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Entwurf

Intelligente Transportsysteme – Geographisches Datenfile (GDF) GDF5.1 – Teil 1: Anwendungsunabhängige Kartendaten, die zwischen verschiedenen Quellen geteilt werden (ISO 20524-1:2020); Englische Fassung prEN ISO 20524-1:2022, nur auf CD-ROM

Intelligent transport systems – Geographic Data Files (GDF) GDF5.1 – Part 1: Application independent map data shared between multiple sources (ISO 20524-1:2020); English version prEN ISO 20524-1:2022, only on CD-ROM

Systèmes de transport intelligents – Fichiers de données géographiques (GDF) GDF5.1 – Partie 1: Données cartographiques partagées entre sources multiples et indépendantes des applications (ISO 20524-1:2020); Version anglaise prEN ISO 20524-1:2022, seulement en CD-ROM

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2022-09-23 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfs besonders zu vereinbaren.

Stellungnahmen werden erbeten

- vorzugsweise online im Norm-Entwurfs-Portal von DIN unter www.din.de/go/entwuerfe bzw. für Norm-Entwürfe der DKE auch im Norm-Entwurfs-Portal der DKE unter www.entwuerfe.normenbibliothek.de, sofern dort wiedergegeben;
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Gesamtumfang 1084 Seiten

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Nationales Vorwort

Dieses Dokument (prEN ISO 20524-1:2022) wurde vom Technischen Komitee ISO/TC 204 „Intelligent Transport Systems“ in Zusammenarbeit mit dem Technischen Komitee CEN/TC 278 „Intelligente Verkehrssysteme“, dessen Sekretariat von NEN (Niederlande) gehalten wird, erarbeitet.

Das zuständige deutsche Normungsgremium ist der Gemeinschaftsarbeitsausschuss NA 052-00-71 GA „Gemeinschaftsarbeitsausschuss NAAutomobil/DKE: Intelligente Verkehrssysteme“ des DIN-Normenausschusses Automobiltechnik (NAAutomobil).

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GDF 5.1 ist eine Weiterentwicklung von GDF 5.0, welches das Konzept von „teilbaren Eigenschaften“ einführt. Dabei wird kooperative ITS berücksichtigt und wurde mit der europäischen Norm EN 12896 (Tansmodel) des öffentlichen Verkehrs harmonisiert.

Für die in diesem Dokument zitierten Dokumente wird im Folgenden auf die entsprechenden deutschen Dokumente hingewiesen:

ISO 690	siehe	DIN ISO 690
ISO 2108	siehe	DIN ISO 2108
ISO 3166-1	siehe	DIN EN ISO 3166-1
ISO 6709	siehe	DIN EN ISO 6709
ISO 19115-1	siehe	DIN EN ISO 19115-1
ISO 19148	siehe	DIN EN ISO 19148

Dieses Dokument repräsentiert den ersten Teil der Spezifikation GDF 5.1. Die Norm legt das übergeordnete konzeptuelle Datenmodell fest. Darin werden die grundlegenden GDF-Bausteine und deren Wechselbeziehungen erklärt. Die Norm beinhaltet weiterhin eine Spezifikation unterschiedlicher Topologie Arten, die von diesem Dokument unterstützt werden. Außerdem wird beschrieben, wie Datenbankdarstellungen realer Objekte, bezogen auf deren Eigenschaften, festgelegt sind. Es werden die Charakteristiken von Eigenschaften, auch Attribute genannt, beschrieben, sowie die topologischen und nicht-topologischen Wechselbeziehungen zwischen Eigenschaften. Schlussendlich werden die Anordnung der Eigenschaften in GDF beschrieben.

Aktuelle Informationen zu diesem Dokument können über die Internetseiten von DIN (www.din.de) durch eine Suche nach der Dokumentennummer aufgerufen werden.

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Nationaler Anhang NA
(informativ)

Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

— IEC Electropedia: verfügbar unter http://www.electropedia.org/

— ISO Online Browsing Platform: verfügbar unter http://www.iso.org/obp

3.1 Allgemeine Begriffe

3.1.1
kartographisches Primitive
en cartographic primitive
atomares Konstruktionselement in kartographischer Darstellung

BEISPIEL Knoten, Kante, Fläche.

