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Geographic information - Spatial data infrastructures - Part 5: Validation and testing

Geoinformationen - Geodateninfrastrukturen - Teil 5:Validierung und Tests

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Foreword

This document (CEN/TR 15449-5:2015) has been prepared by Technical Committee CEN/TC 287 “Geographic information”, the secretariat of which is held by BSI.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

Introduction

Spatial data infrastructure (SDI) is a general term for the computerised environment for handling data that relates to a position on or near the surface of the earth. It may be defined in a range of ways, in different circumstances, from the local up to the global level.

This Technical Report focuses on the technical aspects of SDIs, thereby limiting the term SDI to mean an implementation neutral technological infrastructure for geospatial data and services, based upon standards and specifications. It does not consider an SDI as a carefully designed and dedicated information system; rather, it is viewed as a collaborative framework of disparate information systems that contain resources that stakeholders desire to share. The common denominator of SDI resources, which can be data or services, is their spatial nature. It is understood that the framework is in constant evolution, and that therefore the requirements for standards and specifications supporting SDI implementations evolve continuously.

SDIs are becoming more and more linked and integrated with systems developed in the context of e-Government. Important drivers for this evolution are the Digital Agenda for Europe, and related policies (see Part 1 of this Technical Report). By sharing emerging requirements at an early stage with the standardization bodies, users of SDIs can help influence the revision of existing or the conception of new standards.

The users of an SDI are considered to be those individuals or organisations that, in the context of their business processes, need to share and access geo-resources in a meaningful and sustainable way. Based on platform- and vendor-neutral standards and specifications, an SDI aims at assisting organisations and individuals in publishing, finding, delivering, and eventually, using geographic information and services over the internet across borders of information communities in a more cost-effective manner.

Considering the complexity of the subject and the need to capture and formalize different conceptual and modelling views, CEN/TR 15449 comprises multiple parts. The other parts, published previously, are:

— Part 1: Reference model: This provides a general context model for the other Parts, applying general IT architecture standards;

— Part 2: Best Practice: This provides best practices guidance for implementing SDI, through the evaluation of the projects in the frame of the European Union funding programmes.

— Part 3: Data centric view: This addresses the data, which includes application schemas and metadata.

— Part 4: Service centric view: This addresses the concepts of service specifications, the methodology for developing service specifications through the application of the relevant International Standards, and the content of such service specifications.

Further parts may be created in the future.

One of the major challenges in the implementation of an SDI is to ensure the conformity of its components with the requirements specified in the relevant standards and guidelines. This applies to the data specifications, the derived schemas, the spatial data sets and metadata and the network services. Only if conformance is ensured, can true interoperability of the harmonized metadata and data by means of network services be guaranteed. This Part (5) provides guidance for validation and testing of data, metadata and services, as the main Spatial Data Infrastructure (SDI) components defined in other parts of this Technical Report.

The intended readers of this document belong to a range of categories:

— technicians engaged in validation and testing of SDI components, who need to find reference material to use within the validation and testing processes;

— managers who need to assess the complexity of the processes of validation and testing of SDI components;

— data, metadata and network service providers, aiming at self-validating their own data sets, metadata or services, who wish to implement validation and testing processes within their organizations;

— designers of data and metadata models, who need to validate their schemas;

— data users interested in acquiring a deeper knowledge about validation and testing processes of SDI components.

Because the operation of SDIs in Europe is governed by the INSPIRE Directive EC/02/2007 and its relevant legal and technical documents, this report aims at considering INSPIRE as the reference context, even though some concepts, wherever possible, are generalized beyond INSPIRE.

Because Validation and Testing is a subject in continuous and rapid evolution, and many different implementations could exist based on different technical solutions, the topics covered in this report, as well as the relevant examples provided in the Annexes, cannot be considered complete nor exhaustively presented. In order to keep updated on the subject, the readers of this report are recommended to follow the activities and outcomes of the Working Group 5 "Validation and Conformity Testing", set-up within the INSPIRE MIG (Maintenance and Implementation Group) and MIF (Maintenance and Implementation Framework)[1].

1) http://inspire.ec.europa.eu/index.cfm/pageid/5160

1 Scope

This part of the Technical Report provides guidance for validation and testing of data, metadata and services, as the main Spatial Data Infrastructure (SDI) components defined in other parts of the CEN/TR 15449.

