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ISO/TS 19130-3

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Geographic information — Imagery sensor models for geopositioning —

Part 3: Implementation schema

Information géographique — Modèles de capteurs d'images de géopositionnement —

Partie 3: Schéma d'implémentation

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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.

The name and contact information of the Maintenance Agency for this document can be found at www.iso.org/maintenance_agencies.

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 19123-2, *Geographic information — Schema for coverage geometry and functions — Part 2: Coverage implementation schema*

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 19157-2, *Geographic information — Data quality — Part 2: XML schema implemenation*

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* (3.10) 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/schemas/19123/-2/cis/1.0/	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_GCPRepository* 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.

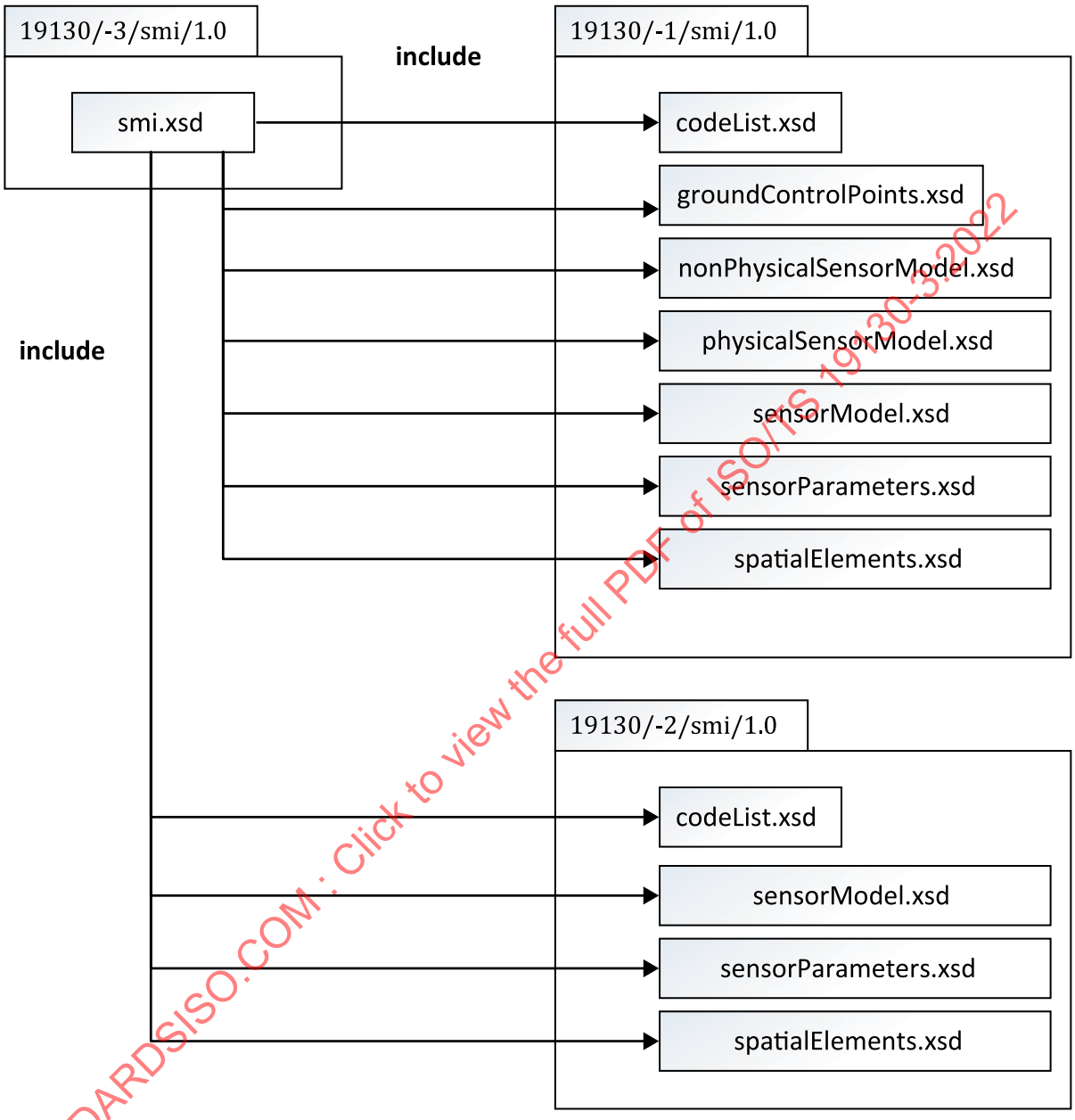

Figure 1 — Organization of smi namespace

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.

Table 3 — Mapping results for UML classes and properties defined in ISO 19130-1

Class and property defined in ISO 19130-1	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
SD_SensorModel	**SD_SensorModel**	AbstractMI_GeolocationInformation	ISO 19115-1: msr	19130/-1/smi/1.1.0/sensorModel.xsd
forImageID: CharacterString	forImageID:IdentifierList		OGC SensorML 2.0:sml	
Role name: physicalSensorModel: SD_PhysicalSensorModel	physicalSensorModel: SD_PhysicalSensorModel			
Role name: trueReplacementModel: SD_TrueReplacementModel	trueReplacementModel: SD_TrueReplacementModel			
Role name: correspondenceModel: SD_CorrespondenceModel	correspondenceModel: SD_CorrespondenceModel			
SD_GCPRepository	**SD_GCPRepository**	SimpleProcess	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/groundControlPoints.xsd
accessInformation: CI_Contact	accessInformation: CI_Contact		ISO 19115-1: cit	
accessRestricted: Boolean	accessRestricted: Boolean		ISO 19103: gco	
Role name: controlPoints: MI_GeolocationInformation	controlPoints: MI_GCPCollection		ISO 19115-1: msr	
SD_LocationGCP	**SD_LocationGCP**	MI_GCP	ISO 19115-1: msr	19130/-1/smi/1.1.0/groundControlPoints.xsd
gridCoordinates: CV_GridCoordinates	gridCoordinates: CV_GridCoordinates		ISO 19123-2: cis	
SD_ImageIdentifiableGCP	**SD_ImageIdentifiableGCP**	MI_GCP	ISO 19115-1: msr	19130/-1/smi/1.1.0/groundControlPoints.xsd
description: CharacterString	description: CharacterString		ISO 19103: gco	
SD_GriddedGCPCollection	**SD_GriddedGCPCollection**	MI_GCPCollection	ISO 19115-1: msr	19130/-1/smi/1.1.0/groundControlPoints.xsd
dimension: Integer	dimension: Integer		ISO 19103: gco	
SD_ImageGridGCPCollection	**SD_ImageGridGCPCollection**	SD_GriddedGCPCollection		19130/-1/smi/1.1.0/groundControlPoints.xsd
origin: CV_GridCoordinates	origin: CV_GridCoordinates		ISO 19123-2: cis	
spacing: Integer [2..3] {ordered}	spacing: Integer [2..3] {ordered}		ISO 19103: gco	
SD_ObjectGridGCPCollection	**SD_ObjectGridGCPCollection**	SD_GriddedGCPCollection		19130/-1/smi/1.1.0/groundControlPoints.xsd
offsets: Vector [2..3] {ordered}	offsets: Vector [2..3] {ordered}		OGC SWE 2.0: swe	
origin: DirectPosition	origin: DirectPosition		OGC GML 3.2: gml	
SD_PhysicalSensorModel	**SD_PhysicalSensorModel**	AggregateProcess	OGC SensorML 2.0: sml	19130/-1/smi/1.1.0/physicalSensorModel.xsd
regionOfValidity: CV_GridPoint [3..*] {ordered}	regionOfValidity: CV_GridPoint [3..*] {ordered}		ISO 19123-2: cis	
Role name: sensorInformation: SD_SensorParameters	sensorInformation: SD_SensorParameters			

