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Intelligent transport systems — Geographic Data Files (GDF) GDF5.1 —

Part 1: Application independent map data shared between multiple sources

Systèmes de transport intelligents — Fichiers de données géographiques (GDF) GDF5.1 —

Partie 1: Données cartographiques partagées entre sources multiples et indépendantes des applications

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Foreword

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A list of all parts in the ISO 20524 series can be found on the ISO website.

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Introduction

GDF5.1 (the ISO 20524 series) is an evolution of GDF5.0 that introduces the concept of Sharable Features, takes cooperative ITS (Cooperative ITS) needs into account and is harmonized with the European public transportation standard EN 12896:2012 (TRANSMODEL). This last harmonization was made in the framework of the European Opticities project.

GDF5.1 consists of two parts:

- GDF5.1 Part 1 (this document) contains GDF5.0 specification except Public Transport Theme specification which has been revised and is now described in Part 2.

- GDF5.1 Part 2 (ISO 20524-2) is dedicated to Sharable Features, Cooperative ITS and Public Transport.

This document presents the specification for GDF5.1 Part 1. GDF5.0 entities are unchanged but Public Transport Theme entities have been removed and corresponding sections and figures are deprecated and refer to GDF5.1 Part 2 (ISO 20524-2). In order to ensure the consistency between GDF5.0 and GDF5.1 Part 1 (this document), the numbering of common figures in both versions has been conserved. GDF5.1 Part 1 (this document) is divided into several parts.

After the introductory clauses, the overall conceptual data model is specified. In it, the basic building blocks of GDF and their interrelations are explained. It contains a specification of the different types of topology supported by this document. It furthermore describes how database representations of real world objects, referred to as Features, are defined. It describes the characteristics of Features, called Attributes, and the topological and non-topological interrelations between Features. Finally, it describes the organization of the Features in GDF. Semantically, Features are organized in different Feature Themes. Logically and physically, Features are organized in Sections by area or in Layers by contents.

In the Feature Catalogue, the different Features supported by this document are defined. A special case is the Features from the Services Feature Theme. Because the requirements for this Feature Theme are highly market-oriented, the Services Feature Theme does not contain any normative Features, but contains an annex comprising an informative list of service definitions to assist users of this document (see Annex C).

In the Attribute Catalogue, the different characteristics of Features, called Attributes, are defined. A usage matrix outlines applicability of Attributes per Feature Theme and per Relationship.

In the Relationship Catalogue, the different non-topological (i.e. semantic) Relationships which Features have been defined. Relationships may relate Features of different Feature Themes, or those from the same or different Section and/or Layer.

In the Feature representation rules, the possible geometrical ways in which the individual Features may be represented are specified for each topology type. This document supports zero-, one- and two-dimensional primitives and up to four-dimensional coordinates.

The specification of Features, Attributes and Relationships by no means dictates mandatory inclusion. The actual contents of GDF, apart from a minimum set of metadata elements as specified in the delivery formats, is not specified by this document since this is considered to be an issue between clients and vendors. This document allows the introduction of user-defined Features, Attributes and Relationships.

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In certain cases, different alternative ways of modelling and representation are offered. Representing Features in different geographical areas also may require the use of different basic representation mechanisms, e.g. character sets, projection systems. It is important that all of these individual choices associated with GDF are specified. Furthermore, GDF should essentially be self-contained and be readable without any external specification. In order to make this possible, this document specifies ways of describing GDF by means of metadata, captured by the Metadata Catalogue.

Apart from providing a standard for the definition of geographic road databases, this document also specifies mechanisms for data exchange and delivery. In order to facilitate the definition and exchange of data, a logical view of the data organization is important. This logical view is presented in the Logical Data Structures. The data structures are specified using the data description language ESN.

Two physical implementations for data exchange and delivery are specified: the Media Record Specifications (ASCII flat file) and the XML schema specifications. These physical implementations are limited to the data specification present in GDF5.1 Part 1 (this document).

These specifications support the explicit registration of updated information, thereby allowing map databases to continue to reflect ground truth over time.

