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Geographic information — Indoor feature model

Information géographique — Modèle d'entités intérieures

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 287, *Geographic Information,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Various location-based indoor applications, such as indoor navigation, indoor car parking and indoor emergency response, are increasingly involved in daily lives and the management of public buildings. These applications need information on indoor features (such as floors, rooms, doors and windows) and their spatial associations to describe the environment inside a building. Accordingly, many application systems and related standards have been developed in recent years.

OGC CityGML 3.0[4] is designed as a universal information model that defines object types and attributes which are useful for a broad range of applications. For the building model, CityGML focuses on the semantic definitions of buildings and their parts (e.g. walls, roofs, dormers, doors, windows, etc.) and the representation of the relations between those features. However, CityGML does not specify strict rules as to which semantic objects have to be included in a specific Level of Detail (LoD) model.[7] Although the CityGML model can be extended by the Application Domain Extension (ADE) mechanism by adding new object types or new properties for specific applications, it is possible to specify different ADEs for different information communities. Every ADE may add their specific properties to the same CityGML feature type as they can all belong to the same substitution group.[6] These CityGML feature types can also have the problem of semantic heterogeneity in sharing and intergrading datasets.

OGC IndoorGML 1.1[4] defines the representation and exchange of indoor navigation network models. It aims to establish a common schema for indoor navigation applications by modelling the topology and semantics of indoor spaces, which are needed for the components of navigation networks.[2] An IndoorGML document contains external links to referenced objects specified in other data sets such as CityGML and IFC (Industry Foundation Classes), where the objects in the external data set include geometric information.[2]

The Industry Foundation Classes (IFC) (ISO 16739-1), an open international standard for Building Information Model (BIM) data, provide detailed 3D geometries and rich semantics to describe architectural components and engineering constructions of buildings. IFC aims to cover the whole project lifecycle, i.e. the "plan", "design", "construct", "operate" and "maintain" phases of buildings with more than 600 classes in different categories. However, IFCs contain too much architectural information and are too complex to be used in their current format for indoor emergency situations.[11] It is not necessary to use all these classes for a specific application such as indoor navigation.[9] However, some information on the architectural components and engineering constructions of buildings defined in IFC can be extracted to describe the attributes of indoor features used in location-based indoor applications to describe indoor spatial environments to help people to implement their works or plans efficiently.

ISO/TS 19166 provides a conceptual framework for mapping BIM to Geographic Information Systems (GIS) with three mapping mechanisms, Perspective Definition (B2GPD), Element Mapping (B2GEM) and LOD Mapping (B2GLM). It focuses on the definition of BIM to GIS conceptual mapping requirements and framework without a bi-directional mapping method and the definition of physical schema. It cannot be used directly to guide which indoor features are to be extracted from BIM to describe indoor environments for location-based indoor applications. Different information communities can set different rules for the mapping from BIM to GIS and then produce GIS databases with different indoor features for the same building. This would make the sharing and integration of databases difficult.

OGC Indoor Mapping Data Format (IMDF)[5] provides a generalized, yet comprehensive model for any indoor location, providing a basis for orientation, navigation and discovery (19-089r1). IMDF mainly focuses on the contents of individual indoor features related to navigation issues and does not define a general structure of these indoor elements to cover the relationship between indoor spaces or features.

Therefore, a relatively independent and concise indoor feature model is needed for describing the required features of an indoor spatial environment for location-based indoor applications such as indoor navigation, indoor addressing, indoor car parking and indoor emergency response. This model could provide a common reference to guide the collection and organization of indoor spatial information, and serve as the foundation of a conceptual model for data mapping and sharing among various application systems.

This document defines such an indoor feature model by following the rules of application schema defined in ISO 19109. A dataset compliant with this document can serve as the common basic database in various location-based (LBS) indoor applications and facilitate data sharing and integrating among different platforms or applications. This document can be beneficial in reducing the overlapping efforts in the

production of the basic database of buildings, and it can also be useful in the transfer of indoor-application platforms or systems with little adjustments from one building to another building based on the common basic database. The intention is for various stakeholders (including indoor data producers and users of location-based indoor application systems) to have a unified understanding of these features for the unambiguous retrieval of information.

Based on this document, a series of profiles can be specified for various location-based indoor applications for example, a profile for indoor navigation or way-finding by linking with a geometric and topological relationship specified in IndoorGML, or a profile for a fire emergency by adding the features related to firefighting emergency utilities.

This document provides two informative annexes to present the class-level referenced relationship between the Indoor Feature Model and BuildingModel of CityGML 3.0, IFC of ISO 16739-1 and IndoorGML.

Geographic information — Indoor feature model

1 Scope

This document specifies a core semantic classification system of essential indoor features to describe indoor environments required commonly in various location-based indoor applications of buildings. The scope includes the following:

— semantic description of indoor features and their attributes;

— feature association between indoor features.

The semantic classification system in this document is compatible with the building model defined in existing related standards. Geometric and topological descriptions of indoor features are not considered in this document. This document does not apply to other architectural structures, such as tunnels.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 19103, *Geographic information — Conceptual schema language*

ISO 19107, *Geographic information — Spatial schema*

ISO 19108, *Geographic information — Temporal schema*

ISO 19109, *Geographic information — Rules for application schema*

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

ISO 16739-1, *Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries — Part 1: Data schema*

ISO 6707-1, *Buildings and civil engineering works — Vocabulary — Part 1: General terms*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
feature
abstraction of real-world phenomena

Note 1 to entry: A feature can occur as a type or an instance. Feature type or feature instance will be used when only one is meant.

[SOURCE: ISO 19101-1:2014, 4.1.11]

3.2
feature attribute
characteristic of a *feature* (3.1)

Note 1 to entry: A feature attribute has a name, a data type, and a value domain associated to it. A feature attribute for a feature instance also has an attribute value taken from the value domain.

[SOURCE: ISO 19101-1:2014, 4.1.12, modified — Examples 1 and 2 along with Notes 2 and 3 have been removed.]

3.3
feature association
relationship that links instances of one *feature type* (3.4) with instances of the same or a different feature type

[SOURCE: ISO 19110:2016, 3.3]

3.4
feature type
class of *features* (3.1) having common characteristics

[SOURCE: ISO 19156:2023, 3.9]

3.5
indoor entity feature
feature (3.1) constructed as indoor architectural components or features attached for a specific use inside a building

EXAMPLE Windows, doors, furniture and facilities are indoor entity features.

3.6
indoor space feature
feature (3.1) that contains *indoor entity features* (3.5) or is used as a place for a specific purpose inside a building, or both

EXAMPLE Rooms, balconies and pathways are indoor space features.

3.7
indoor map
portrayal of an *indoor entity feature* (3.5) and *indoor space features* (3.6) as a digital image or vector file suitable for display on a computer screen

4 Symbols and abbreviated terms

4.1 Abbreviated terms

BIM building information model

GML geography markup language

HMMG Harmonized Model Maintenance Group

IFC industry foundation classes

IFM indoor feature model

LBS location-based service

OGC Open Geospatial Consortium

UML unified modelling language

URI uniform resource identifier

4.2 UML notation

In this document, conceptual schemas are presented in the unified modelling language (UML). The specific profile of UML used in this document is presented in ISO 19103.

5 Conformance

This document defines one conformance class:

— "Indoor Feature Model" (specification target: Indoor Feature Model);

A specification, standard, test suite or test tool claiming conformance to this document shall implement the conformance class relevant to that specification target.

Conformance with this document shall be assessed using all the relevant conformance test cases specified in Annex A of this document.

All requirements specified in this document belong to the Indoor Feature Model requirements class, which is identified by the URI https://standards.isotc211.org/19164/-1/req/IndoorFeatureModel.

Identifiers of requirements and conformance tests specified in this document are relative to https://standards.isotc211.org/19164/-1.

The name and contact information of the maintenance agency for this document can be found at www.iso.org/maintenance_agencies.

6 General

The Indoor Feature Model (IFM) defines a unified structure and description of the generic indoor features which can be understood consistently by users (including indoor data producers, developers and users of location-based indoor applications). The generic indoor features are the basic components constructing the spatial environments inside a building, and the feature attributes and feature associations provide information about these components. One of the applications of IFM is to provide the spatial information to make an indoor map to represent the spatial layouts of these basic components and their characteristics visually.

7 Relationship with the existing International Standards

Figure 1 illustrates the relationship between IFM defined in this document and other International Standards related to indoor data and application schema. This document follows the rules of application schema defined in ISO 19109. The conceptual schema is presented in UML in conformance with ISO 19103.

IFM refers to relative classes and enumerations defined in ISO 16739-1 (IFC) and CityGML and takes IndoorGML, CityGML and IFC as the external data sources of topological and geometric information of IFM.

