SLOVENSKI STANDARD
SIST ENV 12160:1999

01-januar-1999

Geografske informacije - Opis podatkov - Prostorska shema

Geographic information - Data description - Spatial schema

Geoinformation - Datenbeschreibung - Raumbezugsschema

Information géographique - Description des données - Schéma spatial

Ta slovenski standard je istoveten z: **ENV 12160:1997**

ICS:

07.040	Astronomija. Geodezija. Geografija	Astronomy. Geodesy. Geography
35.240.70	Uporabniške rešitve IT v znanosti	IT applications in science

SIST ENV 12160:1999 **en**

EUROPEAN PRESTANDARD
PRÉNORME EUROPÉENNE
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ENV 12160

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ICS 07.040; 35.240.70

Descriptors: geographic information, languages, data, geometry, description

English version

Geographic information - Data description - Spatial schema

Information géographique - Description des données - Schéma spatial

Geoinformation - Datenbeschreibung - Raumbezugsschema

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This European Prestandard has been prepared by the Technical Committee CEN/TC 287 "Geographic Information" the secretariat of which is held by AFNOR.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this European Prestandard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This European Prestandard specifies the spatial schema which defines and describes the spatial aspects of the geographic data. The spatial aspects includes specialised structures, properties and associations for geometry and topology.

The components of the spatial schema are described in clause 6.

A basic spatial schema G0 is defined in 7.1 and predefined standard spatial schemas derived from G0 are defined in 7.3. Each schema is described using EXPRESS and represented using EXPRESS-G (the graphical notation of EXPRESS). The EXPRESS descriptions take precedence on the EXPRESS-G figures.

Clause 7.2 specifies the requirements to be met by the user defined spatial schemas (application schemas) to conform to this European Prestandard.

1 Scope

This European Prestandard establishes principles for describing spatial schemas which can be part of application schemas. These schemas can be used for defining, structuring, querying, updating, encoding, transforming and transferring geographic data.

The spatial schemas specify the constructs for the representation of geometry and topology of geographic objects. The constructs are defined in spatial schemas according to requirements from the applications.

1.1 Geometry

Within the scope of this European Prestandard are :

- definition of vector geometry, e.g. points, curves and surfaces ;
- definition of circular arc, B-spline and clothoid ;
- definition of raster geometry: grid, pixel, raster band, voxel, raster block.

The geometry can be defined in a plane cartesian reference system, a 3-dimensional cartesian reference system, geodetic coordinate systems or an astronomic reference.

Outside the scope of the first version of this European Prestandard are :

- full 3-dimensional vector surfaces and volumes, that can be considered in further extensions ;
- other types of linear functions than mentioned above.

1.2 Topology

Topology is represented by means of topological primitives and the relationships between them.

The definition of the topological primitives Node, Edge and Face is within the scope of this European Prestandard.

The 3-dimensional topological primitives are outside the scope of this European Prestandard.

2 Normative reference

This European Prestandard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to This European Prestandard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

ENV 12009	1997	Geographic information - Reference Model
prEN 12762	1997	Geographic information - Referencing - Position
ISO 10303-11	1994	Information automation systems - Product data representation and exchange - Part 11 : Description methods: The EXPRESS language reference manual

3 Definitions

For the purpose of This European Prestandard, the following definitions apply :

3.1 boundary : Closed 1-dimensional non-intersecting, either implicitly or explicitly, element.

3.2 connected node : Node related to one or more edges.

3.3 coordinates : Ordered set of two or three components of a reference system describing the spatial position of a point.

3.4 curve : Bounded continuous 1-dimensional geometric primitive.

3.5 edge : 1-dimensional topological primitive being an oriented connection between two terminating nodes, which may be the same.

3.6 explicit intersection : Two primitives explicitly intersect one each other when the two respective lists of coordinates have one or more repeated values between them. One primitive intersects explicitly itself when in its list of coordinates there are one or more repeated values.

3.7 face : 2-dimensional topological primitive.

3.8 frame : 2 or 3-dimensional regular tessellation of the space according to a specific local reference system.

3.9 geometric primitive : Description, partial or total, of the spatial aspects of an object by means of coordinates and mathematical functions.

3.10 geometry : Metric spatial aspects of Geographic Information.

