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Intelligent transport systems — Indoor navigation for personal and vehicle ITS stations —

Part 2: Requirements and specification for indoor maps

Systèmes de transport intelligents — Navigation interne pour station personnelle et véhicules ITS —

Partie 2: Exigences et spécifications pour les cartes d'intérieure

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Foreword

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

A list of all parts in the ISO 17438 series can be found on the ISO website.

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

With the spread of nomadic and mobile devices such as smart phones and the rapid expansion of indoor spaces, many of the services and facilities related to the transport system have become accessible to indoor spaces. Consequently, navigation in indoor space is considered a new killer application in the transport industry.

The objective of this document is to provide a basic data model and encoding format for indoor positioning reference data required for indoor navigation functionality for ITS applications. This document is intended to be used by designers, developers and providers of indoor navigation services. When implemented, this document is intended to:

1) provide developers and designers with concepts and appropriate information to implement indoor navigation services;

2) provide developers and designers with interoperable ways to use indoor navigation data from various sources for indoor navigation;

3) enable the provision of indoor navigation services to users;

4) provide developers and designers with an extendable base for indoor navigation.

Intelligent transport systems — Indoor navigation for personal and vehicle ITS stations —

Part 2: Requirements and specification for indoor maps

1 Scope

This document defines requirements and specifications of indoor positioning references, which can be referenced for positioning in indoor space, for supporting indoor navigation functionality of a personal/vehicle (P/V) ITS station.

NOTE Specific structure and contents of indoor positioning references depend on types of indoor positioning technologies.

This document defines:

a) the composition of an indoor map for indoor navigation of P/V ITS stations;

b) the schema and encoding format of the indoor map for indoor navigation at the P/V ITS stations.

This document focuses on the specification and format of the indoor map. The following issues which are adjunctive but essential for commercial navigation services are beyond the scope of this document:

— authorized and authenticated access of users and services, including security;

— payment;

— preparation of indoor data which are necessary for indoor navigation;

— low-level communication protocols required to transfer and share data from and to a roadside ITS station or a central ITS station;

— other issues dependent on implementation of an instance of indoor navigation.

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 13184-2, *Intelligent transport systems (ITS) — Guidance protocol via personal ITS station for advisory safety systems — Part 2: Road guidance protocol (RGP) requirements and specification*

ISO 17438-1, *Intelligent transport systems — Indoor navigation for personal and vehicle ITS station — Part 1: General information and use case definition*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13184-2 and ISO 17438-1 and the following 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/

3.1.1
nomadic device
ND
implementation of a personal ITS station which provides communication connectivity via portable equipment such as cellular telephones, wireless communication network (3G, 4G and 5G), mobile wireless broadband (WIMAX, HC-SDMA, etc.), etc. and includes short range links, such as IEEE 802.11x, etc. to connect portable devices to the motor vehicle communications system network

Note 1 to entry: In detail, nomadic devices that have hardware security modules and have been certified to be ITS trusted are called a personal ITS station.

[SOURCE: ISO 23795-2:2024, 3.1.1, modified — Note 1 to entry has been added.]

3.1.2
indoor navigation
navigation provided in indoor space

[SOURCE: ISO 17438-4:2019, 3.1.2]

3.1.3
indoor space
space within artificial structures such as buildings and facilities connected with transport corridors or roads

EXAMPLE A building or indoor parking lot.

[SOURCE: ISO 17438-1:2016, 3.1.2]

3.1.4
ITS station
ITS-S
entity in a communication network, comprised of application, facilities, networking and access layer components specified in ISO 21217 that operate within a bounded secure management domain

[SOURCE: ISO 13184-2:2016, 3.5]

3.1.5
personal/vehicle ITS station
P/V-ITS-S
ITS station implemented in a vehicle or nomadic device

[SOURCE: ISO 13184-2:2016, modified — "personal mobile device" has been replaced by "nomadic device" in the definition.]

3.1.6
well-known binary
WKB
binary equivalent used to transfer and store the same information in a more compact form, which is convenient for computer processing but which is not human-readable

3.1.7
well-known text
WKT
text markup language for representing vector geometry objects

3.1.8
roadside ITS station
R-ITS-S
system that receives and processes vehicular and pedestrian information within a certain zone

Note 1 to entry: The system is installed at the roadside.

[SOURCE: ISO 13184-2:2016, 3.9, modified — "and determines the situation, in order to provide the safety warning and parking guide service to vehicles and pedestrians" has been removed from the definition.]

3.1.9
central ITS station
central ITS-S
C-ITS-S
implementation of an ITS-S in a central ITS subsystem

[SOURCE: ISO 13184-4:2019, 3.1.6]

3.1.10
indoor positioning
determination of a location in an indoor space

[SOURCE: ISO 17438-4:2019, 3.1.7]

3.1.11
indoor positioning infrastructure
infrastructure used to determine locations of personal/vehicle ITS stations (P/V-ITS-S) in an indoor space

EXAMPLE WiFi, Bluetooth, etc.

[SOURCE: ISO 17438-4:2019, 3.1.11]

3.1.12
indoor positioning reference
information to support indoor positioning

Note 1 to entry: Detailed specifications and contents of indoor positioning references depend on the specific indoor positioning technologies.

EXAMPLE A good example of an indoor positioning reference is information about indoor positioning infrastructure. For Wi-Fi based positioning, the indoor positioning infrastructure information includes the Wi-Fi APs information, such as location, SSID, and RSSI values of APs.

[SOURCE: ISO 17438-4:2019, 3.1.12, modified — Example 1 and Example 2 have been combined into a single Example.]