Table 3 *(continued)*

Class and property defined in ISO 19130-1	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
Role name: controlPointRepository: SD_GCPRepository	SD_GCPRepository			
Role name: controlPoints: MI_GCPCollection	controlPoints: MI_GCPCollection		ISO 19115-1: msr	
SD_Position	**SD_Position**	PhysicalComponent	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/spatialElements.xsd
navigationalConfidence: DQ_PositionalAccuracy	navigationalConfidence: AbstractDQ_PositionalAccuracy		ISO 19157: mdq	
timeOfMeasurement: DateTime	timeOfMeasurement: DateTime		ISO 19103: gco	
SD_EarthMeasuredLocation	**SD_EarthMeasuredLocation**	SD_Position		19130/-1/smi/1.1.0/spatialElements.xsd
position: DirectPosition	position: DirectPosition		OGC GML 3.2: gml	
SD_OrbitMeasuredLocation	**SD_OrbitMeasuredLocation**	SD_Position		19130/-1/smi/1.1.0/spatialElements.xsd
argumentOfPerigee: Angle	argumentOfPerigee: Angle		ISO 19103: gco	
bStarDrag: Real	bStarDrag: Real		ISO 19103: gco	
eccentricity: Real	eccentricity: Real		ISO 19103: gco	
epoch: DateTime	epoch: DateTime		ISO 19103: gco	
inclination: Angle	inclination: Angle		ISO 19103: gco	
meanAnomaly: Angle	meanAnomaly: Angle		ISO 19103: gco	
meanMotion: Real	meanMotion: Real		ISO 19103: gco	
perigeePassageTime: DateTime	perigeePassageTime: DateTime		ISO 19103: gco	
period: TM_Duration	period: TM_PeriodDuration		ISO 19103: gco	
referenceCRS: SC_CRS	referenceCRS: RS_CRS		ISO 19111: rbc	
revNumber: Integer	revNumber: Integer		ISO 19103: gco	
rightAscensionAscendingNode: Angle	rightAscensionAscendingNode: Angle		ISO 19103: gco	
semiMajorAxis: Length	semiMajorAxis: Length		ISO 19103: gco	
SD_Attitude	**SD_Attitude**	PhysicalComponent	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/spatialElements.xsd
SD_AngleAttitude	**SD_AngleAttitude**	SD_Attitude		19130/-1/smi/1.1.0/spatialElements.xsd
rotatedAxes: Boolean	rotatedAxes: Boolean		ISO 19103: gco	
rotationAngleX: Angle	rotationAngleX: Angle		ISO 19103: gco	
rotationAngleY: Angle	rotationAngleY: Angle		ISO 19103: gco	
rotationAngleZ: Angle	rotationAngleZ: Angle		ISO 19103: gco	
rotationSequence: SD_RotationSequence	rotationSequence: SD_RotationSequence			
SD_MatrixAttitude	**SD_MatrixAttitude**	SD_Attitude		19130/-1/smi/1.1.0/spatialElements.xsd
matrixElements: Real[9]{ordered}	matrixElements: attitudeMatrix (Refer to NOTE 1 in Annex B.)			
SD_Dynamics	**SD_Dynamics**	PhysicalComponent	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/spatialElements.xsd
acceleration: Acceleration	acceleration: Quantity		OGC SWE 2.0: swe	
angularAcceleration: AngularAcceleration	angularAcceleration: Quantity		OGC SWE 2.0: swe	
angularVelocity: AngularVelocity	angularVelocity: Quantity		OGC SWE 2.0: swe	
attitude: SD_Attitude	attitude: SD_Attitude			

Table 3 *(continued)*

Class and property defined in ISO 19130-1	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
dateTime: DateTime	dateTime: DateTime		ISO 19103: gco	
velocity: Velocity	velocity: Quantity		OGC SWE 2.0: swe	
SD_PlatformDynamics	**SD_PlatformDynamics**	SD_Dynamics		19130/-1/smi/1.1.0/ spatialElements.xsd
trueHeading: Angle	trueHeading: Angle		ISO 19103: gco	
yaw: Angle	yaw: Angle		ISO 19103: gco	
SD_PositionAndOrientation	**SD_PositionAndOrientation**	PhysicalSystem	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/ spatialElements.xsd
CRS: SC_CRS	CRS: RS_CRS		ISO 19111: rbc	
dynamics: SD_Dynamics	dynamics: SD_Dynamics			
offset: Vector	offset: Vector		OGC SWE 2.0: swe	
position: SD_Position	position: SD_Position			
mountingObject: SD_PositionAndOrientation	mountingObject: SD_PositionAndOrientation			
platform: SD_PlatformParameters	platform: SD_PlatformParameters			
SD_PlatformParameters	**SD_PlatformParameters**	PhysicalComponent	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/ spatialElements.xsd
dynamics: SD_PlatformDy-namics	dynamics: SD_PlatformDynamics			
observedPosition: SD_Position	observedPosition: SD_Position			
offsetOfINS: Vector	offsetOfINS: Vector		OGC SWE 2.0: swe	
positionObservationOffset: Vector	positionObservationOffset: Vector		OGC SWE 2.0: swe	
Role name: platformIdentification: MI_Platform	platformIdentification: MI_Platform		ISO 19115-2: mac	
Role name: aerialTriangulation: SE_AerialTriangulation	aerialTriangulation: SE_AerialTriangulation			
SD_SensorParameters	**SD_SensorParameters**	PhysicalComponent	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/ sensorParameters.xsd
offsetAndOrientation: SD_PositionAndOrientation	offsetAndOrientation: SD_PositionAndOrientation			
operationalMode: CharacterString	operationalMode: CharacterString		ISO 19103: gco	
Role name: detector: SD_DetectorArray	detector: SD_DetectorArray			
Role name: gsdProperties: SD_GSD	gsdProperties: SD_GSD			
Role name: identification: SD_Sensor	identification: SD_Sensor			
Role name: systemAndOperation: SD_Sen-sorSystemAndOperation	systemAndOperation: SD_SensorSystemAndOperation			
Role name: InSARAntennaPosition: SE_InSARDualAntennaPosition	InSARAntennaPosition: SE_InSARDualAntennaPosition			
SD_Sensor	**SD_Sensor**	mac: MI_Instrument	ISO 19115-2: mac	19130/-1/smi/1.1.0/ sensorParameters.xsd
calibration: SD_Calibration	calibration: SD_Calibration			