The guidance is given by means of examples of the validation and testing process required to ensure conformance with the requirements existing in the relevant standards and guidelines.

The National validation and testing context is out of scope of this report.

2 Normative references

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

EN ISO 19105:2005, *Geographic information - Conformance and testing (ISO 19105:2000)*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions of EN ISO 19105:2005 shall apply.

3.2 Abbreviations

ATS: Abstract Test Suite

CRS: Coordinate Reference System

DS: Data Specifications

ESDIN: European Spatial Data Infrastructure with a Best Practice Network — a project supported by eContent+ programme

ETF: ESDIN Testing Framework

ETS: Executable Test Suite

FE: Filter Encoding

GI: Geographic Information

GML: Geography Markup Language

ISO: International Organization for Standardization

IR: Implementing Rule

MD: Metadata

NA: Not Applicable

NS: Network Services

OGC: Open Geospatial Consortium

PS: Protected Sites

SLA: Service Level Agreement

SOAP: Simple Object Access Protocol

XML: eXtensible Markup Language

xsd:	XML Schema Definition
XSLT:	Extensible Stylesheet Language Transformations
W3C:	World Wide Web Consortium
WFS:	Web Feature Service
WMS:	Web Map Service
WMTS:	Web Map Tiles Services

4 Conformance and testing framework

4.1 General

The implementation of rule-based validation requires the translation of the sometimes textually defined rules into a machine readable format, in other words you need a formal rules language. The rules language within a testing environment offers a mechanism for recording conceptual level data management logic. The required characteristics are given in Table 1.

Table 1 — Characteristics of a rules language for data quality evaluation

Intuitive	Language is naturalistic and easy to learn and use (by data experts).
Compact	Concise grammar for manageability and ease of comprehension.
Unambiguous	Domain constraints can be expressed mathematically.
Quantitative	Reports formal metrics to assert the evaluated level of compliance to data quality rules (measures).
Portable	Logical separation between application domain and physical implementation models. Allows rules to be expressed in terms of application schema, which is easier for data experts to relate to and is likely to have a longer life-time than specific technology implementations.
Web Enabled	The language and environment in which it is used shall be compatible with distributed data, and web-based interfaces.
Extensible	Continuous improvement cycles require rules to evolve with time. It is also unusual to be able to capture all data requirements up front and over time these requirements are likely to be extended or subject to change.

There are several rules languages which can be used for this purpose. The choice of which to use often depends on the chosen test engine within the testing environment. Since the data tests are usually executed on a XML file, two main options are considered:

- a XML database (e.g. *BaseX*) and a XML based query language (e.g. XPath/XQuery) are used to run the translated test criteria and perform comprehensive analyses. To develop or extend existing test criteria an interactive graphical user interface is useful.
- the Schematron language is used to translate the necessary formal constraints.

Testing of geometrical criteria needs additional software components (e.g. JTS – Java Topology Suite, Vivid Solutions).

In any case it is essential to know which criteria have been tested and which criteria shall be successfully tested to consider the data set as conformant. Therefore a central repository might be useful to control the content, the versions and changes of the test criteria.

The following sections and examples of this document relevant to data and metadata validation and testing refer to the Schematron option above mentioned. More details about schematron can be found at:

- ISO/IEC 19757-3:2006, Information technology - Document Schema Definition Languages (DSDL) – Part 3: Rule-based validation – Schematron

- www.schematron.com

4.2 Structure of the document

In the following subsections a step by step process is described covering the validation process for:

- data/metadata encoding (according to the specification),

- network services.

For the validation of data/metadata encoding, the following steps are covered:

- Schema Validation: validation of the metadata or data documents against the corresponding XML schema;

- Schematron Validation: the validation of non-syntactic requirements using semantic rules defined in Schematron.

Validation approaches alternative to implementations based on XML schema and/or Schematron are provided as well.

For the validation of network services (view, download, coverage), the following types of services are covered:

- Functional requirements,

- Quality (performance) aspects.

Examples of validation processes are provided in Annex A, while examples of the use of validation tools are provided in Annex B.