3.1.13
indoor navigation data
data needed for indoor navigation, which includes indoor maps and indoor positioning infrastructure information

[SOURCE: ISO 17438-4:2019, 3.1.13]

3.2 Abbreviated terms

ASN	abstract syntax notation
C-ITS-S	central ITS station
CRS	coordinate reference system
EPSG	European Petroleum Survey Group
ITS	intelligent transport systems
ITS-S	ITS station
M/O/C	mandatory/optional/conditional
MO	maximum occurrence
POI	point of interest
P/V-ITS-S	personal/vehicle ITS station
R-ITS-S	roadside ITS station
WKB	well-known binary
WKT	well-known text

4 Requirement and conformance

4.1 Requirements

This document defines use cases and data specifications between a P/V-ITS-S and a C-ITS-S for using indoor maps. In the definitions of data types for supporting the indoor maps, there are mandatory, optional or conditional fields. Mandatory fields shall be provided and conditions for conditional fields shall be satisfied. These are the requirements embedded in the definition of data types for supporting client-based positioning.

Specific encoding of each data types can be adapted for implementation. There can be additional requirements for specific encoding.

4.2 Conformance

For the purpose of conformance to the indoor maps of which specifications are defined in Clause 7, multiplicity of the elements in an indoor map should be observed through their implementations.

5 Conventions

This document is based on the conventions of ASN.1 (Abstract Syntax Notation One) formats.

6 Indoor map for indoor navigation functionality

6.1 Overview

Indoor maps for indoor navigation consist of the following components.

a) Background map — The background map in an indoor mapping system serves as the base layer, providing the fundamental visual guide for users. The background map can be a form of vector and raster maps, which is aligned with a geographic indoor space. By displaying the background map, the

indoor space can be visualized on the user's device. The background map helps ensure that the map provides an effective and accurate representation of the physical environment for users navigating through it.

b) Route network map — The route network map serves as a comprehensive guide for navigation through interconnected pathways within indoor spaces. It outlines the paths, providing information on how different areas of the indoor space are linked together, and how they can be navigated. It details specific points of interest, their types, and the routes connecting them. The map incorporates dynamic features, such as permissible directions of movement, the timings during which specific routes are accessible, and the periodicity of these access times.

c) Space map — The space map provides a representation of the semantic structure of an indoor environment. The semantic structure represents the organization and interrelation of spaces such as rooms, corridors and stairs within one or more buildings, emphasizing the navigable and functional areas rather than the architectural elements that define these spaces. It highlights the relationships between these spaces, facilitating a clear spatial understanding and navigation.

d) Set of POIs — The set of points of interest (POIs) is a collection of notable locations or features that have been marked for special consideration within the indoor maps. These can include specific rooms, areas, individual objects or facilities. Each point in this set is linked to a specific location of indoor nodes or indoor semantic space. It can be highlighted or prioritized for users to navigate the indoor space or find specific locations.

In addition to these components, other types of positioning resources can also be considered according to the configuration of systems and services to be implemented and the type of indoor positioning to be used.

6.2 Scope of indoor maps

This document focuses specifically on requirements and specifications of indoor navigation maps for P/V-ITS stations. It includes the data types and formats for features, network, POIs and base map within indoor maps. Annex A provides the ASN.1 schema encoding.

6.3 Use cases of indoor maps

This document refers to and uses the use cases UC 2.1 – Searching for indoor maps, and UC 2.2 – Retrieving indoor maps, defined in ISO 17438-4:2019, 7.2.2.1 and 7.2.2.2. UC 2.1 is the use case for searching for candidates of indoor maps that satisfy given conditions, and UC 2.2 is the use case for downloading the searched indoor maps. This document defines the contents of indoor maps which are transferred to a P/V-ITS-S, as described in UC 2.2.

7 Definition of indoor map

As described in Table 1, the indoor maps for indoor navigation at a P/V-ITS-S are transferred to a P/V-ITS-S from a C-ITS-S using the "map" attribute of "`indoor-map`" message defined in ISO 17438-4:2019, 8.9.

The whole ASN.1 schema for indoor positioning references shall be as defined in Annex A of this document.

Table 1 defines the "`IndoorMap`" data type, describing an indoor map, which consists of indoor features, indoor networks with relevant indoor cell spaces, indoor POIs and base maps.

Table 1 — Definition of IndoorMap

Type	Name	IndoorMap		
	Description	Describes the indoor map, including indoor features, networks in the form of nodes and edges, indoor POIs and some base maps.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
info	IndoorMapInfo	M	1	The information explaining the indoor map, i.e. a kind of metadata.[a]
features	IndoorFeatures	O	N	A set of features[b] included in the indoor map.[c]
network	IndoorNetwork	O	N	Networks and cell spaces defined in the indoor space.[d,e] The networks consist of indoor nodes and indoor edges describing a semantic network, such as accessibility, and cell spaces representing a semantic space in the indoor space. An indoor node can be a representative point of an indoor cell. An indoor POI can be related to an indoor node or an indoor cell.
pois	POIs	O	N	A set of POIs, included in the indoor map.[a]
bgImages	BackgroundImage	O	N	The set of background images, which serves as a visible base map. One background image is set for one floor.[f]
note	IA5String	O	1	Additional description about the indoor map.
Notes				
[a] See ISO 17438-4:2019, Annex A for the definition. [b] Examples of indoor features are gate, door, etc. The specific list of indoor features for indoor navigation functionality is dependent on implementation. The "features" attribute can be considered as a set of layers, each of which includes specific features of one type. [c] See Table 5 for the definition. [d] See Table 8 for the definition. [e] Most of "network" can be substituted with IndoorCore module classes, described in OGC IndoorGML v1.1, section 7.3, Multi-Layered Space Model. [f] See Table 2 for the definition.				