Table 3 *(continued)*

Class and property defined in ISO 19130-1	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
mode: CharacterString	mode: CharacterString		ISO 19103: gco	
operationalBand: MI_Band	operationalBand: MI_Band		ISO 19115-2: mrc	
SD_Calibration	**SD_Calibration**	DescribedObject	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/ sensorParameters.xsd
calibrationAgency: CI_ResponsibleParty	calibrationAgency: CI_Responsibility		ISO 19115-2: cit	
calibrationDate: Date	calibrationDate: Date		ISO 19103: gco	
SD_GSD	**SD_GSD**	PhysicalComponent	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/ sensorParameters.xsd
azimuthIPR: SD_AzimuthMeasure	azimuthIPR: SD_AzimuthMeasure			
columnSpacing: Distance	columnSpacing: Distance		ISO 19103: gco	
gsdCRS: MD_ReferenceSystem	gsdCRS: MD_ReferenceSystem		ISO 19115-1: mrs	
rangeIPR: Distance	rangeIPR: Distance		ISO 19103: gco	
referenceSurface: SD_SurfaceCode	referenceSurface: SD_SurfaceCode			
rowSpacing: Distance	rowSpacing: Distance		ISO 19103: gco	
SD_AzimuthMeasure	**SD_AzimuthMeasure**			19130/-1/smi/1.1.0/ sensorParameters.xsd
azimuth: Angle	azimuth: Angle		ISO 19103: gco	
distance: Distance	distance: Distance		ISO 19103: gco	
SD_DetectorArray	**SD_DetectorArray**	PhysicalComponent	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/ sensorParameters.xsd
arrayDimensions: SD_ArrayDimension [1..2] {ordered}	arrayDimensions: SD_ArrayDimension [1..2] {ordered}			
arrayOrigin: DirectPosition	arrayOrigin: DirectPosition		ISO 19103: gco	
detectorShape: SD_ShapeCode	detectorShape: SD_ShapeCode			
detectorSize: Length [1..2] {ordered}	detectorSize: Length [1..2] {ordered}		ISO 19103: gco	
distortion: SD_Distortion	distortion: SD_Distortion			
numberOfDimensions: Integer	numberOfDimensions: Integer		ISO 19103: gco	
offsetVectors: Vector [1..2] {ordered}	offsetVectors: Vector [1..2] {ordered}		OGC SWE 2.0: swe	
SD_ArrayDimension	**SD_ArrayDimension**			19130/-1/smi/1.1.0/ sensorParameters.xsd
name: CharacterString	name: CharacterString		ISO 19103: gco	
size: Integer	size: Integer		ISO 19103: gco	
SD_SensorSystemAndOperation	**SD_SensorSystemAndOperation**	PhysicalSystem	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/ sensorParameters.xsd
collectionStartTime: DateTime	collectionStartTime: DateTime		ISO 19103: gco	
collectionEndTime: DateTime	collectionEndTime: DateTime		ISO 19103: gco	
SD_Microwave	**SD_Microwave**	SD_SensorSystemAndOperation		19130/-1/smi/1.1.0/ sensorParameters.xsd
SD_Optics	**SD_Optics**	SD_SensorSystemAndOperation		19130/-1/smi/1.1.0/ sensorParameters.xsd
Role name: opticsOperation: SD_OpticsOperation	opticsOperation: SD_OpticsOperation			
Role name: opticalSystem: SD_OpticsSystem	opticalSystem: SD_OpticsSystem			

Table 3 *(continued)*

Class and property defined in ISO 19130-1	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
Role name: opticalDistortion: SD_Distortion	opticalDistortion: SD_Distortion			
SD_OpticalSystem	**SD_OpticalSystem**	PhysicalSystem	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/sensorParameters.xsd
calibratedFocalLength: Length	calibratedFocalLength: Length		ISO 19103: gco	
covPrincPtAutocoll: DQ_PositionalAccuracy	covPrincPtAutocoll: AbstractDQ_PositionalAccuracy		ISO 19157: mdq	
princPointAutocoll: DirectPosition	princPointAutocoll: DirectPosition		ISO 19103: gco	
qualityOfFocalLength: DQ_QuantitativeAttributeAccuracy	qualityOfFocalLength: DQ_QuantitativeAttributeAccuracy		ISO 19157: mdq	
SD_SAROperation	**SD_SAROperation**	SD_Microwave		19130/-1/smi/1.1.0/sensorParameters.xsd
grpPosition: DirectPosition	grpPosition: DirectPosition		OGC GML 3.2: gml	
orientation: SD_SAROrientationCode	orientation: SD_SAROrientationCode			
SD_OpticsOperation	**SD_OpticsOperation**	SimpleProcess	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/sensorParameters.xsd
instFieldOfView: Angle	instFieldOfView: Angle		ISO 19103: gco	
swathFieldOfView: Angle	swathFieldOfView: Angle		ISO 19103: gco	
SD_WhiskbroomOperation	**SD_WhiskbroomOperation**	SD_OpticsOperation		19130/-1/smi/1.1.0/sensorParameters.xsd
pixelScanDuration: TM_IntervalLength	pixelScanDuration: TM_PeriodDuration		ISO 19103: gco	
scanDuration: TM_IntervalLength	scanDuration: TM_PeriodDuration		ISO 19103: gco	
scanAngleFunction: SD_ScanAngleFunction	scanAngleFunction: SD_ScanAngleFunction			
SD_PushbroomOperation	**SD_PushbroomOperation**	SD_OpticsOperation		19130/-1/smi/1.1.0/sensorParameters.xsd
groundSamplingTime: TM_IntervalLength	groundSamplingTime: TM_PeriodDuration		ISO 19103: gco	
forwardLookingAngle: Angle	forwardLookingAngle: Angle		ISO 19103: gco	
sideLookingAngle: Angle	sideLookingAngle: Angle		ISO 19103: gco	
SD_ScanAngleFunction	**SD_ScanAngleFunction**			19130/-1/smi/1.1.0/sensorParameters.xsd
angleEquation: CharacterString	angleEquation: CharacterString		ISO 19103: gco	
angleTable: SD_ScanAngleTime	angleTable: SD_ScanAngleTime			
rate: AngularVelocity	rate: Quantity		OGC SWE 2.0: swe	
SD_ScanAngleTime	**SD_ScanAngleTime**			19130/-1/smi/1.0/sensorParameters.xsd
angle: Angle [1..*] {ordered}	angle: Angle [1..*] {ordered}		ISO 19103: gco	
time: TM_IntervalLength [1..*] {ordered}	time: TM_PeriodDuration [1..*] {ordered}		ISO 19103: gco	
SD_Distortion	**SD_Distortion**	SimpleProcess	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/sensorParameters.xsd
princPointOfSymmetry: DirectPosition	princPointOfSymmetry: DirectPosition		OGC GML 3.2: gml	

Table 3 *(continued)*

Class and property defined in ISO 19130-1	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
qualityOfPrincPointOfSymmetry: DQ_QuantitativeAttribute Accuracy	qualityOfPrincPointOfSymmetry: DQ_QuantitativeAttribute Accuracy		ISO 19157: mdq	
SD_DistortionPolynomial	**SD_DistortionPolynomial**	SD_Distortion		19130/-1/smi/1.1.0/sensorParameters.xsd
polynomialDecentering: SD_Polynomial	polynomialDecentering: SD_Polynomial			
polynomialRadial: SD_Polynomial	polynomialRadial: SD_Polynomial			
qualityOfPolynomialDecentering: DQ_PositionalAccuracy	qualityOfPolynomialDecentering: AbstractDQ_PositionalAccuracy		ISO 19157: mdq	
qualityOfPolynomialRadial: DQ_PositionalAccuracy	qualityOfPolynomialRadial: AbstractDQ_PositionalAccuracy		ISO 19157: mdq	
SD_DistortionTable	**SD_DistortionTable**	SD_Distortion		19130/-1/smi/1.1.0/sensorParameters.xsd
columns:integer	columns:Integer		ISO 19103: gco	
distortionValues: Real {ordered}	distortionValues: Real {ordered}		ISO 19103: gco	
rows: Integer	rows: Integer		ISO 19103: gco	
xOffset: Integer	xOffset: Integer		ISO 19103: gco	
xSpacing: Integer	xSpacing: Integer		ISO 19103: gco	
yOffset: Integer	yOffset: Integer		ISO 19103: gco	
ySpacing: Integer	ySpacing: Integer		ISO 19103: gco	
SD_FittingFunction	**SD_FittingFunction**	SimpleProcess	OGC SensorML 2.0:sml	19130/-1/smi/1.1.0/nonPhysicalSensorModel.xsd
SD_Polynomial	**SD_Polynomial**	SD_FittingFunction		19130/-1/smi/1.1.0/nonPhysicalSensorModel.xsd
resultDimension: MD_DimensionNameTypeCode	resultDimension: MD_DimensionNameTypeCode		ISO 19115-1: msr	
Role name: coefficient: SD_PolynomialCoefficient	coefficient: SD_PolynomialCoefficient			
SD_RationalPolynomial	**SD_RationalPolynomial**	SD_FittingFunction		19130/-1/smi/1.1.0/nonPhysicalSensorModel.xsd
Role name: numerator: SD_Polynomial	numerator: SD_Polynomial			
Role name: denominator: SD_Polynomial	denominator: SD_Polynomial			
SD_PolynomialCoefficient	**SD_PolynomialCoefficient**			19130/-1/smi/1.1.0/nonPhysicalSensorModel.xsd
value: Real	value: Real		ISO 19103: gco	
Role name: variable: SD_Variable	variable: SD_Variable			
SD_Variable	**SD_Variable**	Abstract_SMI		19130/-1/smi/1.1.0/nonPhysicalSensorModel.xsd

