

Geographic information — Data description — Rules for application schemas

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National foreword

This Draft for Development is the English language version of ENV 13376:1999.

This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature due to the limited duration of the European Prestandard. It should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

Comments arising from the use of this Draft for Development are requested so that UK experience can be reported to the European organization responsible for its conversion into a European Standard. A review of this publication will be initiated 2 years after its publication by the European organization so that a decision can be taken on its status at the end of its three-year life. The commencement of the review period will be notified by an announcement in *Update Standards*.

According to the replies received by the end of the review period, the responsible BSI Committee will decide whether to support the conversion into a European Standard, to extend the life of the prestandard or to withdraw it. Comments should be sent in writing to the Secretary of BSI Technical Committee IST/36, Geographic Information, at 389 Chiswick High Road, London W4 4AL, giving the document reference and clause number and proposing, where possible, an appropriate revision of the text.

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

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

Summary of pages

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This European Prestandard (ENV) was approved by CEN on 26 April 1999 as a prospective standard for provisional application.

The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This European Prestandard has been prepared by 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.

1 Scope

This European Prestandard gives the rules for using the Geographic Information European Prestandards and the data description techniques for developing applications for geographic information.

The scope of this European Prestandard includes the following aspects :

- how to define entities and their properties in an application schema ;
- how to integrate the standardised schemas (spatial schema, quality schema, direct position schema, geographic identifiers schema) with the semantic schema into a full application schema.

The following aspects are beyond the scope of this European Prestandard :

- development of metadata schema ;
- representation of contents of an application schema as metadata ;
- practical development methods for modelling ;
- definition of any particular application schema, and
- the mapping between internal schemas and the agreed application schema specification of rules necessary for using ENV 12658.

2 Normative references

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.

EN 28601:1992, *Data elements and interchange formats – Information interchange – Representation of dates and times.*

ENV 12009:1997, *Geographic information - Reference Model.*

ENV 12160:1997, *Geographic information - Data description - Spatial schema.*

ENV 12656:1998, *Geographic information - Data description – Quality.*

ENV 12657:1998, *Geographic information - Data description – Metadata.*

ENV 12658:1998 *Geographic information - Data description – Transfer.*

ENV 12661:1998, *Geographic information - Referencing - Geographic identifiers.*

ENV 12762:1998, *Geographic information - Referencing – Direct position.*

ENV ISO 10303-11:1995, *Industrial automation systems and integration – Product data representation and exchange – Part 11 : Description methods : The EXPRESS language reference manual.*

ENV ISO 10303-41:1994, *Industrial automation systems and integration – Product data representation and exchange – Part 41 : Integrated generic resources : Fundamentals of product description and support.*

3 Terms and definitions

For the purposes of this European Prestandard, the following definitions apply :

3.1 **application schema**

conceptual schema for a specific field of interest within the field of geographic information

[ENV 12009]

3.2 **conceptual schema**

result from a conceptual modelling of geographic data

[ENV 12009]

3.3 **gazetteer**

directory of instances of locations

[ENV 12661]

3.4 **geographic data**

computer treatable form of information concerning phenomena directly or indirectly associated with a location relative to the Earth

[ENV 12656]

3.5 **geographic identifier**

unique identifier of a location

[ENV 12661]

3.6 **geographic identifiers gazetteer schema**

conceptual schema for the description of a gazetteer

3.7 **geographic identifiers schema**

conceptual schema for the description of geographic identifiers systems

3.8 **geographic identifiers system**

structured collection of geographic identifiers with a common theme and format

[ENV 12661]

3.9 **geographic information**

information concerning phenomena directly or indirectly associated with a location relative to the Earth

[ENV 12009]

3.10 **location**

identifiable part of the real world

[ENV 12661]

3.11

metadata

data about a geographic dataset or geographic datasets

[ENV 12657]

3.12

metadata schema

schema describing metadata

[ENV 12009]

3.13

direct positioning schema

conceptual schema describing positional reference systems

3.14

quality schema

conceptual schema describing the quality aspects of geographic data

[ENV 12009]

3.15

semantic schema

conceptual schema giving the meaning of geographic information

[ENV 12009]

3.16

spatial schema

conceptual schema describing the spatial (geometric and topological) aspects of geographic data

[ENV 12009]

4 General

An application schema is a conceptual schema for a specific field of interest within the field of geographic information. An application schema defines the content and structure of geographic information.