ASN.1 Schema

```
-- Definition of Indoor map of an indoor space for indoor navigation functionality
IndoorMap ::= SEQUENCE {
   info             IndoorMapInfo,
   features         SEQUENCE OF IndoorFeatures       OPTIONAL,
   network          SEQUENCE OF IndoorNetwork        OPTIONAL,
   pois             SEQUENCE OF POIs                 OPTIONAL,
   bgImages         SEQUENCE OF BackgroundImage      OPTIONAL,
   note             IA5String    OPTIONAL,
   ...
}
```

Example

```
{
   Info { identifier       "MAP001",
          spaceIdentiier   "SPACE001",
          type             "Background2DVector"
   boundary  {points   {{x-coordinate 36.383165, y-coordinate 127.369725},
                        {x-coordinate 36.383302, y-coordinate 127.370632},
                        {x-coordinate 36.384083, y-coordinate 127.370427},
                        {x-coordinate 36.383951, y-coordinate 127.369543}}},
         horizontalCRS    "EPSG:4326"
         format           "png"
         size             117760
         },
   features     {...},    -- refer to the example of Table 5
```

Table 1 *(continued)*

```
   network      {...},    -- refer to the example of Table 8
   pois { name          "Gate01"
          identifier    "pois001"
          location {    x-coordinate     36.38408770533706,
                        y-coordinate     127.370260537845}},
   bgImages      {...},    -- refer to the example of Table 2
   note      "an example of Indoor map of an indoor space"
}
```

Table 2 defines the "BackgroundImage" data type, describing a visible image which is used for visible background in an indoor navigation device, i.e. P/V-ITS-S.

Table 2 — Definition of BackgroundImage

Type	**Name**	**BackgroundImage**		
	Description	Describes a background image which is displayed as background on the screen of a nomadic device acting as a P/V-ITS-S.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
id	BackgroundImageID	M	1	An identifier of a background image.[a]
name	IA5String	O	1	Name of the background image.
floorNo	INTEGER	M	1	Floor number which is presented by the background image. For example, 1, 2, etc. for the first floor, the second floor, etc. For underground floors, the negative number is used.
boundary	ImageMappingArea	M	1	The maximum bounding rectangle which represents where this background image is mapped. It is used when the indoor map is displayed with the outdoor map.[b]
size	INTEGER	M	1	The size of a background image in bytes.
format	IA5String	M	1	The format of a background image. It can be a filename extension, such as, "jpg", "png", etc.
resolution	Resolution	M	1	The resolution of a background image, which consists of number of pixels, in the form of (width, height). For example, (128x128)[c].
img	OCTET STRING	M	1	The binary string of a background image itself.
note	IA5String	O	1	Additional description about the background image.
Notes				
[a] How to construct an identifier of a background image is out of the scope of this document and more consensus is needed for its standardization. [b] See Table 3 for the definition. [c] See Table 4 for the definition.				
ASN.1 Schema				

```
-- Identifier type of an image used as a background
BackgroundImageID ::= IA5String
-- Definition of Image used a background of a display of indoor navigation device
BackgroundImage ::= SEQUENCE {
   id               BackgroundImageID,
   name             IA5String           OPTIONAL,
   floorNo          INTEGER,
   boundary         ImageMappingArea,
   size             INTEGER,
   format           IA5String,
   resolution       Resolution,
   img              OCTET STRING,
```

Table 2 *(continued)*

```
    note              IA5String     OPTIONAL,
    ...
}
```

Example

```
{
    id              "001",
    name            "Lobby",
    floorNo         1,
    boundary    {points    {{x-coordinate 36.383165, y-coordinate 127.369725},
                           {x-coordinate 36.383302, y-coordinate 127.370632},
                           {x-coordinate 36.384083, y-coordinate 127.370427},
                           {x-coordinate 36.383951, y-coordinate 127.369543}}},
    size            117760,
    format          "png",
    resolution      {width 80, height 60},
    img             "0110010101100101011..." -- this is a binary representation,
    note            "This sample image shows the lobby floor in the ETRI Convergence
Commercialization Centre"
}
```

Table 3 defines the "ImageMappingArea" data type, describing an area where a background image is mapped.

Table 3 — Definition of ImageMappingArea

Type	Name	ImageMappingArea		
	Description	Describes a geographic area where a background image is mapped.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
points	Location	M	4	The minimum bounding box which describes a mapping region (area) where a background image is displayed.[a]
note	IA5String	O	1	Additional description about the mapping area.
Notes				
[a] The left and upper corner of the minimum bounding box is mapped to left and upper pixel of the image.				

ASN.1 Schema

```
-- Area where a background image is mapped on (map of) outdoor space
ImageMappingArea ::= SEQUENCE {
    points          SEQUENCE (SIZE(4)) OF Location,
    note            IA5String     OPTIONAL,
    ...
}
```

Example

```
-- refer the example of 'boundary' attribute in Table 2
```

Table 4 defines the "Resolution" data type, describing a resolution of a background image.

Table 4 — Definition of Resolution

Type	Name	Resolution		
	Description	Describes the resolution of an image, consisting of number of pixels.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
width	INTEGER	M	1	Number of pixels of an image in width.

Table 4 *(continued)*

height	INTEGER	M	1	Number of pixels of an image in height.
Notes				
(none)				
ASN.1 Schema				

```
-- Resolution of a background image
Resolution ::= SEQUENCE {
   width      INTEGER,
   height     INTEGER
}
```

Example
`-- refer the example of 'resolution' attribute in Table 2`

Table 5 defines the "`IndoorFeatures`" data type, describing a set of indoor features existing in indoor spaces where indoor navigation is provided.

