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Version anglaise EN ISO 19119:2006 + A1:2011

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Nationales Vorwort

Dieses Dokument (EN ISO 19119:2006 + A1:2011) enthält den Text von ISO 19119:2005 einschließlich Amd. 1:2008, die vom Technischen Komitee ISO/TC 211 „Geographic information/Geomatics“ erarbeitet und als EN ISO 19119:2006 und EN ISO 19119:2006/A1:2011 vom Technischen Komitee CEN/TC 287 „Geoinformation“ übernommen wurden, dessen Sekretariat vom NEN (Niederlande) gehalten wird.

Der für die deutsche Mitarbeit zuständige Arbeitsausschuss im DIN Deutsches Institut für Normung e. V. ist der als Spiegelausschuss zum CEN/TC 287 und ISO/TC 211 eingesetzte Arbeitsausschuss NA 005-03-03 AA „Kartographie und Geoinformation“ des Normenausschusses Bauwesen (NABau).

Das Präsidium des DIN hat mit seinem Beschluss 1/2004 festgelegt, dass von dem in den Regeln der europäischen Normungsarbeit von CEN/CENELEC verankerten Grundsatz, wonach Europäische Normen in den drei offiziellen Sprachen Deutsch, Englisch und Französisch veröffentlicht werden, in begründeten Ausnahmefällen abgewichen und auf die deutsche Sprachfassung verzichtet werden kann.

Die Genehmigung dafür hat die DIN-Geschäftsleitung entsprechend ihren in Anlage 1 zu dem DIN-Rundschreiben A 5/2004 festgelegten Kriterien für die vorliegende Norm auf Antrag des NABau-FB 03 „Vermessungswesen; Geoinformation“ erteilt.

Der Beginn und das Ende eines Textes, der durch die Änderung eingefügt oder geändert wurde, wird im Text durch die Markierungen   angezeigt.

Allgemeines

DIN EN ISO 19119 spezifiziert eine Architektur für geographische Dienste, auf deren Basis die koordinierte Entwicklung spezifischer geographischer Dienste ermöglicht wird. Dabei werden vorrangig die folgenden Punkte adressiert:

- Zugriff auf geographische Daten über standardisierte Schnittstellen;
- Spezifikation eines abstrakten Modells für Dienste;
- Spezifikation eines Modells für die Verkettung von Diensten;
- Spezifikation eines Modells für Metadaten über Dienste, um Kataloge für Dienste entwickeln zu können;
- Trennung von Daten- und Dienstinstanzen.

Das abstrakte Rahmenwerk von DIN EN ISO 19119 dient insbesondere dazu, Dienste und Dienstarchitekturen plattformunabhängig zu beschreiben und legt fest, wie diese Beschreibungen in unterschiedliche plattformabhängige Zielumgebungen übertragen werden können.

Im Hinblick auf die semantische Interoperabilität wird eine Taxonomie für geographische Dienste festgelegt, um Dienste vor dem Hintergrund der Katalogisierung und der Verknüpfung innerhalb von Diensteketten eindeutig kategorisieren zu können.

Änderungen

Gegenüber DIN EN ISO 19119:2006-09 wurden folgende Änderungen vorgenommen:

- a) Änderung EN ISO 19119:2006/A1:2011 eingearbeitet;
- b) Abschnitt 7.4.1, vorletzten Absatz ergänzt; Bild 8 und Bild 9 ersetzt;
- c) Zeilen in Tabelle C.1 ergänzt;
- d) Abschnitt C.2.4 gelöscht;
- e) neue Abschnitte C.2.7 C.2.8 und C.2.9 ergänzt.

