2 Overview

2.1 Name

INSPIRE data specification for the theme *Buildings*.

2.2 Informal description

Definition:

Geographical location of buildings [Directive 2007/2/EC].

Description:

Considered as under scope of the theme *Buildings* are **constructions** above and/or underground which are intended or used for the shelter of humans, animals, things, the production of economic goods or the delivery of services and that refer to any structure permanently constructed or erected on its site.

2.2.1 Context

This data specification was developed according to the INSPIRE methodology, the context knowledge being got by an investigation of use cases and user requirements and by a survey of existing data and standards.

2.2.1.1. Use cases

This data specification about *Buildings* addresses the following high level use cases shown on the figure below.

In particular, this data specification addresses the Noise Directive, the Air Quality Directive, the Energy Performance of Building Directive and the Population and Housing Census Directive. The Flood Directive and the project of Soil Directive have also been taken into account.

More detailed information about use cases may be found in annex B of this document.

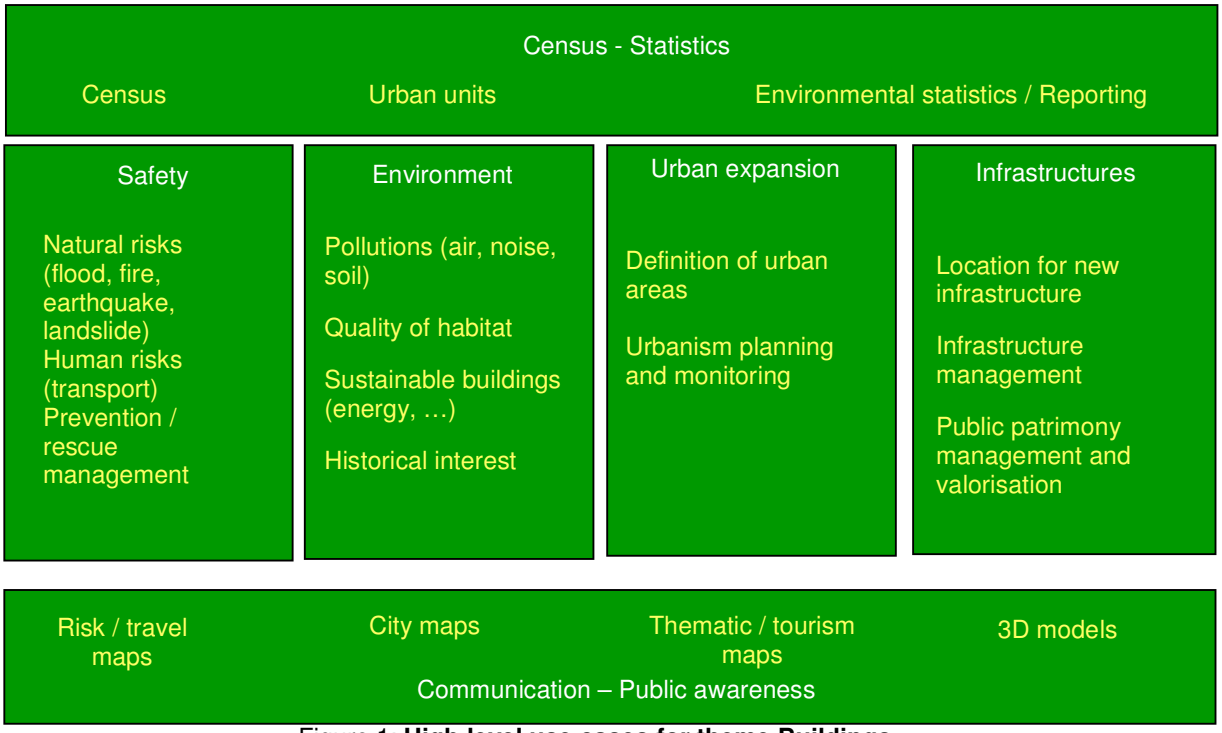

Figure 1: **High level use cases for theme Buildings**

2.2.1.2. Existing data

At national level there may be several databases related to the theme *Buildings*. For instance frequently coexist a topographic view (2D or 2,5D) at scales around 1/ 10 000 and a cadastral view (mostly 2D) at scales generally larger or equal to 1: 2000. In some countries there is also a statistical view on *Buildings*.

A reliable overview about the databases available at the local level cannot be provided, due to the lack of Reference Material. However, some local governments have volumetric views (3D data) on *Buildings*.

Moreover there may be other databases dedicated to a specific use case such as marine navigation, air traffic, inventory of buildings with historical or architectural interest. These databases include only a limited set of buildings.

2.2.1.3. Existing standards

This data specification is based on several standards that may be classified as glossaries, classifications and data models:

- Glossaries

The standard ISO 6707 (Building and Civil Engineering) includes a Vocabulary with part 1 being about General terms.