The purpose of an application schema is dual. The first is to achieve a common and correct understanding of the data, making it possible unambiguously to retrieve information from the data. The second is to provide a computer-readable form for data description, making it possible to apply automated mechanisms for geographic data management.

Application schemas may be standardised.

NOTE This European Prestandard does not define any application schemas. It defines the rules for creating an application schema. This approach of not defining application schemas, but instead providing rules for suppliers and users to agree on definition of joint schemas, is deliberate. It is taken since users of this European Prestandard have different requirements of their geographic applications and of the geographic data managed by such applications.

The rules in this standard are set up in order to ensure the functionality of the Geographic Information of European Prestandard.

Figure 1 illustrates how rules from this European Prestandard are used for different types of application schemas.

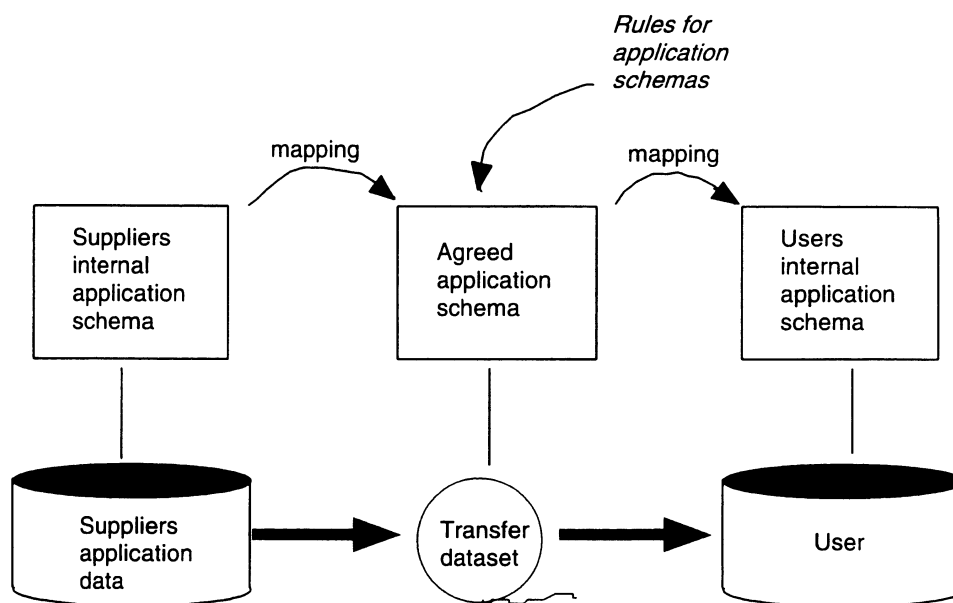


Figure 1 - Rules for application schemas covered by the Geographic Information European Prestandards

A supplier and a user of geographic data can develop internal application schemas independently (they can be different). Transfer from a supplier to a user may make it necessary to have an agreed application schema. Mapping mechanisms between the internal schemas and the agreed schema have to be defined.

NOTE Mapping mechanisms, rules and methods for them, are outside the scope of this European Prestandard.

The supplier's internal application schema, the agreed application schema and the user's internal application schema can be different because :

- the user can reorganise data received from a supplier depending on his own needs ;
- the use of different tools by the supplier and the user may make it necessary to develop an agreed application schema understandable in both environments.

5 Application schema

5.1 General

Figure 2 shows the role played by the application schema in defining the relationship between the real world and the geographic dataset.

The modelling process includes selection, classification and description of the relevant real world phenomena. Classification and description shall follow a formal description language. In the Geographic Information European Prestandards the EXPRESS language defined in ENV ISO 10303-11 is used.

The resulting application schema defines the content and the structure of a specific geographic dataset.

On the data level the process of data capture populates the dataset with geographic data representing real world phenomena.