Frühere Ausgaben

DIN EN ISO 19119: 2006-09

Nationaler Anhang NA (informativ)

Englisch-deutsche Fachwörterliste

Service	Dienst Komponente, die ihre Funktionen über Schnittstellen bereitstellt
Interface	Schnittstelle Anzahl von Operationen, die in ihrer Gesamtheit das Verhalten einer Komponente festlegen
Operation	Operation Spezifikation einer Anforderung, die eine Komponente ausführen soll/kann
Service chain	Dienstekette Kette von Diensten, bei der für jedes Paar von Diensten die Ausführung des ersten Gliedes Voraussetzung für die Ausführung des nachfolgenden Gliedes ist
Workflow	Arbeitsablauf Automatisierung eines Geschäftsprozesses (ganz oder teilweise), in dessen Zuge Dokumente, Informationen oder Aufgaben zwischen Akteuren vor dem Hintergrund festgelegter Regeln ausgetauscht werden
Service metadata	Dienst Metadaten Metadaten, die eine Instanz eines Dienstes beschreiben

English Version

**Geographic information —
Services
(ISO 19119:2005 + AMD 1:2008)**

Information géographique —
Services
(ISO 19119:2005 + AMD 1:2008)

Geoinformation —
Dienste
(ISO 19119:2005 + AMD 1:2008)

This European Standard was approved by CEN on 19 May 2006.

This amendment A1 modifies the European Standard EN ISO 19119:2006, it was approved by CEN on 17 April 2011.

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Foreword

The text of ISO 19119:2005 has been prepared by Technical Committee ISO/TC 211 "Geographic information/Geomatics" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 19119:2006 by Technical Committee CEN/TC 287 "Geographic Information", the secretariat of which is held by NEN.

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 December 2006, and conflicting national standards shall be withdrawn at the latest by December 2006.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Endorsement notice

The text of ISO 19119:2005 has been approved by CEN as EN ISO 19119:2006 without any modifications.

Foreword of A1

The text of ISO 19119:2005/Amd. 1:2008 from Technical Committee ISO/TC 211 "Geographic information/Geomatics" of the International Organization for Standardization (ISO) has been taken over by Technical Committee CEN/TC 287 "Geographic Information" the secretariat of which is held by BSI.

This Amendment to the European Standard EN ISO 19119:2006 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2011, and conflicting national standards shall be withdrawn at the latest by November 2011.

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.

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Endorsement notice

The text of ISO 19119:2005/Amd. 1:2008 has been approved by CEN as a EN ISO 19119:2006/A1:2011 without any modification.

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 is 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), 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 developers to create software that enables users to access and process geographic data from a variety of sources across a generic computing interface within an open information technology environment.

- “a framework for developers” means that this International Standard is based on a comprehensive, common (i.e. formed by consensus for general use) plan for interoperable geoprocessing;
- “access and process” 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.

1 Scope

The scope of this International Standard is as follows:

Identification and definition of the architecture patterns for service interfaces used for geographic information and definition of the relationships to the Open Systems Environment model.

This International Standard presents a geographic services taxonomy and a list of example geographic services placed in the services taxonomy.

This International Standard prescribes how to create a platform-neutral service specification, and how to derive platform-specific service specifications that are conformant with this.

This International Standard provides guidelines for the selection and specification of geographic services from both platform-neutral and platform-specific perspectives.

2 Conformance

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

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

3 Normative references

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

ISO/IEC 10746-1:1998, *Information technology — Open Distributed Processing — Reference model: Overview — Part 1*

ISO/IEC 10746-2:1996, *Information technology — Open Distributed Processing — Reference model: Foundations*

ISO/IEC TR 14252:1996, *Information technology — Guide to the POSIX Open System Environment (OSE)*

ISO/TS 19103: —¹⁾, *Geographic information — Conceptual schema language*

ISO 19115:2003, *Geographic information — Metadata*

1) To be published.

4 Terms and definitions

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

4.1

service

distinct part of the functionality that is provided by an entity through **interfaces** (4.2)

[adapted from ISO/IEC TR 14252]

NOTE See 7.2 for a discussion of service.

4.2

interface

named set of **operations** (4.3) that characterize the behaviour of an entity

NOTE See 7.2 for a discussion of interface.

4.3

operation

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

NOTE 1 An operation has a name and a list of parameters.

NOTE 2 See 7.2 for a discussion of operation.