The standard DFDD (DGIWG Feature Data Dictionary) is the standard established by the military community (DWIWG: Defence Geospatial Information Working Group); it provides terminology and definitions for topographic features, including buildings.

The CLGE (Council of European Geodetic Surveyors) measurement code for the floor area of buildings has provided possible references for the official area of a building.

- Classifications

Eurostat has a hierarchical classification of types of constructions according to the activity hosted by the building. The part of this classification addressing environmental use cases has been adopted by this data specification; it concerns mainly the residential use.

- Data models

LADM (Land Administration Domain Model) is the draft standard ISO 19152. It is an extendable basis for efficient cadastral system development based on a Model Driven Architecture. It offers a cadastral view point on *Buildings*.

CityGML is an OGC standard for the representation of 3D City Models, including *Buildings*. CityGML offers different levels of detail (LoD) for the modeling of *Buildings*:

- LoD 0 that offers a 2D model for buildings has been included in the latest version of City GML (v2.0).
- LoD 1 with block models (flat roofs)
- LoD 2 with the shape of roofs
- LoD 3 with accurate description of exterior (including openings: doors and windows)
- LoD 4: interior model

As this standard is based on ISO TC 211 and OGC concepts, it **was a natural candidate for the modeling of 3D Buildings in INSPIRE.** Annex D of this document provides more explanations about CityGML and how it has been applied for INSPIRE.

Moreover there are two other standards dealing with very specific use of buildings such as:
- annex 15 of ICAO (International Civil Aviation Organisation) offers a data model for vertical structures (including buildings) called AIXM (Aeronautical Information eXchange Model).
- the IHO (International Hydrographic Organisation) has its standard S-57 which comprises the specifications of ENC (Electronic Navigation Charts) and a glossary. Both include information related to theme *Buildings*.

2.2.2 Decisions

2.2.2.1. The profile approach

2.2.2.1.1. Semantic aspects

Various and numerous user requirements were collected. As it seemed impossible to require data harmonisation at European level for all these requirements, this data specification has defined some priority, as shown on the following figure.

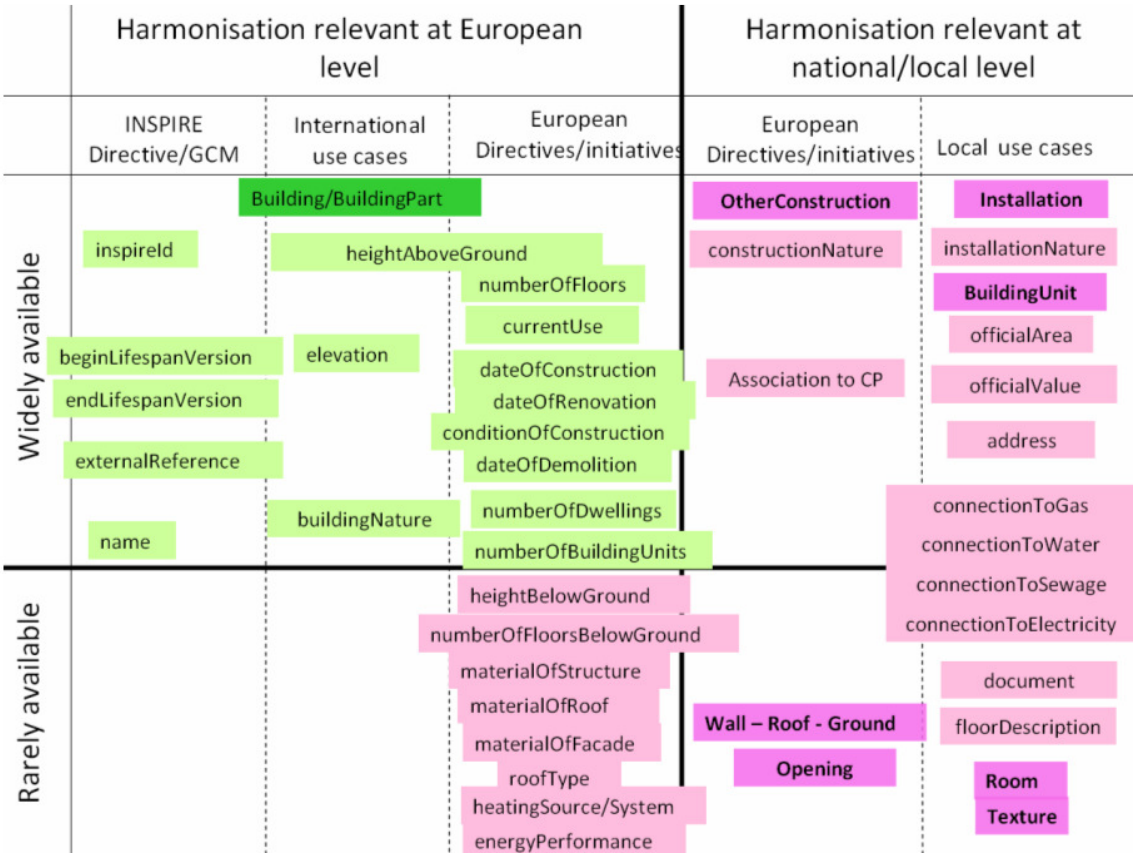

Figure 2: The hierarchy of semantics user requirements (Feature types are represented in bright colours, whereas their properties are represented in clearer colours)