3.1.2
Datenfile
en data file
Sammlung bezogener Datenaufzeichnungen, die eine homogene Struktur haben

Anmerkung 1 zum Begriff: Siehe Referenz [1].

3.1.3
Datenaufzeichnung
en data record
Aufzeichnung, die die eigenschaftsrelevante Daten beinhaltet

3.1.4
allgemeine Aufzeichnung
en global record
Aufzeichnung, die in logischer Art und Weise Datenaufzeichnungen führt und Kontrollparameter, Datenfestlegungen und Dokumentationen beinhaltet die notwendig sind, um begleitende Datenaufzeichnungen interpretieren zu können

Anmerkung 1 zum Begriff: Siehe Referenz [2].

3.1.5
Medieneinheit
en Medium Unit
Datenspeicherobjekt, das als physisch ungeteiltes Ganzes angesehen werden kann

BEISPIEL Eine Floppy-Disk, ein magnetisches Band, eine CD, oder eine DVD.

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3.1.6
Multimedia
en multi-media
beliebige Art von Daten die anders ist, als konventionelle Daten

BEISPIEL Graphische, Audio oder visuelle Daten.

3.1.7
Multimedia Objekt
en Multi-media Object
Multimedia Teil, der von einer Anwendung verarbeitet wird

BEISPIEL Ein Bild, ein Text, ein Film, oder ein Ton.

3.1.8
wiederholender Attributstyp
en repeating Attribute Type
Attributstyp, der viele unterschiedliche Werte haben kann, die auf eine oder mehrere Instanz(en) einer bestimmten Eigenschaftsklasse bezogen sein kann

3.1.9
räumliche Domain
en spatial Domain
Beschreibung von Grenzen eines geographischen Bereiches, dem eine bestimmte Menge von Daten räumlich dazugehören

3.1.10
Quellmaterial
en source material
Datenquelle in analoger, oder digitaler Darstellung, die auf einem beliebigen Datenmedium gespeichert sind

3.1.11
Topologie
en topology
mathematisches Feld, das sich mit den Charakteristiken geometrischer Strukturen beschäftigt, die nach fortlaufender Veränderung aufbewahrt werden

Anmerkung 1 zum Begriff: Siehe Referenz [3].

3.1.12
Umschreibung
en transcription
Darstellung geographischer Namen von einem nicht-alphabetischen Skript in ein Alphabetisches, oder umgedreht

Anmerkung 1 zum Begriff: Siehe Referenz [4].

Anmerkung 2 zum Begriff: Der Begriff wird auch auf initiale Aufzeichnungen in Skript von bisherig ungeschriebenen Namen angewendet.

3.2 Mathematische Begriffe

3.2.1
Gebietseigenschaften
en Area Feature
zweidimensionale Eigenschaft, die von einer oder mehreren Fläche(n) festgelegt ist

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3.2.2
Kante
en Edge
direkte Sequenz von sich nicht überschneidenden Liniensegmenten mit Knoten an jedem Ende

Anmerkung 1 zum Begriff: Siehe Referenz [1].

3.2.3
Einschluss
en enclave
kleiner Gebietsteil, der von einem anderen Gebiet umschlossen ist von dem Gebiet aus gesehen, zu dem der Teil gehört

3.2.4
Ausschluss
en exclave
kleiner Gebietsteil, der von einem anderen Gebiet umschlossen ist von dem umschließenden Gebiet aus gesehen

3.2.5
Fläche
en face
zweidimensionales Element, das von einer geschlossenen Sequenz von Kanten und von keiner oder mehreren Menge(n) sich nicht überschneidenden geschlossen Sequenzen von Kanten innerhalb der ersten Sequenz von Kanten, begrenzt ist

3.2.6
Graph
Menge von Punkten und eine Menge von Pfeilen, bei dem jeder Pfeil einen Punkt nach dem anderen trifft, wobei die Punkte Knoten des Graphen, und die Pfeile die Kanten des Graphen genannt werden

Anmerkung 1 zum Begriff: Siehe Referenz [1].

3.2.7
Zwischenpunkt
en Intermediate Point
Punkt, der anders als ein Knoten ist, und die Form einer Kante festlegt

3.2.8
Linieneigenschaft
en Line Feature
eindimensionale Eigenschaft, die als Sequenz von einer oder mehreren Kante(n) festgelegt ist

3.2.9
Knoten
en Node
Null-dimensionales Element, welches eine topologische Verbindung von zwei oder mehreren Kanten ist, oder ein Endpunkt einer Kante

Anmerkung 1 zum Begriff: Siehe Referenz [1].