Table 5 — Definition of IndoorFeatures

Type	**Name**	**IndoorFeatures**		
	Description	Describes a set of indoor features, of which types are same.[a]		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
id	IndoorFeaturesID	M	1	An identifier of a set of indoor features.[b]
featureName	IA5String	M	1	Name of "IndoorFeatures", e.g. Gate.
featureType	IndoorFeatureType	M	1	Type of "IndoorFeatures".[c]
geometryType	GeometryType	M	1	Type of geometry of the "IndoorFeatures".[d]
features	IndoorFeature	M	N	Indoor Features.[e]
note	IA5String	O	1	Additional description about the indoor features.
Notes				

[a] "IndoorFeatures" can be considered as a layer of indoor features, of which the type is the same. For example, Gate, Door etc. can be indoor features.

[b] How to construct an identifier of the indoor features is out of the scope of this document and more consensus is needed for its standardization.

[c] For the definition of indoor feature types, i.e. a kind of code list or enumeration, a pre-defined code list, such as IFC OmniClass code, can be applied.

[d] For the type of geometry, OGC Simple Feature Code is applied.

[e] See Table 6 for the definition.

ASN.1 Schema

```
-- Identifier type of a set of indoor features
IndoorFeaturesID ::= IA5String
-- Type of an indoor feature
IndoorFeatureType ::= INTEGER
-- Type of geometries
GeometryType ::= INTEGER
-- A set of indoor features, which can be a layer of the indoor features
IndoorFeatures ::= SEQUENCE {
   id             IndoorFeaturesID,
   featureName    IA5String,
   featureType    IndoorFeatureType,
   geometryType   GeometryType,
   features       SEQUENCE OF IndoorFeature,
   note           IA5String    OPTIONAL,
```

Table 5 *(continued)*

```
    ...
}
```

Example

```
{
   id             "001",
   featureName    "Entrance Doors",
   featureType    "AnchorSpace",
   geometryType   "POLYGON",
   features  {    {  id      "001-1",
                     name     "Main Entrance Door",
                     geometry  {wkb "01D7A370...",
                                wkt "POINT(36.383302, 127.370632)"}},
                  {  id      "001-2",
                     name     "Side Entrance Door",
                     geometry  {wkb "01D7A370...",
                                wkt "POINT(36.384083, 127.370427)"}},
                  {  id      "001-3",
                     name     "Back Entrance Door",
                     geometry  {wkb "01D7A370...",
                                wkt "POINT(36.383951, 127.369543)"}}
             },
   note          "This is a set of indoor features representing entrance doors in the ETRI
Convergence Commercialization Centre"
}
```

Table 6 defines the "`IndoorFeature`" data type, describing an indoor feature existing in indoor spaces.

Table 6 — Definition of IndoorFeature

Type	**Name**	**IndoorFeature**		
	Description	Describes an indoor feature.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
id	IndoorFeatureID	M	1	An identifier of an indoor feature object.[a]
name	IA5String	O	1	Name of an indoor feature.
geometry	IndoorFeatureGeometry	M	1	WKB or WKT encoding of the geometry of an indoor feature.[b]
note	IA5String	O	1	Additional description about the indoor feature.
Notes				
[a] How to construct an identifier of the indoor feature objects is out of the scope of this document and more consensus is needed for its standardization. [b] See Table 7 for the definition. See also ISO 19125-1.				

ASN.1 Schema

```
-- Identifier type of an indoor feature
IndoorFeatureID ::= IA5String
-- Definition of Indoor feature
IndoorFeature ::= SEQUENCE {
   id             IndoorFeatureID,
   name           IA5String    OPTIONAL,
   geometry       IndoorFeatureGeometry,
```

Table 6 *(continued)*

```
   note          IA5String     OPTIONAL,
   ...
}
```

Example

```
-- refer the example of 'features' attribute in Table 5
```

Table 7 defines the "IndoorFeatureGeometry" data type, including WKB or WKT encoding of the geometry of an indoor feature.

Table 7 — Definition of IndoorFeatureGeometry

Type	**Name**	**IndoorFeatureGeometry**		
	Description	Describes the geometry of an indoor feature.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
wkb	WKBGeometry[b]	C[a]	1	WKB encoding of the geometry of an indoor feature.
wkt	WKTGeometry[c]	C[a]	1	WKT encoding of the geometry of an indoor feature.
Notes				
[a] A single geometry encoding, either WKB or WKT, should be provided. [b] WKBGeometry is defined as "OCTET STRING". [c] WKTGeometry id defined as "VisibleString".				

ASN.1 Schema

```
-- WKB encoding of the geometry of an indoor feature
WKBGeometry ::= OCTET STRING

-- WKT encoding of the geometry of an indoor feature
WKTGeometry ::= VisibleString

-- Definition of the geometry of an indoor feature
IndoorFeatureGeometry ::= CHOICE {
   wkb        WKBGeometry,
   wkt        WKTGeometry
}
```

Example

```
-- refer the example of features' geometry in Table 5
```

Table 8 defines the "IndoorNetwork" data type, describing an indoor network which can be used for searching an indoor route. An indoor network can be defined by using OGC IndoorGML or represented by a set of indoor nodes, indoor links and indoor cells.

Table 8 — Definition of IndoorNetwork

Type	**Name**	**IndoorNetwork**		
	Description	Describes an indoor network, representing accessible networks.		
Attributes				
Name	**Type**	**M/O/C**	**MO**	**Description**
id	IndoorNetworkID	M	1	An identifier of an indoor network, with cell spaces.[a]
title	IA5String	O	1	Name of an indoor network, with cell spaces.
uri	OCTET STRING	C[c]	1	URI reference representing indoor networks represented by other format, such as OGC IndoorGML.
nodelinks	IndoorNodeEdge NetworkWithCells	C[c]	N	Indoor networks, representing accessible spaces and paths with semantic cell spaces.[b]

Table 8 *(continued)*

note	IA5String	0	1	Additional description about the indoor network.