Table 3 *(continued)*

Class and property defined in ISO 19130-1	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
dimension: MD_DimensionNameTypeCode	dimension: MD_DimensionNameTypeCode		ISO 19115-1: msr	
power: Integer	power: Integer		ISO 19103: gco	
scaleFactor: Real	scaleFactor: Real		ISO 19103: gco	
translationValue: Real	translationValue: Real		ISO 19103: gco	
SD_TrueReplacementModel	**SD_TrueReplacementModel**	SimpleProcess		19130/-1/smi/1.1.0/nonPhysicalSensor-Model.xsd
accuracy: DQ_PositionalAccuracy	accuracy: AbstractDQ_PositionalAccuracy			
regionOfValidity: CV_GridPoint [3..*]	regionOfValidity: CV_GridPoint [3..*]		ISO 19123-2: cis	
Role name: fitAsFunction: SD_FittingFunction	fitAsFunction: SD_FittingFunction			
Role name: fitAsGrid: SD_TRMAsGrid	fitAsGrid: SD_TRMAsGrid			
Role name: controlPoints: MI_GCPCollection	controlPoints: MI_GCPCollection		ISO 19115-2: mrs	
Role name: controlPointRepository: SD_GCPRepository	controlPointRepository: SD_GCPRepository			
SD_TRMAsGrid	**SD_TRMAsGrid**	SD_GriddedGCPCollectionType		19130/-1/smi/1.1.0/nonPhysicalSensor-Model.xsd
interpolation: CV_InterpolationMethod	interpolation: CV_InterpolationMethod		ISO/TS 19163-1: igd	
SD_CorrespondenceModel	**SD_CorrespondenceModel**	SimpleProcess		19130/-1/smi/1.1.0/nonPhysicalSensor-Model.xsd
fittingFunction: SD_FittingFunction	fittingFunction: SD_FittingFunction			
regionOfValidity: CV_GridPoint [3..*]	regionOfValidity: CV_GridPoint [3..*]		ISO 19123-2: cis	
Role name: controlPoints: MI_GCPCollection	controlPoints: MI_GCPCollection		ISO 19115-2: mrs	
Role name: repositoryGCP: SD_GCPRepository	repositoryGCP: SD_GCPRepository			
SD_ShapeCode	**SD_ShapeCode**			19130/-1/smi/1.1.0/codeList.xsd
SD_SurfaceCode	**SD_SurfaceCode**			19130/-1/smi/1.1.0/codeList.xsd
SD_SAROrientationCode	**SD_SAROrientationCode**			19130/-1/smi/1.1.0/codeList.xsd
SD_RotationSequence	**SD_RotationSequence**			19130/-1/smi/1.1.0/codeList.xsd

7.4 Encoding mappings of UML classes and properties defined in ISO/TS 19130-2

UML classes and properties defined in ISO/TS 19130-2 are mapped based on the rules introduced in 7.1. The details are presented in Table 4 below.

Table 4 — Mapping results for UML classes and properties defined in ISO/TS 19130-2

Class and property defined in ISO/TS 19130-2	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
SE_SensorModel	**SE_SensorModel**	SD_SensorModel		19130/-2/smi/1.1.0/ sensorModel.xsd
sensorDataModeling: SE_DataModelingMethod	sensorDataModeling: SE_DataModelingMethod			
sensorManufacturer: CharacterString	sensorManufacturer: CharacterString		ISO 19103: gco	
SE_Dynamics	**SE_Dynamics**	SD_Dyanmics		19130/-2/smi/1.1.0/ spatialElements.xsd
navigationalConfidence: DQ_QuantitativeAttribute Accuracy	navigationalConfidence: DQ_QuantitativeAttribute Accuracy		ISO 19157: mdq	
SE_PlatformDyanmics	**SE_PlatformDynamics**	SD_PlatformDynamics		19130/-2/smi/1.1.0/ spatialElements.xsd
groundSpeed: Velocity	groundSpeed: Quantity		OGC SWE 2.0: swe	
heave: Angle	heave: Angle		ISO 19103: gco	
settlement: Angle	settlement: Angle		ISO 19103: gco	
squat: Length	squat: Length		ISO 19103: gco	
SE_SAROperation	**SE_SAROperation**	SD_SAROperation		19130/-2/smi/1.1.0/ sensorParameters.xsd
collectionMode: SE_SARCollectionModeType	collectionMode: SE_SARCollectionModeType			
SE_InSARTime	**SE_InSARTime**			19130/-2/smi/1.1.0/ sensorParameters.xsd
timeFunction: CharacterString	timeFunction: CharacterString		ISO 19103: gco	
timetable: DateTime [0..*] {ordered}	timetable: DateTime [0..*] {ordered}		ISO 19103: gco	
SE_InSAROperation	**SE_InSAROperation**	SD_SAROperation		19130/-2/smi/1.1.0/ sensorParameters.xsd
collectionMode: SE_InSARCollectionModeType	collectionMode: SE_InSARCollectionModeType			
receiveTime: SE_InSARTime	receiveTime: SE_InSARTime			
transmitterReceiver: SE_InSARTransmitReceiveType	transmitterReceiver: SE_InSARTransmitReceiveType			
transmitTime: SE_InSARTime	transmitTime: SE_InSARTime			
SE_InSARDualAntennaPosition	**SE_InSARDualAntennaPosition**			19130/-2/smi/1.1.0/ sensorParameters.xsd
firstAntennaPosition: SD_PositionAndOrientation	firstAntennaPosition: SD_PositionAndOrientation			
secondAntennaPosition: SD_PositionAndOrientation	secondAntennaPosition: SD_PositionAndOrientation			
SE_LIDAROperation	**SE_LIDAROperation**	SD_OpticsOperation		19130/-2/smi/1.1.0/ sensorParameters.xsd
numberOfPulse: int	numberOfPulse: Integer		ISO 19103: gco	

Table 4 *(continued)*

Class and property defined in ISO/TS 19130-2	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
pulseIntensityValue: Real	pulseIntensityValue: Real		ISO 19103: gco	
pulseIntensityTimeDirection: SE_LIDARPulse	pulseIntensityTimeDirection: SE_LIDARPulse			
SE_LIDARPulse	**SE_LIDARPulse**			19130/-2/smi/1.1.0/ sensorParameters.xsd
pulsePointing: Vector	pulsePointing: Vector		OGC SWE 2.0: swe	
pulseEmissionTime: dateTime	pulseEmissionTime: DateTime		ISO 19103: gco	
pulseReturnTime: dateTime	pulseReturnTime: DateTime		ISO 19103: gco	
SE_SonarOperation	**SE_SonarOperation**	SD_SensorSystemAn-dOperation		19130/-2/smi/1.1.0/ sensorParameters.xsd
deployment: SE_SonarDeploymentType	deployment: SE_SonarDeploymentType			
type: SE_SonarType	type: SE_SonarType			
Role name: mode: SE_SonarOperationMode	mode: SE_SonarOperationMode			
Role name: transducer: SE_Transducer	transducer: SE_Transducer			
Role name: calibration: SE_SonarCalibration	calibration: SE_SonarCalibration			
Role name: tidalAdjustment: SE_TidalAdjustment	tidalAdjustment: SE_TidalAdjustment			
Role name: draft: SE_DraftOffset	draft: SE_DraftOffset			
SE_SonarOperationMode	**SE_SonarOperationMode**			19130/-2/smi/1.1.0/ sensorParameters.xsd
beamAngle: Angle [1..*] {or-dered}	beamAngle: Angle [1..*] {or-dered}		ISO 19103: gco	
beamSpacing: Distance [0..*] {ordered}	beamSpacing: Distance [0..*] {ordered}		ISO 19103: gco	
mode: SE_SonarMode	mode: SE_SonarMode			
numberOfBeams: int	numberOfBeams: Integer		ISO 19103: gco	
SE_Transducer	**SE_Transducer**			19130/-2/smi/1.1.0/ sensorParameters.xsd
operationChannels: Length	operationChannels: Length		ISO 19103: gco	
operationFrequencies: Frequency	operationalFrequencies: Quantity		OGC SWE 2.0: swe	
Role name: receiverInformation: SE_Receiver	receiverInformation: SE_Receiver			
Role name: transmitterInformation: SE_Transmitter	transmitterInformation: SE_Transmitter			