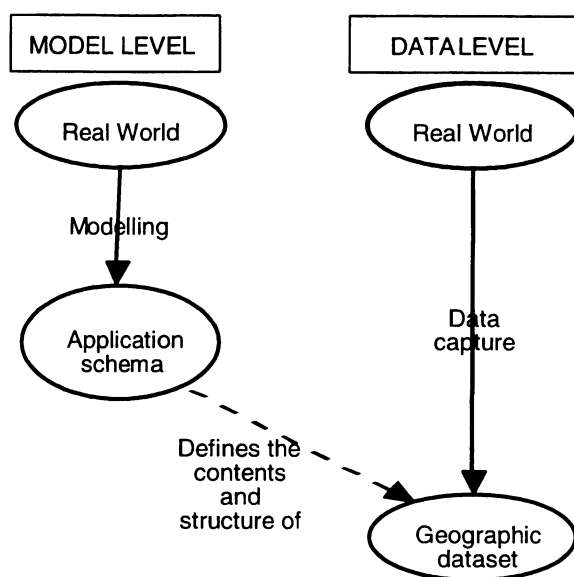


Figure 2 - The role of the application schema

5.2 The modelling process

The application schema serves two purposes. Firstly, it documents the rules for interpreting data. Secondly, it is a computer readable schema for applying automated mechanisms for data management.

The two roles imply a stepwise process for creating an application schema. These steps are not described in detail in this European Prestandard, but consist mainly of :

- surveying the requirements from the intended field of applications ;
- conceptual modelling, finding out the basic semantic entities, relationships, attributes and constraints ;
- integrating the semantic schema and the standardised schemas into a complete application schema.

This process requires a group of experts with knowledge of the real world aspects that are of interest as well as knowledge of information modelling.

5.3 Parts of the application schema

An application schema defines the contents and structure of a geographic dataset. When data from a geographic dataset are to be transferred, the transfer mechanisms require the application schema (see Figure 3).

NOTE A metadata schema defines the contents and structure of metadata. When transferring metadata the transfer mechanisms require the metadata schema defined in ENV 12657.

An application schema shall contain one semantic schema (see 7.1) which may be linked to :

- ENV 12160 (spatial schema) ;
- ENV 12762 (direct position) via the spatial schema ;
- ENV 12661 (geographic identifiers) ;
- ENV 12656 (quality).