Notes

[a] How to construct an identifier of the indoor network is out of the scope of this document and more consensus is needed for its standardization.

[b] See Table 9 for the definition.

[c] Only one option can be selected: either 'uri' or 'nodelinks'. If 'uri' is chosen, 'nodelinks' shall not be used, and vice versa. If "nodelinks" is provided, "indoorgml" shall not be specified.

ASN.1 Schema

```
-- Identifier type of an indoor network
IndoorNetworkID ::= IA5String

-- Definition of Indoor network
IndoorNetwork ::= SEQEUNCE {
   id             IndoorNetworkID,
   title          IA5String       OPTIONAL,

   network CHOICE  {
      uri            OCTET STRING,
      nodelinks      IndoorNodeEdgeNetworkWithCells
   },
   note           IA5String       OPTIONAL,
   ...
}
```

Example

```
{
   id "Network001",
   title "Indoor networks of the ETRI Convergence Commercialization Centre",
   network CHOICE {
      uri "3C 49 6E 64 ..." -- OCTET STRING representation of OGC IndoorGML,

      nodelinks{
         nodes    { id         "Node001",
                    type       0,
                    geometry   {36.3839773184394, 127.3698993563252},
                    edges      {"edge001", "edge002"},
                    cell       "GRD001",
                    poi        "POI001"},

         edges    { id         "Edge001",

            geometry  {   points {{36.3839773184394, 127.3698993563252},
                                  {36.3839265739698, 127.3699127673703},
                                  {36.3838801481496, 127.3699275195198}}},
                    width     3,
                    weight    1,

            allowedMovements  {  objectType 1,
                                 allowedTime   {From "2023-09-01T09:00:00",
                                 to "2023-09-30T18:00:00",
                                 periodic 3},
```

Table 8 *(continued)*

```
            direction    2,
            speedLimit   20}},

   cells {  id          "GRD001",
            name        "indoor cell space",
            boundary  {  polygon   {{233195.8787983209,420702.3822559568},
                                    {233196.6726935889,420698.7940314255},
                                    {233196.1112707766,420698.6698165359},
                                    {233195.8787983209,420702.3822559568},
                                    {233191.2781518695,420697.6004881824},
                                    {233190.3505836227,420697.3952635551},
                                    {233189.4230154499,420697.1900389443},
                                    {233191.2781518695,420697.6004881824}}},
            category 1,
            representative "Node001",
            poi "POI001"}
}
```

Table 9 defines the "IndoorNodeEdgeNetworkWithCells" data type, describing an indoor network, which consists of indoor nodes, indoor links and indoor cells which represent semantic spaces.

Table 9 — Definition of IndoorNodeEdgeNetworkWithCells

Type	**Name**	**IndoorNodeEdgeNetworkWithCells**		
	Description	Describes an indoor network, organized with cell spaces.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
nodes	IndoorNode[a]	M	N	Nodes in an indoor network.[b]
edges	IndoorEdge[c]	O	N	Edges in an indoor network.[d]
cells	IndoorCell[e]	O	N	Cell spaces in an indoor space. A cell space can be connected to an indoor node.[f]
note	IA5String	O	1	Additional description about the indoor network.
Notes				
[a] When compared with OGC IndoorGML, this can be mapped to "IndoorCore::State". [b] See Table 10 for the definition. [c] When compared with OGC IndoorGML, this can be mapped to "IndoorCore::Transition". [d] See Table 12 in this document for the definition. [e] When compared with OGC IndoorGML, this can be mapped to "IndoorCore::CellSpace". [f] See Table 18 in this document for the definition.				
ASN.1 Schema				

`-- Definition of Indoor network, consisting of indoor nodes, indoor edges, and indoor cells`
`IndoorNodeEdgeNetworkWithCells ::= SEQEUNCE {`
`  nodes  SEQUENCE OF IndoorNode,`
`  edges  SEQUENCE OF IndoorEdge  OPTIONAL,`
`  cells  SEQUENCE OF IndoorCell  OPTIONAL,`
`  note  IA5String  OPTIONAL,`
`  ...`
`}`				

Example				

`{`
`  nodes  {  id  "Node001",`
`  type  0,`				

Table 9 *(continued)*

```
                geometry    {36.3839773184394, 127.3698993563252},
                edges       {"edge001", "edge002"},
                cell        "GRD001",
                poi         "POI001"
            },

    edges   {   id          "Edge001",
                geometry    {   points    {{36.3839773184394, 127.3698993563252},
                                           {36.3839265739698, 127.3699127673703},
                                           {36.3838801481496, 127.3699275195198}}},
                width       3,
                weight      1,
                allowedMovements    {     objectType 1,
                                          allowedTime    {From "2023-09-01T09:00:00",
                                          to "2023-09-30T18:00:00",
                                          periodic 3},
                direction     2,
                speedLimit    20},
            },

    cells   {   id           "GRD001",
                name         "indoor cell space",
                boundary    {  polygon    {{233195.8787983209,420702.3822559568},
                                           {233196.6726935889,420698.7940314255},
                                           {233196.1112707766,420698.6698165359},
                                           {233195.8787983209,420702.3822559568},
                                           {233191.2781518695,420697.6004881824},
                                           {233190.3505836227,420697.3952635551},
                                           {233189.4230154499,420697.1900389443},
                                           {233191.2781518695,420697.6004881824}}},
                category 1,
                representative "Node001",
                poi "POI001"}
}
```

Table 10 defines the "IndoorNode" data type, describing an indoor node.

