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Geographic information — Services (ISO 19119:2016)

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The UK participation in its preparation was entrusted to Technical Committee IST/36, Geographic information.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Information géographique - Services (ISO 19119:2016)

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This European Standard was approved by CEN on 20 February 2016.

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European foreword

This document (EN ISO 19119:2016) has been prepared by Technical Committee ISO/TC 211 "Geographic information/Geomatics" in collaboration with Technical Committee CEN/TC 287 "Geographic Information" the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2016, and conflicting national standards shall be withdrawn at the latest by August 2016.

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 211, *Geographic information/Geomatics*.

This second edition cancels and replaces the first edition (ISO 19119:2005), which has been technically revised. It also incorporates the Amendment ISO 19119:2005/Amd 1:2008.

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Introduction

The widespread application of computers and use of geographic information systems (GIS) have led to the increased analysis of geographic data within multiple disciplines. Based on advances in information technology, society's reliance on such data are growing. Geographic datasets are increasingly being shared, exchanged, and used for purposes other than their producers' intended ones. GIS, remote sensing, automated mapping and facilities management (AM/FM), Spatial Data Infrastructure (SDI), traffic analysis, geopositioning systems, and other technologies for Geographic Information (GI) are entering a period of radical integration.

This International Standard provides a framework for platform neutral and platform specific specification of services that can enable users to access, process and manage geographic data from a variety of sources, potentially for various distributed computing platforms (DCPs).

— "a framework for platform neutral and platform specific specification of services" means that this International Standard provides requirements for how services shall be specified in such a way that one service can be specified independently of one or more underlying distributed computing platforms. The framework provides requirements for a further mapping to specific platforms in order to enable conformant platform specific specifications to ensure conforming and interoperable service implementations.

— "access, process and manage" means that geodata users can query remote databases and control remote processing resources and also take advantage of other distributed computing technologies, such as software delivered to the user's local environment from a remote environment for temporary use;

— "from a variety of sources" means that users will have access to data acquired in a variety of ways and stored in a wide variety of relational and non-relational databases;

— "across a generic computing interface" means that ISO 19119 interfaces provide reliable communication between otherwise disparate software resources that are equipped to use these interfaces;

— "within an open information technology environment" means that this International Standard enables geoprocessing to take place outside of the closed environment of monolithic GIS, remote sensing, and AM/FM systems that control and restrict database, user interface, network and data manipulation functions;

— services shall be categorised according to a service taxonomy based on architectural areas and may also be categorised according to a usage life cycle perspective, as well as according to domain specific and user defined service taxonomies, providing support for publication and discovery of services.

The difference between this version of this International Standard and the previous ISO 19119:2005 version is the following:

This International Standard has defined a set of requirements and related abstract tests for the specification of services according to enterprise, computational, information, engineering and technology viewpoints. This International Standard has defined a set of requirements for categorizing services according to service taxonomies. The service metadata has been moved to ISO 19115-1.

Service policies, service contracts including service level agreements (SLAs) are currently not specified as part of this International Standard, as these are considered most relevant for service deployment and service ownership, which is not currently a focus for this International Standard.

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Geographic information — Services

1 Scope

This International Standard defines requirements for how platform neutral and platform specific specification of services shall be created, in order to allow for one service to be specified independently of one or more underlying distributed computing platforms.

This International Standard defines requirements for a further mapping from platform neutral to platform specific service specifications, in order to enable conformant and interoperable service implementations.

This International Standard addresses the Meta:Service foundation of the ISO geographic information reference model described in ISO 19101-1:2014, Clause 6 and Clause 8, respectively.

This International Standard defines how geographic services shall be categorised according to a service taxonomy based on architectural areas and allows also for services to be categorised according to a usage life cycle perspective, as well as according to domain specific and user defined service taxonomies, providing support for easier publication and discovery of services.

2 Conformance

2.1 Claiming conformance

Any product claiming conformance with the conformance classes in this International Standard shall pass all the associated requirements described in the abstract test suite given in Annex A.

2.2 General

This International Standard defines six conformance classes shown in Table 1 to Table 6, matching the six requirements classes described in Clause 7 to Clause 12. Any service claiming conformance to any requirements class in this International Standard shall pass all of the tests listed in the corresponding conformance class, which are described in detail in the abstract test suites in Annex A. Each test relates to one or more specific requirements, which are explicitly indicated in the description of the test.

2.3 Enterprise viewpoint

The enterprise viewpoint conformance class is shown in Table 1.

Table 1 — Enterprise viewpoint conformance class

Conformance class	**/conf/enterpriseviewpoint**
Requirements	/req/enterpriseviewpoint (Table 11)
Tests	All tests in A.2

2.4 Computational viewpoint

The computational viewpoint conformance class is shown in Table 2.

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Table 2 — Computational viewpoint conformance class

Conformance class	**/conf/computationalviewpoint**
Dependency	/conf/enterpriseviewpoint
Requirements	/req/computationalviewpoint (Table 12)
Tests	All tests in A.3

2.5 Information viewpoint

The information viewpoint conformance class is shown in Table 3.

Table 3 — Information viewpoint conformance class

Conformance class	**/conf/informationviewpoint**
Dependency	/conf/uml (2.4)
Requirements	/req/informationviewpoint (Table 18)
Tests	All tests in A.4

2.6 Service taxonomies

The service taxonomy conformance class is shown in Table 4.

Table 4 — Service taxonomies conformance class

Conformance class	**/conf/servicetaxonomies**
Dependency	/conf/uml (2.4)
Requirements	/req/servicetaxonomies (Table 19)
Tests	All tests in A.5

2.7 Engineering viewpoint

The engineering viewpoint conformance class is shown in Table 5.

Table 5 — Engineering viewpoint conformance class

Conformance class	**/conf/engineeringviewpoint**
Dependency	/conf/uml (2.4)
Requirements	/req/engineeringviewpoint (Table 26)
Tests	All tests in A.6

2.8 Technology viewpoint

The technology viewpoint conformance class is shown in Table 6.

Table 6 — Technology viewpoint conformance class

Conformance class	**/conf/technologyviewpoint**
Dependency	/conf/uml (2.4)
Requirements	/req/technologyviewpoint (Table 27)
Tests	All tests in A.7

NOTE The definition of an abstract test suite appears in ISO 19105.

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3 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.

ISO/IEC 10746-1, *Information technology — Open Distributed Processing — Reference model: Overview — Part 1*

ISO 19101-1:2014, *Geographic information — Reference model — Part 1: Fundamentals*

ISO 19103, *Geographic information — Conceptual schema language*

ISO 19115-1:2014, *Geographic information — Metadata — Part 1: Fundamentals*

[SoaML] *Service oriented architecture Modeling Language v 1.0.1*, May 2012, OMG standard[1)]

4 Terms and definitions and abbreviations

4.1 Terms and definitions

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

4.1.1
capability
real-world effect that a *service* (4.1.12) provider is able to provide to a service consumer

[SOURCE: SOA-RAF]

4.1.2
computational viewpoint
viewpoint (4.1.15) on an ODP system and its environment that enables distribution through functional decomposition of the system into objects which interact at *interfaces* (4.1.8)

[SOURCE: ISO/IEC 10746-3:2015, 4.1.1.3]

4.1.3
distribution transparency
property of hiding from a particular user the potential behaviour of some parts of a distributed system

Note 1 to entry: Distribution transparencies enable complexities associated with system distribution to be hidden from applications where they are irrelevant to their purpose.