3.2.10
nicht-planarer Graph
en non-planar graph
Graph, der nicht eine Ebene eingebettet sein muss

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3.2.11
planarer Graph
en planar graph
Graph, der in eine Ebene eingebettet sein kann, d.h. das dieser auf einer Ebene gezeichnet ist, so dass sich die Kanten nur an einem Knoten schneiden, an dem sie sich gegenseitig treffen

3.2.12
Punkt
en point
Null-dimensionales Element, welches einen geometrischen Ort mit einem Koordinatenpaar oder Drilling festlegt

Anmerkung 1 zum Begriff: Siehe Referenz [1].

3.2.13
Liniensegment
Segment
en line segment, segment
direkte Verbindung zwischen zwei Zwischenpunkten, zwei Knoten, oder einem Knoten und einem Zwischenknoten

3.2.14
Wertigkeit
Ausmaß
en valency, degree
Anzahl von Kanten, welche mit einem bestimmten Knoten einwirken

3.3 Geodätische Begriffe

3.3.1
Kontrollpunkt
en control point
Punkt, der bekannte Koordinaten in der realen Welt hat, der mit einem korrespondieren Punkt in einer Karte oder einer fotographischen Gebiets- oder Sattelitenaufnahme identifizierbar ist

3.3.2
ellipsoidische Höhe
en ellipsoidal height
Abstand zischen einem Punkt und eines Referenz-Ellipsoiden, entlang der ellipsoidischen Normalen gemessen

3.3.3
geodätische Bezugshöhe
en geodetic datum
mathematische Oberfläche, die an einen Teil der Erdoberfläche heranreicht

3.3.4
Geoid
Modell eines Bildes der Erde, welches mit dem allgemeinen Meeresspiegel über den Ozeanen übereinstimmt und in kontinentalen Gebieten als eine imaginäre Meeresoberfläche, mit einer Wasserwaage festgelegt, weiterführt

Anmerkung 1 zum Begriff: An jedem Ort ist das/die Geoid Niveau/Oberfläche senkrecht zur Gravitationskraft. Die Form ist unregelmäßig aber kann, für die meisten Zwecke, als abgeplattetes Ellipsoid angenähert werden.

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3.3.5
Geoid Welligkeit
en geoid undulation
Unterschied zwischen der Meereshöhe und der ellipsoidischen Höhe, gemessen entlang der ellipsoidischen Normalen

3.3.6
Höhe
Erhöhung
en height, elevation
(vertikaler) Abstand zwischen einem Punkt und dem Referenz Höhenniveau oder des Referenz Ellipsoiden

Anmerkung 1 zum Begriff: Auf Landkarten ist das Referenzniveau die allgemeine Meereshöhe.

3.3.7
horizontales Referenzsystem
en horizontal reference system
Referenzsystem für Positionen

3.3.8
magnetische Missweisung
en magnetic declination
Winkel zwischen dem magnetischen Nordpol und dem echten Nordpol

Anmerkung 1 zum Begriff: Siehe Referenz [4].

3.3.9
Kartenprojektion
en map projection
Transformationsmethode die dafür verwendet, die gewölbte Erdoberoberfläche auf einer Ebene darzustellen

3.3.10
Offset
Wertepaare, die von allen Koordinatenwerten abgezogen werden, um diese Koordinatenwerte zu kürzen

3.3.11
Meereshöhe
en orthometric height
Abstand zwischen einem Punkt und dem Geoid, gemessen entlang der senkrechten Linie

3.3.12
Referenz Ellipsoid
en reference ellipsoid
abgeplattetes rotierendes Ellipsoid das verwendet wird, die Figur des Geoids anzunähern

Anmerkung 1 zum Begriff: Es wird durch zwei Parameter festgelegt: eine große Halbachse a (äquatorialer Radius der Erde) und eine kleine Halbachse b (Polarradius). Die Abplattung f ist folgendermaßen festgelegt: $f = (a - b)a$.