3.11 grid : Point distribution defining a regular pattern, derived from the corners of the tessellation of a specific frame or a limited part of it.

3.12 implicit intersection : Two primitives implicitly intersect one each other when their respective interpolation methods applied to its respective lists of coordinates pass two or more times for exactly the same spatial position. One primitive intersects implicitly itself when its interpolation method is applied to its list of coordinates and passes two or more times through exactly the same spatial position.

3.13 intermediate node : Connected node coincident with an edge without terminating it.

3.14 isolated node : Node not related to any edge.

3.15 node : 0-dimensional topological primitive.

3.16 object : Single phenomenon existing in the real world.

3.17 pixel : 2-dimensional geometric primitive which is the unit in a specific 2-dimensional frame.

3.18 point : 0-dimensional geometric primitive.

3.19 raster band : 2-dimensional geometric primitive which is a limited rectangular part of a specific 2-dimensional frame.

3.20 raster block : 3-dimensional geometric primitive which is a limited part of a specific 3-dimensional frame.

3.21 ring : Ordered set of connected edges forming a 1-dimensional closed not intersecting, either implicitly or explicitly, element.

3.22 spatial view : Collection of geometric primitives and/or topological primitives conforming to a pre-defined spatial schema.

3.23 surface : Bounded continuous 2-dimensional geometric primitive.

3.24 terminating node : Connected node terminating an edge.

3.25 topological primitive : Description, partial or total, of the topological aspects of an object.

3.26 topology : Non-metric discrete spatial aspects of Geographic Information.

3.27 voxel : 3-dimensional geometric primitive which is the unit in a specific 3-dimensional frame.

4 Symbols and abbreviations

This European Prestandard does not define symbols or abbreviations.

NOTE : This European Prestandard uses the symbols defined in ISO 10303-11, annex D.

5 Context

5.1 Spatial schemas as parts of conceptual schemas

An application schema is a conceptual schema for a certain application. Whenever object types defined in an application schema have spatial characteristics, the representation of those characteristics is defined by a spatial schema. Such a spatial schema is an integrated part of the application schema.

This European Prestandard defines the constructs in spatial schemas.

NOTE : An application schema integrates other schemas in addition to the spatial schema: semantic schema, quality schema, direct positioning schema,...

This European Prestandard defines the possibilities which may be used for a given application area.

5.2 Description of the geometry and the topology of objects

Geometry covers the quantitative description, by means of coordinates and mathematical functions, of the spatial aspects of Geographic Information. Therefore, geometry is the only aspect of Geographic Information changing when a transformation of Geodetic Reference System or Coordinate System is performed.

The geometry is described by geometric primitives. Geometric primitives are based on coordinates and mathematical functions in a well-defined reference system.

EXAMPLE 1 : Point, curve and surface are types of geometric primitives.

Topology covers the qualitative discrete description of the spatial aspects of Geographic Information. Topology remains invariant if the space is deformed elastically and continuously, for example, when a transformation of Geodetic Reference System or Coordinate System is performed.

The topology of objects is described by topological primitives and the relationships established between them.

EXAMPLE 2 : Node, edge and face are types of topological primitives.

References between geometric primitives and topological primitives can be set up.

EXAMPLE 3 : A node might be located by referring to a point.

A certain object can be described by geometric primitives and/or topological primitives.

EXAMPLE 4 : An object can be described by geometric primitives only - e.g. spaghetti data - by topological primitives only - e.g. the air routes of an airline company - or by a combination.

One object can be described by zero to many geometric primitives and/or zero to many topological primitives. The primitives need not to be of the same type. An object need not be described by geometric primitives or by topological primitives.

NOTE 1 : The application schema with spatial schema describes the geometry and topology of objects at type level, as illustrated in figure 1.