[SOURCE: ISO/IEC 10746-2:2009, 11.1.1]

4.1.4
engineering viewpoint
viewpoint (4.1.15) on an ODP system and its environment that focuses on the mechanisms and functions required to support distributed interaction between objects in the system

[SOURCE: ISO/IEC 10746-3:2009, 4.1.1.4]

4.1.5
enterprise viewpoint
viewpoint (4.1.15) on an ODP system and its environment that focuses on the purpose, scope and policies for that system

[SOURCE: ISO/IEC 10746-3:2009, 4.1.1.1]

1) http://www.omg.org/spec/SoaML/1.0.1/

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4.1.6
entity
something that has separate and distinct existence and objective or conceptual reality

4.1.7
information viewpoint
viewpoint (4.1.15) on an ODP system and its environment that focuses on the semantics of information and information processing

[SOURCE: ISO/IEC 10746-3:2009, 4.1.1.2]

4.1.8
interface
named set of *operations* (4.1.10) that characterize the behaviour of an *entity* (4.1.6)

Note 1 to entry: See 8.2 for a discussion of interface.

4.1.9
interoperability
capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units

[SOURCE: ISO/IEC 2382:2009, 2121317]

4.1.10
operation
specification of a transformation or query that an object may be called to execute

Note 1 to entry: An operation has a name and a list of parameters.

Note 2 to entry: See 8.2 for a discussion of operation.

4.1.11
real world effect
actual result of using a *service* (4.1.12), rather than merely the *capability* (4.1.1) offered by a service provider

Note 1 to entry: See 8.3 for a discussion of service.

[SOURCE: OASIS RAF, 3.2.3]

4.1.12
service
distinct part of the functionality that is provided by an *entity* (4.1.6) through *interfaces* (4.1.8)

4.1.13
service chain
sequence of *services* (4.1.12) where, for each adjacent pair of services, occurrence of the first action is necessary for the occurrence of the second action

4.1.14
technology viewpoint
viewpoint (4.1.15) on an ODP system and its environment that focuses on the choice of technology in that system

[SOURCE: ISO/IEC 10746-3:2009, 4.1.1.5]

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4.1.15
viewpoint (on a system)
form of abstraction achieved using a selected set of architectural concepts and structuring rules, in order to focus on particular concerns within a system

[SOURCE: ISO/IEC 10746-2, 3.2.7]

4.1.16
workflow
automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules

4.2 Abbreviations

API	Application Programming Interface
BPEL	Business Process Execution Language
BPMN	Business Process Modelling Notation
CORBA	Common Object Request Broker Architecture
CSL	Conceptual schema language
DAG	Directed Acyclic Graph
DCP	Distributed Computing Platform
DEM	Digital Elevation Model
DTD	Document type definitions
EJB	Enterprise Java Beans
ERP	Enterprise Resource Planning
GIOP	General Inter-ORB Protocol
GFM	General feature model
HTI	Human Technology Interface
HTML	Hypertext Markup language
HTTP	Hypertext Transfer Protocol
IaaS	Infrastructure as a Service
IDL	Interface Definition Language
IIOP	Internet Inter-ORB Protocol
INSPIRE	Infrastructure for Spatial Information in Europe
IT	Information Technology
J2EE	Java 2 Enterprise Edition with EJB
JDBC	Java Data Base Connectivity
OASIS	Organization for the Advancement of Structured Information Standards

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OCL	Object Constraint Language
ODBC	Open Database Connectivity
ODMG	Object Database Management Group
ODP	Open Distributed Processing (see RM-ODP)
OGC	Open Geospatial Consortium
OMG	Object Management Group
ORB	Object Request Broker
OWL	Web Ontology Language
PaaS	Platform as a Service
QoS	Quality of Service
QVT	Query/View/Transformation
REST	Representational state transfer
RDF	Resource Description Framework
RMI	Remote Method Invocation
RM-ODP	Reference Model of Open Distributed Processing (ISO/IEC 10746)
RPC	Remote Procedure Call
SaaS	Software as a Service
SDI	Spatial Data Infrastructure
SDAI	Standard Data Access Interface (ISO 10303-22)
SOA	Service Oriented Architecture
SoaML	Service oriented architecture Modelling Language (OMG)
SOAP	Simple Object Access Protocol
SOF	Service Organizer Folder
SPS	Spatial Planning Service
SQL	Structured Query Language
UML	Unified Modeling Language
URI	Uniform Resource Identifier
W3C	World Wide Web Consortium
WFS	Web Feature Service
WMS	Web Map Service
XML	Extensible Markup Language

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XML RDF XML Resource Description Framework

XSLT XML Stylesheet Language Transformations

Concepts from schemas defined in some other International Standards are designated with names that start with bi-alpha codes as follows:

TM ISO 19108:2002 Temporal Schema, Temporal Objects

5 Notation

5.1 General

This International Standard describes how to describe a service. In addition to stating the rules for creating service descriptions, this International Standard provides guidance through examples.

5.2 Conformance class

Conformance to this International Standard is possible at a number of levels, specified by conformance classes (Clause 2). Each conformance class is summarized using the template shown as Table 7.

Table 7 — Conformance class template

Conformance class	**/conf/{classM}**
Dependency	[identifier for another conformance class]
Requirements	/req/{classA}
Tests	[reference to clause(s) containing tests]

All tests in a class shall be passed, so dependencies are on other conformance classes (see Resolution 570 of ISO/TC 211, N3262). Each conformance class tests conformance to a set of requirements packaged in a requirements class (Clause 7 and Clause 8).

5.3 Requirements class

Each normative statement (requirement or recommendation) in this International Standard forms part of a specific requirements class. In this International Standard, each requirements class is described in a discrete clause or subclause and summarized using the template shown as Table 8.

Table 8 — Requirements class template

Requirements class	**/req/{classM}**
Target type	[artefact or technology type]
Dependency	[identifier for another requirements class]
Requirement	/req/{classM}/{reqN}
Recommendation	/req/{classM}/{recO}
Requirement	/req/{classM}/{reqP}
Requirement /Recommendation	[repeat as necessary]

All requirements in a class shall be satisfied, so the requirements class is the unit of re-use and dependency. Hence, the value of a Dependency requirement is another requirements class.

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5.4 Rules

All rules are normative and each rule is presented using the following template where /req/[classM]/[reqN] identifies the requirement or recommendation. The use of this layout convention allows the normative provisions of this International Standard to be easily located by implementers.

/req/[classM]/[reqN]	[Normative statement]

5.5 Identifiers

Each requirements class, requirement and recommendation has an identifier in the form of a path or partial URI. The identifier supports cross-referencing of class membership, dependencies, and links from each conformance test to requirements tested. The identifier can be appended to a URI that identifies the standard as a whole in order to construct a complete URI which allows the requirements class, requirement or recommendation to be identified in an external context. For example, following the URI scheme for ISO standards [IETF RFC 5141], a URI denoting the ISO 19109 standard is as follows:

http://standards.iso.org/iso/19109/2

The URI for each requirements class has the following form:

http://standards.iso.org/iso/19109/2/req/[classM]

The URI for each requirement or recommendation has the following form:

http://standards.iso.org/iso/19109/2/req/[classM]/[reqN]

5.6 Conceptual schemas

Conceptual schemas in the normative part of this International Standard are presented in the Unified Modeling Language (UML) in conformance with ISO 19103. UML diagrams are presented in compliance with ISO/IEC 19505-2.

5.7 Descriptions of concepts

Concepts from UML are presented in all capitals, e.g. CLASS, PACKAGE, ROLE, ATTRIBUTE, ASSOCIATION.

5.8 Architecture patterns

An architecture pattern expresses a fundamental structural organization or schema for software services. It identifies a set of services, specifies their responsibilities, and includes rules and guidelines for organizing the relationships between them. Services, implemented by classes and objects, can use design patterns but this level of detail is outside the scope of this International Standard.

Table 9 provides a listing of the elements of a pattern. When specific architecture patterns are defined in this International Standard, these elements are suggested to be used.

Table 9 — Elements of a pattern

Element of a pattern	Description of element
Name	The name is a word or short meaningful phrase that describes the pattern. The name is extremely important since it is used to reduce communication overhead. Nick-names or synonyms may be provided.
Problem	This is a statement of the problem which describes its intent, goals and objectives it wants to reach within the given context and forces. Often, the forces oppose these objectives, as well as each other.