In Annex C a validation process is provided for metadata and data specification encoding, covering the following steps:

- Schema Validation: checks that the schema that has been derived from the data model is a valid schema according to the W3C XML Schema Recommendation[2)];

2) The phrase 'schema validation' is generally used to describe validating an XML instance against its schema (from the W3C http://www.w3.org/TR/xmlschema11-1/) In that document, it is clearly distinct from assuring that the schema is itself valid – that is described in a section headed 'Errors in Schema Construction and Structure'. In http://www.w3.org/TR/xmlschema11-1/, any software that goes on to check an XML instance against a schema is allowed to declare an error if the schema itself is invalid.

- Validation of Transposition: checks that all elements from the Data Specification have been properly transposed to XML Schema;
- Validatability: checks that all elements from the Data Specification have been transposed to the XML Schema in a manner that allows for correct semantic interpretation and validation.

The validation process described in Annex C may be useful for those involved in the development of new or extension of existing Data Specifications.

5 Metadata validation

5.1 General

The metadata validation process encompasses several steps. The validation process for metadata validation is shown in Figure 1. As a first step, the metadata shall be validated against the metadata schema provided. As a second step, the metadata shall be validated against formal constraints from the metadata specification using Schematron. In Figure 1, relevant to an INSPIRE metadata validation, this second step has been split into two sub-steps, the first relevant to the validation with respect to the constraints related to the core metadata common to all the INSPIRE themes and then with respect to the theme-specific constraints.

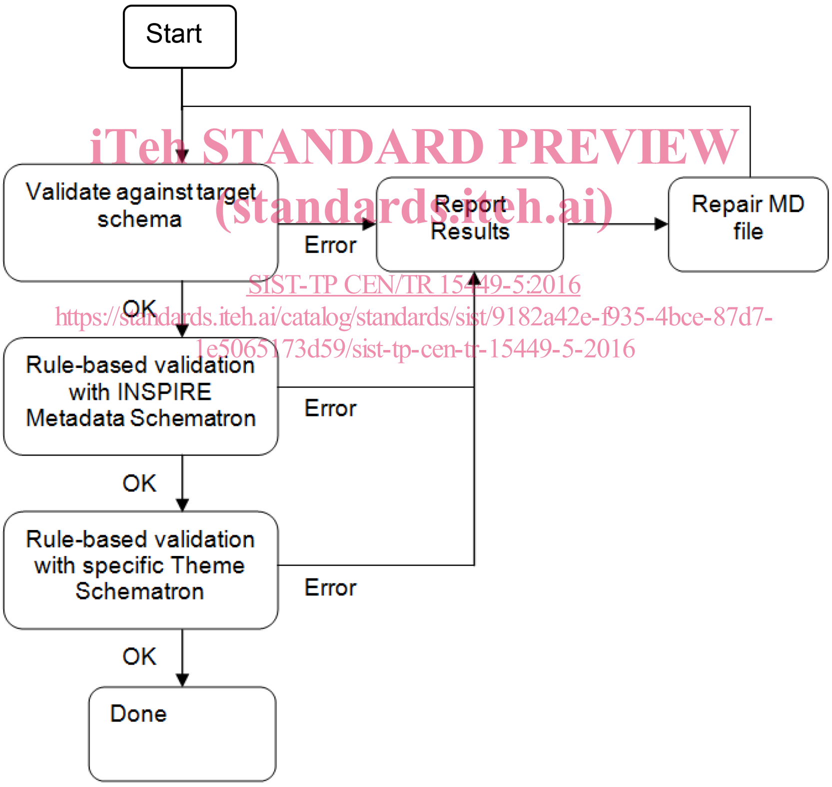

Figure 1 — Metadata validation process

If an error is found and rectified, all validation steps shall be repeated, as the rectification process may have introduced new errors.

5.2 Validation against XML Schema

Before using an XML document, this shall first be validated against the relevant schema using an XML validation tool. Any errors identified during schema validation shall be rectified before the data can be used. The tester shall ensure that the XML document refers to the proper schema; just because a data file is valid XML does not mean that it is valid according to a specific schema.

As many tools used for the creation and validation of xml metadata may use different approaches, it is advisable to validate the metadata generated using different validation tools. Thus, further errors in the metadata can be found and rectified, reducing problems encountered when users attempt to work with faulty metadata.