4.4

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

[ISO/IEC 2382-1]

4.5

service chain

sequence of **services** (4.1) where, for each adjacent pair of services, occurrence of the first action is necessary for the occurrence of the second action

4.6

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

4.7

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

[ISO/IEC 10746-2]

4.8

enterprise viewpoint

viewpoint (4.7) on an ODP system and its environment that focuses on the purpose, scope and policies for that system

4.9

information viewpoint

viewpoint (4.7) on an ODP system and its environment that focuses on the semantics of information and information processing

4.10

computational viewpoint

viewpoint (4.7) on a system and its environment that enables distribution through functional decomposition of the system into objects which interact at **interfaces** (4.2)

4.11

engineering viewpoint

viewpoint (4.7) on an ODP system and its environment that focuses on the mechanisms and functions required to support distributed interaction between objects in the system

4.12

technology viewpoint

viewpoint (4.7) on an ODP system and its environment that focuses on the choice of technology in that system

4.13

distribution transparency

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

[ISO/IEC 10746-2]

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

5 Abbreviated terms

ADO	ActiveX Data Objects
API	Application Programming Interface
CCM	Client Configuration Manager
COM	Component Object Model
CORBA	Common Object Request Broker Architecture
CICS	Customer Information Control System
DAG	Directed Acyclic Graph
DCOM	Distributed Component Object Model
DCP	Distributed Computing Platform
DEM	Digital Elevation Model
DNA	Distributed interNet Applications
EDOC	Enterprise Distributed Object Computing
DTD	Document type definitions
EJB	Enterprise Java Beans
EOSE	Extended Open Systems Environment Model
ERP	Enterprise Resource Planning
GIOP	General Inter-ORB Protocol
GUI	Graphic User Interface
HIS	Information Technology Human Interaction Service
HTI	Human Technology Interface
HTML	Hypertext Markup language
HTTP	Hypertext Transfer Protocol
IDL	Interface Definition Language
IOP	Internet Inter-ORB Protocol
IIS	Internet Information Server

IT	Information Technology
J2EE	Java 2 Enterprise Edition with EJB
JDBC	Java Data Base Connectivity
JSP	Java Server Pages
JINI	Sun's open architecture that enables developers to create network-centric services
JNDI	Java Naming and Directory Interface
JTA	Java Connector Architecture
JTS	Java Transaction Service
MAPI	Messaging Application Programming Interface
MS MTS	Microsoft Transaction Server
MSMQ	Microsoft Message Queuing
MTS	Microsoft Transaction Server
OCL	Object Constraint Language
ODBC	Open Database Connectivity
ODMG	Object Database Management Group
ODP	Open Distributed Processing (see RM-ODP)
OGC	Open GIS Consortium
OMG	Object Management Group
OODB	Object-oriented database
ORB	Object Request Broker
OSE	Open Systems Environment
RMI	Remote Method Invocation
RM-ODP	Reference Model of Open Distributed Processing (ISO/IEC 10746)
RPC	Remote Procedure Call
SDAI	Standard Data Access Interface (ISO 10303-22)
SOAP	Simple Object Access Protocol
SOF	Service Organizer Folder
SQL	Structured Query Language
UML	Unified Modelling Language
URI	Uniform Resource Identifier
XML	Extensible Markup Language
XML RDF	XML Resource Description Framework
XSLT	XML Stylesheet Language Transformations

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 proprietary products, standardization of the interfaces to those services allows interoperability between proprietary products. Geographic information system and software developers will use these standards 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.

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.

This International Standard extends the architectural reference model defined in ISO 19101, in which an Extended Open Systems Environment (EOSE) model for geographic services is defined.

6.2 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; see ISO/IEC 10746. 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 1 shows how the RM-ODP viewpoints are utilized in this International Standard.

Table 1 — Use of RM-ODP viewpoints in this International Standard

Viewpoint Name	Definition of RM-ODP Viewpoint (ISO/IEC 10746-1:1998)	How viewpoint is addressed in this International Standard
enterprise viewpoint	a viewpoint on an ODP system and its environment that focuses on the purpose, scope and policies for that system	This is available in other parts of the ISO 19100 series of standards, e.g., reference model (ISO 19101).
computational viewpoint	a viewpoint on an ODP system and its environment that enables distribution through functional decomposition of the system into objects which interact at interfaces	See Clause 7, computational viewpoint.
information viewpoint	a viewpoint on an ODP system and its environment that focuses on the semantics of information and information processing	See Clause 8, information viewpoint.
engineering viewpoint	a viewpoint on an ODP system and its environment that focuses on the mechanisms and functions required to support distributed interaction between objects in the system	See Clause 9, engineering viewpoint.
technology viewpoint	a viewpoint on an ODP system and its environment that focuses on the choice of technology in that system	See Clause 10 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 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.