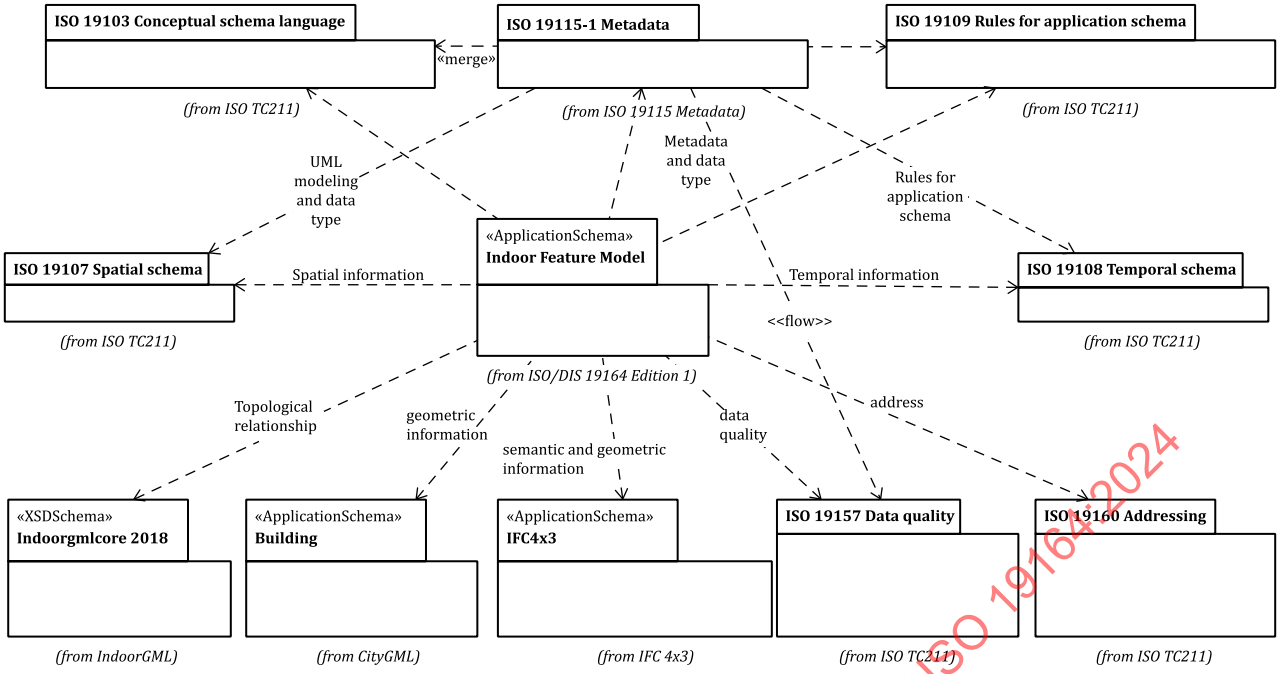
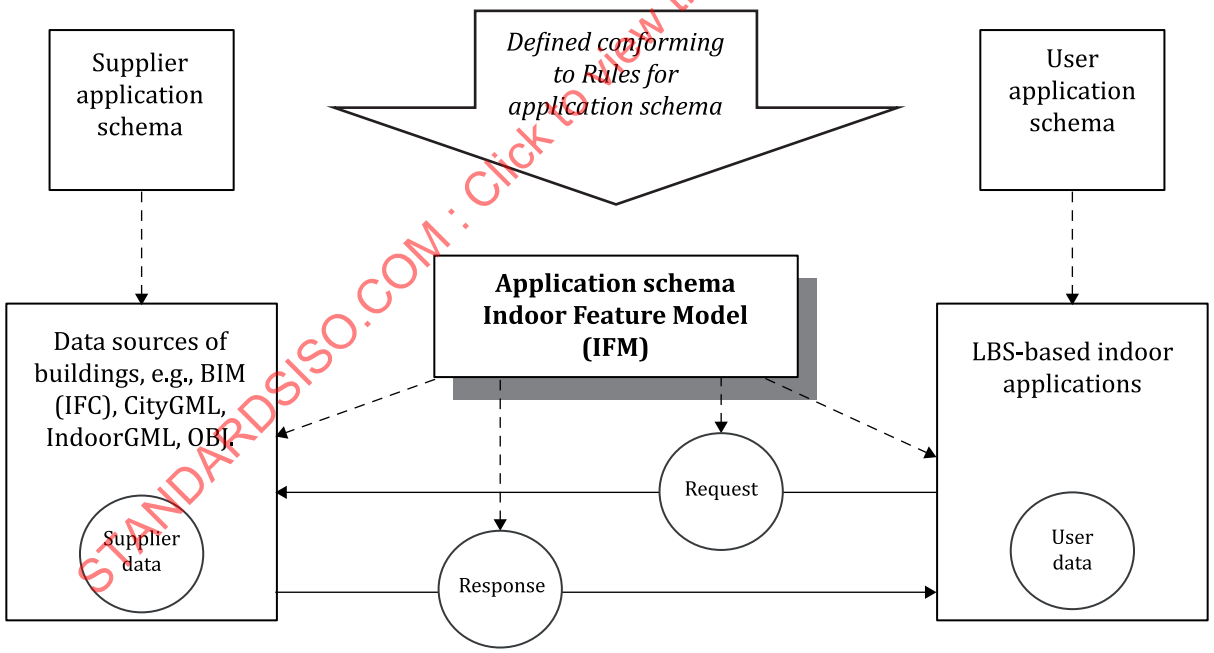


Figure 1 — Relationship with ISO and OGC standards

Following the rules of the application pattern defined in ISO 19109 on data interchange, Figure 2 shows the role of IFM in data interchange between supplier data sources and user data sources related to LBS-based applications.



NOTE Modified from ISO 19109:2015. The unbroken lines show the flow of data. Broken lines denote the role of the application schema on the data interchange.

Figure 2 — The role of IFM on data interchange

8 Indoor Feature Model

8.1 Indoor top features

IFM defines the semantic structure of a minimal set of the generic feature types, feature attributes and feature associations of a building, especially a large public building or office building, with complex structures, multiple functions and diverse public users (Figure 3). These generic feature types should be involved as the basic datasets for location-based indoor applications such as indoor navigation for shopping or car parking, emergency escape, and management of facilities or instruments in a hospital. The building components which are irrelevant to location-based services are not covered in this model.

A building can span over several connected or disconnected buildings to make up a building complex (ISO 16739-1). A building complex (BuildingComplex class) is a complex feature (the definition in ISO 19109 applies), which is composed of more than one individual building (Building class). Each building is composed of multiple floors, also called levels or storeys.

Several floors can have a specific usage or ownership as a building subdivision. Examples of building subdivisions are commercial floors, office floors and accommodation floors in a building. A floor can composite several floor subdivisions according to the usage or ownership or both. An example of floor subdivision is the waiting area, commercial area and boarding area on a floor of an airport.

Each floor is composed of various indoor space features and indoor entity features. Indoor space features may contain indoor entity features. AbstractIndoorSpaceFeature is an abstract superclass to describe the common attributes of space feature classes. AbstractIndoorEntityFeature is an abstract superclass to describe the common attributes of indoor constructive features and attached features.

The detailed descriptions of the attributes of the feature types and their associations shall be in accordance with the data dictionary of Annex B. Annexes C, D and E present the class-level referenced relationship between IFM of this document and the BuildingModel of CityGML 3.0, IFC (ISO 16739-1) and IndoorGML 1.1.

Requirement 1 /req/IndoorFeatureModel/BasicInfo

Each indoor top feature type shall use the basic information as specified in B.32.1.