3.3.13
Referenz Höhenniveau
en reference height level
Niveau, auf das sich alle terrestrischen Höhen beziehen

Anmerkung 1 zum Begriff: Dies ändert sich von Land zu Land und bildet Teile des nationalen Koordinatensystems für die Landvermessung und das Kartographieren.

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3.3.14
Referenzsystem
en reference system
Koordinatensystem basierend auf einer nationalen Landvermessung

Anmerkung 1 zum Begriff: Siehe Referenz [4].

3.3.15
vertikales Referenzsystem
en vertical reference system
Referenzsystem für Erhebungen

3.3.15
geodätisches Bezugssystem
WGS, world geodetic system
Menge von normierten Referenzellipsoiden, die Breitengrad, Längengrad und Höhe für jeden Punkt der Erde festlegen

3.4 GDF-Begriffe

Anmerkung: Alle unten erwähnten Eigenschaftsklassen sind im Eigenschaftskatalog festgelegt.

3.4.1
Album
Sammlung bezogener Datenmengen (logische Unterteilung) und, wenn vorhanden, Inhalte (physische Unterteilung)

3.4.2
Attribut
en Attribute
Charakteristik einer Eigenschaft, die von anderen Eigenschaften unabhängig ist

Anmerkung 1 zum Begriff: Siehe Referenz [1].

3.4.3
Attribut Kodierung
en Attribute Code
alphanumerischer Bezeichner eines Attribut Typs

Anmerkung 1 zum Begriff: Siehe Referenz [5].

3.4.4
Attribut Name
en Attribute Name
Name bezogen auf einen Attribut Typ

Anmerkung 1 zum Begriff: Siehe Referenz [5].

3.4.5
Attribut Typ
en Attribute Type
festgelegte Charakteristik einer Eigenschaft, die von anderen Eigenschaften unabhängig ist

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3.4.6
Attribut Wert
en Attribute Value
spezifische Qualität oder Quantität, die einem Attribut zugeordnet ist

3.4.7
Datenmenge
en Dataset
Unterteilung eines Albums, welches wiederum in Sektionen unterteilt sein kann

Anmerkung 1 zum Begriff: Eine große Datenmenge, die einen bestimmten geographischen Bereich abdeckt, kann als Datenmenge betrachtet werden.

3.4.8
Bezirk
en District
als geographische Einheit betrachteter Bereich, der durch die Übermittlung eines spezifischen öffentlichen, oder privaten Abschnittsdienst festgelegt ist

3.4.9
Eigenschaft
en Feature
Datenbankdarstellung eines Objektes in der realen Welt

3.4.10
Eigenschaftskategorie
en Feature Category
Art der Darstellung einer Eigenschaft, inklusive Punkt, Line, Bereich und komplexe Eigenschaft

3.4.11
Eigenschaftsklasse
en Feature Class
Kategorisierung einer Eigenschaft

3.4.12
Eigenschaftsklassenkodierung
en Feature Class Code
alphanumerischer Bezeichner einer Eigenschaftsklasse

Anmerkung 1 zum Begriff: Siehe Referenz [5].

3.4.13
Eigenschaftsname
en Feature Name
Name bezogen auf eine Eigenschaftsklasse

Anmerkung 1 zum Begriff: Siehe Referenz [1].

3.4.14
Eigenschaftsthema
en Feature Theme
festgelegte Gruppe bezogener Eigenschaften

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3.4.15
Feld
en field
Menge von Charakteristiken, die eine Dateneinheit darstellt

3.4.16
Schicht
en Layer
gewisse Untermenge einer Datenmenge, die auf Informationsinhalten basiert

3.4.17
Manöver
en Manoeuvre
geordnete Sequenz eines Straßenelementes, eines Abzweigs und eines oder mehreren Straßenelementes(n) und optional mit einem bezogenen Straßenschild

3.4.18
Platz
en Place
administrative Bereich der Typen: Order-I-Bereich, Land, staatenübergreifender Bereich, administrativer Platz A-Z, oder benannte Gebietseigenschaft der Typen: bebauter Bereich, benannter Bereich, Bezirk

3.4.19
Besitz
en Property
Kombination von Attributs- und Beziehungswerten, die eine Eigenschaft betreffen und die zusammen eine gewisse Charakteristik der Eigenschaft festlegen