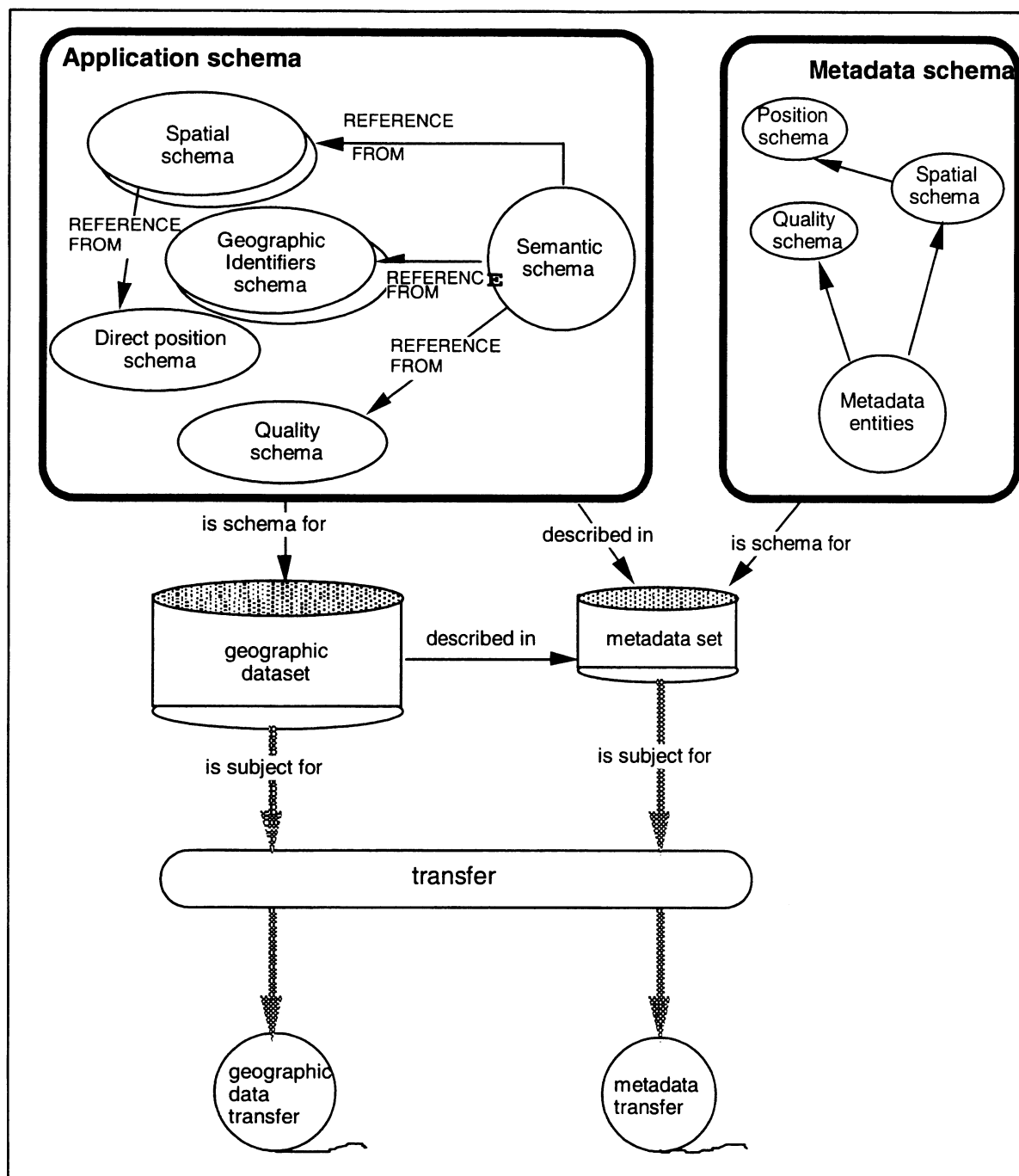


Figure 3 - Interaction between different standardised schemas and semantic schema for description and transfer of geographic data and metadata

The geographic data shall be in conformance with the application schema.

In the application schema, the entities in the semantic schema are integrated with constructs from the standardised schemas to meet the geographic information requirements of specific applications. This is achieved by selecting appropriate constructs and refining their meaning and by specifying the appropriate attributes, relationships, and constraints.

A spatial schema may be one of the standardised spatial schemas defined in ENV 12160, or a user-defined spatial schema defined in compliance with the conformance requirements of ENV 12160. The rules for referencing the spatial schemas are given in 6.2.

The direct positioning schema is defined in ENV 12762. The rules for referencing the direct position schema are defined in 6.3.

The geographic identifiers schema is defined in ENV 12661. The rules for referencing the geographic identifiers gazetteer schema are defined in 6.4.

The quality schema is defined in ENV 12656. The rules for referencing the quality schema are given in 6.5.

Parts of the application schema may be included in metadata. The rules for this inclusion are defined in ENV 12657.

5.4 Use of EXPRESS language

This European Prestandard uses the EXPRESS language, defined in ENV ISO 10303-11:1994 as its formal description language. The use of a formal language provides unambiguous and consistent representation and facilitates development of implementations.

Users of the Geographic Information European Prestandards shall use the EXPRESS language when creating an application schema (as defined in 7.1-7.5). This schema shall be sent to the user to permit interpretation of the data.

When using ENV 12658 some specific rules shall be followed, which include restrictions on the use of the EXPRESS language.

Annex A gives the guidelines for using the EXPRESS language.

5.5 Identification of application schemas

Each application schema shall include a unique name and version identification.

NOTE The inclusion of version identification makes it possible for a supplier and a user to unambiguously identify the version of the application schema that defines the contents of a particular dataset.

5.6 Temporal aspects

The temporal aspects of geographic information are partly standardised in ENV 12657. Temporal aspects that are not defined in the quality schema shall be included in the semantic schema.

Dates and times shall be represented in accordance with existing international standards (EN 28601:1992 and ENV ISO 10303-41).

5.7 Presentation aspects

Display rules, such as line-width and line-colour are modelled in the semantic schema when needed.

Display rules are modelled in the semantic schema in two ways :

- as attributes of the specific EXPRESS entities to which they apply ;
- as attributes of one or more EXPRESS entities created for the purpose of re-use through reference from other entities.

5.8 Use of sound, video and other binary modes

An application may require data that cannot be represented by means of the standardised schemas and cannot be defined in the semantic part. Examples are binary representation of sound or video. To allow this, an entity "external_file" may be created in the application schema. This entity is referenced as an attribute of those entities that require this representation.