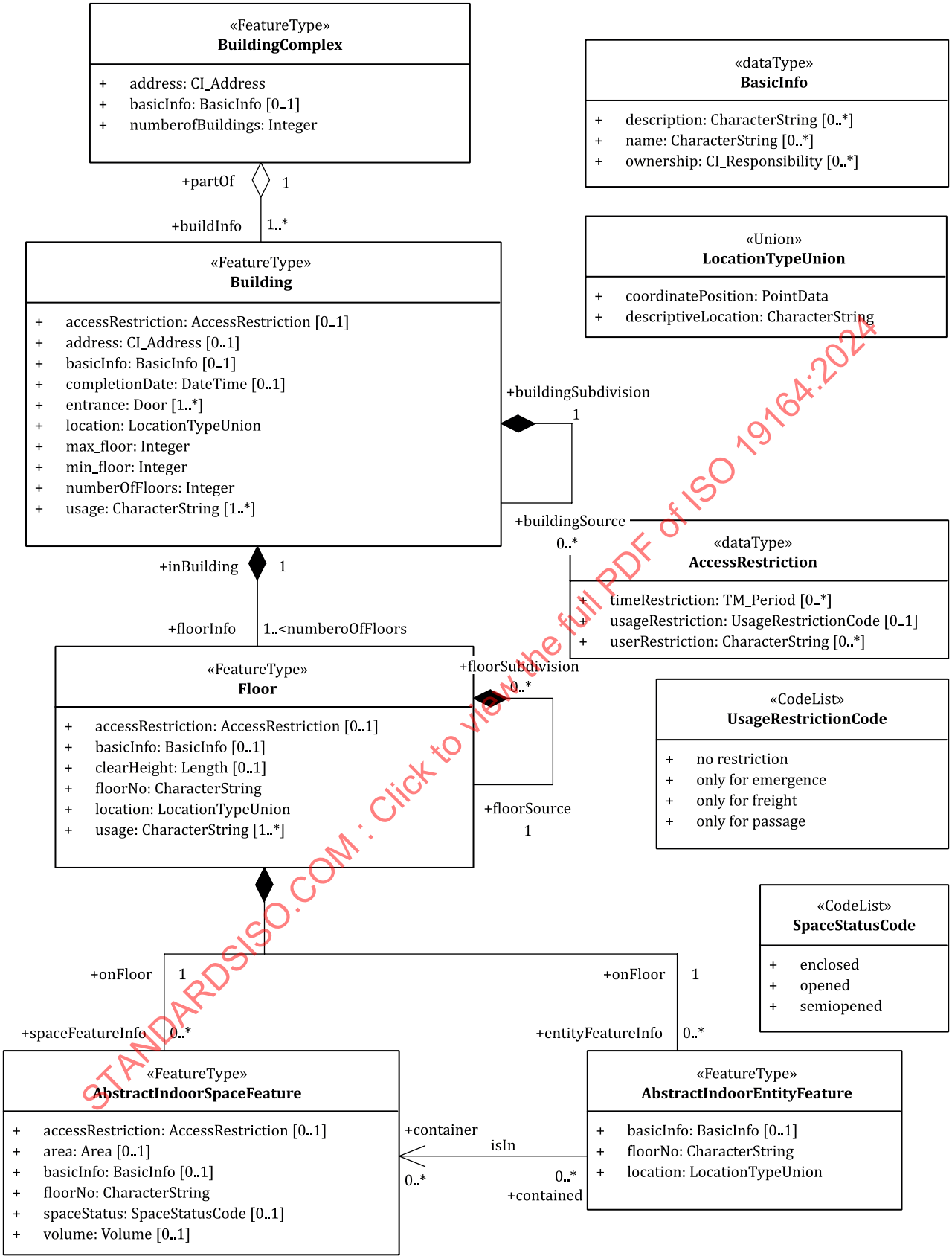


Figure 3 — Indoor top features

Requirement 2 /req/IndoorFeatureModel/BuildingComplex

The BuildingComplex class shall be used to describe a group of buildings included in a site, as specified in Clause B.2.

Requirement 3 /req/IndoorFeatureModel/Building

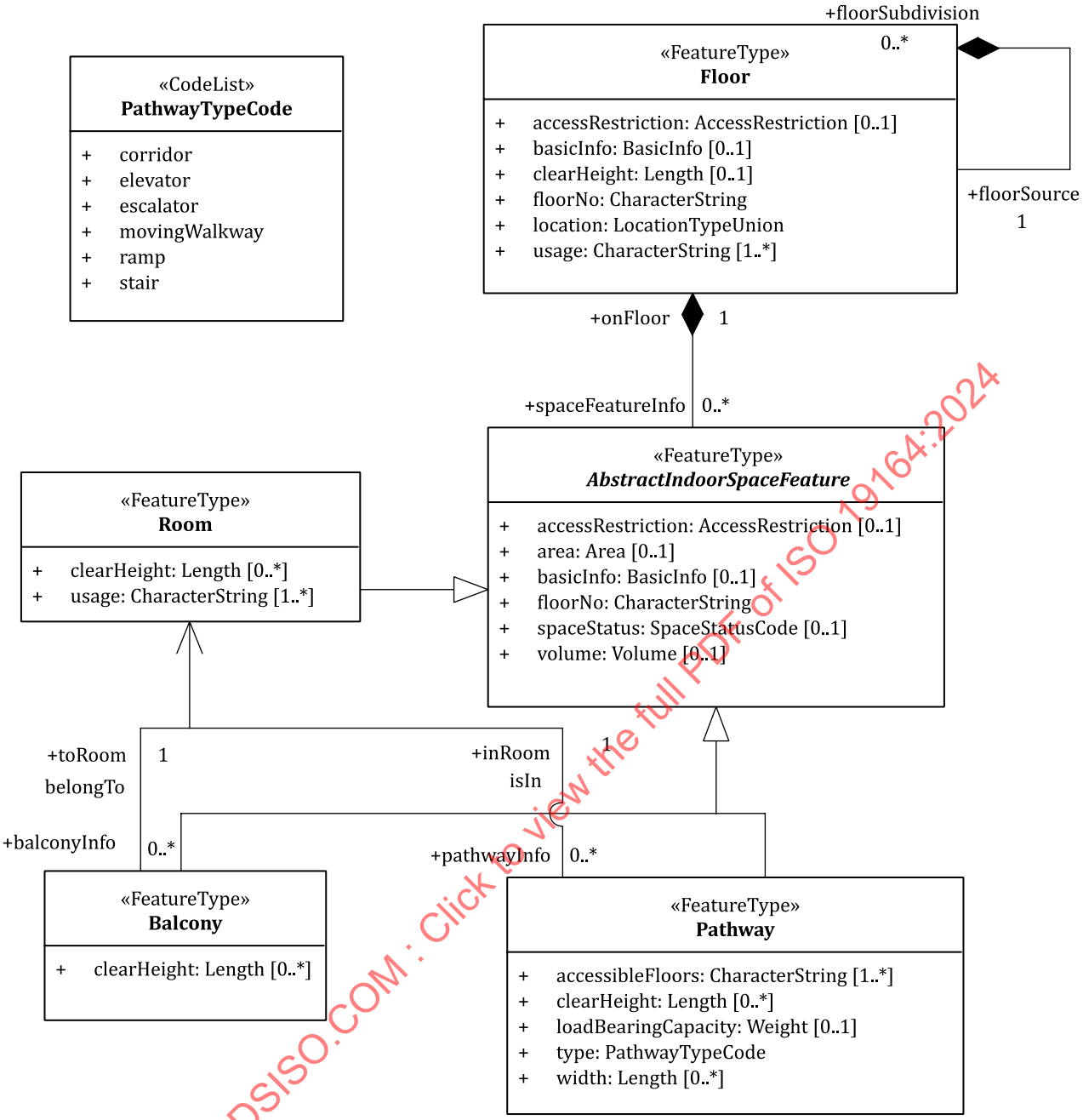
The Building class shall be used to describe the characteristics of a building, as specified in Clause B.3.

8.2 Indoor space features

AbstractIndoorSpaceFeature is an abstract superclass for describing the common attributes of space feature classes (Figure 4). Table 1 lists the subclasses of AbstractIndoorSpaceFeature.

Requirement 4 /req/IndoorFeatureModel/AbstractIndoorSpaceFeature

AbstractIndoorSpaceFeature class shall describe the common attributes (as specified in Clause B.5) of indoor space feature subclasses (as specified in (Figure 4 and Table 1).



NOTE The classes are designed from a common understanding of these features in the real world and the descriptions of the classes are based information from References [14], [15], [16], [17] or existing ISO standards.

Figure 4 — Indoor Space Features

Table 1 — Description of indoor space feature classes

Class	Description
Room	An internal space in a building intended for specific usages, open or surrounded by walls, doors, floor surface and ceiling. The details of Room are specified in Clause B.22.
Balcony	A raised platform enclosed by one or more walls, zero or one ceiling and/or balustrade connected to the side of a building, with access from a window or door. The details of Balcony are specified in Clause B.23.
Pathway	A linking space between different places (e.g. different floors, rooms or buildings). The details of Pathway are specified in Clause B.24.

The Pathway class describes the common attributes of various pathways, including stair, elevator, escalator, corridor, moving walkway, ramp, etc. in a building. The descriptions of the Pathway and its subclasses are defined in Figure 5 and Table 2.

Requirement 5 /req/IndoorFeatureModel/Pathway

The Pathway class shall describe the common attributes of pathway subclasses as specified in Figure 5 and Table 2.