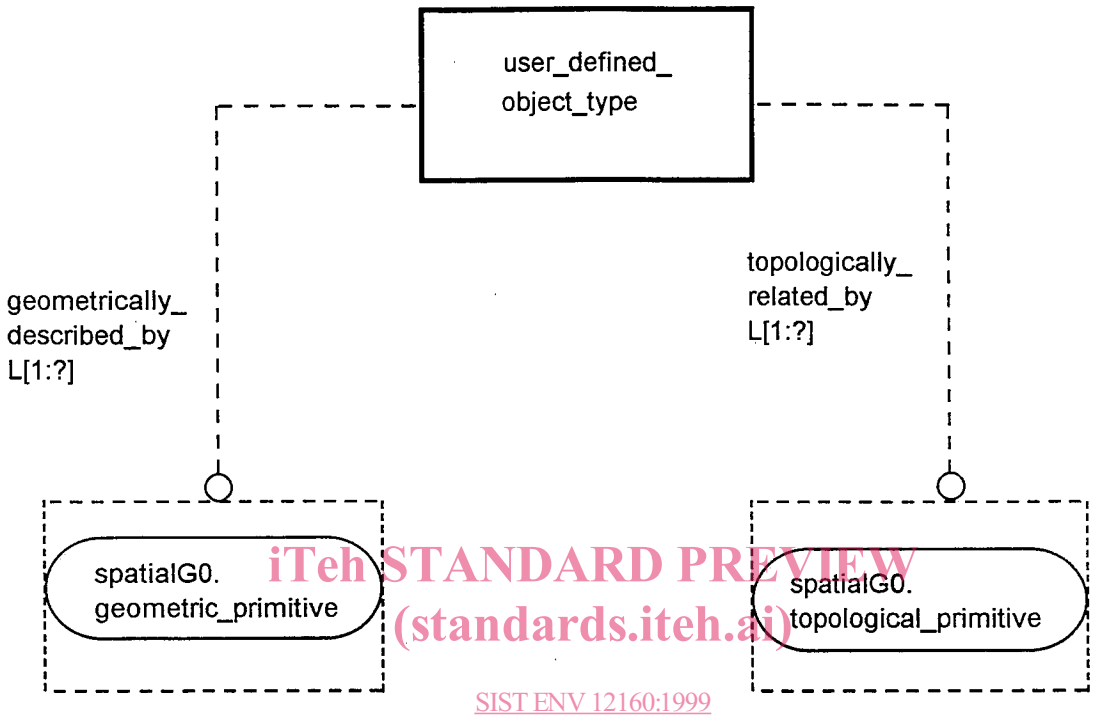

Figure 1 : Example of an application schema with representation of geometry and topology for objects of type user-defined object type

NOTE 2 : The application schema may define a relationship between an user-defined object type and any geometric primitive(s) and/or topological primitive(s). The EN Rules for application schemas will describe the composition of application schemas, using the data description techniques and integrating components for geometry, topology, quality, and direct positioning.

5.3 Spatial schemas and spatial view

A great number of combinations of geometric and topological primitives can exist. Each combination can be defined in a spatial schema.

EXAMPLE : Some of the combinations are particularly characteristic of geographic information, such as spaghetti, network, full topology, etc.

A collection of geometric primitives and/or topological primitives conforming to a spatial schema is called a spatial view. An example of an application schema with spatial view is shown in figure 2.