Harmonisation was considered as relevant at European level when funded on international or European use cases and when no significant feasibility issue regarding harmonisation was expected. Harmonisation was considered as relevant at national/local level if funded only on national/local level and/or if feasibility issues were expected (e.g. official data depending on national regulation, privacy issue, lack of consensus about the scope of theme *Buildings*).

Based on this classification, two kinds of semantic profiles are proposed in this data specification:

- **normative core profile** based on the data widely used, widely available and whose harmonisation is required at European level, e.g. for homogeneous reporting on Environmental Directives
- **informative extended profile** based on data that is widely required but whose harmonisation is not easily achievable at short term (e.g. data rarely available or data whose harmonisation may/should be done at national level).

The common semantics used by all profiles has been described in a **base application schema**.

Core profile includes both basic topographic data (such as height, number of floors, nature of buildings, date of construction …) and coarse official data (such as current use, number of dwellings or of building units); the core profile aims to fulfil most user requirements, at least in a rough way. Core profile is based on the concepts shown in green on the previous figure.

Extended profile includes more detailed information about buildings and building related objects. Extended profile is based on the concepts shown in pink on the previous figure.

Extended profile may be applied as a whole but also aims to be a “reservoir” of proposals for extensions of core INSPIRE profile, i.e. only a selection of proposed feature types and attributes may be added. More explanations about this topic are given in annex F.

Moreover, some mechanisms (external reference, address and document) have been included to enable data producers to provide a link between the data considered as directly under the scope of theme *Buildings* and business data considered as out of scope of the theme (such as owner/tenant, building permit, detailed activity of the building).

2.2.2.1.2. Geometric aspects

Building data may be available and required either as 2D (or 2,5D) data or as 3D data. This data specification is proposing two kinds of geometric profiles:

- 2D profile (with 2D or 2,5D geometry)
- 3D profile (with 3D geometry)

NOTE: term "2D profile" is used for simplicity reason (in order to have a short title) but accommodates both 2D and 2,5D data.

These 2D and 3D profiles are proposed to make life easier both to data producers and data users:

- most data producers have only 2D or 2,5D data ; it will be easier for them to make their data compliant with core 2D profile that deals only with 2D and 2,5D data
- a core 3D profile has been developed, mainly to enable producers of 3D data to conform to INSPIRE model without having to "flatten" their data.
- most GIS deals only with 2D or 2,5D data; users will be enabled to choose data compliant with INSPIRE 2D or 3D profiles

This core normative 3D profile is based on the simple semantic of core profile and allows all the levels of detail of CityGML.

2.2.2.1.3. Application schemas and profiles

The data specification includes six application schemas. Two of them are just abstract application schemas gathering the concepts that are used in common by the other application schemas, i.e. the instanciable ones.

The delivery of data may be done, using four options (called profiles) that consist of a combination of application schemas, as explained in the following table and figure.

Table 1: The profile approach for theme Buildings

	Basic semantic	Rich semantic
2D geometry	**Core 2D profile** *uses application schemas:* - *base* - *Buildings2D*	**Extended 2D profile** *uses application schemas:* *- base* *- Buildings2D* *- base extended* *- extended 2D*
3D geometry	**Core 3D profile** *uses application schemas:* - *base* - *Buildings3D*	**Extended 3D profile** *uses application schemas:* *- base* *- Buildings3D* *- base extended* *- extended 3D*

The profiles (Core 2D, Core 3D, Extended 2D, Extended 3D) are defined by the respective instanciable application schemas and may use the concepts defined in other application schemas, as explained in the previous table.