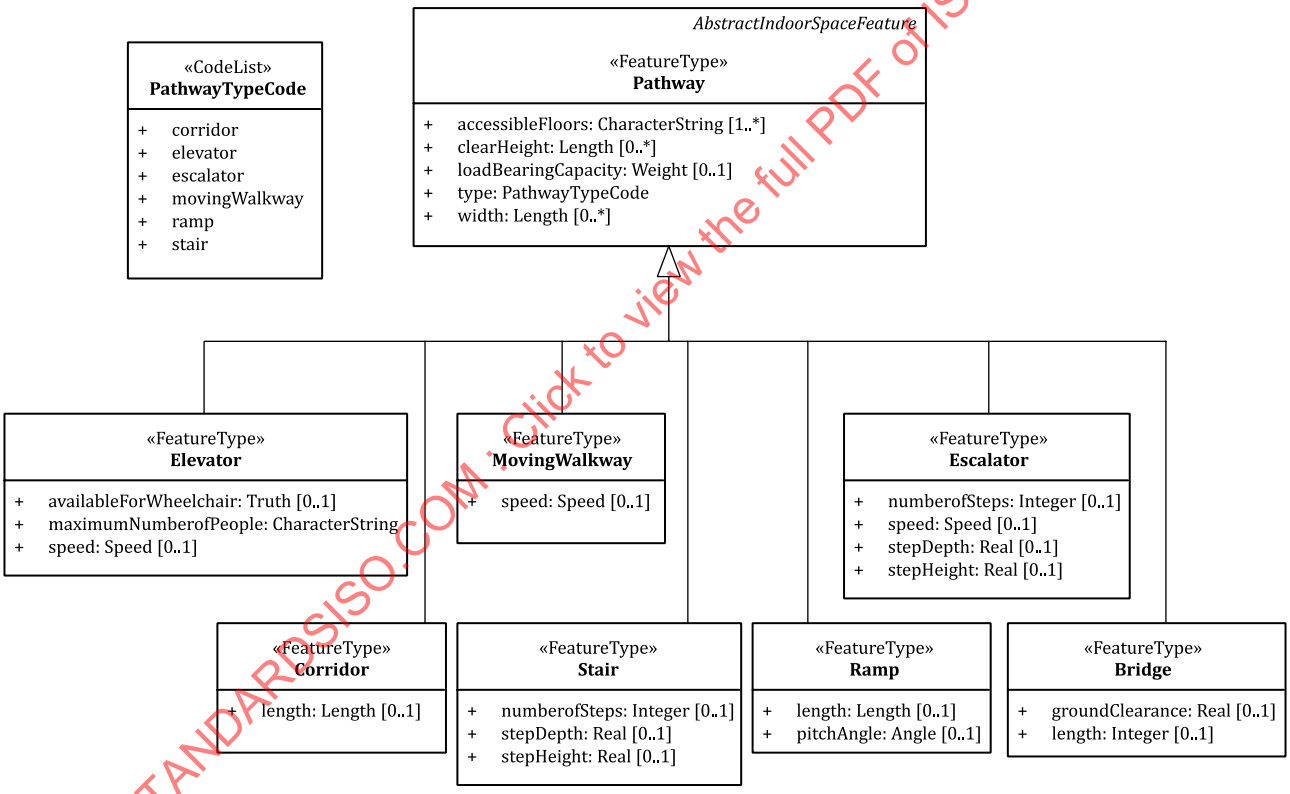


Figure 5 — Pathway class and subclasses

Table 2 — Description of subclasses of Pathway

Class	Description
Stair	A vertical pathway allowing occupants to walk (step) from one floor level to another floor level at a different elevation.[a] The details of Stair are specified in Clause B.25.
Elevator	A conveyor transport device for carrying people and freights (vertically) between floors in a building, also called a "lift. The details of Elevator are specified in Clause B.26.
Escalator	A vertically-moving stair used as a conveyor transport device for carrying people between floors in a building. The details of Escalator are specified in Clause B.27.
MovingWalkway	A slow-moving conveyor pathway that transports people across a horizontal or inclined plane. The details of MovingWalkway are specified in Clause B.28.
Ramp	A vertical pathway which provides a human circulation link between one floor level and another floor level at a different elevation. A ramp normally does not include steps.[a] The details of Ramp are specified in Clause B.29.
Corridor	A narrow and enclosed circulation space that gives access to rooms or other spaces.[b] The details of Corridor are specified in Clause B.30.
Bridge	An aerial pathway built within or between buildings to allow people or vehicles to traverse from one side to the other. The details of Bridge are specified in Clause B.31.

8.3 Indoor entity features

AbstractIndoorEntityFeature is an abstract superclass for describing the common attributes of the subclasses (Figure 6). Table 3 lists the subclasses of AbstractIndoorEntityFeature.

Requirement 6 /req/IndoorFeatureModel/AbstractIndoorEntityFeature

The AbstractIndoorEntityFeature class shall describe the common attributes (as specified in Clause B.6) of constructive features and attached features, which are defined as subclasses (as specified in Figure 6 and Table 3).

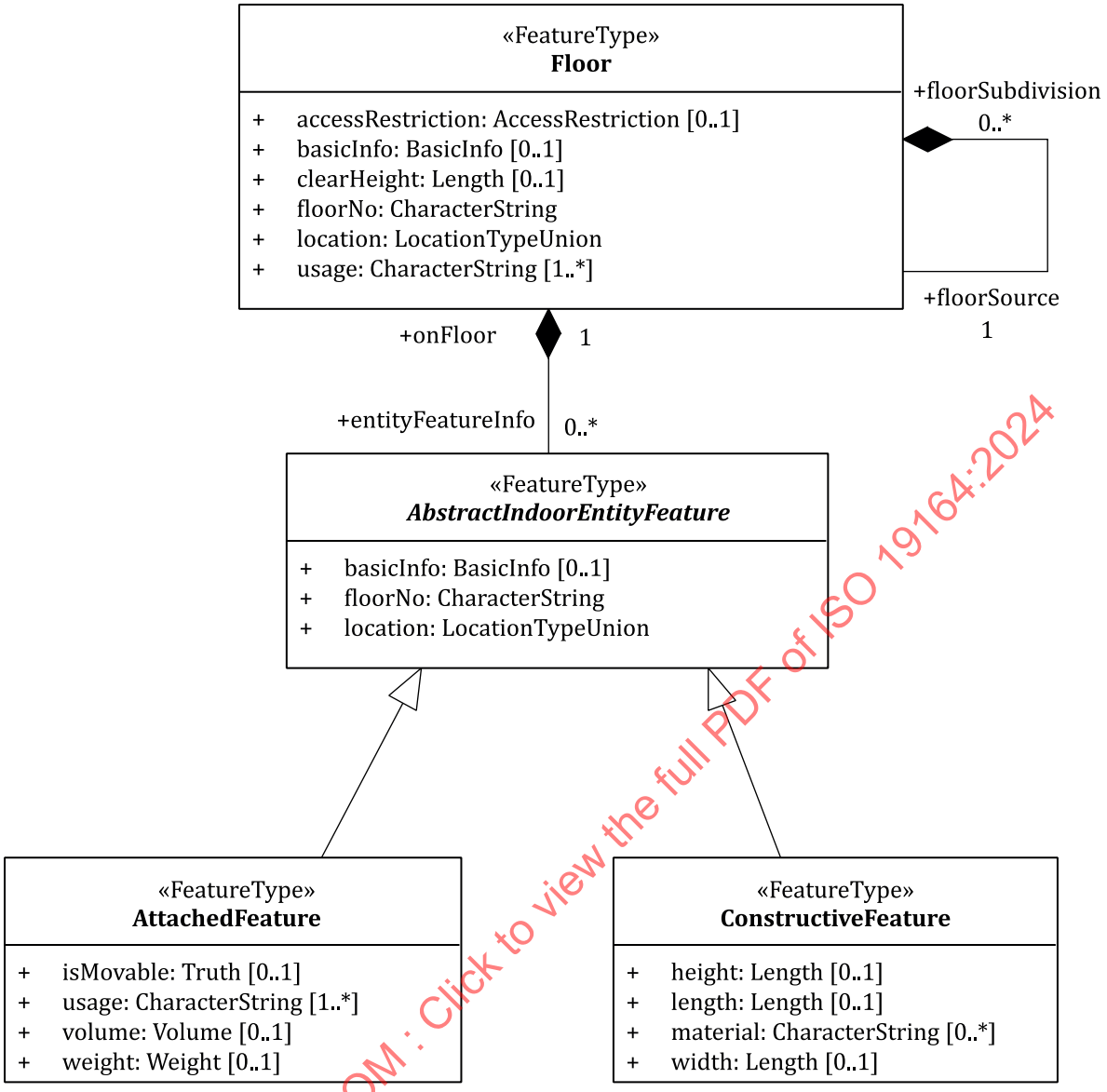


Figure 6 — Indoor Entity Features

Table 3 — Description of indoor entity feature classes

Class	Description
AttachedFeature	Features attached to a specific space in a building related to the special usages (see 8.5). The details of AttachedFeature are specified in Clause B.7.
ConstructiveFeature	Features are constructed as the inherent components of a building, which are related to LBS applications in a building (see 8.4). The details of ConstructiveFeature are specified in Clause B.13.

8.4 Constructive features

The ConstructiveFeature class describes the common attributes of some constructive features related to LBS applications (including wall, celling, railing, slab, etc.) in a building (Figure 7). Table 4 lists the subclasses of ConstructiveFeature.

Requirement 7 /req/IndoorFeatureModel/ConstructiveFeature

The ConstructiveFeature class shall describe the common attributes of constructive features in a building, as specified in Figure 7 and Table 4.