Table 4 *(continued)*

Class and property defined in ISO/TS 19130-2	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
SE_Receiver	**SE_Receiver**			19130/-2/smi/1.1.0/ sensorParameters.xsd
position: SD_Position	position: SD_Position			
orientation: SD_Attitude	orientation: SD_Attitude			
SE_Transmitter	**SE_Transmitter**			19130/-2/smi/1.1.0/ sensorParameters.xsd
orientation: SD_Attitude	orientation: SD_Attitude			
position: SD_Position	position: SD_Position			
SE_SonarCalibration	**SE_SonarCalibration**			19130/-2/smi/1.1.0/ sensorParameters.xsd
SE_BarCheck	**SE_BarCheck**	SE_SonarCalibration		19130/-2/smi/1.1.0/ sensorParameters.xsd
depthOffset: Distance [1..*] {ordered}	depthOffset: Distance [1..*] {ordered}		ISO 19103: gco	
numberOfDepth: int	numberOfDepth: Integer		ISO 19103: gco	
SE_PatchTest	**SE_PatchTest**	SE_SonarCalibration		19130/-2/smi/1.1.0/ sensorParameters.xsd
azimuthalOffset: Angle	azimuthalOffset: Angle		ISO 19103: gco	
pitchOffset: Angle	pitchOffset: Angle		ISO 19103: gco	
positioningTimeDelay: TM_IntervalLength	positioningTimeDelay: TM_PeriodDuration		ISO 19103: gco	
rollOffset: Angle	rollOffset: Angle		ISO 19103: gco	
SE_SoundVelocityProfile	**SE_SoundVelocityProfile**	SE_SonarCalibration-type		19130/-2/smi/1.1.0/ sensorParameters.xsd
frequency: Frequency	frequency: Quantity		OGC SWE 2.0: swe	
numberOfMeasure: int	numberOfMeasure: Integer		ISO 19103: gco	
soundSpeed: Velocity	soundSpeed: Quantity		OGC SWE 2.0: swe	
SE_NavCheck	**SE_NavCheck**	SE_SonarCalibration		19130/-2/smi/1.1.0/ sensorParameters.xsd
positionValidationOn IndependentNavSys: boolean	positionValidationOn IndependentNavSys: Boolean		ISO 19103: gco	
positionValidationOnKnown-Mark: boolean	positionValidationOnKnown-Mark: Boolean		ISO 19103: gco	
SE_DraftOffset	**SE_DraftOffset**	SE_SonarCalibration		19130/-2/smi/1.1.0/ sensorParameters.xsd
draft: Distance [0..*] {ordered}	draft: Distance [0..*] {ordered}		ISO 19103: gco	
draftMeasureTime: Time	draftMeasureTime: Time		OGC SWE 2.0: swe	
SE_TidalAdjustment	**SE_TidalAdjustment**			19130/-2/smi/1.1.0/ sensorParameters.xsd
time: Time [1..*] {ordered}	time: Time [1..*] {ordered}		OGC SWE 2.0: swe	
type: SE_TideAdjustType	type: SE_TideAdjustType			
value: Distance [1..*] {ordered}	value: Distance [1..*] {ordered}		ISO 19103: gco	
SE_AerialTriangulation	**SE_AerialTriangulation**	SD_PlatformParam-eters		19130/-2/smi/1.1.0/ spatialElements.xsd
additionalParameter: double	additionalParameter: double			
atName: CharacterString	atName: CharacterString		ISO 19103: gco	
gcpReference: CharacterString	gcpReference: CharacterString		ISO 19103: gco	
terrainHeight: Distance	terrainHeight: Distance		ISO 19103: gco	
SE_ATImage	SE_ATImage			
SE_ATStrip	SE_ATStrip			

Table 4 *(continued)*

Class and property defined in ISO/TS 19130-2	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
SE_ATBlock	SE_ATBlock			
SE_ATObservations	SE_ATObservations			
SE_ATUnknowns	SE_ATUnknowns			
SE_ATOtherResults	SE_ATOtherResults			
SE_ATImage	**SE_ATImage**			19130/-2/smi/1.1.0/ spatialElements.xsd
blockID: CharacterString	blockID: CharacterString		ISO 19103: gco	
imageID: CharacterString	imageID: CharacterString		ISO 19103: gco	
stripID: CharacterString	stripID: CharacterString		ISO 19103: gco	
SE_ATStrip	**SE_ATStrip**			19130/-2/smi/1.1.0/ spatialElements.xsd
stripID: CharacterString	stripID: CharacterString		ISO 19103: gco	
blockID: CharacterString	blockID: CharacterString		ISO 19103: gco	
numberOfImages: Integer	numberOfImages: Integer		ISO 19103: gco	
imageID: CharacterString	imageID: CharacterString		ISO 19103: gco	
stripAzimuth: Angle	stripAzimuth: Angle		ISO 19103: gco	
crabAngle: Angle	crabAngle: Angle		ISO 19103: gco	
SE_ATBlock	**SE_ATBlock**			19130/-2/smi/1.1.0/ spatialElements.xsd
blockID: CharacterString	blockID: CharacterString		ISO 19103: gco	
numberOfStrips: Integer	numberOfStrips: Integer		ISO 19103: gco	
stripID: CharacterString	stripID: CharacterString		ISO 19103: gco	
SE_ATObservations	**SE_ATObservations**			19130/-2/smi/1.1.0/ spatialElements.xsd
errorType: SE_ATErrorType	errorType: SE_ATErrorType			
errorAutomaticAPriori: Distance	errorAutomaticAPriori: Distance		ISO 19103: gco	
errorManualAPriori: Distance	errorManualAPriori: Distance		ISO 19103: gco	
eliminateFlag: Boolean	eliminateFlag: Boolean		ISO 19103: gco	
SE_ATUnknowns	**SE_ATUnknowns**			19130/-2/smi/1.1.0/ spatialElements.xsd
SE_ATOtherResults	**SE_ATOtherResults**			19130/-2/smi/1.1.0/ spatialElements.xsd
numberCheckPoints: Integer	numberCheckPoints: Integer		ISO 19103: gco	
numberGcp: Integer	numberGcp: Integer		ISO 19103: gco	
numberTiePoints: Integer	numberTiePoints: Integer		ISO 19103: gco	
SE_ATAdjustedPointPosition	**SE_ATAdjustedPointPosition**			19130/-2/smi/1.1.0/ spatialElements.xsd
pointID: CharacterString	pointID: CharacterString		ISO 19103: gco	
pointType: SE_ATPointType	pointType: SE_ATPointType			
horizontalPosition: DirectPosition	horizontalPosition: DirectPosition		OGC GML 3.2: gml	
verticalPosition: Distance	verticalPosition: Distance		ISO 19103: gco	
SE_ATImageMeasurements	**SE_ATImageMeasurements**			19130/-2/smi/1.1.0/ spatialElements.xsd
imageID: CharacterString	imageID: CharacterString		ISO 19103: gco	
imagePointID: CharacterString	imagePointID: CharacterString		ISO 19103: gco	