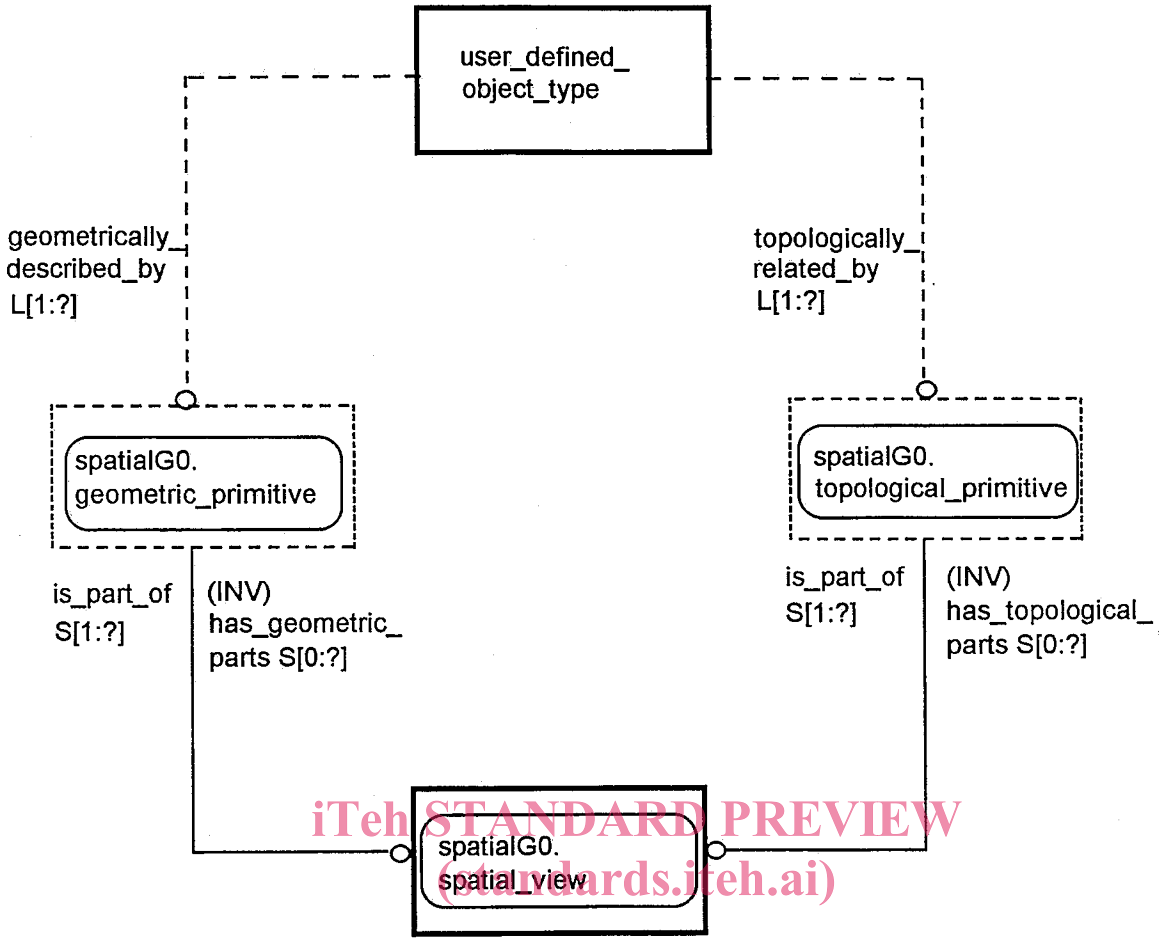
user_defined_
object_type
geometrically_
described_by
L[1:?]
topologically_
related_by
L[1:?]
spatialG0.
geometric_primitive
spatialG0.
topological_primitive
is_part_of
S[1:?]
(INV)
has_geometric_
parts S[0:?]
is_part_of
S[1:?]
(INV)
has_topological_
parts S[0:?]
spatialG0.
spatial_view

Figure 2 : Example of an application schema with spatial view

6 Components of spatial schemas

The main components of a spatial schema are illustrated in figure 3. The definition of spatial schemas are in clause 7.