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 an ODP 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 an ODP system defines a networked computing infrastructure that supports the system structure defined in the computational specification and provides the distribution transparencies that it defines. ODP 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 the ODP 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 SQL-3/ODBC, ODMG, CORBA, DCOM/OLE, Internet or similar technology.

6.3 Service abstraction

This International Standard defines the approach to defining services that shall be used in the ISO 19100 series of standards. 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. A SV_PlatformNeutralServiceSpecification provides the abstract definition of a specific type of service but does not specify the implementation of the service. Service types are given in the geographic service taxonomy in 8.3. SV_PlatformSpecificServiceSpecification defines the implementation of a specific type of service. There may be multiple platform-specific specifications for a single platform-neutral specification. SV_Service is an implementation of a service. The requirements for these specifications are addressed in this International Standard, in particular in Clause 10.

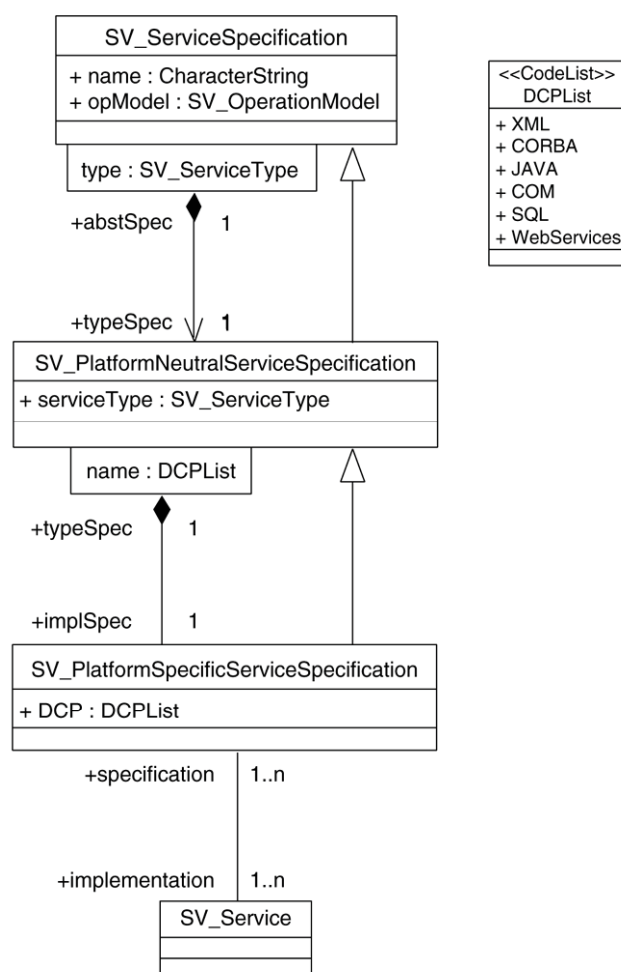


Figure 1 — Abstract and implementation service specifications

6.4 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 X and Y (see Figure 2) can interoperate (are interoperable) if X can send requests R for services to Y, based on a mutual understanding of R by X and Y, and if Y can similarly return mutually understandable responses S to X.

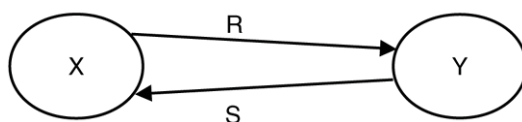


Figure 2 — Interoperability

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 1) 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 2) cooperatively, over networks, run software capable of manipulating such information.

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 assures that there is a technical connection, i.e. that the data can be transferred between systems. Semantic interoperability assures that the content is understood in the same way in both systems, including by those humans interacting with the systems in a given context.