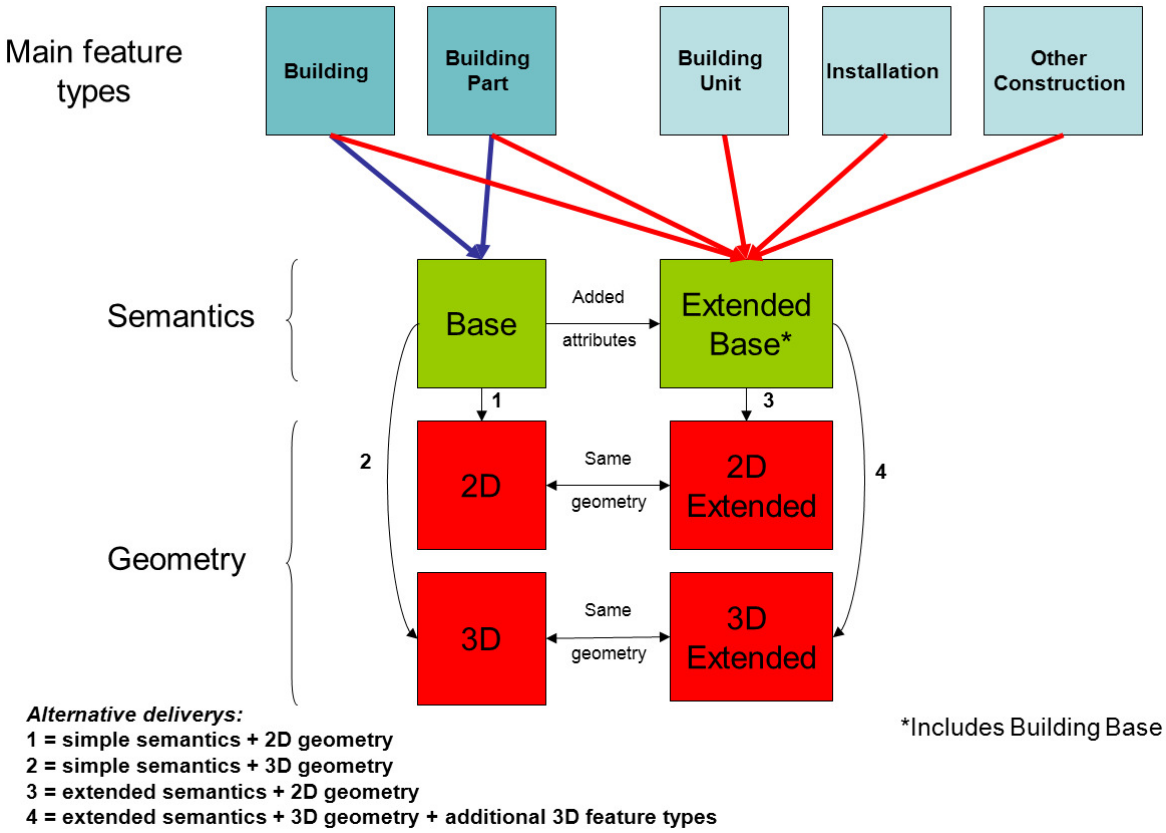

Figure 3: Content and structure of application schemas for theme Buildings

Feature types are represented in blue. Abstract application schemas are represented in green. Instanciable application schemas are represented in red.

NOTE: **Data producers may also extend INSPIRE profiles by other information not included in this specification, under the condition they respect the rules provided in the Generic Conceptual Model.**

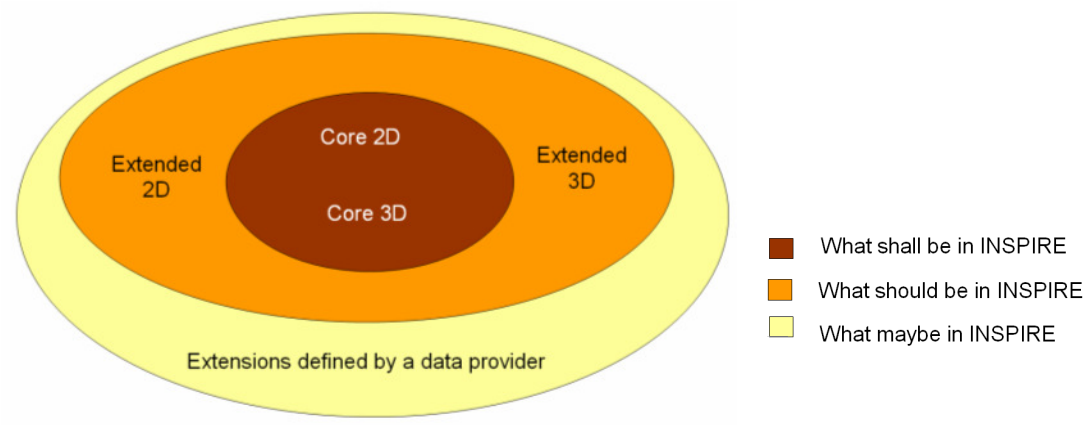

Figure 4: Modular approach for modelling Buildings theme

2.2.2.2. Modular scope:

There may be different kinds and sizes of buildings and constructions. In a similar way to the modular levels of information offered by the profile approach, this data specification defines three levels of priority for INSPIRE, regarding the scope of the theme:

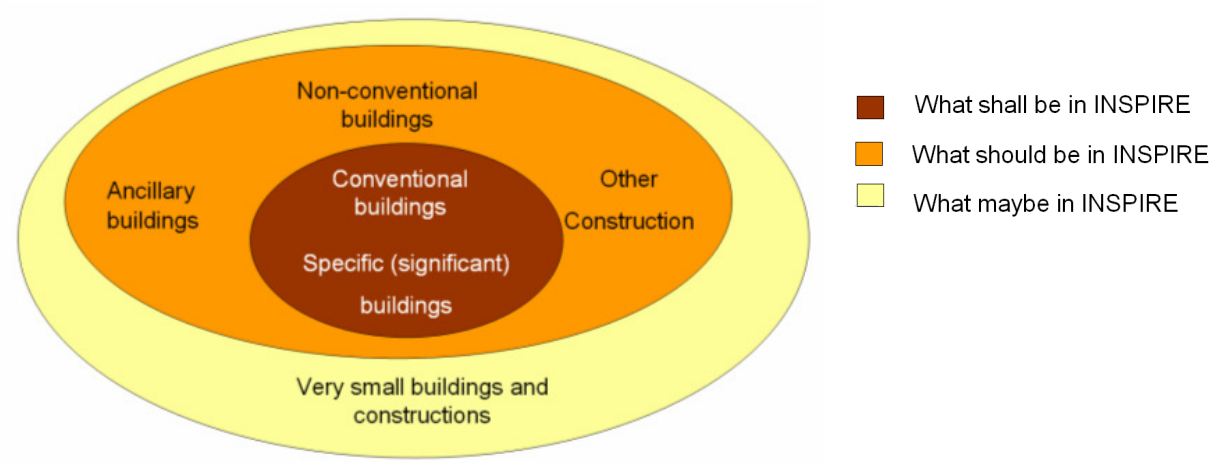

Figure 5: Modular approach for scope of theme Buildings

The first priority, the data the most expected by INSPIRE includes:

- The conventional buildings are considered as building by every one (fitting with all the various definitions of buildings), generally hosting human activities (residential, industrial, commerce and services) and being of large or medium size (around 15-20 m^2 and more); these conventional buildings are required by most use cases, such as for assessment of population in an area of interest, census, spatial planning, modelling of physical phenomena. Typical examples are houses, block of flats, factories, supermarkets, …
- The specific (significant) buildings are the buildings of significant size or height with specific physical aspect that make them usable as landmarks and required by use cases such as mapping or travel safety. Typical examples are towers, stadium, churches, …

The second priority, the data that should be in INSPIRE includes:

- The non-conventional buildings fit only partly with the definition(s) of building; for instance, they are only partly constructed, such as caves or underground shelters, stations, car parks or they are permanent only by fact but not by nature such as mobile homes, huts, …If hosting human activities, these non-conventional buildings are required by use cases such as census, studies about precarious habitat, vulnerability to risk
- The ancillary buildings are buildings of small size (around 10 m^2) that are used only in connection with another larger building, such as the garages or garden shelters near houses. These ancillary buildings may influence the land use / land cover phenomena.
- Other constructions are the constructions required by the use cases considered by this data specification. Typical examples are city walls, bridges, chimneys, acoustic fences. The whole list may be found in the model (clause 5).

The last priority, the data that may be in INSPIRE includes all the other buildings and constructions, mainly the very small size ones (one or several m^2), such as phone booth, bus shelters, statues, … These buildings and constructions may be required at local level for asset management, protection of patrimony, …

2.2.2.3. Links and overlaps with other themes

2.2.2.3.1. Overview

Theme *Buildings* has overlaps with themes dealing with facilities, as buildings may be part of governmental services, industrial, agricultural, transport or hydrographical facilities and with theme Geographical Names as buildings may have a toponym.

Some buildings and constructions are included in other INSPIRE themes, mainly in the facilities themes (for instance, a building may host a school, a prison, a city hall or be part of a farm or a factory). The general principle is that, for same entities, the theme Building focuses on a physical/topographic view whereas the facility themes focus on a functional view.

Aggregated building data may be found as built-up areas in themes Land Cover or Land Use and as settlements in theme Geographical Names.

Moreover, theme *Buildings* is often used in conjunction with other INSPIRE themes by the use cases addressed by this data specification. For more details, see annex B.