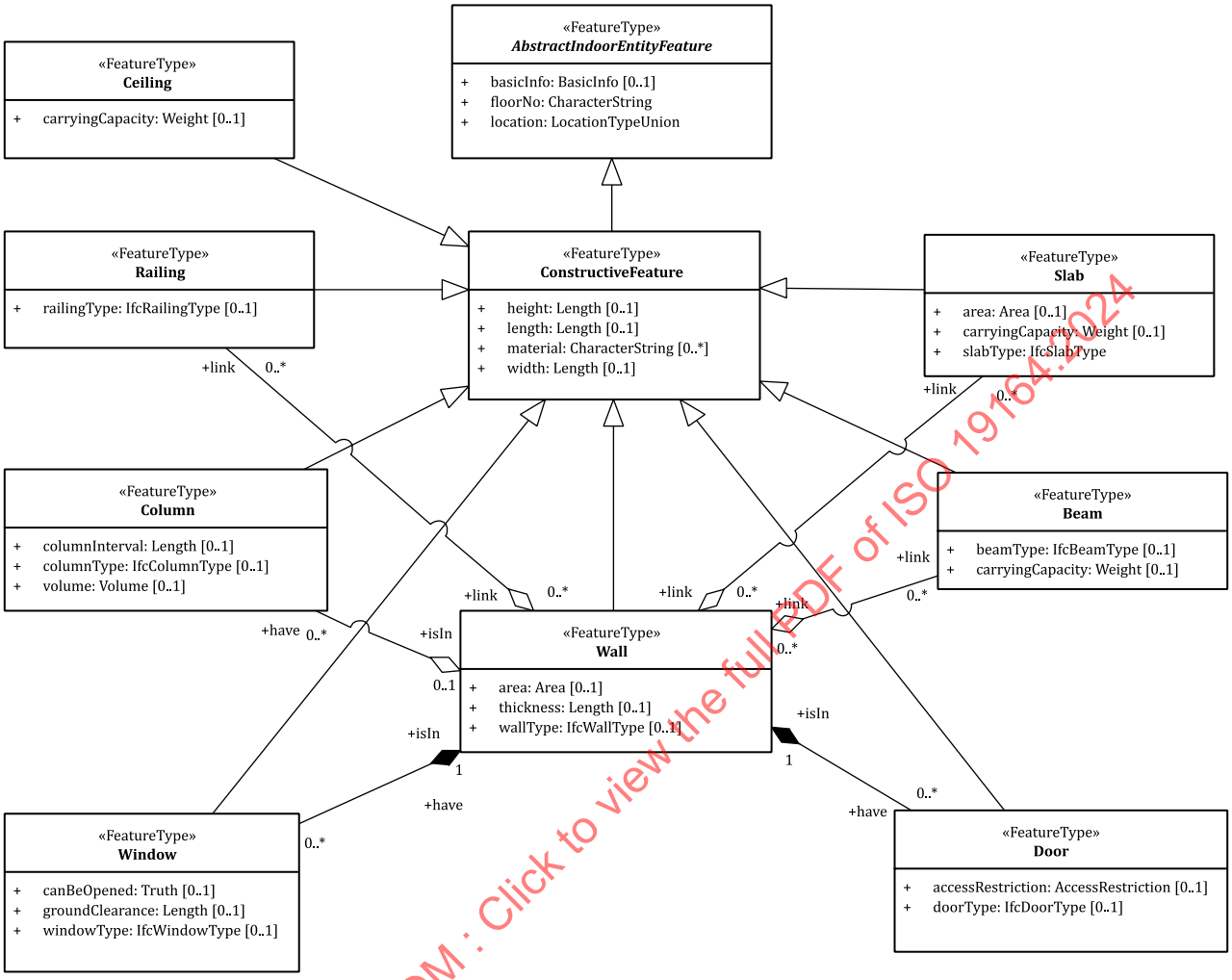


Figure 7 — ConstructiveFeature class and subclasses

Table 4 — Description of subclasses of ConstructiveFeature

Class	Description
Wall	A vertical construction that bounds or subdivides a space and usually fulfils a loadbearing or retaining function.[a] The details of Wall are specified in Clause B.14.
Door	A construction for closing an opening intended primarily for access or egress or both.[a] The details of Door are specified in Clause B.15.
Window	A construction for closing a vertical or near-vertical opening in a wall or pitched roof, which will admit light and can provide ventilation.[a] The details of Window are specified in Clause B.16.
Column	(pillar, GB) A structural member of slender form, usually vertical, that transmits to its base the forces, primarily in compression, that are applied to it.[a] The details of Column are specified in Clause B.17.
Ceiling	A construction covering the underside of a floor or roof, and providing the overhead surface of an enclosed space, often to conceal structural members or services.[a] The details of Ceiling are specified in Clause B.18.
Beam	A horizontal, or nearly horizontal, structural member that is capable of withstanding load primarily by resisting bending.[b] The details of Beam are specified in Clause B.19.
Slab	A construction providing the lower support (floor) or upper construction (roof slab, ceiling) in any space in a building.[b] The details of Slab are specified in Clause B.20.
Railing	A frame assembly adjacent to human circulation spaces and at some space boundaries where it is used in lieu of walls or to compliment walls.[b] The details of Railing are specified in Clause B.21.

8.5 Attached features

The AttachedFeature class describes the features attached to a specific space related to special usages (including facility, furniture, etc.) in a building (Figure 8). Table 5 lists the subclasses of AttachedFeature.

Requirement 8 /req/IndoorFeatureModel/AttachedFeature

The AttachedFeature class shall describe the common attributes of attached features in a building, as specified in Figure 8 and Table 5.

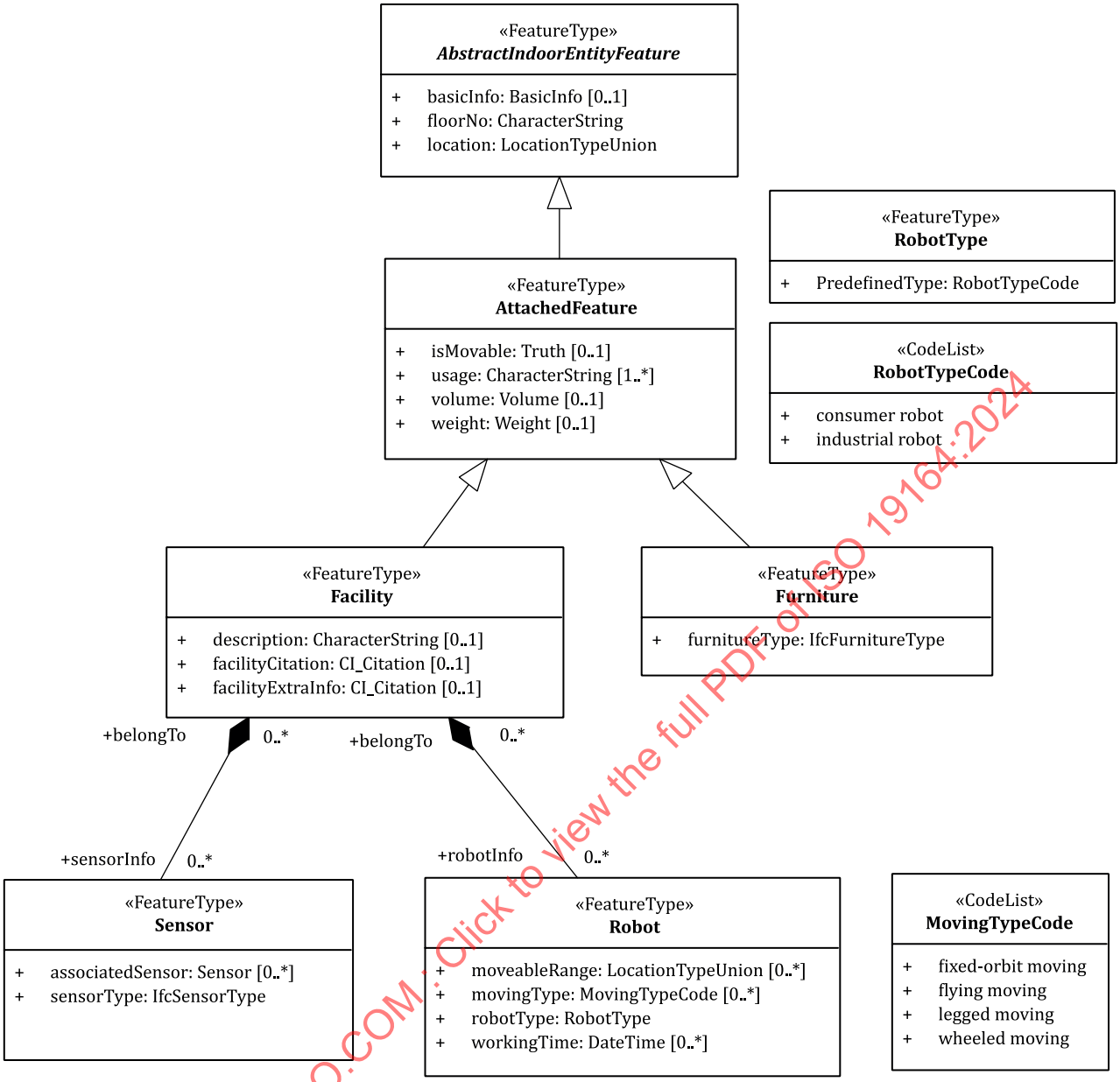


Figure 8 — AttachedFeature class and subclasses

Table 5 — Description of subclasses of AttachedFeature

Class	Description
Facility	A movable or unmovable instrument or equipment installed and utilized within a building, making an activity (e.g. action, operation) easier. The details of Facility are specified in Clause B.8.
Furniture	A furnishing such as a table, desk, chair or cabinet, which is permanently or non-permanently attached to a building structure.[a] The details of Furniture are specified in Clause B.9.
Sensor	A device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument.[a] The details of Sensor are specified in Clause B.10.
Robot	A machine that can do the work of a person and that works automatically or is controlled by a computer. The details of Robot are specified in Clause B.11.