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Table 9 *(continued)*

Element of a pattern	Description of element
Context	Context defines the preconditions under which the problem and its solution seem to recur, and for which the solution is desirable. This defines the pattern's applicability. It can be thought of as the initial configuration of the system before the pattern is applied.
Forces	The forces are considerations that should be weighed to reach the best solution. Forces define the kinds of trade-offs that should be considered in the presence of the tension or dissonance they create. The forces answer the question: "Why is this a hard problem?"
Structure	Structure defines the static relationships and dynamic rules describing how to realize the desired outcome. The structure description is accomplished through a collaboration diagram.

6 Overview of geographic services architecture

6.1 Purpose and justification

The definition of service includes a variety of applications with different levels of functionality to access and use geographic information. While specialized services will appropriately remain an area for service producers, standardization of the interfaces to those services allows interoperability between proprietary products. Geographic information system and software developers will use this International Standard to provide general and specialized services that can be used for all geographic information. The approach of this International Standard is integrated with the approaches being developed within the more general world of information technology, in particular related to service oriented architectures.

The geographic services architecture specified in this International Standard has been developed to meet the following purposes:

— provide an abstract framework to allow coordinated development of specific services;

— enable interoperable data services through interface standardization;

— support development of a service catalogue through the definition of service metadata;

— allow separation of data instances and service instances;

— enable use of one provider's service on another provider's data;

— define an abstract framework which can be implemented in multiple ways.

6.2 Relationship to ISO 19101-1

Table 10 — Reference model conceptual framework

Reference model conceptual framework				
Level\Foundation	**Interoperability**			**Procedural standards**
	Semantic foundation	**Syntactic foundation**	**Service foundation**	
Meta-meta	Meta-meta:Semantic	Meta-meta:Syntactic	Meta-meta:Service	Meta-meta:Procedural
Meta	Meta:Semantic	Meta:Syntactic	Meta:Service	Meta:Procedural
Application	Application:Semantic	Application:Syntactic	Application:Service	Application:Procedural
Instance	*Instance:Semantic*	*Instance:Syntactic*	*Instance:Service*	*Instance:Procedural*

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Table 10 shows the service ISO 19101-1 Reference model conceptual framework with the Service foundation for Interoperability, which is being addressed by this International Standard as follows:

— **Meta-meta:Service**

Meta-meta:Service consists of standards that serve as foundation for the definition of rules and methodologies for the development of geographic information processing and services for, but not limited to, the discovery, the access and the processing of geographic information.

This International Standard is relating to other standards for this level (Meta-meta:Service), in particular, ISO RM/ODP, OASIS SOA RM, ISO 19101-1:2014, ISO 19103, ISO 19109 and OMG SoaML.

— **Meta:Service**

Meta:Service consists of standards defining rules and methodologies for the modelling and development of geographic information processing and services. This International Standard is addressing this level in particular.

— **Application:Service**

Application:Service consists of definitions of standardized geographic information services. Capabilities of the service agree with the Application:Semantic level. Application:Service includes the following:

— standards for geographic human interaction services;

— standards for geographic model/information management services;

— standards for geographic workflow/task management services;

— standards for geographic processing services:

  — spatial (i.e. vector, coverage, and imagery and gridded data);

  — thematic (e.g. web services for mapping, delivering data about features, and filtering data);

  — temporal;

  — metadata;

— standards for geographic communication services.

— **Instance:Service**

Instance:Service is included in the reference model conceptual framework for completeness but is not part of the scope of this International Standard. It consists of service instances (including Web services) complying with services defined as part of Application:Service.

6.3 Interoperability reference model based on ISO RM-ODP

This International Standard is developed based on a system architecture approach to system design known as the Reference Model of Open Distributed Processing (RM-ODP); see ISO/IEC 10746-1. Architecture is defined as a set of components, connections and topologies defined through a series of views. The geographic infrastructure enabled by this International Standard will have multiple users, developers, operators and reviewers. Each group will view the system from their own perspective. The purpose of architecture is to provide a description of the system from multiple viewpoints. Furthermore, architecture helps to ensure that each view will be consistent with the requirements and with the other views.

Table 11 shows how the RM-ODP viewpoints are utilized in this International Standard.

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Table 11 — Use of RM-ODP viewpoints in this International Standard

Viewpoint name	Definition of RM-ODP Viewpoint (ISO/IEC 10746-1)	How viewpoint is addressed in this International Standard
enterprise viewpoint	See 4.1.5.	See Clause 7, enterprise viewpoint.
computational viewpoint	See 4.1.2.	See Clause 8, computational viewpoint.
information viewpoint	See 4.1.7.	See Clause 9, information viewpoint.
engineering viewpoint	See 4.1.4.	See Clause 11, engineering viewpoint.
technology viewpoint	See 4.1.14.	See Clause 12 technology viewpoint; also to be addressed by platform-specific service specifications.

The enterprise viewpoint is concerned with the purpose, scope and policies of an enterprise or business and how they relate to the specified system or service. An enterprise specification of a service is a model of that service and the environment within which the service operates. It covers the role of the service in the business and the human-user roles and business policies related to the service.

The computational viewpoint is concerned with the interaction patterns between the components (services) of the system, described through their interfaces. A computational specification of a service is a model of the service interface seen from a client and the potential set of other services that this service requires to have available, with the interacting services described as sources and sinks of information.

The information viewpoint is concerned with the semantics of information and information processing. An information specification of a system is a model of the information that it holds and of the information processing that it carries out.

The engineering viewpoint is concerned with the design of distribution-oriented aspects, i.e. the infrastructure required to support distribution. An engineering specification of a system defines a networked computing infrastructure that supports the system structure defined in the computational specification and provides the distribution transparencies that it defines. This viewpoint defines the following distribution transparencies: access, failure, location, migration, relocation, replication, persistence and transaction. Security may also be a mechanism.

The technology viewpoint describes the implementation of a system in terms of a configuration of technology objects representing the hardware and software components of the implementation. It is constrained by cost and availability of technology objects (hardware and software products) that would satisfy this specification. These may conform to platform-specific standards that are effectively templates for technology objects.

In the computational and information viewpoint clauses of this International Standard, specific approaches that shall be followed for defining geographic information services are provided. For the engineering and technology viewpoints, this International Standard defines how a particular service shall be mapped on to an implementation technology, such as Web services, REST services, SQL, CORBA, Internet or similar technologies.

6.4 Service abstraction

Various definitions for services exist; however, in this International Standard, the following definition for services is used:

A service is a distinct part of the functionality that is provided by an entity through interfaces.

Other standard developments in this area have introduced more elaborate definitions. The following definition for a service can be found in the OASIS SOA Reference Architecture Framework [SOA-RAF].

*A **service** is a mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description. A service is provided by an entity (the service provider) for use by others, but the eventual*

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consumers of the service may not be known to the service provider and may demonstrate uses of the service beyond the scope originally conceived by the provider.

OMG SoaML defines service as follows [SoaML].

*A **service** is value delivered to another through a well-defined interface and available to a community (which may be the general public). A service results in work provided to one by another.*

A Service represents a feature of a Participant that is the offer of a service by one participant to others using well defined terms, conditions and interfaces. A Service designates a Port that defines the connection point through which a Participant offers its capabilities and provides a service to clients.

In this context, participants, ports, service description and capabilities are defined as follows.

— Participants: participants are either specific entities or kinds of entities that provide or use services. Participants can represent people, organizations, or information system components. Participants may provide any number of services and may consume any number of services.

— Ports: participants provide or consume services via ports. A port is the part or feature of a participant that is the interaction point for a service, where it is provided or consumed. A port where a service is offered may be designated as a "Service" port and the port where a service is consumed may be designated as a "Request" port.

— Service description: the description of how the participant interacts to provide or use a service is encapsulated in a specification for the service (there are two ways to specify a service interaction) as a simple UML Interface or as a two-way ServiceInterface. These different ways to specify a service related to the service oriented architecture (SOA) approach and the complexity of the service, but in each case, they result in interfaces and behaviours that define how the participant will provide or use a service through ports. The service descriptions are independent of, but consistent with, how the provider provides the service or how (or why) the consumer consumes it. This separation of concerns between the service description and how it is implemented is fundamental to SOA. A service specification specifies how consumers and providers are expected to interact through their ports to enact a service, but not how they do it.

