much as possible. Implementing ISO 19130 Sensor models in SensorML allows OGC Sensor-Web Enablement access to ISO 19130 sensor models, making ISO 19130 sensor models and OGC SWE interoperable.

6.2 XML namespaces

XML code fragments adhere to the namespace conventions shown in Table 1. The namespace prefixes used in this document are not normative and are merely chosen for convenience, they may appear in examples without being formally declared and have no semantic significance. The namespaces to which the prefixes correspond are normative.

Table 1 — XML Namespaces

Namespace Prefix	Namespace URI	Description of namespace prefix
smi	https://schemas.isotc211.org/19130/-3/smi/1.1	XML schema encodings of sensor models defined in ISO 19130-1 and ISO/TS 19130-2, which is based on SensorML (whose namespace is sml).
cit	https://schemas.isotc211.org/19115/-1/cit/1.3	Citation and responsible party information
cis	https://schemas.isotc211.org/19123/-/cis/1.1	Coverage Implementation Schema
gco	https://schemas.isotc211.org/19103/-/gco/1.2	Geographic Metadata XML schema implementation for fundamental concepts
gcx	https://schemas.isotc211.org/19103/-/gcx/1.2	Geospatial Common eXtension
gml	http://www.opengis.net/gml/3.2	Geography Markup Language
igd	https://schemas.isotc211.org/19163/-1/igd/1.1	Imagery and Gridded Data
mac	https://schemas.isotc211.org/19115/-2/mac/2.2	Metadata for Acquisition
mcc	https://schemas.isotc211.org/19115/-1/mcc/1.3	Metadata Common Classes
mdq	https://schemas.isotc211.org/19157/-/mdq/1.2	Metadata for Data Quality
mrc	https://schemas.isotc211.org/19115/-1/mrc/1.3	Metadata for Resource Content
mrs	https://schemas.isotc211.org/19115/-1/mrs/1.3	Metadata for Reference System
msr	https://schemas.isotc211.org/19115/-1/msr/1.3	Metadata for Spatial Representation
rbc	https://schemas.isotc211.org/19111/-/rbc/3.1	Referencing By Coordinates
sml	http://www.opengis.net/sensorml/2.0	OGC Sensor Model Language 2.0
swe	http://www.opengis.net/swe/2.0	OGC SWE Common 2.0
xsi	http://www.w3.org/2001/XMLSchema-instance	W3C XML Schema

6.3 Requirements classes for XML instance documents

The requirements to create valid XML metadata instances for the sensor models presented in ISO 19130-1 and ISO/TS 19130-2 are defined in Table 2. HTTP URIs are used to identify clauses in

corresponding normative ISO documents that do not define and assign identifiers to the requirements and conformance classes that can be referenced in this document.

Table 2 — Requirements classes for XML instance documents

Namespace	Requirement Class URI[a]	Requirements[b]
/smi/1.0	/req/instance	/req/instance/root-element A metadata element conforming to this document shall have *smi:SD_SensorModel* or *smi:SE_SensorModel* as its root element.
	/req/SD_SensorModel	/req/SD_SensorModel/legalconstraints If an *SD_SensorModel* element is instantiated as the root element, then one or more instances of one, but no more than one, of the three sensor model types (i.e. *SD_PhysicalSensorModel*, *SD_TrueReplacementModel*, *SD_CorrespondenceModel*) shall be present as its child elements.
	/req/SD_GCPRepository /accessRestricted-controlPoints	/req/SD_GCPRepository/accessRestricted-controlPoints/legalconstraints If an *SD_GCPRepository* element is instantiated, and if the text content of the instantiated *accessRestricted* element is "false", then one and only one instance element of *controlPoints* shall be present.
	/req/SD_PhysicalSensor-Model/controlPointReposito-ry-controlPoints	/req/SD_PhysicalSensorModel/control PointRepository-controlPoints/legalconstraints If an *SD_PhysicalSensorModel* element is instantiated, then instance elements of *SD_GCPRespository* and of *MI_GCPCollection* shall not be present at the same time.
	/req/SD_OrbitMeasured Location/meanAnomaly -perigeePassageTime	/req/SD_OrbitMeasuredLocation/meanAnomaly-perigeePassageTime/legalconstraints If an *SD_OrbitMeasuredLocation* element is instantiated, then a value for either "meanAnomaly" or "perigeePassageTime" shall be present.
	/req/SD_OrbitMeasured Location/meanMotion-period-semiMajorAxis	/req/SD_OrbitMeasuredLocation/meanMotion-period-semiMajorAxis/legalconstraints If an *SD_OrbitMeasuredLocation* element is instantiated, then a value for either "meanMotion," "period," or "semiMajorAxis" shall be present.
	/req/SD_PlatformDynamics/ velocity-trueHeading	/req/SD_PlatformDynamics/velocity-trueHeading/ legalconstraints If an *SD_PlatformDynamics* element is instantiated, then an instance element of "velocity" or "trueHeading" shall not be present at the same time.
	/req/SD_PlatformDynamics/ attitude-yaw	/req/SD_PlatformDynamics/attitude-yaw/ legalconstraints If an *SD_PlatformDynamics* element is instantiated, then one and only one instance element of "attitude" or "yaw" shall be present.
	/req/SD_SensorParameters/ identification-type-detector	/req/SD_SensorParameters/identification-detector/legalcon-straints If an *SD_SensorParameters* element is instantiated, then if the text content of the type element nested inside its instantiated *identification* element is "frame, " "pushbroom, " or "whiskbroom, " then a value for "detector" shall be present. Otherwise, it shall not be present.
	/req/SD_TrueReplacement Model/fitAsGrid-fitAs Function	/req/SD_TrueReplacementModel/fitAsGrid-fitAsFunction/ legalconstraints If an *SD_TrueReplacementModel* element is instantiated, then one and only one instance element of "fitAsGrid" or "fitAsFunction" shall be present.