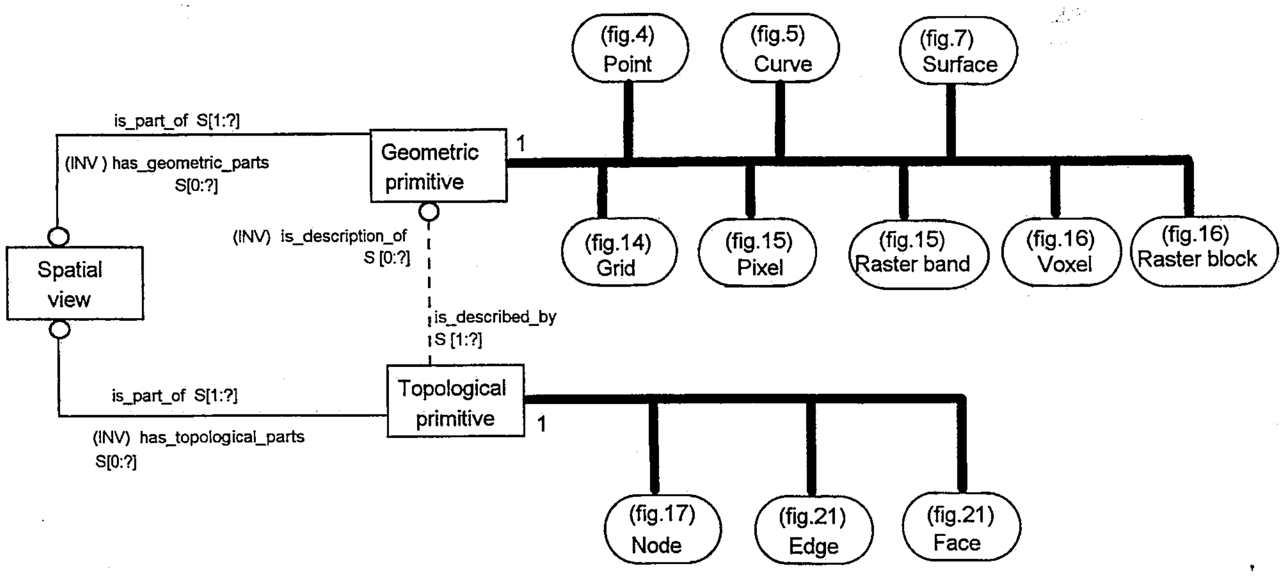
(fig.4)
Point
(fig.5)
Curve
(fig.7)
Surface
is_part_of S[1:?]
(INV) has_geometric_parts
S[0:?]
Geometric
primitive
1
(INV) is_description_of
S [0:?]
Spatial
view
(fig.14)
Grid
(fig.15)
Pixel
(fig.15)
Raster band
(fig.16)
Voxel
(fig.16)
Raster block
is_described_by
S [1:?]
is_part_of S[1:?]
Topological
primitive
1
(INV) has_topological_parts
S[0:?]
(fig.17)
Node
(fig.21)
Edge
(fig.21)
Face

Figure 3 : Main components of spatial schemas

6.1 Geometric primitives

6.1.1 Geometric primitives and direct position

A **geometric primitive** describes, partially or totally, the spatial representation of an object directly by coordinates and mathematical functions.

The mathematical functions used for describing the geometry of an object depend on the type of Geodetic Reference System and Coordinate System defining the used Direct Position.

All the direct positions used in the description of a single geometric primitive shall be defined in the same Geodetic Reference System and Coordinate System.

As illustrated in the figure 3, different types of geometric primitives can be used for the spatial representation of objects.

EXPRESS Specification:

```
ENTITY geometric_primitive
      ABSTRACT SUPERTYPE OF
            (ONEOF  (point, curve, surface, grid, pixel, raster_band, voxel,
            raster_block));
      is_part_of:                SET[1:?] OF spatial_view;
      INVERSE
            is_description_of :  SET [0:?] OF topological_primitive
                                 FOR is_described_by;
END_ENTITY;
```


Attribute definition:

is_part_of:	The set of spatial view to which the geometric primitive belongs (see 6.3).
is_description _of:	The set of topological primitive (see 6.2) whose spatial position is described by the geometric primitive.

6.1.2 Geometric primitive Point

A **Point** is a 0-dimensional geometric primitive. The spatial position of a Point is described by coordinates as illustrated in figure 4.

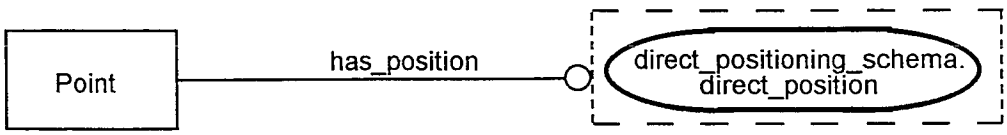

Figure 4 : Point

EXPRESS Specification:

```
ENTITY point
      SUBTYPE OF (geometric_primitive);
      has_position:              direct_position;
END_ENTITY;
```

Attribute definition:

has_position: The spatial position of the Point.

6.1.3 Geometric primitive Curve

A **Curve** is a bounded, continuous 1-dimensional geometric primitive. A Curve can be closed or not. The spatial position of a Curve is described by an interpolation method applied to a list of two or more direct positions as illustrated in figure 5. A Curve may intersect itself explicitly or implicitly .