8.6 Geometric and topological information

Geometric and topological descriptions of indoor features are not considered in this document. In case of an external data source whose geometric and/or topological model matches IFM feature types, the geometric and/or topological information of the external data sources can be linked with IFM-based datasets during implementation.

Geometric and related information of IndoorGML, CityGML and IFC-based data may be linked to IFM if needed.

Permission 1 /per/IndoorFeatureModel/topology

IFM may link with a geometric and topological relationship defined in IndoorGML for the implementation of indoor navigation or wayfinding.

Permission 2 /per/IndoorFeatureModel/CityGMLObject

IFM may reference links to CityGML objects for further geometric and semantic modelling and take CityGML data as one of the data sources for implementation.

Permission 3 /per/IndoorFeatureModel/IFCObject

IFM may reference links to IFC objects for further geometric and semantic modelling and take IFC data as one of the data sources for implementation.

9 Extension mechanism of IFM

9.1 General

An Application Domain Extension (ADE) can be modelled directly in the XML schema or can be generated by extending the UML model of IFM with application-specific information and later deriving the XML schema from it.

Permission 4 /per/IndoorFeatureModel/Extension

Therefore, similarly to CityGML, ADEs may use elements from the IFM to associate extra attributes to the existing classes and derive application-specific subclasses.

IFM accepts two types of extension: attribute hooking and subclasses.

9.2 Attribute hooking

Every IFM feature class has a GML "hook" of the form "GenericApplicationPropertyOf<Featuretypename>" in its XML schema definition. For example, GenericApplicationPropertyOfFloor can be used to attach a new attribute “numberOfElevator” to Floor class.

<element name="FloorNo" type="CharacterString" />

<element name="numberOfElevator" type="xsd:positive Integer" substitutionGroup="GenericApplicationPropertyOfFloor"/>

9.3 Subclasses

The IFM can be extended with new classes for new feature types as subclasses of the existing IFM classes. The subclasses can also use the same stereotype «FeatureType» as the IFM classes. As shown in Figure 9, the IFM Door class is extended with a new feature type “FireproofDoor” as a subclass with new attributes “fireProtectionLevel” and “fireResistantTime”.

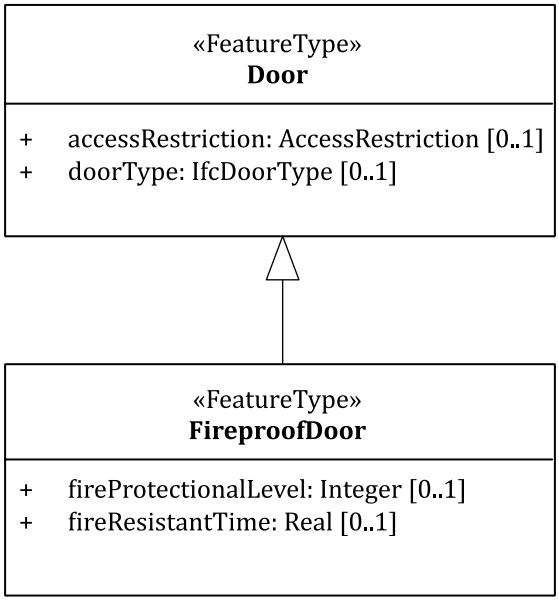


Figure 9 — Example for subclass extension

Annex A
(normative)

Abstract test suite

A.1 General

This annex specifies an Abstract Test Suite which shall be passed by any implementation claiming conformance with this document.

A.2 Conformance Test Class: Indoor Feature Model

A.2.1 General

The URI identifier of this conformance class is: https://standards.isotc211.org/19164/-/1/conf/IndoorFeatureModel.

The URI identifier of this requirements class is: https://standards.isotc211.org/19164/-/1/req/IndoorFeatureModel.

Tests identifiers below are relative to https://standards.isotc211.org/19164/-/1.

A.2.2 Basic description

a) Test ID: /conf/IndoorFeatureModel/BasicInfo

b) Test purpose: Verify that each indoor top feature type shall use the basic description as specified in the data dictionary of B.32.1.

c) Test method: Inspect the content of the data intended to support IFM. Each indoor top feature instance shall use the basic description as specified in the data dictionary of B.32.1. Test passes if constraint evaluates to be "true".

A.2.3 BuildingComplex

a) Test ID: /conf/IndoorFeatureModel/BuildingComplex

b) Test purpose: Verify that the BuildingComplex class is used to describe a group of buildings included in a site, as specified in Clause B.2.

c) Test method: Inspect the content of the data intended to support the indoor feature model, check that BuildingComplex instance contains information as specified in Clause B.2. Test passes if constraint evaluates to be "true".

A.2.4 Building

a) Test ID: /conf/IndoorFeatureModel/Building

b) Test purpose: Verify that the Building class is used to describe the characteristics of a building as specified in Clause B.3.

c) Test method: Inspect the content of the data intended to support IFM, check that Building instance contains the characteristics of a building as specified in Clause B.3. Test passes if the constraint evaluates to be "true".

A.2.5 AbstractIndoorSpaceFeature

a) Test ID: /conf/IndoorFeatureModel/AbstractIndoorSpaceFeature

b) Test purpose: Verify that the AbstractIndoorSpaceFeature class is an abstract superclass to describe the common attributes of indoor space feature classes, which are defined as subclasses in Table 1.

c) Test method: Inspect the content of the data intended to support IFM, check that the instance of AbstractIndoorSpaceFeature subclass contains the common attributes of indoor space feature classes, which are defined as subclasses in Table 1. Test passes if constraint evaluates to be "true".

A.2.6 Pathway

a) Test ID: /conf/IndoorFeatureModel/Pathway

b) Test purpose: Verify that the Pathway class is used to describe the common attributes of pathways in a building, as described in Table 2.

c) Test method: Inspect the content of the data intended to support IFM, check that the Pathway instance contains common attributes of pathways in a building, as described in Table 2. Test passes if constraint evaluates to be "true".

A.2.7 AbstractIndoorEntityFeature

a) Test ID: /conf/IndoorFeatureModel/AbstractIndoorEntityFeature

b) Test purpose: Verify that the AbstractIndoorEntityFeature class is an abstract superclass to describe the common attributes of constructive features and attached features, which are defined as subclasses in Table 4.

c) Test method: Inspect the content of the data intended to support IFM, check that the instance of AbstractIndoorEntityFeature subclass contain the common attributes of constructive features and attached features, which are defined as subclasses in Table 4. Test passes if constraint evaluates to be "true".

A.2.8 ConstructiveFeature

a) Test ID: /conf/IndoorFeatureModel/ConstructiveFeature

b) Test purpose: Verify that the ConstructiveFeature class is used to describe common attributes of constructive features related to LBS applications in a building, as described in Figure 8 and Table 4.

c) Test method: Inspect the content of common attributes of constructive features related to LBS applications in a building, check that the instance of ConstructiveFeature contains the common attributes of constructive features as described in Figure 8 and Table 4. Test passes if constraint evaluates to be "true".

A.2.9 AttachedFeature

a) Test ID: /conf/IndoorFeatureModel/AttachedFeature

b) Test purpose: Verify that the AttachedFeature class is used to describe the common attributes of attached features in a building, as described in Figure 9 and Table 5.

c) Test method: Inspect the content of the data intended to support IFM, check that the AttachedFeature instance contains the common attributes of attached features in a building, as described in Figure 9 and Table 5. Test passes if constraint evaluates to be "true".

Annex B
(normative)

Data dictionary

B.1 General

Tables B.1 to B.38 define the detailed information of the classes included in the Indoor Feature Model in Figure 4. In the column of “Obligation”, “M” means that the attribute is mandatory (to be specified), “O” means that the attribute is optional (to be specified as necessary). In the column of “Maximum occurrence”, “*” means that the attribute can have more than one value.

The column headed "Data type" lists the data type or class for each attribute. The given data types (e.g. Integer, CharacterString) shall conform to the corresponding definition in ISO 19103. The given classes shall conform to the referenced classes defined in this document or in the following International Standards: ISO 19107, ISO 19108, ISO 19115-1 and ISO 16739-1, which are listed in the column headed "Domain".