5.3 Rule-based validation with Schematron

Once the metadata file has been shown to be formally valid against the schema provided, compliance to further constraints arising from the data specification shall be checked. This should be done using Schematron validation; a Schematron rule file shall be provided for each metadata specification. All metadata provided in the form of XML documents shall pass validation according to the corresponding Schematron file before it is considered valid. While in most cases the Schematron rules are configured so that they only display message texts for errors, some also provide informative texts.

6 Data validation

6.1 General

The data validation process encompasses several steps, as shown in Figure 2, relevant to an INSPIRE data validation. As a first step, the data should be validated against the data schema provided. As a second step, the data should be validated against formal constraints from the data specification using Schematron, first with respect to the constraints related to the GML encoding and then with respect to the data-specific constraints.

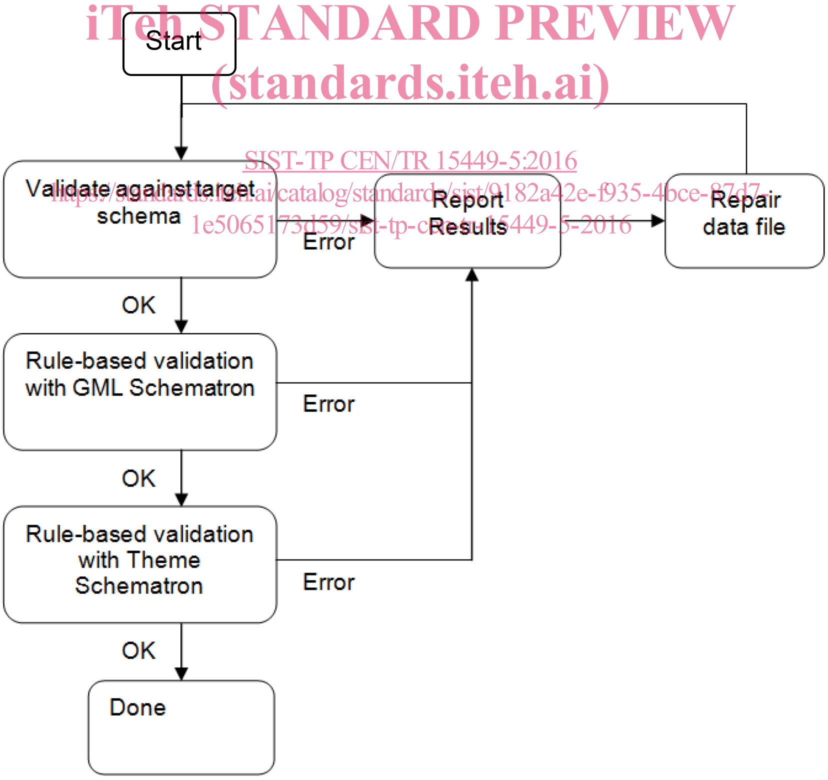

Figure 2 — Data validation process

If an error is found and rectified, all validation steps shall be repeated, as the rectification process may have introduced new errors.

6.2 Validation against XML Schema

Before using an XML document, this shall first be validated against the relevant schema for the data file using an XML validation tool. Any errors identified during schema validation shall be rectified before the data can be used. The tester shall ensure that the XML document refers to the proper schema; just because a data file is valid XML does not mean that it is valid according to a specific schema.

As many tools used for the creation and validation of xml data may use different approaches, it is advisable to validate the data generated using different validation tools. Thus, further errors in the data may be found and rectified, reducing problems encountered when users attempt to work with faulty data.

6.3 Rule-based validation with Schematron

Once the data file has been shown to be formally valid against the schema provided, compliance to further constraints arising from the data specification shall be checked. This should be done using Schematron validation; a Schematron rule file shall be provided for each metadata and data specification. All data provided in the form of XML documents shall pass validation according to the corresponding Schematron file before it is considered valid. While in most cases the Schematron rules are configured so that they only display message texts for errors, some also provide informative texts.

6.4 INSPIRE Abstract Test Suite for Annex I, II and III data themes

The INSPIRE Data Specifications - Technical Guidelines for the Annex I, II and III data themes have an annex, “Annex A - Abstract Test Suite”, which contains a set of tests to help the conformance testing process.