Table 4 *(continued)*

Class and property defined in ISO/TS 19130-2	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
imagePointPosition: DirectPosition	imagePointPosition: DirectPosition		ISO 19103: gco	
SE_ATTiePoints	**SE_ATTiePoints**	SE_ATObservations		19130/-2/smi/1.1.0/spatialElements.xsd
tiePointID: CharacterString	tiePointID: CharacterString		ISO 19103: gco	
measurementType: SE_ATMeasType	measurementType: SE_ATMeasType			
SE_ATGCP	**SE_ATGCP**	SE_ATObservations		19130/-2/smi/1.1.0/spatialElements.xsd
gcpID: CharacterString	gcpID: CharacterString		ISO 19103: gco	
dimensionType: SE_ATDimensionType	dimensionType: SE_ATDimensionType			
errorGcpAPriori: Distance	errorGcpAPriori: Distance		ISO 19103: gco	
errorType: SE_ATErrorType	Refer to NOTE 3 in Annex B.			
gcpPosition: DirectPosition	gcpPosition: DirectPosition		OGC GML 3.2: gml	
gcpElevation: Distance	gcpElevation: Distance		ISO 19103: gco	
pointType: SE_ATPointType	pointType: SE_ATPointType			
SE_ATGNSSMeasurements	**SE_ATGNSSMeasurements**	SE_ATObservations		19130/-2/smi/1.1.0/spatialElements.xsd
dimensionType: SE_ATDimensionType	dimensionType: SE_ATDimensionType			
errorGnss: Distance	errorGnss: Distance		ISO 19103: gco	
errorType: SE_ATErrorType	Refer to NOTE 3 in Annex B.			
gnssCameraID: CharacterString	gnssCameraID: CharacterString		ISO 19103: gco	
gnssImageID: CharacterString	gnssImageID: CharacterString		ISO 19103: gco	
gnssPosition: DirectPosition	gnssPosition: DirectPosition		OGC GML 3.2: gml	
gnssElevation: Distance	gnssElevation: Distance		ISO 19103: gco	
gnssStripID: CharacterString	gnssStripID: CharacterString		ISO 19103: gco	
gnssTime: DateTime	gnssTime: DateTime		ISO 19103: gco	
SE_ATIMUMeasurements	**SE_ATIMUMeasurements**	SE_ATObservations		19130/-2/smi/1.1.0/spatialElements.xsd
dimensionType: SE_ATDimensionType	dimensionType: SE_ATDimensionType			
errorImuKappa: Angle	errorImuKappa: Angle		ISO 19103: gco	
errorImuOmega: Angle	errorImuOmega: Angle		ISO 19103: gco	
errorImuPhi: Angle	errorImuPhi: Angle		ISO 19103: gco	

Table 4 *(continued)*

Class and property defined in ISO/TS 19130-2	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
errorType: SE_ATErrorType	Refer to NOTE 3 in Annex B.			
imuCameraID: CharacterString	imuCameraID: CharacterString		ISO 19103: gco	
imuImageID: CharacterString	imuImageID: CharacterString		ISO 19103: gco	
imuKappa: Angle	imuKappa: Angle		ISO 19103: gco	
imuOmega: Angle	imuOmega: Angle		ISO 19103: gco	
imuPhi: Angle	imuPhi: Angle		ISO 19103: gco	
imuStripID: CharacterString	imuStripID: CharacterString		ISO 19103: gco	
SE_ATAdjustedTiePoint	**SE_ATAdjustedTiePoint**	SE_ATOtherResults		19130/-2/smi/1.1.0/ spatialElements.xsd
eliminateFlag: Boolean	eliminateFlag: Boolean		ISO 19103: gco	
errorAdjustedTiePoint: Distance	errorAdjustedTiePoint: Distance		ISO 19103: gco	
imageID: CharacterString	imageID: CharacterString		ISO 19103: gco	
numberOfRays: Integer	numberOfRays: Integer		ISO 19103: gco	
pointID: CharacterString	pointID: CharacterString		ISO 19103: gco	
SE_ATAdjustmentStatistics	**SE_ATAdjustmentStatistics**	SE_AtOtherResults		19130/-2/smi/1.1.0/ spatialElements.xsd
dimensionType: SE_ATDimensionType	dimensionType: SE_ATDimensionType			
type: SE_ATStatisticType	type: SE_ATStatisticType			
errorTieAdjustedMax: Distance	errorTieAdjustedMax: Distance		ISO 19103: gco	
errorTieAdjustedMin: Distance	errorTieAdjustedMin: Distance		ISO 19103: gco	
errorType: SE_ATErrorType	errorType: SE_ATErrorType			
sigmaZero: Distance	sigmaZero: Distance		ISO 19103: gco	
SE_ATAdjustedGCP	**SE_ATAdjustedGCP**	SE_ATOtherResults		19130/-2/smi/1.1.0/ spatialElements.xsd
dimensionType: SE_ATDimensionType	dimensionType: SE_ATDimensionType			
errorAdjustedGcp: Distance	errorAdjustedGcp: Distance		ISO 19103: gco	
errorType: SE_ATErrorType	errorType: SE_ATErrorType			
gcpID: CharacterString	gcpID: CharacterString		ISO 19103: gco	
SE_ATCheckPoint	**SE_ATCheckPoint**	SE_ATOtherResults		19130/-2/smi/1.1.0/ spatialElements.xsd
checkPointID: CharacterString	checkPointID: CharacterString		ISO 19103: gco	
dimensionType: SE_ATDimensionType	dimensionType: SE_ATDimensionType			
errorCp: Distance	errorCp: Distance		ISO 19103: gco	
errorType: SE_ATerrorType	errorType: SE_ATerrorType			
SE_ATExteriorOrientation	**SE_ATExteriorOrientation**	SE_ATUnknowns		19130/-2/smi/1.1.0/ spatialElements.xsd

Table 4 *(continued)*

Class and property defined in ISO/TS 19130-2	Corresponding XML Schema class or element	Base class extended from (if applicable)	Source for the type (if applicable)	Schema file location
approximateAttitude: SD_Attitude	approximateAttitude: SD_Attitude			
approximatePosition: SD_Position	approximatePosition: SD_Position			
attitude: SD_Attitude	attitude: SD_Attitude			
position: SD_Position	position: SD_Position			
SE_ATDimensionType: CodeList	**SE_ATDimensionType: CodeListvalue**		ISO 19103: gco	19130/-2/smi/1.1.0/codeList.xsd
SE_ATMeasType	**SE_ATMeasType**		ISO 19103: gco	19130/-2/smi/1.1.0/codeList.xsd
SE_ATPointType	**SE_ATPointType**			19130/-2/smi/1.1.0/codeList.xsd
SE_ATStatisticType	**SE_ATStatisticType**			19130/-2/smi/1.1.0/codeList.xsd
SE_DataModelingMethod	**SE_DataModelingMethod**			19130/-2/smi/1.1.0/codeList.xsd
SE_SARCollectionMode	**SE_SARCollectionMode**			19130/-2/smi/1.1.0/codeList.xsd
SE_SonarDeploymentType	**SE_SonarDeploymentType**			19130/-2/smi/1.1.0/codeList.xsd
SE_SonarMode	**SE_SonarMode**			19130/-2/smi/1.1.0/codeList.xsd
SE_SonarType	**SE_SonarType**			19130/-2/smi/1.1.0/codeList.xsd
SE_TideAdjustType	**SE_TideAdjustType**			19130/-2/smi/1.1.0/codeList.xsd
SE_InSARCollectionMode-Type	**SE_InSARCollectionModeType**			19130/-2/smi/1.1.0/codeList.xsd
SE_InSARTransmitReceive-Type	**SE_InSARTransmitReceiveType**			19130/-2/smi/1.1.0/codeList.xsd
SE_ATErrorType	**SE_ATErrorType**			

Annex A
(normative)

Abstract Test Suite

A.1 Conformance test

Conformance test tools for this document require that metadata instance (XML) documents can be validated without error against the XML Schemas defined in this document.

The normative XML Schema documents are available in three directories at https://schemas.isotc211.org/19130/-1/smi/1.1.0, https://schemas.isotc211.org/19130/-2/smi/1.1.0 and https://schemas.isotc211.org/19130/-3/smi/1.1.0. Their directory structures are described in Annex B.