6.5 Use of other geographic information standards in service specifications

A service specification shall include relevant information models from the appropriate geographic information standards in the ISO 19100 series. The corresponding UML models shall be used in the definition of the service interfaces as appropriate.

6.6 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, may use design patterns but this level of detail is outside the scope of this International Standard.

The Table 2 provides a listing of the elements of a pattern. When specific architecture patterns are defined in this International Standard, these elements shall be used.

Table 2 — 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. Nicknames 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.
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 must be weighed to reach the best solution. Forces define the kinds of trade-offs that must 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.

7 Computational viewpoint: A basis for service chaining

7.1 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 must 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.

The computational viewpoint clause 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.

7.2 Services, interfaces and operations

Definitions and relationships of several terms are provided in this subclause. These 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.

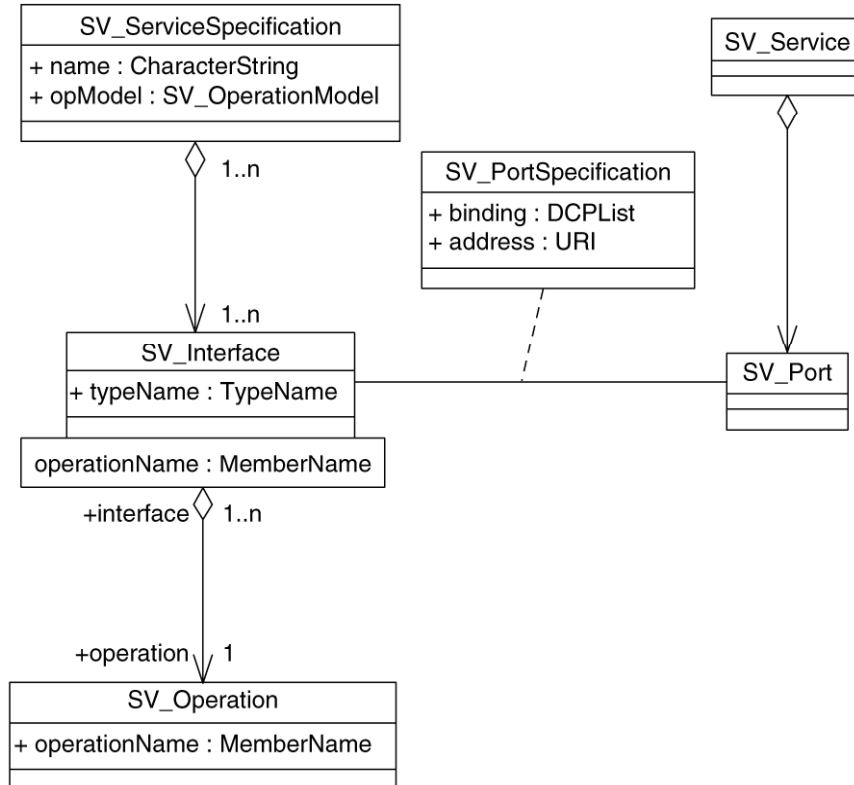


Figure 3 — Service definition relationships

The aggregation of interfaces in a service shall be 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, shall be for the purpose of software reusability. Interfaces shall be 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 shall be defined consistent with the service taxonomy of 8.3. When a service provides functionally beyond that of a single category in the service taxonomy, it shall be an aggregate service. Services' chaining results in aggregate services as defined in 7.3.5.

Interfaces are abstract specifications separate from the concrete deployment or data format bindings. The specification of an interface shall include a static portion that includes definition of the operations. The specification of an interface shall include 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. The second case is referred to as a loosely coupled service (see 7.4.1).

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.

7.3 Service chaining

7.3.1 Introduction to service chaining

Subclause 7.3 defines a model for combining services in a dependent series to achieve larger tasks. Subclause 7.3 addresses the syntactic issues of service chaining, e.g. the data structure of a chain. Semantic issues associated with service chaining are addressed in 8.6, e.g.: does a specific chain produce a valid result? Examples of service chaining are provided in Annex B.

This International Standard enables users to combine data and services in ways that are not pre-defined 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.