Table 10 — Definition of IndoorNode

Type	Name	IndoorNode		
	Description	Describes an indoor node represented as a point.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
id	IndoorNodeID	M	1	An identifier of an indoor node.[a,b,c]
type	IndoorNodeType	M	1	Type of an indoor node.[d]
geometry	Location[e]	M	1	Geometry (Point) of an indoor node.
edges	IndoorEdgeID	O	N	Indoor edges[f,g] connected to the indoor node.
cell	IndoorCellID	O	1	Indoor cell[h,i] representing a semantic space of an indoor node.
poi	IndoorPOIID	O	1	POI[j] relevant to an indoor node.

Table 10 *(continued)*

note	IA5String	0	1	Additional description about an indoor node.
Notes				
[a] How to construct an identifier of the indoor node is out of the scope of this document and more consensus is needed for its standardization. [b] When compared with OGC IndoorGML, an "IndoorNode" can be mapped to "IndoorCore::State". [c] The "id" should be a valid identifier of an "IndoorNode" included in "IndoorNodeEdgeNetworkWithCells::nodes". [d] See Table 11 for the definition. [e] See ISO 17438-4:2019, Annex A for the definition. [f] When compared with OGC IndoorGML, an "IndoorEdge" can be mapped to "IndoorCore::Transition". [g] The "edges" should be valid identifiers of an "IndoorEdge" included in "IndoorNodeEdgeNetworkWithCells::edges". [h] When compared with OGC IndoorGML, an "IndoorCellSpace" can be mapped to "IndoorCore::CellSpace". [i] The "cells" should be valid identifiers of an "IndoorCellSpace" included in "IndoorNodeEdgeNetworkWithCells::cells". [j] See ISO 17438-4:2019, Annex A for the definition.				
ASN.1 Schema				

`-- Identifier type of an indoor node`
`IndoorNodeID ::= IA5String`
`-- Identifier type of an indoor edge`
`IndooeEdgeID ::= IA5String`
`-- Identifier type of an indoor cell`
`IndoorCellID ::= IA5String`
`-- Identifier type of an indoor POI`
`IndoorPOIID ::= IA5String`
`-- Definition of Indoor node`
`IndoorNode ::= SEQUENCE {`
`  id  IndoorNodeID,`
`  type  IndoorNodeType,`
`  geometry  Location,`
`  edges  SEQUENCE OF IndoorEdgeID  OPTIONAL,`
`  cell  IndoorCellID  OPTIONAL,`
`  poi  IndoorPOIID  OPTIONAL,`
`  note  IA5String  OPTIONAL,`
`  ...}`				

Example				

`{`
`  id  "Node001",`
`  type  0,`
`  geometry  {36.3839773184394, 127.3698993563252},`
`  edges  {"edge001", "edge002"},`
`  cell  "GRD001",`
`  poi  "POI001"`
`}`				

Table 11 defines the "`IndoorNodeType`" code list, enumerating types of the indoor nodes.

Table 11 — Definition of IndoorNodeType

Code list	**Name**	**IndoorNodeType**
	Description	Enumerates types of an indoor node.
Code values		
Name	**Bit**	**Description**
Anchor-in	0	Indoor node representing an entry.
Anchor-out	1	Indoor node representing an exit.

Table 11 *(continued)*

Connection	2	Indoor node connecting two indoor semantic networks.
Merge-point	3	Indoor node of a merge-point.
Diverge-point	4	Indoor node of a diverge-point.
... (More codes can be added depending on an extension)		
Notes		
(none)		
ASN.1 Schema		

```
-- Type of an indoor node
IndoorNodeType ::= BIT STRING {
   Anchor-in         (0),
   Anchor-out        (1),
   Connection        (2),
   Merge-point       (3),
   Diverge-point     (4),
   ...
}
```

Example

```
-- refer the example of 'type' attribute in Table 10
```

Table 12 defines the "IndoorEdge" data type, describing an indoor edge.

Table 12 — Definition of IndoorEdge

Type	**Name**	**IndoorEdge**		
	Description	Describes an indoor edge, represented by a curve.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
id	IndoorEdgeID	M	1	An identifier of an indoor edge.[a]
geometry	IndoorCurve	M	1	Geometry (Curve) of an indoor edge.[b]
width	REAL	O	1	Width of the access path, represented by an indoor edge, in metres.
weight	REAL	O	1	A weight which can be used for route calculation. The meaning of the weight is dependent on implementations.
allowedMovements	AllowedMovement	M	N	Information regarding allowed movements, which consist of allowed moving object type, accessible date-time.[c]
note	IA5String	O	1	Additional description about an indoor edge.
Notes				
[a] How to construct an identifier of the indoor edge is out of the scope of this document and more consensus is needed for its standardization. [b] See Table 20 for the definition. [c] See Table 18 for the definition.				
ASN.1 Schema				

```
-- Identifier type of an indoor edge, "IndoorEdgeID" is defined above as "IA5String"
-- Definition of Indoor edge
IndoorEdge ::= SEQUENCE {
   id                  IndoorEdgeID,
   geometry            IndoorCurve,
   width               REAL         OPTIONAL,
   weight              REAL         OPTIONAL,
   allowedMovements    SEQUENCE OF AllowedMovement,
   note                IA5String    OPTIONAL,
```

Table 12 *(continued)*

```
   ...
}
```

Example

```
{
   id "Edge001",
   geometry {
         points   {{36.3839773184394, 127.3698993563252},
                   {36.3839265739698, 127.3699127673703},
                   {36.3838801481496, 127.3699275195198}}},
   width 3,
   weight 1,
   allowedMovements   {objectType 1,
                       allowedTime   {From "2023-09-01T09:00:00",
                                      to "2023-09-30T18:00:00",
                                      periodic 3},
                       direction 2,
                       speedLimit 20},
   note "the indoor edge is main entrance road in the ETRI Convergence Commercialization
Centre"
}
```

Table 13 defines the "AllowedMovement" data type, describing types of movements allowed in a relevant indoor edge.