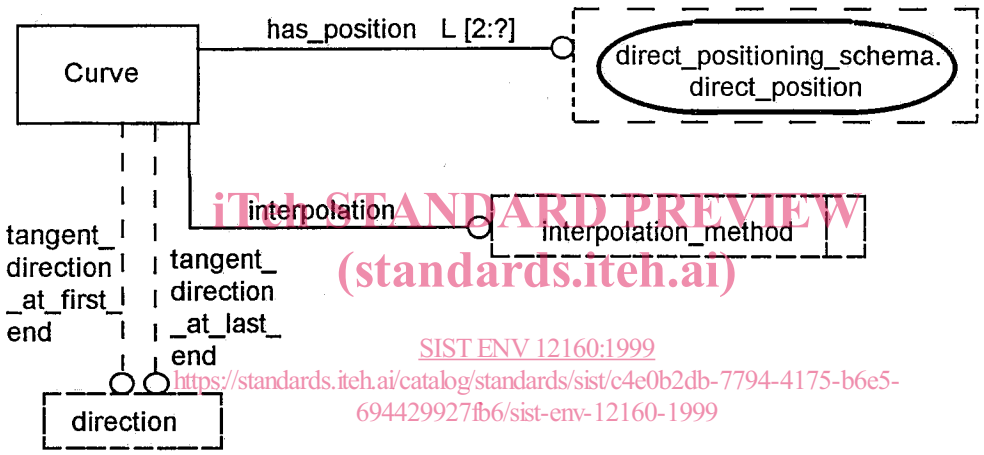

Figure 5 : Curve

EXPRESS Specification:

```
TYPE interpolation_method = ENUMERATION OF (shortest_way,  circular_arc,
           B_spline, clothoid);
END_TYPE;

TYPE direction = real;
WHERE
      (SELF > - PI)  AND  (SELF <= PI);
(* Angles are counted from the first axis and counterclockwise *)
END_TYPE;

ENTITY curve
      SUBTYPE OF (geometric_primitive);
      has_position:              LIST [2:?] OF direct_position;
      interpolation:             interpolation_method;
      tangent_direction_at_first_end: OPTIONAL direction;
      tangent_direction_at_last_end:  OPTIONAL direction;
INVERSE
      is_a_component_of:         SET [0:?] OF boundary
                                 FOR is_composed_of;
(* WHERE
      IR1: Two subsequent direct_position shall not be equal
      IR2: All the direct positions of a curve shall have the same values of
           geodetic_reference_system and coordinate_system *)
END_ENTITY;
```

Type definition:

interpolation_method: Defines the different allowed interpolation methods
direction: An angle defining the direction of a straight curve.

Attribute definition:

has_position: The list of direct positions defining the spatial position of a Curve.
interpolation The interpolation method to be applied to the list of direct positions.
tangent_direction_at_first_end / tangent_direction_at_last_end:
The direction of tangent to the Curve used as parameter by some of the allowed interpolation methods.
is_a_component_of: The single boundary to which the curve belongs.

6.1.4 Geometric primitive Surface

A **Surface** is a bounded, continuous 2-dimensional geometric primitive, delimited by one outer non-intersecting boundary and zero or more non-nested non-intersecting inner boundaries.

A distinction is made between the geometric primitives Curve and Surface, although the Surface is described by its boundaries as illustrated in figure 7. The main reasons why this distinction is made are :

1) in the case of a Curve, the Curve itself (even if it is closed) is the carrier of the information. The surface inside the closed curve is of no importance ;

2) in the case of a Surface, its boundaries are only of secondary importance. The boundaries are only there to delimit the Surface. This is also the main reason why the Surface has only one outer boundary but may have more than one inner boundary. Inner boundaries are necessary to describe the intended Surface.

EXPRESS Specification:

```
ENTITY surface
      SUBTYPE OF (geometric_primitive);
      has_outer_boundary:       boundary;
      has_inner_boundary:       SET[0:?] OF boundary;
(* WHERE
      IR1: Each inner boundary shall not intersect, either implicitly or
           explicitly outer boundary
      IR2: Each inner boundary shall not intersect, either implicitly or
           explicitly other inner boundary
      IR3: Inner boundaries shall not be nested between them
      IR4: Inner boundaries shall be nested into outer boundary *)
END_ENTITY;
```

Attribute definition:

has_outer_boundary: The outer boundary which bounds the Surface.
has_inner_boundary: The zero or more boundary which describe holes within the Surface.