Since the XML Schema validation is insufficient to test all of the constraints declared in ISO 19130-1 and ISO/TS 19130-2, conformance classes presented in Clause 6 require further validation procedures, which are described in the section below.

A.2 Conformance classes

Identifier	https://standards.isotc211.org/19130/-3/1/conf/instance/root-element	
Requirements	https://standards.isotc211.org/19130/-3/1/req/instance/root-element	
Test	Test purpose	Verify that the root element is valid.
	Test method	Verify that the instance document does have smi:SD_SensorModel or smi:SF_SensorModel as the root element.
	Test type	Conformance

Identifier	https://standards.isotc211.org/19130/-3/1/conf/SD_SensorModel/legalconstraints	
Requirements	https://standards.isotc211.org/19130/-3/1/req/SD_SensorModel/legalconstraints	
Test	Test purpose	Verify that SD_SensorModel element is valid.
	Test method	Verify that instance document does have 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), if an SD_SensorModel element is instantiated as the root element.
	Test type	Conformance

Identifier	https://standards.isotc211.org/19130/-3/1/conf/SD_GCPRepository/accessRestricted-controlPoints/legalconstraints	
Requirements	https://standards.isotc211.org/19130/-3/1/req/SD_GCPRepository/accessRestricted-controlPoints/legalconstraints	
Test	Test purpose	Verify that SD_GCPRepository element is valid.
	Test method	Verify that if the text content of the instantiated accessRestricted element is 'false', then one and only one value of controlPoints is present, if an SD_GCPRepository element is instantiated.
	Test type	Conformance

Identifier	https://standards.isotc211.org/19130/-3/1/conf/SD_PhysicalSensorModel/controlPointRepository-controlPoints/legalconstraints	
Requirements	https://standards.isotc211.org/19130/-3/1/req/SD_PhysicalSensorModel/controlPointRepository-controlPoints/legalconstraints	
Test	Test purpose	Verify that SD_PhysicalSensorModel element is valid.
	Test method	Verify that a value of SD_GCPRespository, or of MI_GCPCollection are not present at the same time, if an SD_PhysicalSensorModel element is instantiated.
	Test type	Conformance

Identifier	https://standards.isotc211.org/19130/-3/1/conf/SD_OrbitMeasuredLocation/meanAnomaly-perigeePassageTime/legalconstraints	
Requirements	https://standards.isotc211.org/19130/-3/1/req/SD_OrbitMeasuredLocation/meanAnomaly-perigeePassageTime/legalconstraints	
Test	Test purpose	Verify that SD_OrbitMeasuredLocation element is valid.
	Test method	Verify that a value for either 'meanAnomaly' or ' perigeePassageTime' is present, if an SD_PhysicalSensorModel element is instantiated.
	Test type	Conformance

Identifier	https://standards.isotc211.org/19130/-3/1/conf/SD_PlatformDynamics/velocity-trueHeading/legalconstraints	
Requirements	https://standards.isotc211.org/19130/-3/1/req/SD_PlatformDynamics/velocity-trueHeading/legalconstraints	
Test	Test purpose	Verify that SD_PlatformDynamics element is valid.
	Test method	Verify that a value for either 'velocity' or ' trueHeading' is not present at the same time, if an SD_ PlatformDynamics element is instantiated.
	Test type	Conformance

Identifier	https://standards.isotc211.org/19130/-3/1/conf/SD_PlatformDynamics/attitude-yaw/legalconstraints	
Requirements	https://standards.isotc211.org/19130/-3/1/req/SD_PlatformDynamics/attitude-yaw/legalconstraints	
Test	Test purpose	Verify that SD_PlatformDynamics element is valid.
	Test method	Verify that one and only one instance element of 'attitude', or of 'yaw' is present, if an SD_PlatformDynamics element is instantiated.
	Test type	Conformance

Identifier	https://standards.isotc211.org/19130/-3/1/conf/SD_SensorParameters/identification-detector/legalconstraints	
Requirements	https://standards.isotc211.org/19130/-3/1/req/SD_SensorParameters/identification-detector/legalconstraints	
Test	Test purpose	Verify that SD_SensorParameters element is valid.
	Test method	Verify that if an SD_PlatformDynamics element is instantiated, and if the text content of the 'type' element nested inside its instantiated 'identification' element is 'frame,' 'pushbroom,' or 'whiskbroom', then a value for 'detector' is present; and otherwise not.
	Test type	Conformance

Identifier	https://standards.isotc211.org/19130/-3/1/conf/SD_TrueReplacementModel/fitAsGrid-fitAsFunction/legalconstraints	
Requirements	https://standards.isotc211.org/19130/-3/1/req/SD_TrueReplacementModel/fitAsGrid-fitAsFunction/legalconstraints	
Test	Test purpose	Verify that SD_TrueReplacementModel element is valid.
	Test method	Verify that one and only one instance element of 'fitAsGrid' or of 'fitAsFunction' is present, if an SD_TrueReplacementModel element is instantiated.
	Test type	Conformance

Identifier	https://standards.isotc211.org/19130/-3/1/conf/SD_TrueReplacementModel/controlPoints-controlPointRepository/legalconstraints	
Requirements	https://standards.isotc211.org/19130/-3/1/req/SD_TrueReplacementModel/controlPoints-controlPointRepository/legalconstraints	
Test	Test purpose	Verify that SD_TrueReplacementModel element is valid.
	Test method	Verify that an instance element of 'controlPoints' or of 'controlPointRepository' are not present at the same time, if an SD_TrueReplacementModel element is instantiated.
	Test type	Conformance

Identifier	https://standards.isotc211.org/19130/-3/1/conf/SD_CorrespondenceModel/controlPoints-repositoryGCP/legalconstraints	
Requirements	https://standards.isotc211.org/19130/-3/1/req/SD_CorrespondenceModel/controlPoints-repositoryGCP/legalconstraints	
Test	Test purpose	Verify that SD_CorrespondenceModel element is valid.
	Test method	Verify that an instance element of 'controlPoints' or of 'controlPointRepository' are not present at the same time, if an SD_CorrespondenceModel element is instantiated.
	Test type	Conformance

Annex B
(informative)

XML Resources

The XML Schemas defined in this document can be found online at https://schemas.isotc211.org/19130/-3/smi/1.1.0/.

https://schemas.isotc211.org/19130/-3/smi/1.1.0/smi.xsd is the root schema file.

NOTE 1 In ISO 19130-1, *matrixElements* is defined as an "element of the 3-by-3 rotation matrix." In order to rigorously encode it, a new data type, "attitudeMatrix_Type," is introduced. The schema snippet for this complex type is shown below.

NOTE 2 Future usage of SWE: Matrix (SWE comon OGC 08-094rq1) and / or ISO 19103 addition of Matrix type will be considered in order to avoid the definition of this resource.

```
<element name="matrixElements" type="smi:attitudeMatrix_Type"/>
<complexType name="attitudeMatrix_Type">
     <sequence>
         <element name="r1c1" type="gco:Real_PropertyType">
             <annotation>
                 <documentation>r means row and c means column</documentation>
             </annotation>
         </element>
         <element name="r1c2" type="gco:Real_PropertyType"/>
         <element name="r1c3" type="gco:Real_PropertyType"/>
         <element name="r2c1" type="gco:Real_PropertyType"/>
         <element name="r2c2" type="gco:Real_PropertyType"/>
         <element name="r2c3" type="gco:Real_PropertyType"/>
         <element name="r3c1" type="gco:Real_PropertyType"/>
         <element name="r3c2" type="gco:Real_PropertyType"/>
         <element name="r3c3" type="gco:Real_PropertyType"/>
     </sequence>
 </complexType>
```

NOTE 3 In ISO/TS 19130-2, *SE_ATGCP* and *SE_ATGNSSMeasurements* are classes extended from *SE_ATObservation*. Both contain one *errorType* element. However, since *SE_ATObservation* does consist of such an element, it is not allowed to have the same element in both the parent class and its extended classes. Therefore, when defining schema for ISO/TS 19130-2 in this document, *errorType* is not modeled in *SE_ATGCP* and *SE_ATGNSSMeasurements*.