Table 13 — Definition of AllowedMovement

Type	**Name**	**AllowedMovement**		
	Description	Describes a movement, allowed on the relevant indoor edge.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
objectType	MovingObjectType	M	1	Type of moving object, such as bus, bike, car, etc.[a]
allowedTime	AllowedDateTime	M	N	Duration for which the moving object specified by "MovingObjectType" can move on the indoor edge.[b]
direction	Direction	O	1	Possible direction of the movement.[c]
speedLimit	REAL	O	1	Limitation of moving speed, in km/s.
note	IA5String	O	1	Additional description about the allowed movement.
Notes				
[a] See Table 14 for the definition. [b] See Table 16 for the definition. [c] See Table 15 for the definition.				

ASN.1 Schema

```
-- Definition of allowed movements on an indoor edge
AllowedMovement ::= SEQUENCE {
   objectType       MovingObjectType,
   allowedTime      SEQUENCE OF AllowedDateTime,
   direction        Direction    OPTIONAL,
   speedLimit       REAL         OPTIONAL,
   note             IA5String    OPTIONAL,
   ...
```

Table 13 *(continued)*

}
Example
-- refer the example of 'allowedMovements' attribute in Table 12

Table 14 defines the "MovingObjectType" code list, enumerating types of moving objects in indoor spaces.

Table 14 — Definition of MovingObjectType

Code list	**Name**		**MovingObjectType**
	Description		Enumerates types of an object moving in indoor spaces.
Code values			
Name		**Code**	**Description**
VehicleExceptForBus		0	Car, except for bus.
Bus		1	Bus or public transportation.
Motorbike		2	Bike or motorcycle.
Bicycle		3	Bicycle.
Pedestrian		4	Pedestrian.
Wheelchair		5	Wheelchair.
Others		6	Other types of moving objects.
... (More codes can be added depending on an extension)			
Notes			
(none)			
ASN.1 Schema			

-- Code list as moving object type
MovingObjectType ::= ENUMERATED {
VehicleExceptForBus (0),
Bus (1),
Motorbike (2),
Bicycle (3),
Pedestrian (4),
Wheelchair (5),
Others (6),
...
}			

Example			
-- refer the example of 'allowedMovements' objectType code in Table 12			

Table 15 defines the "Direction" code list, enumerating types for representing the direction of an indoor edge.

Table 15 — Definition of Direction

Code list	**Name**	**Direction**
	Description	Enumerates the direction of an indoor edge.
Code values		
Name	**Code**	**Description**
Oneway-ingress	0	One direction from the start node to the end node.
Oneway-egress	1	One direction from the end node to the start node.
Twoway	2	Both direction – ingress & egress direction.
... (More codes can be added depending on an extension)		
Notes		
(none)		

Table 15 *(continued)*

ASN.1 Schema

`-- Code list as type of direction`
`Direction ::= ENUMERATED {`
`  Oneway-ingress  (0),`
`  Oneway-egress  (1),`
`  Twoway  (2),`
`  ...`
`}`

Example
`-- refer the example of 'allowedMovements' direction code in Table 12`

Table 16 defines the "`AllowedDateTime`" data type, describing a time period during which a movement is allowed.

Table 16 — Definition of AllowedDateTime

Type	**Name**	**AllowedDateTime**		
	Description	Describes the duration for which an indoor edge is accessible by a moving object.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
from	DATE-TIME	M	1	Start time of the allowed duration for access.[a]
to	DATE-TIME	M	1	End time of the allowed duration for access.[b]
periodic	PeriodType	O	1	Whether the pair of ("from", "to") is periodical or not and the type of the period.[c]
note	IA5String	O	1	Additional description about the allowed duration for accessibility.
Notes				
[a] If not available, set the value as "1951-10-14T15:30:00". [b] If not available, set the value as "9999-12-31T59:59:59". [c] See Table 17 for the definition.				
ASN.1 Schema				

`-- Definition of allowed date-time`
`AllowedDateTime ::= SEQUENCE {`
`  from  DATE-TIME,`
`  to  DATE-TIME,`
`  periodic  PeriodType  OPTIONAL,`
`  note  IA5String  OPTIONAL,`
`  ...`
`}`				

Example				
`-- refer the example of 'allowedMovements' AllowedDateTime in Table 12`				

Table 17 defines the "`PeriodType`" code list, enumerating types of a duration for moving object's accessibility to an indoor edge.

Table 17 — Definition of PeriodType

Code list	**Name**	**PeriodType**
	Description	Enumerates the types of duration according to periodicity.
Code values		
Name	**Code**	**Description**
None	0	Not periodic
Hour	1	The duration is repeated in a hour.
Day	2	The duration is repeated in a day.
Week	3	The duration is repeated in a week.
Month	4	The duration is repeated in a month.
Year	5	The duration is repeated in a year.
... (More codes can be added depending on an extension)		
Notes		
(none)		
ASN.1 Schema		

```
-- Code list as type of a period
PeriodType ::= ENUMERATED {
   None       (0),
   Hour       (1),
   Day        (2),
   Week       (3),
   Month      (4),
   Year       (5),
   ...
}
```

Example
`-- refer the example of 'allowedMovements' PeriodType code in Table 12`

Table 18 defines the "`IndoorCell`" data type, describing an indoor cell space. An indoor cell space has a specific meaning or semantic, and it is represented by a cell, of which the boundary is represented by a polygon or a solid.