— Capabilities: participants that provide a service should have a capability to provide it, but different providers may have different capabilities to provide the same service; some may even "outsource" or delegate the service implementation through a request for services from others. The capability behind the service will provide the service according to a service description and may also have dependencies on other services to provide that capability. The service capability is frequently integral to the provider's business process. Capabilities can be seen from two perspectives: capabilities that a participant has that can be exploited to provide services and capabilities that an enterprise needs that can be used to identify candidate services.

Regardless of how services are identified, they are formalized by service descriptions. A service description defines the purpose of the service and any interaction or communication protocol for how to properly use and provide a service. A service description may define the complete interface for a service from its own perspective, irrespective of any consumer request it might be connected to. Alternatively, the agreement between a consumer request and provider service may be captured in a common service contract defined in one place and constraining both the consumer's request service interface and the provider's service interface.

This approach to service modelling relies on model-driven techniques to separate the logical implementation of a service from its possible physical realizations on various platforms. This separation of concerns both keeps the services models simpler and more resilient to changes in underlying platform and execution environments. Using this approach, service models can support a variety of technology implementations and tool support can help automate these technology mappings.

Figure 1 defines the relationship between the various types of service specifications. SV_ ServiceSpecification defines services without reference to the type of specification or to its implementation. An SV_PlatformNeutralServiceSpecification provides the abstract definition of a specific type of service but does not specify the implementation of the service. Service types are

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given in the geographic service taxonomy in 10.8. SV_PlatformSpecificServiceSpecification defines the implementation of a specific type of service. There may be multiple platform-specific specifications for a single platform-neutral specification. CodeList ServiceMetadata:DCP contains different alternatives for target technology platforms. SV_Service is an implementation of a service. The requirements for these specifications are addressed in this International Standard, in particular in Clause 10.

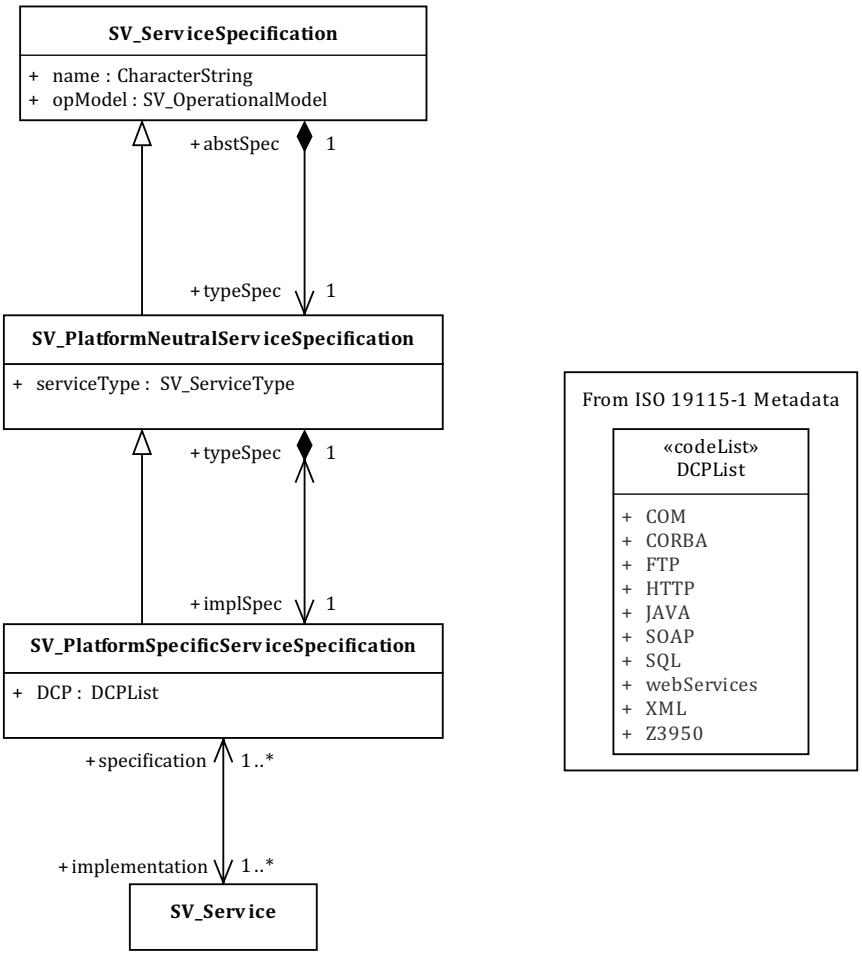

Figure 1 — Abstract and implementation service specifications

6.5 Interoperability

Interoperability is the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units.

Two components 1 and 2 (see Figure 2) can interoperate (are interoperable) if 1 can send requests 3 for services to 2, based on a mutual understanding of 3 by 1 and 2, and if 2 can similarly return mutually understandable responses 4 to 1.

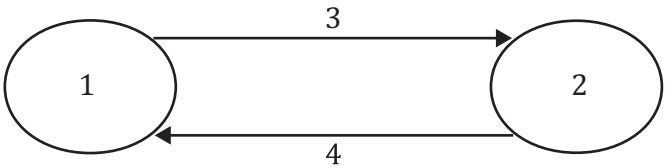

Figure 2 — Interoperability

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This means that two interoperable systems can interact jointly to execute tasks. For the geographic domain, the following description of the term "geographic interoperability" is applicable:

"Geographic interoperability" is the ability of information systems to a) freely exchange all kinds of spatial information about the Earth and about the objects and phenomena on, above, and below the Earth's surface, and b) cooperatively, over networks, run software capable of manipulating such information.

Interoperability in the geographic information context is further described in ISO 19101-1.

The ODP viewpoint abstraction provides a framework for describing a system at several abstraction levels. In this International Standard, interoperability is viewed in terms of the different abstraction levels provided by RM-ODP. This International Standard focuses, from different viewpoints, on how semantic and syntactic interoperability of geographic metadata and geographic data can be supported.

When two different organizations have independently developed distributed systems, each can be described according to the RM-ODP viewpoints, and interoperability between the systems can be discussed with respect to each of the five RM-ODP viewpoints.

For each interoperability aspect, a distinction is made between syntactical interoperability and semantic interoperability. Syntactical interoperability ensures that there is a technical connection, i.e. that the data can be transferred between systems. Semantic interoperability ensures that the content is understood in the same way in both systems, including by those humans interacting with the systems in a given context.

6.6 Use of other geographic information standards in service specifications

A service specification shall include relevant information models from the appropriate geographic information in the ISO geographic information suite of standards. The corresponding UML models may be used in the definition of the service interfaces as appropriate.

7 Enterprise viewpoint: A context for services

7.1 Enterprise viewpoint

The Enterprise viewpoint describes the context for a system and a set of services. It concentrates on the objectives, business rules and policies that need to be supported by systems and services. An enterprise specification of a service is a model of that service and the environment with which the service interacts. It covers the role of the service in the business and the human-user roles and business policies related to the service. In the context of service specifications, there is a particular focus on the use cases and external functionally related to the particular services.

Experience with the development of services has shown that it is very useful to have models for the enterprise viewpoint, focusing on generic descriptions of the usage, and typical process for usage. This helps to shape the understanding of the functionality and constraints that are placed on systems and services. It also helps concrete project and development activities to place the needs of project and development activities in the context of both existing and available standards and services, as well as supporting the identification of new services.

The enterprise viewpoint contains the scope and structure of the service being described. This viewpoint will explain why the service is needed and what it is intended to do, and relates the service to its objectives. It should be clear and concise and targeted for a nontechnical audience.