Features, Attributes and Relationships appear in the physical GDF as codes. These codes are specified in Annex A. Codes used in the metadata are given in Annex B, which is an informative part of this document. In order to access the most up-to-date information, the user is referred to the original source organization. Annex C contains the specification of Features of the theme Services as an informative part of this document. In Annex D, the syntax for specifying temporal aspects of geographic information is described. The specific rules for organizing GDF in different spatial subdivisions (Sections) is described in Annex E. As informative parts of this document, guidelines for the formation of Level 2 Features from the Feature Theme Roads and Ferries are given in Annex F. A list of local Administrative Area names in different countries is provided in Annex G, as well as illustrative examples for the description of the (non-hierarchical) geopolitical structures and their components in a number of countries. Finally, the use of notation and phonetic Attributes for character strings are illustrated in the informative Annex H. Annex H provides a range of examples showing how the different notation- and phoneme-related Attribute properties may be used to qualify name strings, in both their written and their pronounced form.

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Intelligent transport systems — Geographic Data Files (GDF) GDF5.1 —

Part 1:
Application independent map data shared between multiple sources

1 Scope

This document specifies the conceptual and logical data model and physical encoding formats for geographic databases for Intelligent Transport Systems (ITS) applications and services. It includes a specification of potential contents of such databases (data dictionaries for Features, Attributes and Relationships), a specification of how these contents shall be represented, and of how relevant information about the database itself may be specified (metadata).

The focus of this document is on ITS applications and services and it emphasizes road and road-related information. ITS applications and services, however, also require information in addition to road and road-related information.

EXAMPLE 1 ITS applications and services need information about addressing systems in order to specify locations and/or destinations. Consequently, information about the administrative and postal subdivisions of an area is essential.

EXAMPLE 2 Map display is an important component of ITS applications and services. For proper map display, the inclusion of contextual information such as land and water cover is essential.

EXAMPLE 3 Point-of-Interest (POI) or service information is a key feature of traveller information. It adds value to end-user ITS applications and services.

Typical ITS applications and services targeted by this document are in-vehicle or portable navigation systems, traffic management centres, or services linked with road management systems, including public transport systems.

The Conceptual Data Model has a broader focus than ITS applications and services. It is application independent, allowing for future harmonization of this document with other geographic database standards.

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 690, *Information and documentation — Guidelines for bibliographic references and citations to information resources*

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ISO 639-2, *Codes for the representation of names of languages — Part 2: Alpha-3 code*

NOTE 1 Codes are available at http://www.loc.gov/standards/iso639-2/

ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes*

NOTE 2 Codes are available at https://www.iso.org/obp/ui

3 Terms and definitions

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

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

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

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

3.1 General terms

3.1.1
cartographic primitive
atomic construction element in a cartographic representation

EXAMPLES Node, Edge and Face.

3.1.2
data file
collection of related data records having a homogeneous structure

Note 1 to entry See Reference [1].

3.1.3
data record
record containing Feature-related data

3.1.4
global record
record that logically precedes the data records and contains control parameters, data definition and documentation necessary to interpret companion data records

Note 1 to entry See Reference [2].

3.1.5
Medium Unit
object for data storage that may be considered as a physically undivided whole

EXAMPLE One floppy disk, one magnetic tape, a CD, or a DVD.

3.1.6
multi-media
any kind of data other than conventional data

EXAMPLE Graphical, audio or visual data.

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3.1.7
Multi-media Object
piece of multi-media to be processed by an application

EXAMPLE A picture, a text, a movie, or a sound.

3.1.8
repeating Attribute Type
Attribute Type that may have multiple values associated to one and the same instance of a particular Feature Class

3.1.9
Spatial Domain
description of the limits of a geographical area to which a particular set of data belongs spatially

3.1.10
source material
origin of data in analogue or digital representation, stored on any kind of data medium

3.1.11
topology
field of mathematics that deals with characteristics of geometric structures that are preserved after continual variation

Note 1 to entry See Reference [3].

3.1.12
transcription
rendering of geographic names from a non-alphabetic script into an alphabetic one or vice versa

Note 1 to entry See Reference [4].

Note 2 to entry The term is also applied to initial recording in script of hitherto unwritten names.

3.2 Mathematical terms

3.2.1
Area Feature
two-dimensional Feature, defined by one or more Faces

3.2.2
Edge
directed sequence of non-intersecting Line Segments with Nodes at each end

Note 1 to entry See Reference [1].