B.2 BuildingComplex class

Table B.1 — BuildingComplex class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
	BuildingComplex	Root entity that defines the general information about building complex	Use obligation from referencing object	Use maximum occurrence from referencing object	Class	
1.	basicInfo	The basic information about a building complex including name and ownership.	O	*	DataType	BasicInfo (B.32.1)
2.	address	The address of a building complex	M	1	Class	CI_Address (ISO 19115:2014)
3.	numberofBuildings	The number of individual buildings made up a building complex	M	1	Integer	ISO 19103
4.	Role name: buildingInfo	Information on individual buildings that make up a building complex	M	*	Class	Building (Clause B.3)

B.3 Building class

Table B.2 — Building class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
5.	Building	Information of building	Use obligation from referencing object	Use maximum occurrence from referencing object	Class	
6.	basicInfo	The basic information including name and ownership.	O	1	DataType	BasicInfo (B.32.1)
7.	address	The address of a building	M	1	Class	CI_Address (ISO 19115-1)
8.	location	The location of a building	M	1	Union	LocationTypeUnion (B.33)
9.	usage	The function of a building	M	1	CharacterString	ISO 19103
10.	numberofFloors	The number of floors in a building	M	1	Integer	ISO 19103
11.	max_floor	The No. of the top floor	M	1	Integer	ISO 19103
12.	min_floor	The No. of the bottom floor	M	1	Integer	ISO 19103
13.	entrance	The entrance entity of a building	M	*	Class	Door (Clause B.15)
14.	completionDate	The date of completion of a building	O	1	DateTime	ISO 19103
15.	accessRestriction	Accessing restrictions of a building	O	1	DataType	AccessRestriction(B.32.2)
16.	Role name: buildingSubdivision	Information on building subdivisions of a building	O	*	Class	Building (Clause B.3)
17.	Role name: floor	Information on floors in a building	O	*	Class	Floor (Clause B.4)

B.4 Floor class

Table B.3 — Floor class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
18.	Floor	Information about the floor in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Aggregated Class (Building)	
19.	basicInfo	The basic information including name and ownership	O	1	DataType	BasicInfo(B.32.1)
20.	location	The location of a floor	M	1	Union	LocationTypeUnion(B.33)
21.2	floorNo	The number or name of a floor	M	1	CharacterString	ISO 19103
22.	usage	The utility of a floor	M	*	CharacterString	ISO 19103

Table B.3 *(continued)*

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
23.	clearHeight	The clear height of a floor, interior net storey height	O	1	Length	ISO 19103
24.	accessRestriction	Accessing restrictions of a floor	O	1	DataType	AccessRestriction(B.32.2)
25.	Role name: floorSubdivision	Information on floor subdivisions on a floor	O	*	Class	Floor (Clause B.4)

B.5 AbstractIndoorSpaceFeature class

Table B.4 — AbstractIndoorSpaceFeature class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
26.	AbstractIndoorSpaceFeature	Information about the abstract indoor space feature	Use obligation from referencing object	Use maximum occurrence from referencing object	Aggregated Class (Floor)	
27.	basicInfo	The basic information including name and ownership	O	1	Class	BasicInfo (B.32.1)
28.	floorNo	The number or name of the floor in which a space feature lies	M	1	DateTime	ISO 19103
29.	accessRestriction	Accessing restrictions of a space feature	O	1	DataType	AccessRestriction (B.32.2)
30.	spaceStatus	The space status of an indoor space	O	1	CodeList	SpaceStatusCode (B.34.3)
31.	area	The area of an indoor space	O	1	Area	ISO 19103
32.	volume	The volume of a space feature	O	1	Volume	ISO 19103

B.6 AbstractIndoorEntityFeature class

Table B.5 — AbstractIndoorEntityFeature class

	Name	Definition	Obligation	Max imum occurrence	Data type	Domain
33.	AbstractIndoorEntityFeature	Information of the abstract indoor entity feature	Use obligation from referencing object	Use maximum occurrence from referencing object	Aggregated Class (Floor)	
34.	basicInfo	The basic information including name and ownership	O	*	Class	BasicInfo (B.32.1)
35.	floorNo	The number or name of the floor in which an entity feature lies	M	1	CharacterString	ISO 19103
36.	location	The location of the indoor feature	M	1	Union	LocationTypeUnion (Clause B.33)

B.7 AttachedFeature class

Table B.6 — AttachedFeature class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
37.	AttachedFeature	Information about an attached feature	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (AbstractIndoorEntityFeature)	
38.	isMovable	Whether or not an attached feature is movable	O	1	Boolean	ISO 19103
39.	usage	The usage of an attached feature	M	*	CharacterString	ISO 19103
40.	volume	The volume of an attached feature	O	1	Volume	ISO 19103
41.	weight	The weight of an attached feature	O	1	Weight	ISO 19103

B.8 Facility class

Table B.7 — Facility class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
42.	Facility	Information about a facility in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (AttachedFeature)	
43.	facilityCitation	The citation of a facility which could be added by users	O	1	Class	CI_Citation (ISO 19115-1)
44.	description	The information about a facility	O	1	CharacterString	ISO 19103
45.	facilityExtraInfo	The extra information about a facility	O	1	Class	CI_Citation (ISO 19115-1)

B.9 Furniture class

Table B.8 — Furniture class

	Name	Definition	Obligation	Maximum ccurrence	Data type	Domain
46.	Furniture	Information about furniture in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (AttachedFeature)	
47.	type	The type of furniture	M	1	Class	IfcFurnitureType (ISO 16739-1)

B.10 Sensor class

Table B.9 — Sensor class

	Name	Definition	Obligation	Max o	Data type	Domain
48.	Sensor	Information about a sensor in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Aggregated Class (Facility)	
49.	sensorType	The type of sensor	M	1	Class	IfcSensorType (ISO 16739-1)
50.	associatedSensor	The associated sensors of a sensor	O	*	Class	Sensor (Clause B.10)

B.11 Robot class

Table B.10 — Robot class

	Name	Definition	Obligation	Max Occurrence	Data Type	Domain
51.	Robot	Information about a robot in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Aggregated Class (Facility)	
52.	robotType	The type of robot	M	1	Class	RobotType (Clause B.12)
53.	moveableRange	The moveable range of a robot	M	*	Union	LocationTypeUnion(B.33)
54.	workingTime	The working time of a robot	O	*	DateTime	ISO 19103
55.	movingType	The moveable type of a robot	O	*	CodeList	MovingTypeCode (B.34.1)

B.12 RobotType class

Table B.11 — RobotType Class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
56.	RobotType	Information about the type of robot in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	FeatureType	
57.	PredefinedType	The type of robot	M	1	CodeList	RobotTypeCode (B.34.4)

B.13 ConstructiveFeature class

Table B.12 — ConstructiveFeature class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
58.	Constructive-Feature	Information about the constructive feature	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (AbstractIndoorEntityFeature)	
59.	height	The height of a constructive feature	O	1	Length	ISO 19103
60.	length	The length of a constructive feature	O	1	Length	ISO 19103
61.	width	The width of a constructive feature	O	1	Length	ISO 19103
62.	material	The material of a constructive feature	O	*	CharacterString	ISO 19103

B.14 Wall class

Table B.13 — Wall class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
63.	Wall	Information about a wall in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (ConstructiveFeature)	
64.	area	The area of a wall	O	1	Area	ISO 19103
65.	thickness	The thickness of a wall	O	1	Length	ISO 19103
66.	wallType	The type of wall	O	1	Class	IfcWallType (ISO 16739-1)

B.15 Door class

Table B.14 — Door class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
67.	Door	Information about a door in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (ConstructiveFeature)	
68.	accessRestriction	Accessing restriction of a door	O	1	DataType	AccessRestriction (B.32.2)
69.	doorType	The type of door	M	1	Class	IfcDoorType (ISO 16739-1)

B.16 Window class

Table B.15 — Window class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
70.	Window	Information about a window in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (ConstructiveFeature)	
71.	canBeOpened	Identify whether a window can be opened	0	1	Boolean	ISO 19103
72.	groundClearance	The ground clearance of a window	0	1	Length	ISO 19103
73.	windowType	The type of window	0	1	Class	IfcWindowType (ISO 16739-1)

B.17 Column class

Table B.16 — Column class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
74.	Column	Information about a column in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (ConstructiveFeature)	
75.	volume	The volume of a column	0	1	Volume	ISO 19103
76.	columnInterval	The interval distance between adjacent columns	0	1	Length	ISO 19103
77.	columnType	The type of column	0	1	Class	IfcColumnType (ISO 16739-1)

B.18 Ceiling class

Table B.17 — Ceiling class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
78.	Ceiling	Information about a ceiling in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (ConstructiveFeature)	
79.	carryingCapacity	The carrying capacity of a ceiling	0	1	Weight	ISO 19103

B.19 Beam class

Table B.18 — Beam class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
80.	Beam	Information about a beam in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (ConstructiveFeature)	
81.	beamType	The type of beam	O	1	Class	IfcBeamType (ISO 16739-1)
82.	carryingCapacity	The carrying capacity of a beam	O	1	Weight	ISO 19103