The Enterprise viewpoint is a human-oriented description of the service. The purpose of this viewpoint is to provide a good understanding of the service and its actions for people who may have an interest in the service. The other viewpoints will also have a computer-oriented specification of the service for the purpose of supporting realization and conformance testing of the service.

Geographic information services aim at supporting a multitude of users and organizations to support the variety of work processes in which they are involved. In order to reach their goals of enhanced spatial

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data sharing and processing, they should cover the business requirements of as many organizations and processes as possible.

A work process is defined as the way in which organizations create products, services or policies. It is a succession of structured and interconnected activities across time and space which, starting from an identifiable input, result in a defined output in the form of a product or service. In order to obtain the desired output, the input should be transformed. Ideally, the transformation that occurs in the process should add value to the input and create an output that is more useful to the recipient either upstream or downstream. Traditionally, work processes occurred within single organizations, but increasingly cross organizational and even country boundaries. Often, a process is divided into several sub-processes due to complexity, which can in turn be sub-divided in a series of activities and tasks. Therefore, the simple input-throughput-output model will rather consist of several interconnected input-throughput-output chains whereby the output of one sub-process serves as the input for another sub-process. Services with service chaining can be used to support such work processes.

Many processes create products based on other products, which is, for example, the case for manufacturers of cars. For work processes dealing with policy preparation, monitoring and evaluation, decision making, or service provision, the notion of data and information flows is crucial. Data and information are needed as input, to services and service chains, in order to process them and to create new data and information that can be used to make decisions, to serve other organisations, policy makers or even individual citizens.

7.2 Enterprise viewpoint service specifications

The requirements for creating a service specification in the enterprise viewpoint are formalized as a requirements class summarized in Table 12.

Table 12 — Requirements class for Enterprise viewpoint service specifications

Requirements class	**/req/enterpriseviewpoint**
Target type	Service description
Requirement	/req/enterpriseviewpoint/servicename
Requirement	/req/enterpriseviewpoint/servicetypes
Requirement	/req/enterpriseviewpoint/purpose
Requirement	/req/enterpriseviewpoint/scope
Requirement	/req/enterpriseviewpoint/capabilities
Requirement	/req/enterpriseviewpoint/community
Recommendation	/rec/enterpriseviewpoint/scenarios

/req/enterpriseviewpoint/ servicename	Service name shall be described as a textual string stating the name of this service.

NOTE 1 This is a human-readable identification for this service (e.g. Web Map Service, Web Feature Service, Sensor Planning Service, Feature Extraction Service). The name might also have a corresponding short name (e.g. WMS, WFS, SPD, FES).

/req/enterpriseviewpoint/ servicetypes	The service shall be categorised according to its service type based on the architectural service taxonomy in this International Standard, and may also be categorised according to other service taxonomies.

The service purpose should clearly describe the intentional goals of the service. Defines the purpose the service intends or resolve, to perform or accomplish.

/req/enterpriseviewpoint/ purpose	Service purpose shall be described as a textual paragraph stating the scope and objective of the service

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The service purpose should clearly describe the intentional goals of the service. Defines the purpose the service intends or resolve, to perform or accomplish.

/req/enterpriseviewpoint/scope	Service scope shall be described as a textual paragraph stating the capabilities that will be provided through the service, and may also state relevant capabilities that are out of scope.

NOTE 2 The capabilities can be described as a list of different capabilities and the real world effects provided by the service. Capabilities generate real-world effects that can be as simple as sharing information or can involve performing a function as part of a complex process or changing the state of other related processes

/rec/enterpriseviewpoint/capabilities	Service capabilities shall be specified as a list of the functionalities offered by the service and their corresponding real world effect.

NOTE 3 The capabilities can be described as a list of different capabilities and the real world effects provided by the service. Capabilities generate real-world effects that can be as simple as sharing information or can involve performing a function as part of a complex process or changing the state of other related processes.

/req/enterpriseviewpoint/community	Service community shall be described as a textual paragraph stating roles of potential actors involved in using the service

The roles should be described in terms of the high level provisioning and use of capabilities with data exchanges between the user/consumer roles and the role of the service.

/rec/enterpriseviewpoint/scenarios	Service usage may be specified through a process diagram (i.e. BPMN and/or UML use cases) to show service usage in the context of a possible usage process.

This is a description of relevant usage scenarios. These scenarios represent the conceptual model for the use of the interfaces/operations provided by the service.

The scenarios are used to describe a typical usage of the service from an enterprise viewpoint. The scenarios should describe the primary flow. If the scenarios have alternative flows, these should also be documented.

Simple alternative flows can be documented in text within the primary flow. Complex alternative flows should be described separately.

The scenarios could be described as a sequence of steps, but it is recommended that diagrams be utilized to augment the narrative description of each business scenario. The use of BPMN and/or UML use case diagrams/templates is recommended.

Scenarios will better describe the service than explanatory text, since they are illustrations of the role the service is envisioned to play. This should be done for representative scenarios and it does not need to be exhaustive.

The scenarios can also be related to test cases that describe the specific functions and objectives for validating usage of a service. Specific actions are identified and might be measured against expected testing results and outcomes.

Specifications of Quality of Service (QoS) can be useful to associate with service descriptions. For this purpose, there is a recommendation to use the "UML Profile for Modeling Quality of Service and Fault Tolerance Characteristics and Mechanisms (QFTP) [QoS].

7.3 Examples of relevant standards

— Business Process Model and Notation (BPMN). This a standard from OMG that is used for the purpose of both enterprise and business-oriented modelling, as well as for technology mapping to process execution with technologies, such as BPEL.

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— Use cases (UML). Use cases with use case templates[5] have been the most used form for documentation of typical user needs for system and services functionality, within the geographic information community. The UML standard provides only a graphical form for diagramming of use cases, while the geographic information community typically has adopted various forms of use case templates for the technical documentation of use cases.

— Agile requirements engineering with user stories. The software engineering community has recently evolved a set of approaches around agile methods that focuses on close interactions between potential system users and developers, and focuses on more light-weight user stories as input to a system development backlog. A user story can be expanded further into a use case.

— Business Motivation Metamodel (BMM) (http://www.omg.org/spec/BMM/). This is a standard from OMG that provides a foundation for modelling of vision, goals and objectives for an enterprise, with mappings to tactics for solutions including use of processes and services.

— UML4ODP Enterprise specification profile (ISO/IEC 19793). This standard provides a UML profile for all of the main concepts defined in the RM-ODP enterprise viewpoints. It is a good reference and foundation for doing full RM-ODP enterprise viewpoint modelling but in the geographic information community, it has so far been a preference to use a more light weight approach with BPMN and/or Use cases. See example in Reference [41].

7.4 Example and tools

Annex D provides an example of a use case-based methodology for the identification of needed resources in a geographic information service context, with an example use case template in Annex E including both data and service resources.

To illustrate service specifications for the various viewpoints, some elements of examples will be related to parts of ISO 19123 and a Sensor Planning Service and in particular, the GetCapabilities operation used in both WMS and WFS.

8 Computational viewpoint: A basis for service interfaces and chaining

8.1 Component and service interoperability and the computational viewpoint

The computational viewpoint is concerned with describing the entities of a distributed system independent of implementation and semantic content. It describes the interaction patterns between the entities and their interfaces. To be able to interoperate from the computational viewpoints, two systems should be *interface-and-services-interoperable*. Two systems are interface-and-services-interoperable if they agree on the set of services offered by the entities of the two systems and the interfaces to these entities. If standardized interfaces are defined, the entities of one system will be able to request services from entities in another system.

Clause 8 provides the following:

— defines the concepts of services, interfaces and operations and the relations between these concepts;

— provides an approach to physical distribution of services using an n-tier architecture;

— defines a model for combining services in a dependent series to achieve larger tasks, e.g. service chaining;

— defines a service metadata model to support service discovery through a service catalogue.

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8.2 Services, interfaces and operations

Definitions and relationships of several terms are provided in 8.2. The following terms are used extensively in this International Standard:

— service: distinct part of the functionality that is provided by an entity through interfaces;

— interface: named set of operations that characterize the behaviour of an entity;

— operation: specification of a transformation or query that an object may be called to execute. It has a name and a list of parameters.