[a] For complete namespace URIs, prefix "https://schemas.isotc211.org/19130/-3."

[b] All URIs are HTTP URIs, prefix "https://standards.isotc211.org/19130/-3" to the paths in the table cell to get the complete URI.

Table 2 *(continued)*

Namespace	Requirement Class URI[a]	Requirements[b]
	/req/SD_True ReplacementModel/ controlPoints-controlPointRepository	/req/SD_TrueReplacementModel/ controlPoints-controlPointRepository/legalconstraints If an *SD_TrueReplacementModel* element is instantiated, then an instance element of "controlPoints" or "controlPointRepository" shall not be present at the same time.
	/req/SD_Correspondence Model/controlPoints-repositoryGCP	/req/SD_CorrespondenceModel/controlPoints-repositoryGCP/ legalconstraints If an *SD_CorrespondenceModel* element is instantiated, then an instance element of "controlPoints" or "controlPointRepository" shall not be present at the same time.

[a] For complete namespace URIs, prefix "https://schemas.isotc211.org/19130/-3."

[b] All URIs are HTTP URIs, prefix "https://standards.isotc211.org/19130/-3" to the paths in the table cell to get the complete URI.

7 Encoding Descriptions

7.1 Mapping rules

When leveraging models and XML Schema encodings defined in OGC SensorML to encode sensor model classes defined in ISO 19130-1 and ISO/TS 19130-2, three mapping rules are introduced in this document. The mapping rules are provided below as a), b) and c):

a) Directly use: Sensor model elements that perfectly match the meaning and contents of SensorML classes can be directly encoded using the existing SensorML classes. There are still some classes that are referenceable in other ISO standards, such as ISO 19103. In this case, they are directly referenced in this document.

b) Extension: For sensor model elements that share similar meanings with some SensorML classes but differ in contents, one or more extensions of the corresponding SensorML classes are introduced.

c) New definition: For sensor model elements that have no corresponding SensorML classes, new classes are defined to enrich SensorML to encode the sensor model elements defined in ISO 19130-1 and ISO/TS 19130-2.

As shown in Figure 1, the resultant XML Schema consists of three packages, ISO 19130-1, ISO/TS 19130-2 and ISO/TS 19130-3 (this document), depending on the part of the ISO 19130 series that defines the corresponding UML packages and classes. Only smi.xsd is included in this document.

7.2 smi namespace

The XML Schema definitions shall pertain to the smi namespace as illustrated in Figure 1. There are three subdirectories: ISO 19130-1, ISO/TS 19130-2, and ISO/TS 19130-3 (this document). The smi.xsd under 19130/-3/smi/1.0 is the root schema file. It directly includes all of the other XML Schema documents implementing all of the sensor models defined in ISO 19130-1 and ISO/TS 19130-2.

All of the schema files are introduced in detail in the text and tables below. In each row, one UML class or element defined in ISO 19130-1 or ISO/TS 19130-2 that is modeled in this schema document is listed in the first column. The corresponding XML Schema element defined in this standard is presented in the second column. If this schema element is an extension from an existing ISO or OGC XML Schema class, then the base class is introduced in the third column. If it is directly referenced from an existing ISO or OGC XML Schema, then the source for the type definition is identified in the last column.