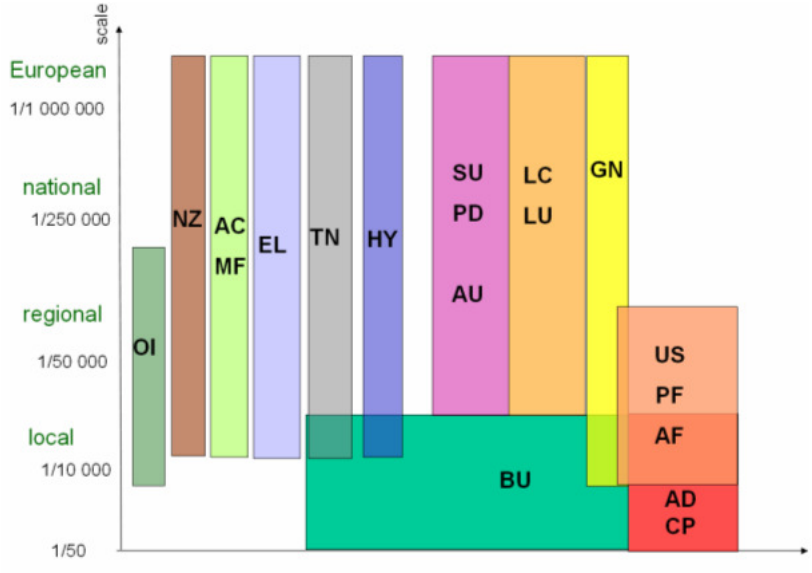

Figure 6: Links and overlaps between Buildings and other INSPIRE themes

2.2.2.3.2. Classification of buildings

This data specification proposes a simple classification of buildings, based on their current use. Users will find more detailed information in the themes dealing with facilities.

Table 2: The classification of buildings

Current use – high level	Current use – detailed level
residential	Provided by DS BU
agricultural	Provided by DS AF
industrial	Provided by DS PF
commerceAndServices - office	
commerceAndServices - trade	
commerceAndServices – public service	Provided by DS US

Open issue 1: The articulation between *Buildings* and facilities was poorly tested or not tested at all during the consultation phase. So, there is a real risk that data between these themes will not connect as expected. This will be a point to be carefully monitored by the maintenance process of INSPIRE specifications.

Definition:
Geographical location of buildings [Directive 2007/2/EC].

Description:
A building is a covered facility, usable for the protection of humans, animals, things or the production of economic goods. A building refers to any structure permanently constructed or erected on its site. Information on location of buildings may be supplied as points or with the actual basic form of the building. Usually buildings are part of cadastre. On the local level buildings are available within the large scale cadastral maps or cadastral data sets and are geometrically represented as surfaces.
Most buildings can be identified (geocoded) by address (separate theme in INSPIRE).

Entry in the INSPIRE registry: *http://inspire.ec.europa.eu/theme/bu/*

2.3 Normative References

[Directive 2007/2/EC] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

[ISO 19107] EN ISO 19107:2005, Geographic Information – Spatial Schema

[ISO 19108] EN ISO 19108:2005, Geographic Information – Temporal Schema

[ISO 19108-c] ISO 19108:2002/Cor 1:2006, Geographic Information – Temporal Schema, Technical Corrigendum 1

[ISO 19111] EN ISO 19111:2007 Geographic information - Spatial referencing by coordinates (ISO 19111:2007)

[ISO 19113] EN ISO 19113:2005, Geographic Information – Quality principles

[ISO 19115] EN ISO 19115:2005, Geographic information – Metadata (ISO 19115:2003)

[ISO 19118] EN ISO 19118:2006, Geographic information – Encoding (ISO 19118:2005)

[ISO 19125-1] EN ISO 19125-1:2004, Geographic Information – Simple feature access – Part 1: Common architecture

[ISO 19135] EN ISO 19135:2007 Geographic information – Procedures for item registration (ISO 19135:2005)

[ISO 19138] ISO/TS 19138:2006, Geographic Information – Data quality measures

[ISO 19139] ISO/TS 19139:2007, Geographic information – Metadata – XML schema implementation

[ISO 19157] ISO/DIS 19157, Geographic information – Data quality

[OGC 06-103r4] Implementation Specification for Geographic Information - Simple feature access – Part 1: Common Architecture v1.2.1

NOTE This is an updated version of "EN ISO 19125-1:2004, Geographic information – Simple feature access – Part 1: Common architecture".

[Regulation 1205/2008/EC]	Regulation 1205/2008/EC implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata
[Regulation 976/2009/EC]	Commission Regulation (EC) No 976/2009 of 19 October 2009 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards the Network Services
[Regulation 1089/2010/EC]	Commission Regulation (EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services

2.4 Terms and definitions

General terms and definitions helpful for understanding the INSPIRE data specification documents are defined in the INSPIRE Glossary[13].

Specifically, for the theme *Buildings*, the following terms are defined:

1. 2D data
Geometry of features is represented in a two-dimensional space

NOTE: **In other words, the geometry of 2D data is given using (X,Y) coordinates.**

EXAMPLE:

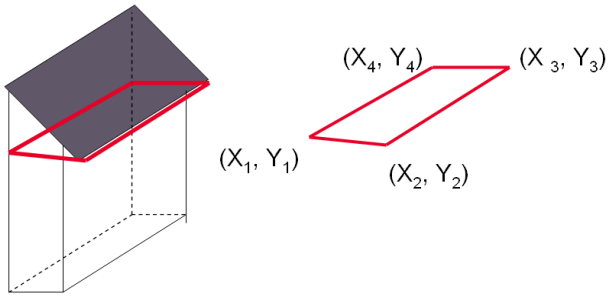

Figure 7: A building represented by 2D data

2. 2.5D data
Geometry of features is represented in a three-dimensional space with the constraint that, for each (X,Y) position, there is only one Z.