Based on the ODP definition of chain, a service chain is defined as a sequence of services where, for each adjacent pair of services, occurrence of the first action is necessary for the occurrence of the second action.

7.3.2 Anatomy of a service chain

7.3.2.1 Chains as directed graphs

The action of making the input of one service dependent upon another service leads to treating service chains as directed graphs, where each service is a node in the graph and references to service interactions form the edges. In some cases, the directed graph structure is implicit. In other cases, it is necessary to make the notion of a processing graph explicit and allow such graphs to be considered as entities in their own right. Explicit representation of a service chain allows the chain to be visually represented and passed to a chain-execution service, e.g. workflow service.

A node in the directed graph is a representation of the service. When explicitly formed into a data structure, a service node contains two types of information: parameters and sources. Parameters in a service node provide the configurations of the service for the particular chain in which the service class is being used. Sources in a service node indicate the sources of input data to the node.

The arcs of a directed graph representing a service chain can be of several types. These types of arcs are detailed below as service interactions.

A key aspect of a directed graph is whether it is cyclic or acyclic. The case of directed graphs without loops, i.e. acyclic, is simpler. In some applications, an iterative approach is needed; therefore, the chain will be cyclic with conditions in the control function to address convergence.

Chains can be considered templates or as immutable graphs. A template is a directed graph that defines the chain based on abstract classes, including identification of each service type. A template can be instantiated as an immutable graph, at which time the service instances are fixed.

The following are additional elements characterizing a service chain:

- parallel vs. serial chains: Does the directed graph have parallel paths based on branches or are only serial chains permitted? Potential branch types include: if/else, merge, switch and trigger.
- iteration: Does a node in the directed graph operate as an iteration, e.g. while and count loops?
- data transport types: Does the directed graph allow variations in the links between nodes reflecting different methods for transporting data or invoking the service?
- parameters in nodes: Do the description of nodes in the directed graph contain parameters that can be changed?
- variations in control design pattern: Pull processing vs. push processing.

7.3.2.2 UML modelling of a chain

Figure 4 provides a UML model of a chain.

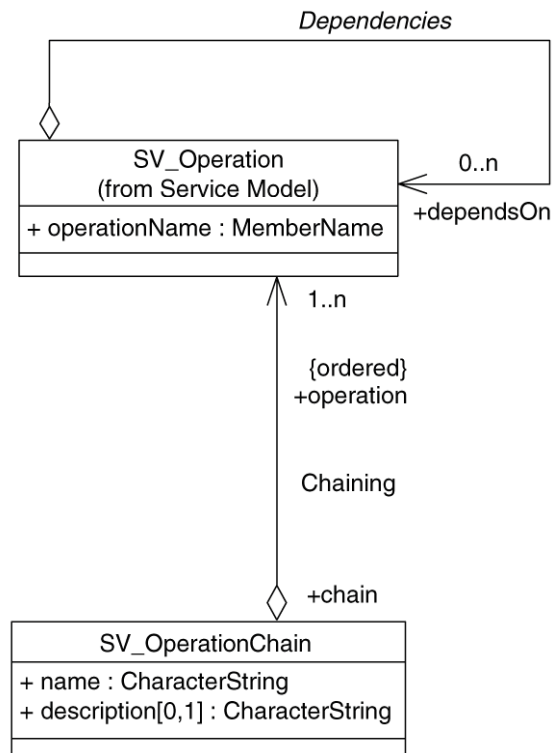


Figure 4 — Chain

In accordance with ISO/TS 19103, the modelling of directed graphs for service chains shall be done using the Unified Modeling Language (UML) activity graphs. An activity graph represents the states of executing a service chain. Table 3 identifies the elements of an activity graph.

Table 3 — UML Activity Graph entities

Element of an UML activity graph	Description for service chaining
Activity State	a state that represents the execution of a service, typically triggered by the invocation of an operation
Transition	a 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	the beginning/end of alternative threads in an activity graph
Fork/Join	the beginning/end of concurrent threads in an activity graph
Signal	an asynchronous communication between services intended to trigger transitions in an activity graph

7.3.3 Services organizer folder

Services are of many types as indicated in 8.3. Only a subset of available services is applicable to a specific situation, e.g. image analysis. A service organizer folder (SOF) is an aid for users in finding services applicable to their situation. A user may construct an SOF and then make that SOF available to other users performing tasks in a similar situation.