Annex C
(informative)

Implementation examples

C.1 Encoding example for passive observation

Below is an example of an encoding optical sensor model using schema encodings defined in this document. One Landsat-8 satellite image acquired on 2019-12-19 (path 095, row 054) was used as an exemplar.

SD_SensorModel and trueReplacementModel classes are utilized to describe the geopositioning information for this optical image.

```
<?xml version="1.0" encoding="UTF-8"?>
<SD_SensorModel xmlns="https://schemas.isotc211.org/19130/-3/smi"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation=
 "https://schemas.isotc211.org/19130/-3/smi/1.0.1 https://schemas.isotc211.org/19130/-3/
smi/1.1.0/smi.xsd">

 <forImageId>
  <identifier xmlns="http://www.opengis.net/sensorml/2.0">
   <Term>
    <label>imageID</label>
    <value>LC80150532020003LGN00</value>
   </Term>
  </identifier>
 </forImageId>

 <trueReplacementModel>
  <SD_TrueReplacementModel>
   <accuracy>
    <DQ_GriddedDataPositionalAccuracy xmlns="https://schemas.isotc211.org/19157/-/
mdq/1.2">
     <result>
      <DQ_QuantitativeResult>
       <value>
        <Record xmlns="https://schemas.isotc211.org/19103/-/gco/1.2">
         <field>
          <Field>
           <value>
            <CharacterString>393000e1.+00</CharacterString>
           </value>
           <type>
            <FieldType>
             <fieldName>
              <CharacterString>absoluteCalibrationConstant</CharacterString>
             </fieldName>
             <fieldType>
              <TypeName>
               <aName>
                <CharacterString>double</CharacterString>
               </aName>
              </TypeName>
             </fieldType>
            </FieldType>
           </type>
          </Field>
         </field>

        </Record>
          </value>
```

```
      </DQ_QuantitativeResult>
     </result>
    </DQ_GriddedDataPositionalAccuracy>
   </accuracy>
   <regionOfValidity>
    <CV_GridPoint>
     <gridCoord xmlns="http://www.opengis.net/gmlcov/1.0">
         <CV_GridCoordinates>
             <coordValues> -84.68507 11.16687</coordValues>
         </CV_GridCoordinates>
     </gridCoord>
    </CV_GridPoint>
    <CV_GridPoint>
     <gridCoord xmlns="http://www.opengis.net/gmlcov/1.0">
         <CV_GridCoordinates>
            <coordValues> -82.98286 10.80635</coordValues>
         </CV_GridCoordinates>
     </gridCoord>
    </CV_GridPoint>
    <CV_GridPoint>
     <gridCoord xmlns="http://www.opengis.net/gmlcov/1.0">
         <CV_GridCoordinates>
      <coordValues> -83.36406 9.06862</coordValues>
         </CV_GridCoordinates>
     </gridCoord>
    </CV_GridPoint>
    <CV_GridPoint>
     <gridCoord xmlns="http://www.opengis.net/gmlcov/1.0">
         <CV_GridCoordinates>
             <coordValues> -85.05687 9.43177</coordValues>
         </CV_GridCoordinates>
     </gridCoord>
    </CV_GridPoint>
    <CV_GridPoint>
     <gridCoord xmlns="http://www.opengis.net/gmlcov/1.0">
         <CV_GridCoordinates>
              <coordValues>-84.02152 10.12223</coordValues>
         </CV_GridCoordinates>
     </gridCoord>
    </CV_GridPoint>
   </regionOfValidity>

   <fitAsGrid>
    <SD_TRMAsGrid>
     <collectionIdentification xmlns="https://schemas.isotc211.org/19115/-1/msr/1.3">
      <Integer xmlns="https://schemas.isotc211.org/19103/-/gco/1.2">1</Integer>
     </collectionIdentification>
     <collectionName xmlns="https://schemas.isotc211.org/19115/-1/msr/1.3">
      <CharacterString xmlns="https://schemas.isotc211.org/19103/-/gco/1.2">Landsat_8_OLI_
TIRS_C1</CharacterString>
     </collectionName>
     <coordinateReferenceSystem xmlns="https://schemas.isotc211.org/19115/-1/msr/1.3">
      <MD_ReferenceSystem xmlns="https://schemas.isotc211.org/19115/-1/mrs/1.3">
       <referenceSystemIdentifier>
        <MD_Identifier xmlns="https://schemas.isotc211.org/19115/-1/mcc/1.3">
         <code>
          <MD_ReferenceSystemTypeCode xmlns="https://schemas.isotc211.org/19115/-1/
mrs/1.3" codeList="compoundGeographic2DVertical" codeListValue="EPSG:4326"/>
         </code>
        </MD_Identifier>
       </referenceSystemIdentifier>
      </MD_ReferenceSystem>
     </coordinateReferenceSystem>

     <gcp xmlns="https://schemas.isotc211.org/19115/-1/msr/1.3">
      <MI_GCP>
       <geographicCoordinates>
        <Point xmlns="http://www.opengis.net/gml/3.2">
         <coordinates>
          38.9198140 -76.4661200
         </coordinates>
```

```
        </Point>
       </geographicCoordinates>
      </MI_GCP>
     </gcp>

     <dimension>
      <Integer xmlns="https://schemas.isotc211.org/19103/-/gco/1.2">3</Integer>
     </dimension>
     <interpolation>cubic</interpolation>

    </SD_TRMAsGrid>

   </fitAsGrid>
   <controlPointRepository>
    <SD_GCPRepository>
     <accessInformation>
      <CI_Contact xmlns="https://schemas.isotc211.org/19115/-1/cit/1.3">
       <onlineResource>
        <CI_OnlineResource>
         <linkage>
          <CharacterString xmlns="https://schemas.isotc211.org/19103/-/gco/1.2">https://
landsat.usgs.gov/gcp</CharacterString>
         </linkage>
        </CI_OnlineResource>
       </onlineResource>
      </CI_Contact>
     </accessInformation>
     <accessRestricted>
      <Boolean xmlns="https://schemas.isotc211.org/19103/-/gco/1.2">true</Boolean>
     </accessRestricted>
    </SD_GCPRepository>
   </controlPointRepository>
  </SD_TrueReplacementModel>
 </trueReplacementModel>
</SD_SensorModel>
```

C.2 Encoding example for active observation

This subclause shows an example of an encoding active sensor model using schema encodings defined in this document. One sentinel-1 satellite image acquired on 2019-07-30 (path 5, frame 64) was used as an exemplar.

SE_SensorModel and physicalSensorModel are utilized to model the SAR sensor model for this SAR image.

```
<?xml version="1.0" encoding="UTF-8"?>
<SE_SensorModel
 xmlns="https://schemas.isotc211.org/19130/-3/smi/1.1"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns:gml="http://www.opengis.net/gml/3.2
 xmlns:swe="http://www.opengis.net/swe/2.0"
xsi:schemaLocation=
 "https://schemas.isotc211.org/19130/-3/smi/1.1 https://schemas.isotc211.org/19130/-3/
smi/1.1.0/smi.xsd">

 <forImageID>
  <identifier xmlns="http://www.opengis.net/sensorml/2.0">
   <Term>
    <label>imageID</label>
    <value>s1b-iw1-slc-vh-20190730t004009-20190730t004023-017356-020a31-001</value>
   </Term>
  </identifier>
 </forImageID>

 <physicalSensorModel>
  <SD_PhysicalSensorModel>
   <regionOfValidity>
    <CV_GridPoint>
     <gridCoord xmlns="http://www.opengis.net/gmlcov/1.0">
    <CV_GridCoordinates>
```