B.20 Slab class

Table B.19 — Slab class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
83.	Slab	Information about a slab in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (ConstructiveFeature)	
84.	slabType	The type of slab	M	1	Class	IfcSlabType (ISO 16739-1)
85.	carryingCapacity	The carrying capacity of a slab	O	1	Weight	ISO 19103
86.	area	The area of a slab	O	1	Area	ISO 19103

B.21 Railing class

Table B.20 — Railing

	Name	Definition	Obligation	Max Occurrence	Data Type	Domain
87.	Railing	Information about a railing in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (ConstructiveFeature)	
88.	railingType	The type of railing	O	1	class	IfcRailingType (ISO 16739-1)

B.22 Room class

Table B.21 — Room class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
89.	Room	Information about a room in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (AbstractIndoorSpaceFeature)	
90.	usage	The usage of a room	M	*	CharacterString	ISO 19103
91.	clearHeight	The clear height of a room	O	*	Length	ISO 19103

B.23 Balcony class

Table B.22 — Balcony class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
92.	Balcony	Information about a balcony in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (AbstractIndoorSpaceFeature)	
93.	clearHeight	The clear height of a balcony (If there is a ceiling, the height of a balcony is the clear height, the distance between the floor surface and the ceiling. If there is no ceiling, this attribute can be blank.)	O	*	Length	ISO 19103

B.24 Pathway class

Table B.23 — Pathway class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
94.	Pathway	Information about a pathway in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (AbstractIndoorSpaceFeature)	
95.	type	The type of pathway on a floor or between floors	M	1	CodeList	PathwayTypeCode (B.34.2)
96.	accessibleFloors	The accessible floors of a pathway	M	*	CharacterString	ISO 19103
97.	clearHeight	The clear height of a pathway if it has a ceiling.	O	*	Length	ISO 19103
98.	width	The width of a pathway	O	*	Length	ISO 19103
99.	loadBearingCapacity	The load bearing capacity of a pathway	O	1	Weight	ISO 19103

B.25 Stair class

Table B.24 — Stair class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
100.	Stair	Information about a stair in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (Pathway)	
101.	numberofSteps	The number of steps of a stair	O	1	Integer	ISO 19103
102.	stepHeight	The height of a step	O	1	Real	ISO 19103
103.	stepDepth	The depth of a step	O	1	Real	ISO 19103

B.26 Elevator class

Table B.25 — Elevator

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
104.	Elevator	Information about an elevator in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (Pathway)	
105.	maximumNumberofPeople	The maximum number of people that can be carried	M	1	Integer	ISO 19103
106.	availableForWheelchair	Whether or not an elevator is available for wheelchairs (If not available, this elevator cannot be included in the route selection for a person with a wheelchair.)	O	1	Boolean	ISO 19103
107.	speed	The moving speed of an elevator	O	1	Speed	ISO 19103

B.27 Escalator class

Table B.26 — Escalator class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
108.	Escalator	Information about an escalator in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (Pathway)	
109.	numberofSteps	The number of steps of an escalator	0	1	Integer	ISO 19103
110.	stepHeight	The height of a step	0	1	Real	ISO 19103
111.	stepDepth	The depth of a step	0	1	Real	ISO 19103
112.	speed	The moving speed of an escalator	0	1	Speed	ISO 19103

B.28 MovingWalkway class

Table B.27 — MovingWalkway class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
113.	MovingWalkway	Information about a moving walkway in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (Pathway)	
114.	speed	The moving speed of a moving walkway	0	1	Speed	ISO 19103

B.29 Ramp class

Table B.28 — Ramp class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
115.	Ramp	Information about a ramp in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (Pathway)	
116.	pitchAngle	The pitch angle of a ramp	0	1	Angle	ISO 19103
117.	length	The length of a ramp	0	1	Length	ISO 19103

B.30 Corridor class

Table B.29 — Corridor class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
118.	Corridor	Information about a corridor in a building	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (Pathway)	
119.	length	The length of a corridor	O	1	Length	ISO 19103

B.31 Bridge class

Table B.30 — Bridge class

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
118.	Bridge	Information about a bridge within or between buildings	Use obligation from referencing object	Use maximum occurrence from referencing object	Specified Class (Pathway)	
119	groundClearance	Ground clearance of a bridge	O	1	Real	ISO 19103
120.	length	The length of a corridor	O	1	Length	ISO 19103

B.32 Data Type definition

B.32.1 BasicInfo

Table B.31 — BasicInfo

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
120.	BasicInfo	Basic information on an object	Use obligation from referencing object	Use maximum occurrence from referencing object	Class <<DataType>>	
121.	name	Name of the object	O	1	CharacterString	ISO 19103
122.	description	Descriptive information on the object	O	*	CharacterString	ISO 19103
123.	ownership	Information about the people or organization that owns the object	O	1	Class	CI_Responsibility (ISO 19115-1)

B.32.2 AccessRestriction

Table B.32 — AccessRestriction

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
124.	AccessRestriction	Accessing restriction of a space	Use obligation from referencing object	Use maximum occurrence from referencing object	Class <<DataType>>	
125.	timeRestriction	The period during which a space can be accessed	O	*	Class	TM_Period (ISO 19108)
126.	userRestriction	The user who can access a space	O	*	CharacterString	ISO 19103
127.	usageRestriction	The restriction of usage	O	1	CodeList	UsageRestrictionCode (B.34.5)

B.33 Union definition — LocationTypeUnion

Table B.33 — LocationTypeUnion

	Name	Definition	Obligation	Maximum occurrence	Data type	Domain
128.	LocationTypeUnion	Traffic direction of an object	Use obligation from referencing object	Use maximum occurrence from referencing object	Class <<DataType>>	
129.	coordinatePosition	Position defined with point coordinates	M	1	Class	PointData (ISO 19107)
130.	descriptiveLocation	Location expressed with descriptive location	M	1	CharacterString	ISO 19103

B.34 CodeList definition

B.34.1 MovingTypeCode

Table B.34 — MovingTypeCode

	Name	Domain code	Definition
131.	MovingTypeCode	MovingTypeCode	The type of moving mode in an indoor space
132.	fixed-orbit moving	001	Fixed-orbit moving
133.	wheeled moving	002	Wheeled moving
134.	legged moving	003	Legged moving
135.	flying moving	004	Flying moving

B.34.2 PathwayTypeCode

Table B.35 — PathwayTypeCode

	Name	Domain code	Definition
136.	PathwayTypeCode	PathwayTypeCode	The type of Pathway in an indoor space
137.	elevator	001	A conveyor transport device for carrying people and freights (vertically) between floors in a building, also called a "lift"
138.	escalator	002	A vertically moving stair used as a conveyor transport device for carrying people between floors in a building
139.	stair	003	A vertical pathway allowing occupants to walk (step) from one-floor level to another floor level at a different elevation
140.	corridor	004	A narrow hallway to provide access between rooms inside an indoor space
141.	movingWalkway	005	A slow-moving conveyor pathway that transports people across a horizontal or inclined plane
142.	ramp	006	A vertical pathway which provides a human circulation link between one floor level and another floor level at a different elevation. A ramp normally does not include steps
143.	bridge	007	An aerial pathway built within or between buildings to allow people or vehicles to traverse from one side to the other

B.34.3 SpaceStatusCode

Table B.36 — SpaceStatusCode

	Name	Domain code	Definition
144.	SpaceStatusCode	SpaceStatusCode	The space status of an indoor space
145.	enclosed	001	The indoor space can be enclosed
146.	semiopened	002	The indoor space is opened on one or more sides but not completely opened
147.	opened	003	The indoor space is completely opened

B.34.4 RobotTypeCode

Table B.37 — RobotTypeCode

	Name	Domain code	Definition
148.	RobotTypeCode	RobotTypeCode	The type of robot
149.	consumer robot	001	Consumer robots are robots used just for fun or to finish tasks and chores
150.	industrial robot	002	The traditional industrial robot consists of a manipulator arm designed to perform repetitive tasks

B.34.5 UsageRestrictionCode

Table B.38 — UsageRestrictionCode

	Name	Domain code	Definition
151.	UsageRestrictionCode	UsageRestrictionCode	The type of usage restriction
152.	noRestriction	001	No usage restriction
153.	onlyForEmergency	002	Only used during emergency
154.	onlyForPassenger	003	Only used by passenger
155.	onlyForFreight	004	Only used for freight

Annex C
(informative)

The referenced relationship with BuildingModel of CityGML 3.0

C.1 Overview

The Building module of CityGML provides the representation of thematic and spatial aspects of buildings. This annex discusses the referenced relationship between the IFM and BuildingModel of CityGML 3.0. This relationship involves taking CityGML 3.0 as one of the data sources for the implementation of the IFM.

C.2 Referenced relationship related to building and floor

The base class of BuildingModel of CityGML 3.0 is AbstractBuilding, which is a subclass of AbstractConstruction, and the base class of the BuildingModel is General Feature Model::AnyFeature.

IFM simplifies the structural elements of the Building Model of CityGML 3.0 and adds elements recording the environment features and spaces, their attributes and spatial relationship (Figure C.1).