3.4.20
Beziehungskodierung
en Relationship Code
alphanumerischer Bezeichner für eine Beziehung

3.4.21
Beziehungsname
en Relationship Name
Name, der sich auf einen Beziehungstyp bezieht

3.4.22
Beziehungstyp
en Relationship Type
festgelegte Charakteristik einer Eigenschaft, die von anderen Eigenschaften abhängig ist

3.4.23
semantische Beziehung
Beziehung
en Semantic Relationship, Relationship
Charakteristik einer Eigenschaft, die weitere Eigenschaften zur Folge hat

3.4.24
Abschnitt
en Section
räumliche Untermenge einer Datenmenge

Anmerkung 1 zum Begriff: Der Überdeckungsbereich eines Kartenblattes, der durch geographische Koordinaten begrenzt ist, kann als Abschnitt betrachtet werden.

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3.4.25
Verkehrselement
en Transportation Element
Straßenelement, Weg, Eisenbahn Element, Pfad, Fährverbindung, Wasserkörper, Wasserbegrenzungselement, Abzweig, Eisenbahnelement Abzweig, oder Wasserbegrenzungsabzweig

3.4.26
Wendepunkt
en turn
geordnete Sequenz eines Straßenelementes, ein Abzweig und ein Straßenelement

3.4.27
Datenträger
en Volume
kleinste physische Einheit eines Mediums

Anmerkung 1 zum Begriff: ein einzelner Raum kann eine oder mehrere GDF-Datenmenge(n), abhängig der Datengröße, beinhalten.

BEISPIEL Ein magnetisches Band, eine Floppy-Disk.

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Nationaler Anhang NB
(informativ)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

A list of all parts in the ISO 20524 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.

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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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Figure 1 shows that each Feature shall belong to exactly one Feature Class and exactly one Feature Theme. The diagram also shows that Feature Classes and Feature Themes are uniquely referenced by a name and a code.