EXAMPLE:

[13] The INSPIRE Glossary is available from http://inspire-registry.jrc.ec.europa.eu/registers/GLOSSARY

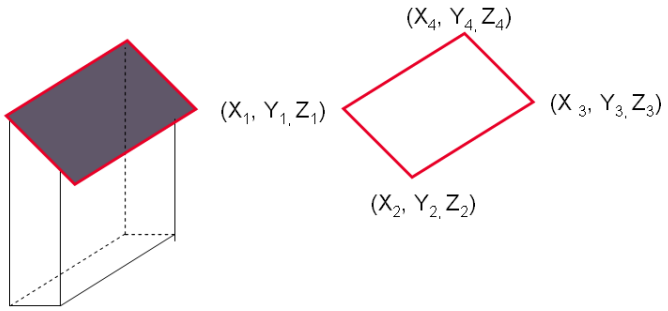

Figure 8: A building represented by 2,5D data

3. 3D data
Geometry of features is represented in a three-dimensional space.

NOTE: **In other words, the geometry of 2D data is given using (X,Y,Z) coordinates without any constraints**.

EXAMPLE:

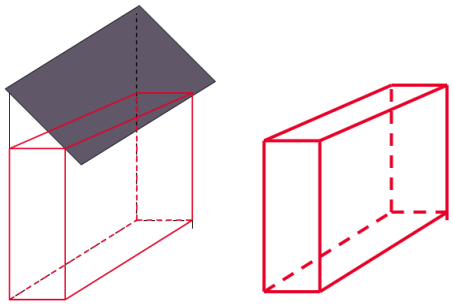

Figure 9: A building represented by 3D data

4. Building component
Any sub-division or elements of a building.

EXAMPLES: wall, roof, room

2.5 Symbols and abbreviations

AC	Atmospheric Conditions
AD	Address
AF	Agricultural and Aquacultural Facilities
ATS	Abstract Test Suite
AU	Administrative Units
BU	*Buildings*
CP	Cadastral Parcels
CRS	Coordinate Reference System
DS DT	Data Specification Drafting Team
DTM	Digital Terrain Model
EC	European Commission
EEA	European Environmental Agency
EL	Elevation
ENC	Electronic Navigation Charts
EPBD	Energy Performance of Buildings Directive
ETRS89	European Terrestrial Reference System 1989
ETRS89-LAEA	Lambert Azimuthal Equal Area
EVRS	European Vertical Reference System
FE	Filter Encoding
GCM	General Conceptual Model
GML	Geographic Markup Language
GN	Geographical Names
GRS80	Geodetic Reference System 1980
HY	Hydrography
ICAO	International Civil Aviation Organization
IR	Implementing Rule
ISDSS	Interoperability of Spatial Data Sets and Services
ISO	International Organization for Standardization
ITRS	International Terrestrial Reference System
JRC	Joint Research Centre
LADM	Land Administration Domain Model
LAT	Lowest Astronomical Tide
LC	Land Cover
LMO	Legally Mandated Organization
LoD	Level Of Detail
LU	Land Use

MF	Meteorological geographical Features
MS	Member State
NMCA	National Mapping and Cadastral Agency
NZ	Natural Risk Zones
OGC	Open Geospatial Consortium
OI	Orthoimagery
PD	Population Distribution
PF	Production and Industrial Facilities
RGB	Red Green Blue
SDIC	Spatial Data Interest Community
SE	Style Encoding
SU	Statistical Units
TG	Technical Guidance
TN	Transport Networks
TWG	Thematic Working Group
UML	Unified Modeling Language
URI	Uniform Resource Identifier
US	Utility and Governmental Services
UTC	Coordinated Universal Time
UTF	Unicode Transformation Format
WFS	Web Feature Service
WMS	Web Map Service
XML	EXtensible Markup Language

2.6 How the Technical Guidelines map to the Implementing Rules

The schematic diagram in Figure 10 gives an overview of the relationships between the INSPIRE legal acts (the INSPIRE Directive and Implementing Rules) and the INSPIRE Technical Guidelines. The INSPIRE Directive and Implementing Rules include legally binding requirements that describe, usually on an abstract level, *what* Member States must implement.

In contrast, the Technical Guidelines define *how* Member States might implement the requirements included in the INSPIRE Implementing Rules. As such, they may include non-binding technical requirements that must be satisfied if a Member State data provider chooses to conform to the Technical Guidelines. Implementing these Technical Guidelines will maximise the interoperability of INSPIRE spatial data sets.