6 Development of the application schema

6.1 Defining the semantic schema

The application schema shall contain a semantic schema. In the semantic schema the real world phenomena are modelled as EXPRESS entities.

EXAMPLES Road, House, Person.

The entities and their attributes shall be given proper definitions. The entity and attribute names and their definitions shall be included as comments in the formal EXPRESS schema (see example in Figure 4).

```
SCHEMA orchard;
( *
ENTITY farmer Physical person who grows fruit trees.
Of interest for this application area are people who grow apple trees and walnut trees. Only farmers who owns at
least one field are dealt with.
EXPRESS specification :
*)
ENTITY farmer;
    farmer_id : person_name_and_id;
    has_address : address;
INVERSE
    owns : SET[1:?] OF field FOR owner;
UNIQUE
    UR1: farmer_id;
END_ENTITY;
( *
Attribute definitions :
farmer_id : Personal_code_number is given as an unique identifier. Family name and given name(s) shall always
be given.
has_address : Locational address for the home of the farmer with telephone number and E-mail address if known.
Formal propositions :
UR1 : farmer_id uniquely identifies the farmer    *)
END_SCHEMA;
```

NOTE Figure 4 is not a complete schema. For a full example see annex B.

Figure 4 - Definitions given as comments in the EXPRESS Schema

6.2 Using the spatial schema

The spatial (geometric and topological) representation shall be defined in a spatial schema according to ENV 12160:1997.

The geometric and topological representation of the real world phenomena becomes part of the application schema by interfacing the semantic schema with one or more spatial schemas. This is realised by relating the entities of the semantic schema to entities in one or more spatial schemas.

If an interfaced spatial schema is one of the pre-defined spatial schemas of ENV 12160, the entity from the semantic schema shall have an inter-schema reference to the appropriate entity in this pre-defined spatial schema. If the spatial schema is a user-defined spatial schema developed in compliance with the conformance requirements of ENV 12160, the application schema shall contain completely either that user-defined spatial schema or, if the user-defined spatial schema is described in a separate schema, inter-schema references to that separate schema.

NOTE ENV 12658 does not allow the REFERENCE of an entity FROM any user-defined schema.

6.2.1 Referencing a geometric primitive or a topological primitive

The linking of the entities of the semantic schema to one or more spatial schemas is performed by establishing relationships between the entities (named as a user-defined object type) and the standardised entities (geometric primitives and/or topological primitives) in the spatial schema (see Figure 5).

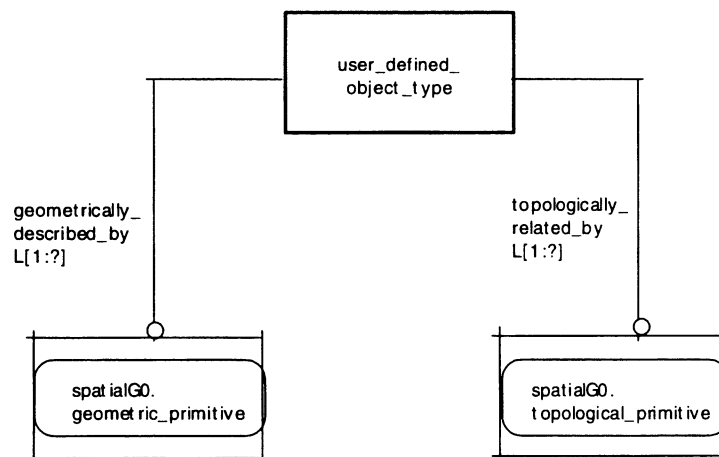


Figure 5 - Basic principle for linking the entities of the semantic schema to one or more spatial schemas

NOTE 1 The inverse relationship from the spatial schema to the semantic schema is not included in the ENV 12160. It exists conceptually, and can be implemented using the internal database mechanisms. When receiving a transfer file, no explicit relationship from the geometric and topological primitives to the entities will exist in the received data. The receiving software has to build these relationships.

For this purpose the appropriate geometric and topological primitives preferably be REFERENCED in the semantic schema.

NOTE 2 The REFERENCE FROM interface specification ensures that only instances of primitives referenced from this application schema will occur in a dataset.