3.2.3
enclave
small part of an area enclosed by another area, seen from the area to which that part belongs

3.2.4
exclave
small part of an area enclosed by another area, seen from the enclosing area

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3.2.5
Face
two-dimensional element bounded by a closed sequence of Edges and by zero or more sets of non-intersecting closed sequences of Edges within the first sequence of Edges

Note 1 to entry The Face is the atomic two-dimensional element.

3.2.6
graph
set of points and a set of arrows, with each arrow joining one point to another, whereby the points are called Nodes of the graph, and the arrows are called the Edges of the graph

Note 1 to entry See Reference [1].

3.2.7
Intermediate Point
point, other than a Node, that defines the shape of an Edge

3.2.8
Line Feature
one-dimensional Feature defined as a sequence of one or more Edges

3.2.9
Node
zero-dimensional element that is a topological junction of two or more Edges, or an end point of an Edge

Note 1 to entry See Reference [1].

3.2.10
non-planar graph
graph which may not be embedded in a plane

3.2.11
planar graph
graph which may be embedded in a plane, i.e. it may be drawn on the plane so that Edges intersect only at a Node mutually incident with them

3.2.12
point
zero-dimensional element that specifies geometric location specified by one coordinate pair or triplet

Note 1 to entry See Reference [1].

3.2.13
Line Segment
Segment
direct connection between two Intermediate Points, two Nodes or a Node and an Intermediate Point

3.2.14
valency
degree
number of Edges which are incident with a particular Node

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3.3 Geodetical terms

3.3.1
control point
point having known coordinates in the real world, identifiable with a corresponding point in a map or an aerial photograph or satellite image

3.3.2
ellipsoidal height
distance between a point and the reference ellipsoid, measured along the ellipsoidal normal

3.3.3
geodetic datum
mathematical surface that approximates a portion of the earth's surface

3.3.4
geoid
model of the figure of the earth that coincides with the mean sea level over the oceans and continues in continental areas as an imaginary sea level surface, defined by spirit level

Note 1 to entry At every place, geoid level/surface is perpendicular to the pull of gravity. The shape is irregular but may, for most purposes, be approximated by an oblate ellipsoid.

3.3.5
Geoid Undulation
difference between the orthometric height and the ellipsoidal height, measured along the ellipsoid normal

3.3.6
height
elevation
(vertical) distance between a point and the reference height level or the reference ellipsoid

Note 1 to entry On land maps, the reference level is commonly the mean sea level.

3.3.7
horizontal reference system
reference system for positions

3.3.8
magnetic declination
angle between Magnetic North and True North

Note 1 to entry See Reference [4].

3.3.9
map projection
transformation method used to represent the curved earth surface on a plane

3.3.10
offset
pair of values subtracted from all coordinate values in order to shorten these coordinate values

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3.3.11
orthometric height
distance between a point and the geoid, measured along the perpendicular line

3.3.12
reference ellipsoid
oblate ellipsoid of revolution that is used to approximate the figure of the geoid

Note 1 to entry It is specified by two parameters: a semi-major axis a (equatorial radius of the earth) and a semi-minor axis b (polar radius). The flattening f is defined as: $f = (a - b)a$.

3.3.13
reference height level
level to which all terrestrial heights are referred

Note 1 to entry It changes from country to country and it forms part of the national coordinate system for surveying and mapping.

3.3.14
reference system
coordinate system on which a national survey is based

Note 1 to entry See Reference [4].

3.3.15
vertical reference system
reference system for elevations

3.3.16
world geodetic system
WGS
set of standard reference ellipsoids that define latitude, longitude and height for every point on the earth

3.4 GDF terms

NOTE All Feature Classes mentioned below are defined in the Feature Catalogue.

3.4.1
Album
collection of related Datasets (logical sub-division) and, if applicable, Volumes (physical sub-division)

3.4.2
Attribute
characteristic of a Feature which is independent of other Features

Note 1 to entry See Reference [1].

3.4.3
Attribute Code
alphanumeric identifier for an Attribute Type

Note 1 to entry See Reference [5].

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3.4.4
Attribute Name
name associated to an Attribute Type

Note 1 to entry See Reference [5].

3.4.5
Attribute Type
defined characteristic of a Feature, which is independent of the other Features

3.4.6
Attribute Value
specific quality or quantity assigned to an Attribute

Note 1 to entry See Reference [1].