Table 18 — Definition of IndoorCell

Type	**Name**	**IndoorCell**		
	Description	Describes an indoor space, representing a semantic, as a cell.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
id	IndoorCellID	M	1	An identifier of an indoor space.[a,b]
name	IA5String	O	1	Name of an indoor cell.
geometry	IndoorCellBGeometry	O	1	Geometry of an indoor cell[c] boundary.
category	IndoorCellType	M	1	Type (Category) of an indoor cell.[d]
representative	IndoorNodeID[e]	O	1	An identifier of an indoor node[f] representing the indoor cell space.
poi	IndoorPOIID	O	1	An identifier of a POI[g] regarding the indoor cell space.
note	IA5String	O	1	Additional description about an indoor cell space.
Note				

Table 18 *(continued)*

[a] How to construct an identifier of the indoor Space is out of the scope of this document and more consensus is needed for its standardization.
[b] When compared with OGC IndoorGML, this can be mapped to "IndoorCore::IndoorCellSpace".
[c] See Table 19 for the definition.
[d] "IndoorCellType" is defined as INTEGER. For the definition of the type of indoor cell spaces, i.e. a kind of code list or enumeration, a pre-defined code list, such as IFC OmniClass code, can be applied.
[e] The "id" should be a valid identifier of an "IndoorNode" included in "IndoorNodeEdgeNetworkWithCells::nodes".
[f] See Table 10 for the definition.
[g] See ISO 17438-4:2019, Annex A for the definition.

ASN.1 Schema

```
-- Identifier type of an indoor cell
IndoorCellID ::= IA5String
-- Definition of an indoor cell space
-- Pre-defined code, such as IFC OmniClass code, can be used as the type of an indoor cell space
IndoorCellType ::= INTEGER
-- Definition of Indoor cell space.
-- This is correspondent to IndoorCore::CellSpace, defined in OGC IndoorGML
IndoorCell ::= SEQUENCE {
   id               IndoorCellID,
   name             IA5String               OPTIONAL,
   geometry         IndoorCellGeometry      OPTIONAL,
   category         IndoorCellType,
   representative   IndoorNodeID            OPTIONAL,
   poi              IndoorPOIID             OPTIONAL,
   note             IA5String               OPTIONAL,
   ...}
```

Example

```
-- Example of IndoorCell defined by polygon boundary
{
   id "GRD001",
   name "indoor cell space",
   boundary  {polygon  {{233195.8787983209,420702.3822559568},
                        {233196.6726935889,420698.7940314255},
                        {233196.1112707766,420698.6698165359},
                        {233195.8787983209,420702.3822559568},
                        {233191.2781518695,420697.6004881824},
                        {233190.3505836227,420697.3952635551},
                        {233189.4230154499,420697.1900389443},
                        {233191.2781518695,420697.6004881824}}},
   category 1,
   representative "Node001",
   poi "POI001",
   note "This is indoor cell space representing floor area defined by polygon boundary"
}
-- Example of IndoorCell defined by solid boundary
{
   id "GRD001",
   name "indoor cell space",
   boundary  {polygon  {{233195.8787983209,420702.3822559568, 45.2},
                        {233196.6726935889,420698.7940314255, 45.5},
                        {233196.1112707766,420698.6698165359, 45.8},
```

Table 18 *(continued)*

```
                        {233195.8787983209,420702.3822559568, 46.0},
                        {233191.2781518695,420697.6004881824, 45.1},
                        {233190.3505836227,420697.3952635551, 45.3},
                        {233189.4230154499,420697.1900389443, 45.6},
                        {233191.2781518695,420697.6004881824, 45.9}}}
,
   category 1,
   representative "Node001",
   poi "POI001",
   note "This is indoor cell space representing floor area defined by solid boundary"
}
```

Table 19 defines the "`IndoorCellGeometry`" data type, describing a boundary of an indoor cell space.

Table 19 — Definition of IndoorCellGeometry

Type	**Name**	**IndoorCellGeometry**		
	Description	Describes the geometry of boundary of an indoor cell space.		
Attributes				
Name	**Type**	**M/O/C**	**MO**	**Description**
polygon	IndoorPolygon	C[a]	1	A polygon representing the boundary of an indoor space, 2-dimensional.
solid	IndoorSolid	C[a]	1	A solid representing the boundary of an indoor space, 3-dimensional.
Notes				
[a] Only one option, either 'polygon' or 'solid', can be selected. Specifying 'polygon' excludes the use of 'solid', and vice versa.				

ASN.1 Schema

```
-- Type of the geometry of the boundary of an indoor cell space.
-- polygon (2-dimensional) vs. solid (3-dimensional)
IndoorCellGeometry ::= CHOICE {
   polygon   Polygon,
   solid     Solid
}
```

Example

```
-- refer the example of boundary attribute in Table 18
```

Table 20 defines the "`IndoorCurve`" data type, describing the geometry of an indoor edge used in an indoor network.

Table 20 — Definition of IndoorCurve

Type	**Name**	**IndoorCurve**		
	Description	Describes an edge in an indoor network.		
Attributes				
Name	**Type**	**M/O**	**MO**	**Description**
points	Location[a]	M	N	Points consisting of the curve.
note	IA5String	O	1	Additional description about the curve.
Notes				
[a] See ISO 17438-4:2019, Annex A for the definition.				

ASN.1 Schema

```
-- Definition of an indoor curve
IndoorCurve ::= SEQUENCE {
```