These terms are related to each other as depicted in Figure 3, which shows that services are specified by a set of interfaces that are a set of operations. Interfaces are implemented as ports that make services available to users.

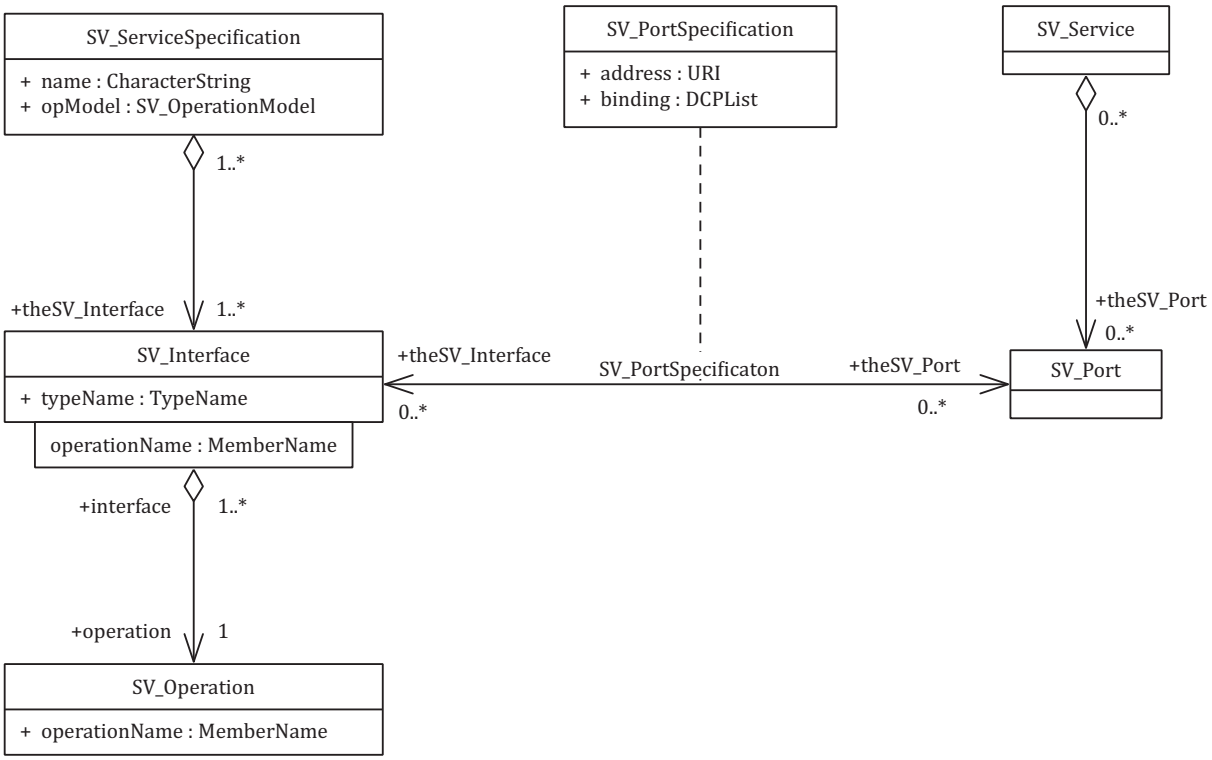

Figure 3 — Service definition relationships

The aggregation of interfaces in a service is for the purpose of defining functionality of value to the users. Users in this context are either software agents or human users. A service provides functionality that adds value. The value is apparent to the user who invoked the service.

The aggregation of operations in an interface and the definition of interface are defined for the purpose of software reusability. Interfaces are defined in order to be reusable for multiple service types. The syntax of an interface may be reused with multiple services with different semantics.

Services of multiple types may be aggregated. The service types are defined consistent with the service taxonomy described in Clause 10. When a service provides functionality beyond that of a single category in the service taxonomy, it will be an aggregate service. Service chaining results in aggregate services as defined in 8.4.

Interfaces are abstract specifications separate from the concrete deployment or data format bindings. The specification of an interface includes a static portion that includes definition of the operations. The

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specification of an interface includes a dynamic portion that includes any restrictions on the order of invoking the operations.

An implementation of an interface is a port. The implementation includes implementation of the platform-specific specification and a method to identify the service, e.g. an address.

An implementation of a service may be associated with a specific dataset or it may be a service that can be used to operate on multiple, unspecified datasets. The first case is referred to as a tightly coupled service while the second case is referred to as a loosely coupled service (see 8.4.1).

Interfaces are defined through operations. An operation specifies a transformation on the state of the target object or a query that returns a value to the caller of the operation. An operation shall be an abstract description of an action supported by the interface. Operations contain parameters.

The computational viewpoint is concerned with the interaction patterns between the components (services) of the system, described through their interfaces. A computational specification of a service is a model of the service interface seen from a client and the potential set of other services that this service requires to have available, with the interacting services described as sources and sinks of information. In the context of multi style SOA, the service specification might also include signals (events) that are generated or received and support both synchronous and asynchronous interactions and both RPC oriented and document-oriented/RESTful styles of interaction. The computational viewpoint is the core viewpoint for the identification of interfaces and services.

8.3 Computational viewpoint service specifications

8.3.1 Requirements class for computational viewpoint service specifications

The requirements for creating the service specification part for the computational viewpoint are formalized as a requirements class summarized in Table 13.

Table 13 — Requirements class for Computational viewpoint service specifications

Requirements class	**/req/computationalviewpoint**
Target type	UML service model
Dependency	ISO 19103 (Conceptual schema language) ISO 19115-1 (Metadata)
Requirement	/req/computationalviewpoint/interfaces
Requirement	/req/computationalviewpoint/operations
Recommendation	/rec/computationalviewpoint/behaviour
Recommendation	/rec/computationalviewpoint/pre_and_post_conditions
Requirement	/req/computationalviewpoint/servicechaining
Requirement	/req/computationalviewpoint/servicemetadata
Recommendation	/rec/computationalviewpoint/servicechaining

8.3.2 Service interfaces with operations

/req/computationalviewpoint/interfaces	Services shall be described in a platform neutral way using abstract interfaces for simple one way interfaces and <<Service Interface>> for more complex multi-way interfaces. Interfaces for a service can be categorised as mandatory or optional.

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These two approaches to specifying a service can be described as follows.

— Simple Interfaces: The simple interface focuses attention on a one-way interaction provided by a participant on a port represented as a UML interface. The participant receives operations on this port and may provide results to the caller. This kind of one-way interface can be used with "anonymous" callers and the participant makes no assumptions about the caller or the choreography of the service. The one-way service corresponds most directly to simpler "RPC style web services", as well as many object-oriented programming language objects. Simple interfaces are often used to expose the "raw" capability of existing systems or to define simpler services that have no protocols. Simple interfaces are the degenerate case of the ServiceInterface where the service is unidirectional (the consumer calls operations on the provider) the provider does not call back the consumer and may not even know who the consumer is. For the kind of interfaces that reflects two messages only to realize a request and reply interaction, there is no need to split this into a bi-directional service on the specification level, as the two-way interaction then is given by the patterns of the architectural style.

— ServiceInterface based: A ServiceInterface-based approach allows for bi-directional services, those where there are "callbacks" from the provider to the consumer as part of a conversation between the parties. A service interface is defined in terms of the provider of the service and specifies the interface that the provider offers, as well as the interface, if any, it expects from the consumer. The service interface may also specify the choreography of the service, what information is sent between the provider and consumer and in what order. A consumer of a service specifies the service interface they require using a request port. The provider and consumer interfaces should either be the same or compatible. If they are compatible, the provider can provide the service to that consumer. The consumer should adhere to the provider's service interface, but there may not be any prior agreement between the provider and consumer of a service. Compatibility of service interfaces determines whether these agreements are consistent and can therefore be connected to accomplish the real world effect of the service and any exchange in value. The ServiceInterface is the type of a "Service" port on a provider and the type of a "Request" port on the consumer. In summary, the consumer agrees to use the service as defined by its service interface and the provider agrees to provide the service according to its service interface. Compatibility of service interfaces determines whether these agreements are consistent and can therefore be connected. The ServiceInterface approach is most applicable where existing capabilities are directly exposed as services and then used in various ways or in situations that involve one or two parties in the service protocol.