A services organizer folder is a data structure that shall contain references to a set of services that are applicable to a given situation. The SOF need not contain service chains but may contain just individual services.

7.3.4 Services to enable service chaining

Table 4 provides a list of services that are needed to enable service chaining. These services are placed in the extended OSE framework. Details on the services can be found in Clause 8. Some of the services are generic to all IT domains. Other services are specific to geographic data and the large size of geographic data sets.

Table 4 — Services to enable service chaining

Services needed to enable service chaining		
OSE categories	Generic IT services	Geographic services
human interaction services	- service-centric service for defining, controlling and statusing service chains - catalogue-centric service that views and browses metadata about services	- catalogue-centric service that locates, browses, and manages metadata about spatial data - spatial-centric service for editing, displaying, querying, and analyzing map data - calculation-centric service allowing viewing and manipulation of geographic data using a spreadsheet format
workflow/task services	- workflow enactment service to define, invoke, status and control service chaining (interaction with other workflow services, optional) - service chain validation service - resource reservation and co-allocation mechanism for both storage system and other resources such as networks, to support the end-to-end performance guarantee required for predictable transfer	—
processing services	—	geographic processing services (see Clause 8)
model/Information management services	- service instance metadata catalogue, with discovery and management sub-services - service type registry, with discovery and management sub-services - brokering - mediation	- geographic dataset instance - geographic metadata catalogue with discovery, access and management sub-services
system management service	- authorization and authentication - payment methods - privacy of client - performance measurement and estimation techniques for key resources involved in data grid operation, including storage systems, networks, and computer - instrumentation services that enable the end-to-end instrumentation of storage transfer and other operation	—
communication services	- messaging mechanisms - large data object transfer - remote file and executable management: provides access to secondary storage as if it were local - format conversions	geographic format conversions

7.3.5 Architecture patterns for service chaining

7.3.5.1 Introduction

The remainder of this subclause provides architecture patterns for service chaining. The architecture patterns use the template provided in 6.6.

There are many options for the allocation of service chaining services to components. Different allocation approaches reflect different priorities for different applications: user in the loop vs. user supervision. To demonstrate the breadth of the trade space defined by this variation, three design patterns are offered that vary the allocation of the control function:

- user defined (transparent) chaining: the human user manages the workflow;
- workflow-managed (translucent) chaining: in which the human user invokes a workflow management service that controls the chain and the user is aware of the individual services;
- aggregate service (opaque): in which the user invokes a service that carries out the chain, with the user having no awareness of the individual services.

In addition to the difference in visibility of the services to the user, a key distinction between these patterns is the difference in control. In transparent chaining, the control is exclusively with the user. In translucent, a workflow service is present which controls the chain execution, perhaps with oversight by the human. In the aggregate pattern, the aggregate service exclusively performs the control function with no visibility by the user.

7.3.5.2 User-defined (transparent) chaining

7.3.5.2.1 Name

As the name implies, the user defines and controls the order of execution of the individual services. Details of the services are not hidden from the user; hence, the alias for this pattern is Transparent Chaining.

7.3.5.2.2 Problem

In this pattern, the user is knowledgeable about how services can be combined. The user discovers and evaluates the available services, determines their fitness to the need, determines a valid sequence of services and controls the chaining. This pattern presupposes a knowledgeable user. The user is provided information sufficient to make the control decisions.

7.3.5.2.3 Context

The user refers to a service catalogue in order to discover services of interest. A specific chain does not exist before the user begins. The user has the ability to define a valid chain and/or be able to modify the implied chain if there are failures in execution.