The new and updated structure of the Data Specifications contains two different types of requirements:

- the requirements present in the Regulation (Implementing Rules - IR) on interoperability of spatial data sets and services (IR Requirements)

- the requirements for a specific technical solution proposed in the Technical Guidance for an IR requirement (TG requirements).

For this reason the Abstract Test Suite (ATS) is composed of two parts:

- Part 1 (normative) - Conformity with Commission Regulation No 1089/2010 (IR Requirements)
- Part 2 (informative) - Conformity with the technical guideline (TG) Requirements

In each part, the requirements to be tested are grouped in several *conformance classes* and each of these classes covers a specific aspect.

The ATS contains a detailed list of abstract tests, but for their physical implementation an Executable Test Suite (ETS) is required. The ETS shall contain operative instructions on how to execute the relevant abstract test.

Some tests, such as in the Application schema conformance class, may be automated by using xml schema validation tools. Conversely, other tests can require manual execution.

An overview of the INSPIRE ATS for Data Specifications is provided in Figure 3[3)].

3) Abstract Test Suite for INSPIRE Data Specifications, Vlado Cetl, Katalin Tóth, Tomas Reznik and Robert Tomas, INSPIRE conference 2012

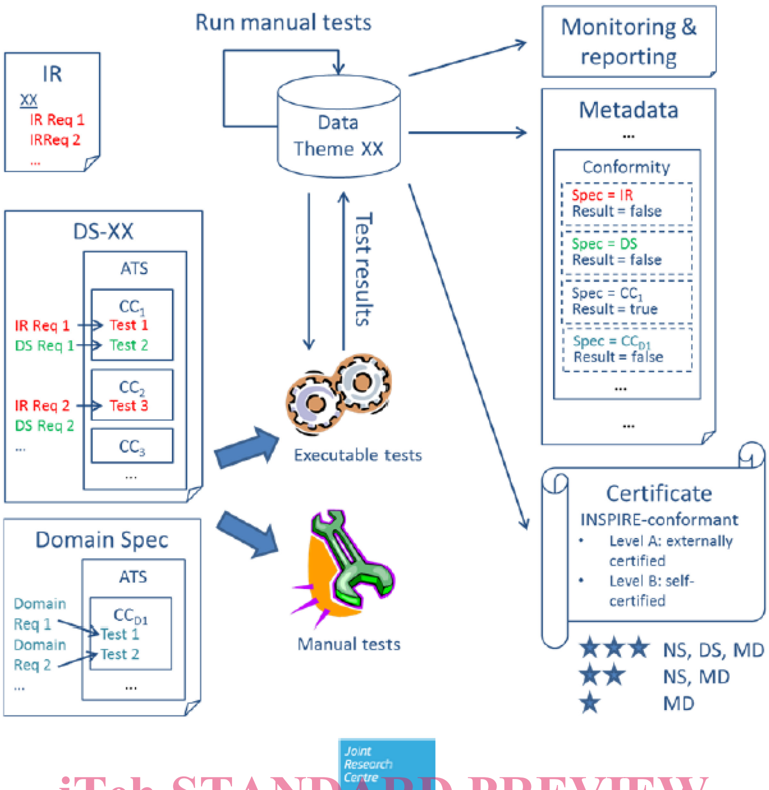

Figure 3 — Overview of the INSPIRE ATS for Data Specifications

An example of a test (A.1.1) of the Application Schema Conformance Class (A.1) for the INSPIRE Environmental Monitoring Facilities data theme is shown in Figure 4.

Part 1
(normative)

Conformity with Commission Regulation No 1089/2010

A.1 Application Schema Conformance Class

Conformance class:
http://inspire.ec.europa.eu/conformance-class/ir/ef/as/<application schema namespace prefix>

A.1.1 Schema element denomination test

a) Purpose: Verification whether each element of the dataset under inspection carries a name specified in the target application schema(s).

b) Reference: Art. 3 and Art.4 of Commission Regulation No 1089/2010

c) Test Method: Examine whether the corresponding elements of the source schema (spatial object types, data types, attributes, association roles, code lists, and enumerations) are mapped to the target schema with the correct designation of mnemonic names.

NOTE Further technical information is in the Feature catalogue and UML diagram of the application schema(s) in section 5.2.

Figure 4 — Example Test for Application Schema