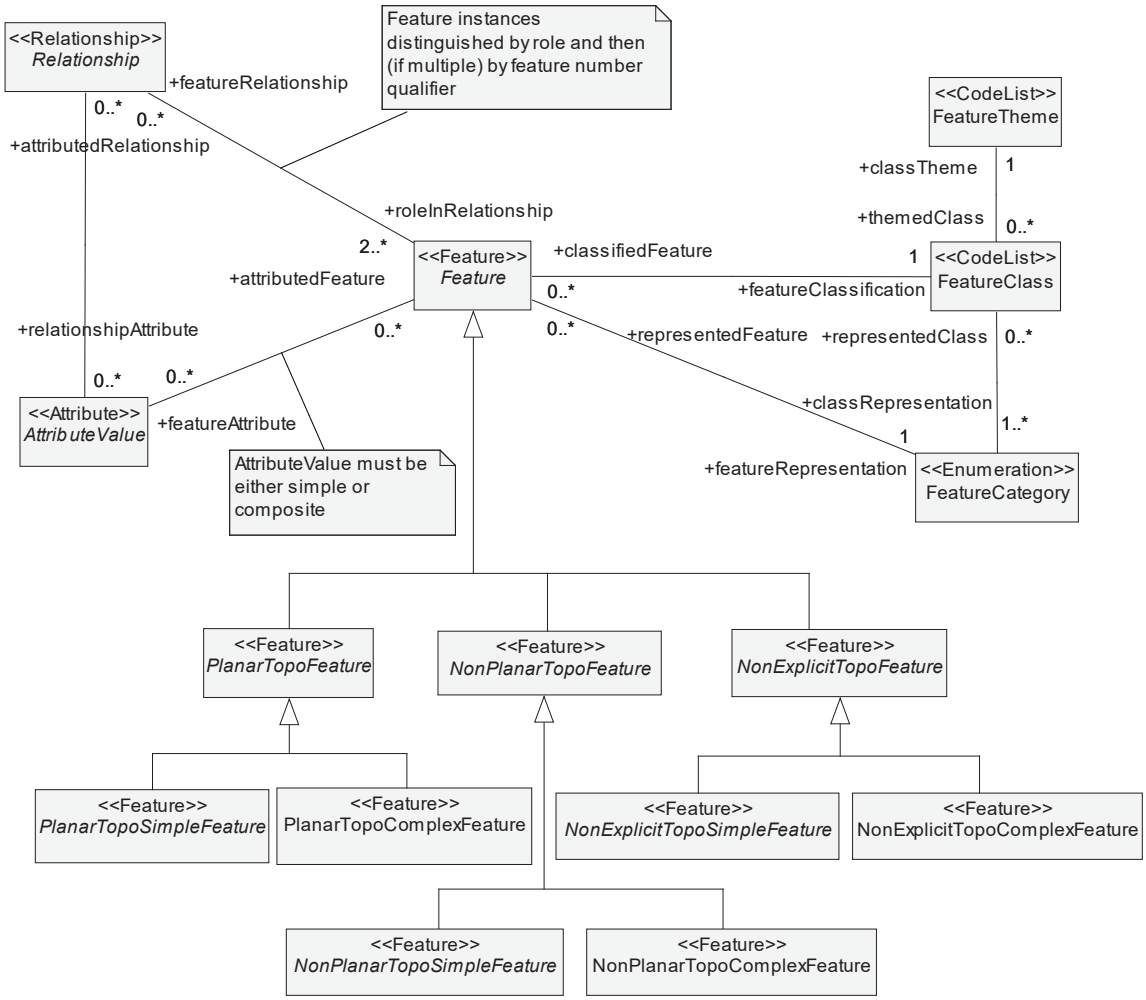


Figure 1 — Overall Conceptual Data Model

Each Feature belongs to exactly one Feature Class. This constraint is indicated in Figure 1 by the depiction of Feature Class with a multiplicity of 1 in the association between classes Feature and Feature Class. Thus, neither classless Features (Features belonging to no Feature Class) nor hybrid Features (Features belonging to multiple Feature Classes) are allowed in a GDF.

A Feature may have zero or more Attributes. Attributes serve to represent characteristics of a Feature that are independent of other Features.

A Relationship is used to associate two or more Features together. However, a Feature is not required to participate in a Relationship. A Relationship may have zero or more Attributes.

Each Feature is of exactly one Feature Category. A Feature Category is uniquely referenced by a Name and a Code. GDF defines four Feature Categories – Point, Line, Area and Complex. Collectively, Point, Line, and Area Features are referred to as Simple Features. Complex Features are aggregations of other Features, either Simple, Complex or in combination.

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5.2.2 Graph topology

The first subdivision of Features relates to the topology of the underlying graph with which the Features are defined. The GDF supports three different types of graph topologies: Planar topology, Non-planar topology and Non-explicit topology:

- Non-explicit topology: No topological relations between objects are explicitly defined. That is, topological relations are only defined via coordinate values.
- Non-planar topology: Topological relations are explicitly defined; objects may fully or partially coincide, or intersect or overlap each other.
- Planar topology: Topological relations are explicitly defined; objects shall not fully or partially coincide, and shall not intersect or overlap each other. Intersecting objects or overlapping objects are broken-up into object fragments, whereby common parts (such as a street coinciding with a boundary) are present only once.

In exceptional cases this document also supports the explicit definition of topology on the Feature level[2)].

Non-explicit topology gives the possibility to define and process data, for which topological relations are less relevant (e.g. map display data) in a very efficient way. Non-planar topology gives the possibility to perform network operations efficiently. Planar topology gives also the possibility to efficiently integrate area information in network operations.

In the GDF model, the rendering method chosen for planar topology is the full integration method, and for non-planar topology the connectivity method. Both methods are further described below.

Obviously since planar topology is a special case of non-planar topology it is quite possible to have utilized the "connectivity" approach to render the planar topology case. However, it is even conceivable (although less likely) to make use of the full integration method to render non-planar topology. It is important not to confuse the rendering choice with the topology choice.

In planar topology, the zero- and one-dimensional basic building blocks, Nodes and Edges, form a graph. In special cases where in reality two Point Features are located above each other, a single Node is being defined (possibly connected by a vertical Edge (of “length” zero) representing a Line Feature, e.g. an lift between different building levels). Furthermore, in the GDF model of topological planarity, a fully topologically integrated representation is provided for Area Features. Area Features are defined by referencing the two-dimensional building blocks, Faces, which make up that Area Feature (Figure 2).

2) This document allows the following additional explicit definitions of topology:

The start and end Point Feature of a Line Feature.

The start and end Complex Feature of a Complex Feature.

Through the use of Relationships (See below: The Relationship Model).