7.3.5.2.4 Forces

The user must be able to design an efficient chain that will execute. The inputs and outputs of the individual services must be compatible, or an intervening service must be added, e.g. format translation. These patterns assume that each service has sufficient resources to run efficiently, but the user may need to choose services based on network considerations, e.g. network bandwidth, security, authorization. The semantic correctness of the chain is judged by the user; issues such as when data is re-gridded in a chain will affect the validity of the results. A user may iterate a chain until an acceptable result is achieved, resulting in a chain that can be saved and used by others, perhaps using the workflow-chaining pattern.

7.3.5.2.5 Structure

The user-defined chaining architecture pattern is shown in Figure 5.

NOTE The unique feature of the transparent pattern is that the chain is defined and controlled by the user. In the figure, the user discovers an available service through a catalogue service. Alternatives for the user to select services are part of this pattern. For example, a service organizer folder could be substituted for the catalogue.

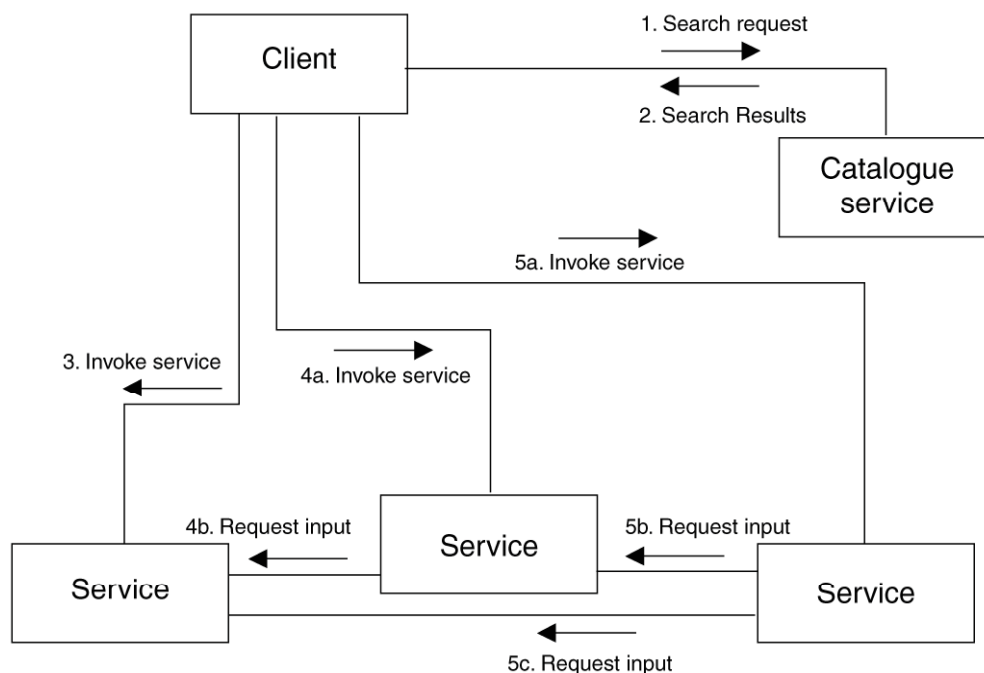


Figure 5 — Transparent chaining — user-defined chaining architecture pattern

Table 5 — Description of steps in Figure 5

Step 1. Search request	A human uses a client to send a search request (or series of searches) to a catalogue service. The catalogue service provides queries on service metadata.
Step 2. Search results	Catalogue service returns metadata about services of interest to the user. For this example, the user has found three services that will be chained.
Step 3. Invoke service	User invokes a service using the client, causing a result to be available for a subsequent service.
Step 4a. Invoke service step 4b. Request input	User invokes a second service using the client. The request includes a reference to the results from the previous step. The service creates a result that is available for the next service.
Step 5a. Invoke service Step 5b. Request input Step 5c. Request input	User invokes a third service using the client. The request includes references to the two previous services. This third service returns a result to the client.

7.3.5.3 Workflow-managed (translucent) chaining

7.3.5.3.1 Name

As the name implies, in this pattern the execution of the chain is managed by a workflow service (or multiple workflow services). The user's involvement in the steps of the chain is mostly one of watching the chain execute the individual services that are apparent to the user, hence the alias of translucent chaining. A key distinction for this pattern is the existence of a defined chain prior to the user executing the pattern.