The USE FROM interface specification is not recommended.

NOTE 3 The USE FROM interface specification allows instances of geometric and topological primitives not referenced by any entity from this application schema to occur in a dataset.

Method 1 - Establishing relationships

The entity is related to the proper primitive (see example in Figure 6).

```
SCHEMA orchard;  
REFERENCE FROM spatialG5  
    (point);  
ENTITY tree ;  
    position : point;  
END_ENTITY;  
END_SCHEMA;
```

Figure 6 - Example of an entity related to the proper spatial primitive.

Method 2 - Implicit supertyping

A subtype of the proper primitive shall be defined (see example in Figure 7).

```
SCHEMA orchard;  
REFERENCE FROM spatialG5  
    (point);  
ENTITY tree  
    SUBTYPE OF (point);  
END_ENTITY;  
END_SCHEMA;
```

Figure 7 - Example of an application schema using implicit supertyping

NOTE ENV 12658 does not allow implicit supertyping

6.2.2 Choice of spatial schema

Reference to the basic spatial schema G0 is not recommended. This schema is intended to be a framework for all spatial schemas, in order to allow the upgrading of data content and the increase of spatial complexity without violating existing data structures. Thus it contains all the allowed constructs for representing geometry and topology. If the spatial schema G0 is referenced the receiver of data must be able to handle all possible constructs.

It is recommended that the simplest possible spatial schema which fulfils the requirements of the application is used. If the requirements increase later on, it is possible to upgrade the application schema to a more advanced spatial representation.

For **full planar graph face topology**, the schema G1 is recommended. Examples of applications are administrative subdivision, cadastral databases, land use.

For **planar graph linear networks**, the schema G2 is recommended. No faces are explicitly defined. Examples of applications are boundary networks where the faces are of no interest, or not implemented.

NOTE In planar graph topology some rules apply to the spatial structure. Edges cannot cross or intersect. If they do, a node is created and the edges are split.

For **non planar graph linear networks**, the schema G3 is normally suitable. It covers the same fields of applications as G2, but it allows edges to cross without creating nodes. This truly reflects the 2 ½-dimensional representation of, for example, road and rail networks, electric power and telecommunication lines.

For **non planar graph linear networks with surfaces**, the schema G4 is suitable. It covers the same fields of applications as G3, but it allows surfaces with gaps and overlaps to be included.

For **spaghetti** representation, the schema G5 may be used. It contains points and curves, but no surfaces and no topology. It is suitable for isolated features, where areal representation is not needed.

For **bounded triangulated irregular networks**, the schema G6 may be used. It is especially suitable for terrain models, for example for orography or spatial diagrams for statistical presentations.

For **raster images**, the schema G7 is recommended. It may be used for satellite imagery, digital aerial photography and other raster applications, but also for the display of pictures of varying types.

For **grid** structures, the schema G8 is recommended. It may be used for such things as elevation grid models.

If none of the schemas G1-G8 is sufficient, it is possible to create a user-defined spatial schema according to the conformance requirements of ENV 12160:1997.

6.2.3 Referencing different spatial schemas from one semantic schema

Primitives from different spatial schemas may be used in one application schema and thus for the same set of geographic data. This allows for example a topological representation of land use and in the same application schema a spaghetti representation of isolated objects. No topological relationships exist between land use parcels and isolated objects, but those relationships can be calculated by using GIS methods (see example in Figure 8).

```
SCHEMA fields_and_houses;  
  
REFERENCE FROM spatialG1 (face);  
  
REFERENCE FROM spatialG4 (point AS G4point,  
                           curve AS G4curve);  
  
ENTITY field;  
    topologically_related_by : face;  
END_ENTITY;  
  
ENTITY house;  
    geometrically_described_by : G4point;  
END_ENTITY;  
  
ENTITY big_house ;  
    geometrically_described_by : SET [1:?] OF G4curve;  
END_ENTITY;  
  
END_SCHEMA;
```

Figure 8 - Example of an application schema using primitives from different spatial schemas

6.2.4 Referencing the same spatial schema for two separate spatial views

The same spatial schema may be used independently for two or more independent sets of application-specific entities.

For example, a power line network and a road network may both use the spatial schema G2 or G3, without interfering with each other (see Figure 9 and 10).