3.4.7
Dataset
sub-division of Album, which in turn may be sub-divided into Sections

Note 1 to entry A large set of data covering a particular geographic area may be considered a Dataset.

3.4.8
District
area regarded as a geographical unit, which is defined by the delivery of a specific public or private sector service

3.4.9
Feature
database representation of a real-world object

3.4.10
Feature Category
type of representation of a Feature, including Point, Line, Area and Complex Feature

3.4.11
Feature Class
categorization of a Feature

3.4.12
Feature Class Code
alphanumeric identifier for a Feature Class

Note 1 to entry See Reference [5].

3.4.13
Feature Name
name associated with a Feature Class

Note 1 to entry See Reference [1].

3.4.14
Feature Theme
specified group of related Features

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3.4.15
field
set of characters representing one unit of data

3.4.16
Layer
certain subset of a Dataset based upon information contents

3.4.17
Manoeuvre
ordered sequence of a Road Element, a Junction and one or more Road Elements, and optionally associated with a Traffic Sign

3.4.18
Place
administrative area of the types: Order-i Area, Country, Supra-National Area, Administrative Place A-Z or Named Area Feature of the types: Built-up Area, Named Area, District

3.4.19
Property
combination of Attribute and Relationship values which pertain to a Feature and which together define a certain characteristic of the Feature

3.4.20
Relationship Code
alphanumerical identifier for a Relationship

3.4.21
Relationship name
name associated with a Relationship Type

Note 1 to entry See Reference [1].

3.4.22
Relationship Type
defined characteristic of a Feature which is dependent on other Features

3.4.23
Semantic Relationship
Relationship
characteristic of a Feature involving other Features

3.4.24
Section
spatial subset of a Dataset

Note 1 to entry The coverage area of a map sheet, confined by geographic coordinates, may be considered a Section.

3.4.25
Transportation Element
Road Element, Pathway, Railway Element, Path, Ferry Connection, Water Body, Water Boundary Element, Junction, Railway Element Junction or Water Boundary Junction

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3.4.26
turn
ordered sequence of a Road Element, a Junction and a Road Element

Note 1 to entry A turn is a special case of a Manœuvre, relating exactly two Road Elements.

3.4.27
Volume
smallest physical unit of a medium

Note 1 to entry A single Volume may contain one or more GDF Datasets depending on Dataset size.

EXAMPLE A magnetic tape, a floppy disk.

4 Symbolization and notation elements

Many of the basic concepts of GDF are best expressed diagrammatically in data models. The Unified Modeling Language (UML) [6] has been adopted as the conceptual modeling language for GDF.

Annex I provides a summary of the UML Class Diagram notation conventions used in this document.

5 Overall conceptual data model

5.1 Conceptual data models in GDF

The general data model of GDF is presented in Figure 1 and Figure 2, Figure 4 through Figure 8, and Figure 10 through Figure 18. Detailed sub-schemas are presented in the respective clauses. The data model diagrams convey a range of dedicated terms describing concepts of the GDF model; according to UML practise, these terms are spelled using "CamelCase" notation. Textual descriptions complementing the graphical descriptions use initial capitals for each constituent word of a given GDF term.

The general data model—serving as meta-model for the respective semantic models of the individual Feature classes (see Feature Catalogue), of the individual Attribute types (see Attribute Catalogue), and of the individual Relationship Types (see Relationship Catalogue)—are presented and explained in detail in the remainder of this clause. Each Feature class, Attribute type, and Relationship Type may be considered an instance of the generic UML classes for Feature class, Attribute type, and Relationship Type, respectively, in the meta-model. This two-level notion is implemented using UML class sub-typing.

While IDs are usually not part of a conceptual model, it has been decided to explicitly include them here due to their conceptual relevance. This refers to the fact that they provide a means of unique identification of elements regardless of a particular physical realization of the GDF conceptual model. This, despite the fact that certain physical realizations may not require the use of physical IDs. Consequently, transition between different physical realizations will not result in loss of information.

5.2 The general data model of GDF

5.2.1 The Feature model

In the centre of the model in Figure 1 resides the “Feature” which is a database representation of a real world geographic object. Examples of real world geographic objects are roads or buildings. Note that in this diagram “Feature” has the meaning of Feature instance, i.e. an individual occurrence of a geographic object, such as the Eiffel Tower in Paris.

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