/req/computationalviewpoint/operations	Operations in interfaces shall be described in a platform neutral way showing their input and output parameters (and exceptions).

Operations shall be specified as follows: for each operation (main action), describe the operation (action) name, operation (action) purpose and operation (action) input/outputs in terms of parameters, and further refined and described through the Information viewpoint. For the document/message centred document style, the input and output parameters shall be typed <<MessageTypes>>.

The SoaML standard also provides support for the specification of service contracts and service architectures, represented through UML collaborations, but the use of these is not required in this International Standard.

In an abstract interface, all operations are shown with their input and output parameter in a logical form, related to the definition in corresponding UML models described in the information viewpoint.

Experience has shown that most services are being specified with simple interfaces, where there is no complex two-way protocol between the user and the provider of a service. Sometimes, however, it is the case that more complex two-way interaction is needed. This International Standard is following the recommendation of SoaML to use specifications with standard UML interfaces for simple protocols and to make use of the service interface concept of SoaML only when more complex two-way protocols are needed.

Figure 4 gives an example of description of simple interfaces (source: OGC SOS 2.0).

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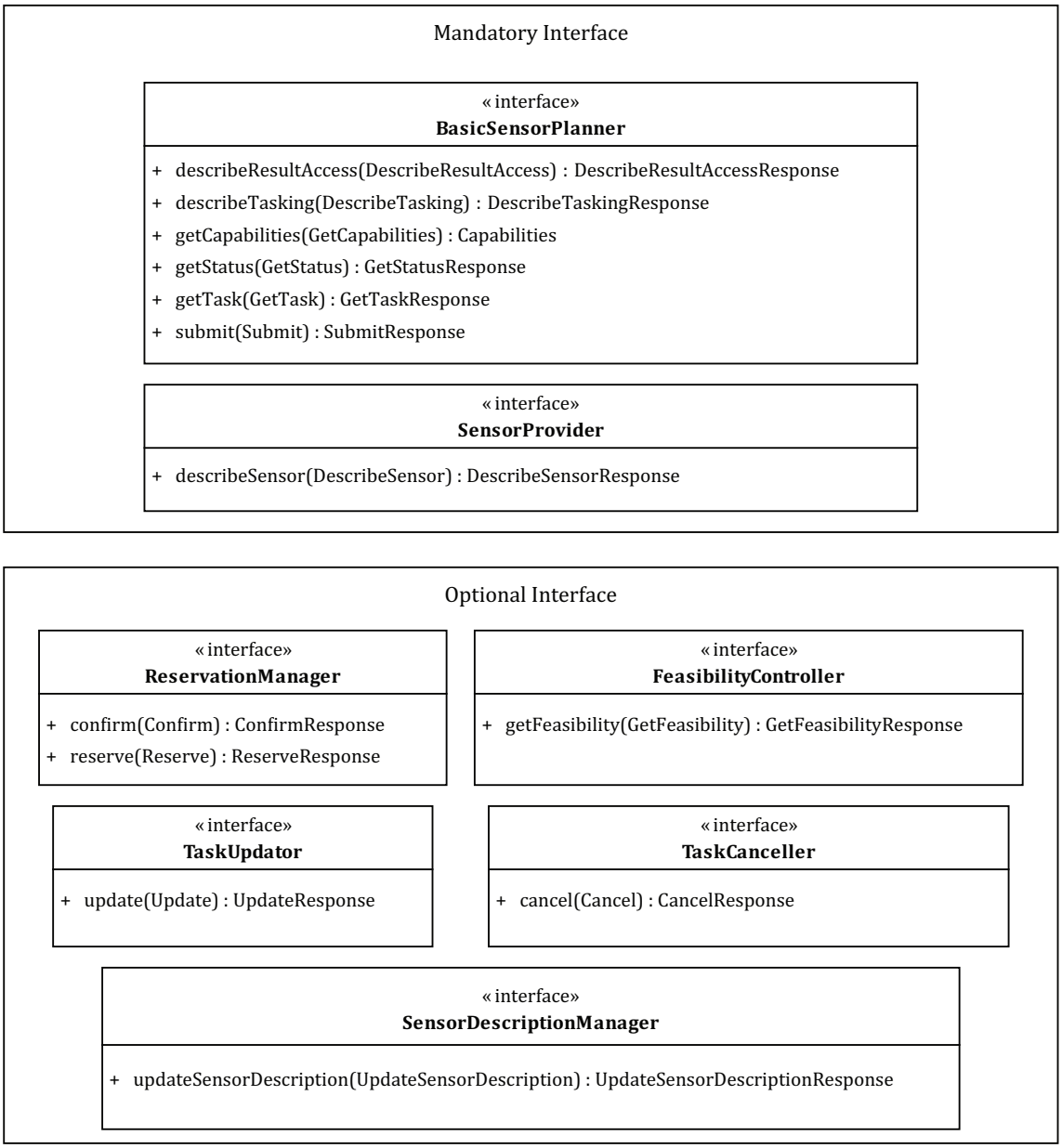

Figure 4 — Example of description of simple interfaces

EXAMPLE BasicSensor planner with operation *GetCapabilities*. This operation allows a client to request and receive service metadata documents that describe the capabilities of the specific server implementation. This operation also supports negotiation of the specification version being used for client-server interactions.

8.3.3 Service behaviour and constraints

/rec/computationalviewpoint/behaviour	The behaviour of services should be illustrated with UML sequence diagrams, showing possible sequence operations. The potential states and state transitions for a service should be illustrated with UML state diagrams.

Figure 5 gives an example on use of sequence diagram showing possible sequenced use of operations (source: OGC SPS).

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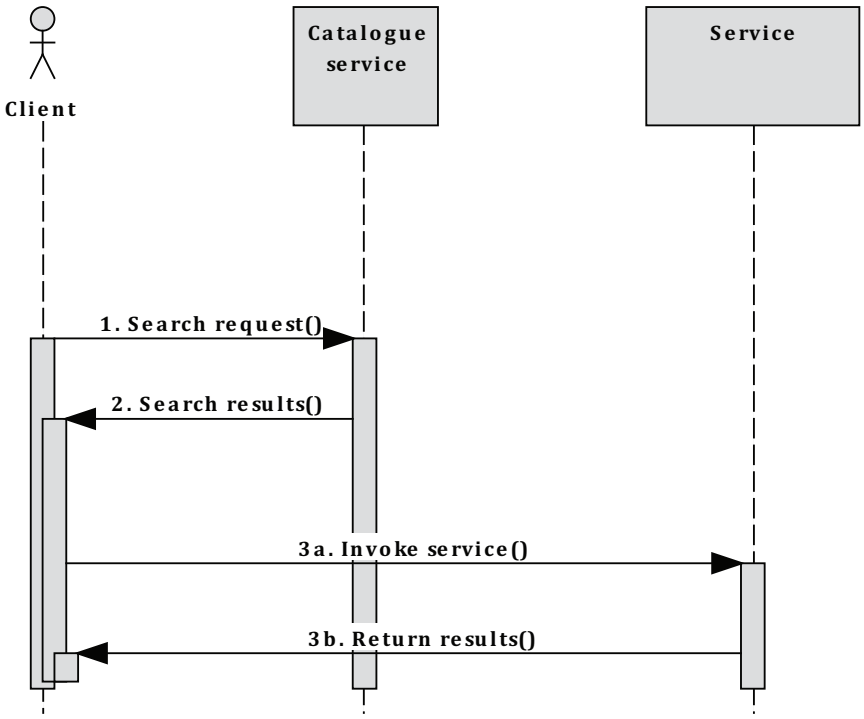