Names of classes (bold) and attributes (non-bold) are listed in the first column of Table 3 and Table 4, with definitions included in either ISO 19130-1 or ISO/TS 19130-2. The corresponding schema element is listed in the second column. If mapping rule 1 is followed, then this schema element is defined in OGC SensorML. Therefore, SensorML and the namespace prefix are provided in the fourth column as

the source. If mapping rule 2 is followed, then this schema element is extended from other ISO or OGC schema elements. Therefore, the base class is listed in the third column. The physical schema file where this schema element is defined is presented in the last column.

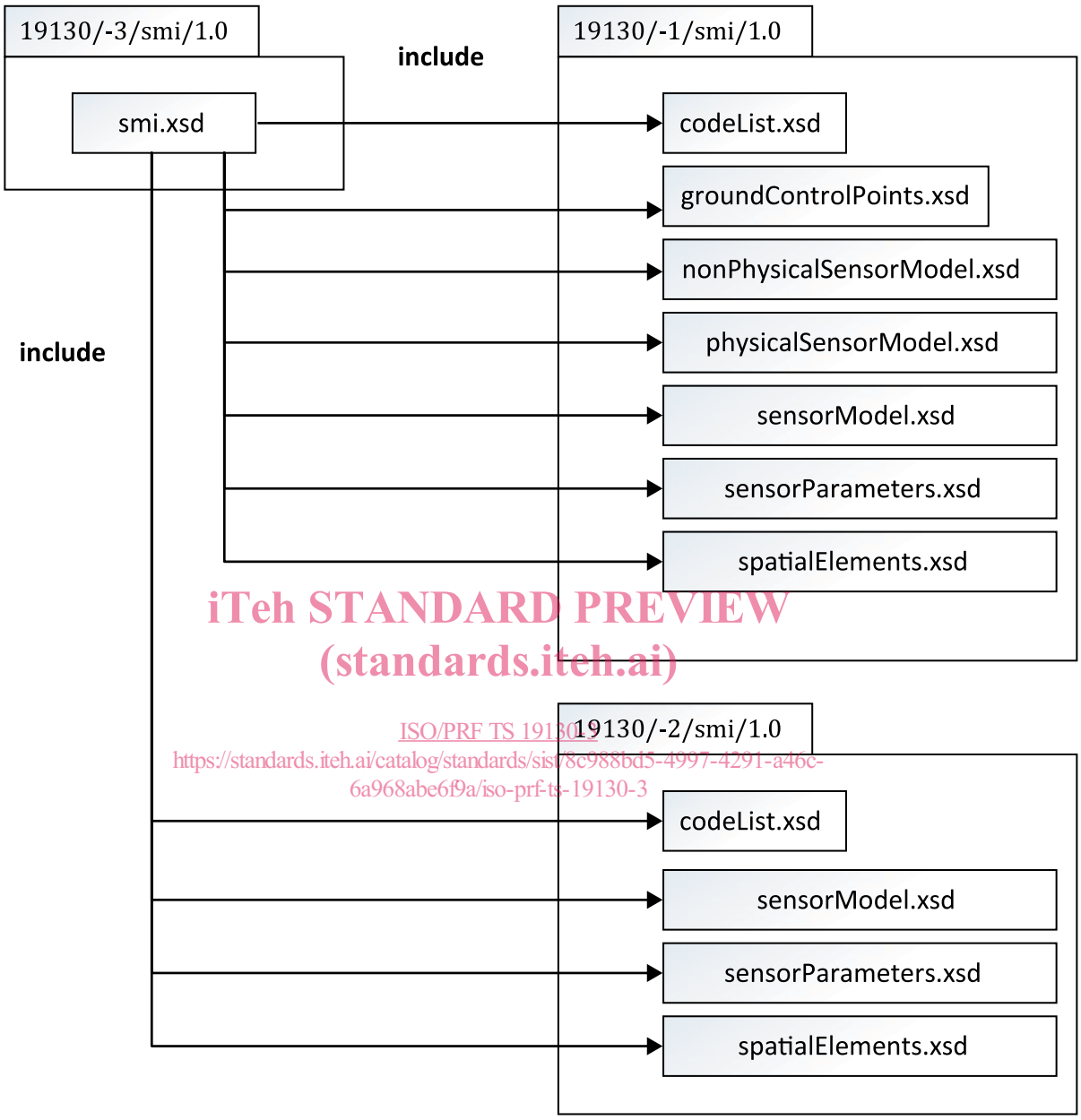

Figure 1 — Organization of smi namespace

7.3 Encoding mappings of UML classes and properties defined in ISO 19130-1

UML classes and properties defined in ISO 19130-1 are mapped based on the rules introduced in 7.1. The details are presented in Table 3.