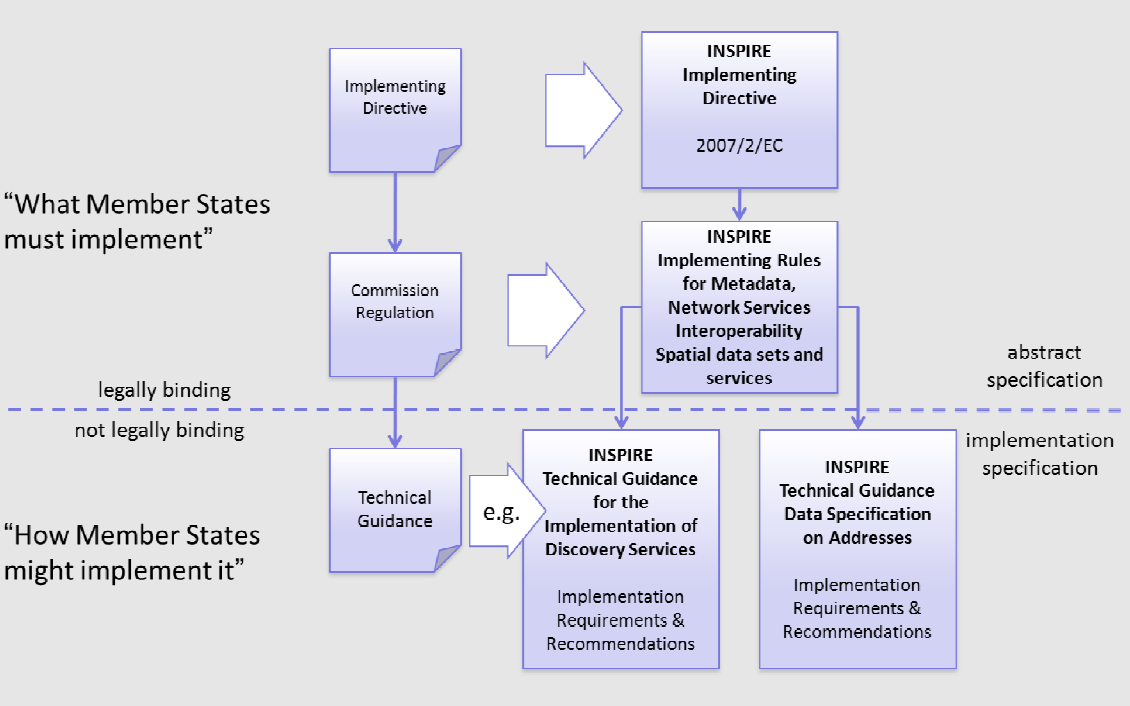

Figure 10 - Relationship between INSPIRE Implementing Rules and Technical Guidelines

2.6.1 Requirements

The purpose of these Technical Guidelines (Data specifications on *Buildings*) is to provide practical guidance for implementation that is guided by, and satisfies, the (legally binding) requirements included for the spatial data theme *Buildings* in the Regulation (Implementing Rules) on interoperability of spatial data sets and services. These requirements are highlighted in this document as follows:

IR Requirement
Article / Annex / Section no.
Title / Heading

This style is used for requirements contained in the Implementing Rules on interoperability of spatial data sets and services (Commission Regulation (EU) No 1089/2010).

For each of these IR requirements, these Technical Guidelines contain additional explanations and examples.

NOTE The Abstract Test Suite (ATS) in Annex A contains conformance tests that directly check conformance with these IR requirements.

Furthermore, these Technical Guidelines may propose a specific technical implementation for satisfying an IR requirement. In such cases, these Technical Guidelines may contain additional technical requirements that need to be met in order to be conformant with the corresponding IR requirement *when using this proposed implementation*. These technical requirements are highlighted as follows:

TG Requirement X	This style is used for requirements for a specific technical solution proposed in these Technical Guidelines for an IR requirement.

NOTE 1 Conformance of a data set with the TG requirement(s) included in the ATS implies conformance with the corresponding IR requirement(s).

NOTE 2 In addition to the requirements included in the Implementing Rules on interoperability of spatial data sets and services, the INSPIRE Directive includes further legally binding obligations that put additional requirements on data providers. For example, Art. 10(2) requires that Member States shall, where appropriate, decide by mutual consent on the depiction and position of geographical features whose location spans the frontier between two or more Member States. General guidance for how to meet these obligations is provided in the INSPIRE framework documents.

2.6.2 Recommendations

In addition to IR and TG requirements, these Technical Guidelines may also include a number of recommendations for facilitating implementation or for further and coherent development of an interoperable infrastructure.

Recommendation X	Recommendations are shown using this style.

NOTE The implementation of recommendations is not mandatory. Compliance with these Technical Guidelines or the legal obligation does not depend on the fulfilment of the recommendations.

2.6.3 Conformance

Annex A includes the abstract test suite for checking conformance with the requirements included in these Technical Guidelines and the corresponding parts of the Implementing Rules (Commission Regulation (EU) No 1089/2010).