Figure 5 — Example of use of sequence diagram showing possible sequenced use of operations

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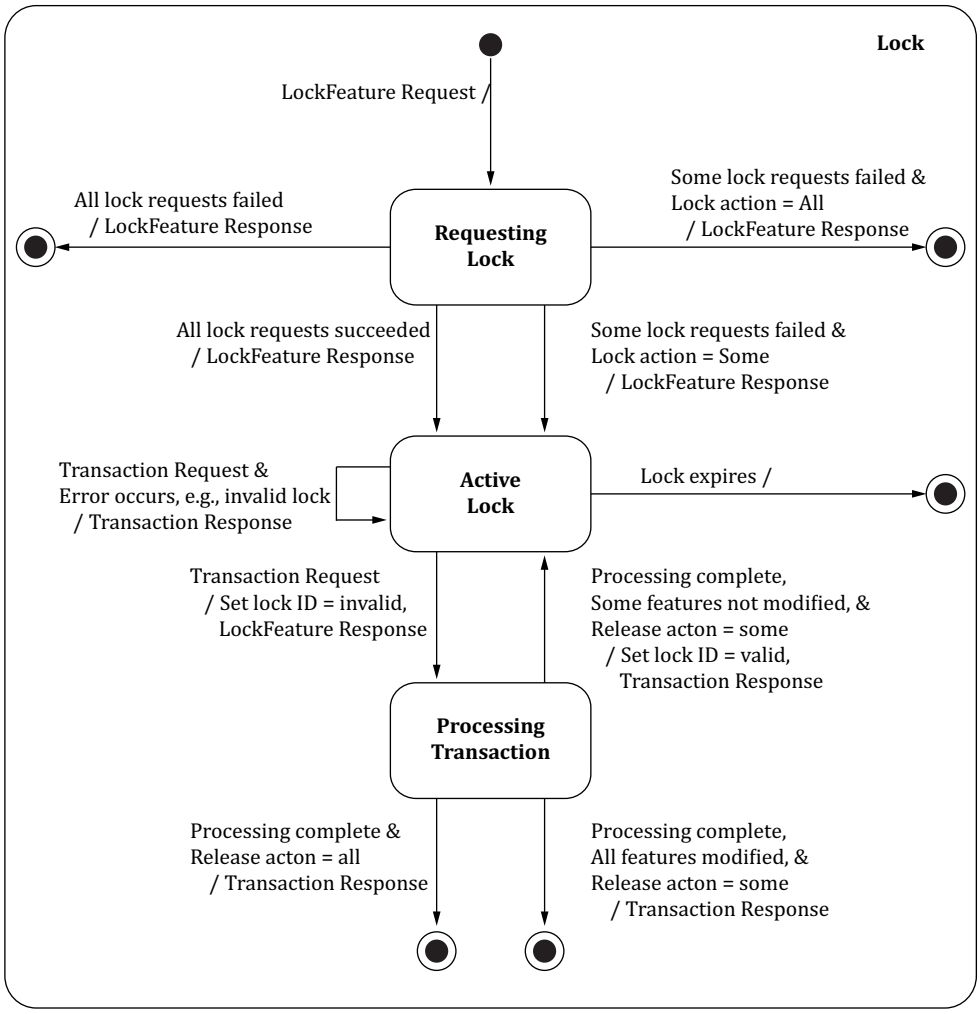

Figure 6 — Locking process during transaction

Figure 6 gives an example on a locking process during transaction (source: ISO 19142).

/rec/computationalviewpoint/ pre_and_post_conditions	The pre-conditions and post-conditions and invariants of an operation should be shown through expressions in OCL.

8.4 Service chaining

8.4.1 General

A model for combining services in a dependent series to perform complex tasks is defined in 8.4.

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The syntactic issues of service chaining, e.g. the data structure of a chain, is addressed in 8.4. Examples of service chaining are provided in Annex B.

/rec/computationalviewpoint/servicechaining	Possible composition/construction of services may be shown through service chaining. Review the data structure for a service chain and determine whether it is a directed graph. Determine whether the nodes of the service chains are services. An architecture should provide a means to make a chain extant and transferable between users and for users to evaluate the validity of a chain. An extant service chain is required for the translucent chaining pattern. If an architecture claims to implement the transparent chaining pattern, confirm that a human user is controlling the execution of the chain. If an architecture claims to implement the translucent chaining pattern, confirm that a service chain can be made extant separate from human users and that control of the chain execution is accomplished separate from human users. For the transparent chaining pattern, the architecture should provide the human user with mechanisms to determine services of value, e.g. a service catalogue or service organizer folder.

This International Standard enables users to combine data and services in ways that are not predefined by the data or service providers. This level of data/service interoperability will be achieved in stages. At first, service catalogues will hold entries with tight data/service binding. Eventually, the infrastructure will be available for a user to determine which data can be acted on by a loosely coupled service. This capability will be enabled by the infrastructure of the larger domain of IT.

8.4.2 Anatomy of a service chain

8.4.2.1 UML modelling of a chain

Figure 7 provides a UML model of a chain.

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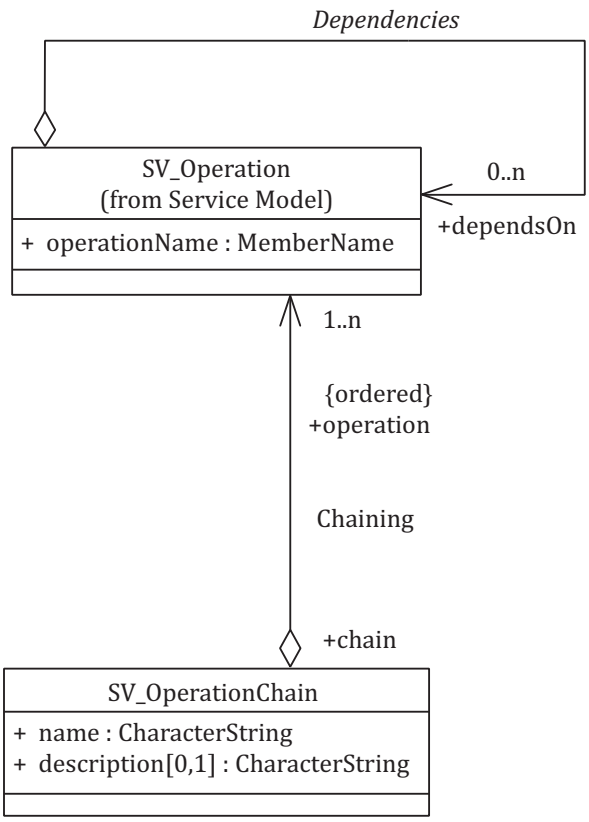

Figure 7 — Basic service chain

In accordance with ISO 19103, the modelling of directed graphs for service chains can be done using the Unified Modeling Language (UML) activity graphs. An activity graph represents the states of executing a service chain. Table 14 identifies the elements of an activity graph. A related approach is to use BPMN as a modelling language for service composition and orchestration. BPMN (see ISO/IEC 19510) has been developed with an explicit aim of being able to support web service composition in BPEL,[45] in addition to the aim of supporting business process modelling from a user point of view.

Table 14 — UML Activity Graph entities

Element of an UML activity graph	Description for service chaining
Activity State	State that represents the execution of a service, typically triggered by the invocation of an operation.
Transition	Relationship between two states. A transition indicates that specified Actions are performed in the first state and the second state is entered when a specified Event occurs and specified Guard Conditions are satisfied.
Branch/Merge	Beginning/end of alternative threads in an activity graph.
Fork/Join	Beginning/end of concurrent threads in an activity graph.
Signal	Asynchronous communication between services intended to trigger transitions in an activity graph.

8.4.3 Service chain modelling

8.4.3.1 Chains as directed graphs

A directed graph is a set of nodes connected by edges, where a direction is associated with each edge.

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