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Geographic information — Gap analysis of geospatial standards for indoor-outdoor seamless navigation

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Foreword

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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, indoor-outdoor seamless navigation is becoming more important as an extension of existing navigations. For indoor or outdoor navigation, there are several standardization activities which could improve interoperability of data and services.

Geographic information — Gap analysis of geospatial standards for indoor-outdoor seamless navigation

1 Scope

The objective of this document is to analyse gaps in geospatial standards for indoor-outdoor seamless navigation. This document is intended to be used by designers, developers and providers of outdoor or indoor navigation services.

This document:

a) specifies the concepts for the indoor-outdoor seamless navigation;

b) outlines conceptual architecture and scenarios (or use-cases) for indoor-outdoor seamless navigation;

c) analyses the gap of the current geospatial standards for implementing the indoor-outdoor seamless navigation;

d) highlights standardization items to be proceeded to get more interoperability.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 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/

3.1.1
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]

3.1.2
indoor entity feature
feature (3.1.1) 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.

[SOURCE: ISO 19164:2024, 3.5]

3.1.3
indoor space feature
feature (3.1.1) that contains *indoor entity features* (3.1.2) or is used as a place for a specific purpose inside a building, or both

EXAMPLE Rooms, balconies and pathways are indoor space features.

[SOURCE: ISO 19164:2024, 3.6]

3.1.4
indoor map
portrayal of an *indoor entity feature* (3.1.2) and *indoor space features* (3.1.3) as a digital image or vector file suitable for display on a computer screen

[SOURCE: ISO 19164:2024, 3.7]

3.1.5
indoor-outdoor map
portrayal of seamless interconnected entity features and space features between indoor and outdoor environments as a digital image or vector file suitable for display on a computer screen

3.1.6
nomadic device
ND
implementation of a personal ITS station which provides communication connectivity via equipment such as cellular telephones, mobile wireless broadband (WIMAX, HC-SDMA, etc.), WiFi etc. and includes short range links, such as Bluetooth®, Zigbee, etc. to connect portable devices to the motor vehicle communications system network

Note 1 to entry: Bluetooth is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

[SOURCE: ISO 23795-2:2024, 3.1.1, modified — "portable" has been removed from "portable equipment," "wireless communication network (3G, 4G, and 5G)" has been removed, "WiFi" has been added, "such as IEEE 802.11x" has been replaced by "such as Bluetooth, Zigbee, etc." A new Note 1 to entry has been added.]

3.1.7
indoor navigation
navigation provided in indoor space

3.1.8
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]

3.1.9
personal/vehicle ITS station
P/V-ITS-S
ITS station implemented in a vehicle or mobile device

Note 1 to entry: 'mobile device' is replaced by the term '*nomadic device*' (3.1.6) to assure the consistency in this document.

[SOURCE: ISO 17438-2:2024, 3.1.5, modified — "personal mobile device" has been replaced by "nomadic device" in the definition. "Note 1 to entry" has been added.]

3.1.10
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 17438-2:2024, 3.1.8, 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.]

3.1.11
central ITS station, central ITS-S, C-ITS-S
implementation of an ITS-S in a central ITS subsystem

3.1.12
indoor positioning
determination of a location in an indoor space

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

3.1.13
indoor positioning infrastructure
infrastructure used to determine locations of personal/vehicle ITS stations (P/V-ITS-S) in an indoor space

EXAMPLE Wi-Fi, Bluetooth, etc.

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

3.1.14
indoor positioning reference
information to support indoor positioning

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.

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

[SOURCE: ISO 17438-2:2024, 3.1.12, modified — Example 1 and Example 2 have been combined into a single Example.]

3.1.15
indoor navigation data
data needed for indoor navigation, which includes *indoor maps* (3.1.4) and indoor positioning infrastructure information

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

3.2 Abbreviated terms

C-ITS-S	central ITS station
GML	geography markup language
GNSS	global navigation satellite system
IFC	industry foundation classes
IFM	indoor feature model
ITS	intelligent transport systems

ITS-S	ITS station
OGC	open geospatial consortium
P/V-ITS-S	personal/vehicle ITS station
POI	point of interest
R-ITS-S	roadside ITS station

4 Indoor-outdoor seamless navigation

4.1 Overview

In general, navigation refers to outdoor navigation, which involves route planning from the starting point to the destination and providing guidance for users to reach their destination based on their current location. To offer this as a service, a node-link road network, including weight values used for background mapping and route searching, as well as spatial data in the form of points of interest (POI), are constructed and utilized. For route searching and guidance in outdoor navigation, the user's location is typically determined using Global Navigation Satellite System (GNSS)-based location determination methods, which are widely used.

4.2 Indoor navigation

Indoor navigation refers to navigation within indoor spaces where location determination using GNSS is challenging (see ISO 17438-1). Various indoor positioning methods can be used to determine the user's location in areas with poor GNSS signal quality, and some of these methods include proximity detection, triangulation, dead reckoning, fingerprinting, and multilateration.[2]

To enable indoor positioning, information about the positioning infrastructure needs to be pre-established, and this varies in definition and configuration depending on the indoor positioning method. In this document, such information is referred to as indoor positioning references.

In the same manner as outdoor navigation, when navigating within indoor areas, it is essential to have background maps for indoor spaces, indoor networks, indoor POIs, and indoor positioning references. These components collectively support seamless indoor navigation (see ISO 17438-3):

— The background map in an indoor navigation system serves as the base layer, providing the fundamental visual guide for users by displaying a detailed image of the indoor space on the user's device, aligned with a specific geographic area within that space. It ensures an effective and accurate representation of the physical environment.

— Indoor networks, depicted in route network maps, offer a comprehensive guide for navigation through interconnected pathways within indoor spaces, including details about paths, points of interest, and dynamic features like permissible directions and access times.

— POIs are notable locations or features marked for special consideration within indoor maps, such as rooms, areas, objects, or facilities. They are linked to specific locations within indoor nodes or semantic space, aiding users in navigating and locating specific destinations.

— Indoor positioning references, which encompass signal sources, beacons, or other positioning technologies, play a crucial role in accurately determining the user's location within indoor environments, facilitating precise navigation.