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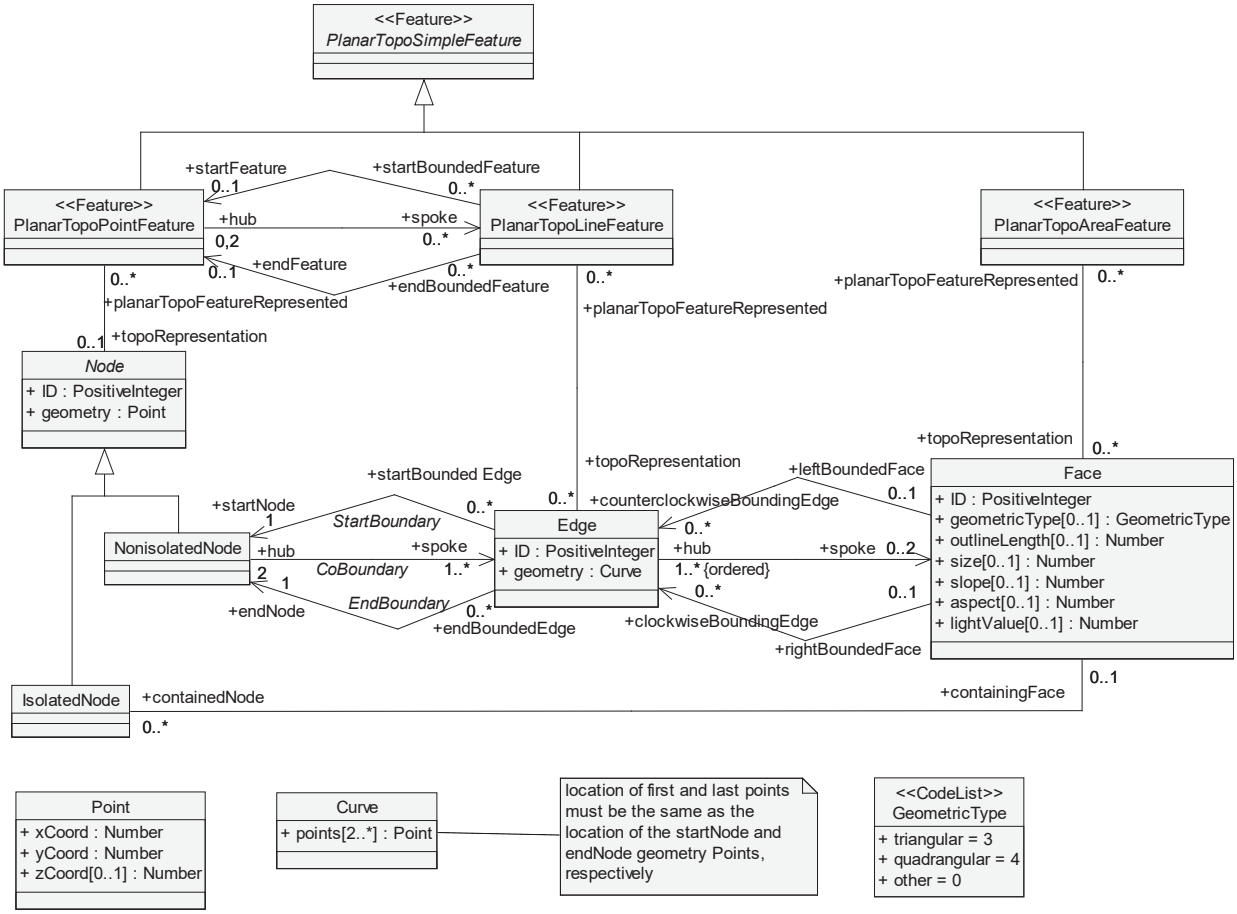


Figure 2 — Conceptual data model of Planar Topological Simple Features

Here, an Area Feature shall have at least one Face and a Face at least one Edge. This constraint is depicted in Figure 2 by the hub and spoke association between Face and Edge. The relation between a Face and its composing Edges is determined by the location of the Face relative to the Edge (left or right) relative to the direction of an Edge or, when approached from the Face, by the orientation of the Edge (clockwise or counter clockwise) when seen from the inside or the outside of the Face. This means that an Edge which bounds two Faces will have a clockwise orientation in the definition of one Face and a counter-clockwise orientation in the definition of the other Face (See Figure 3).

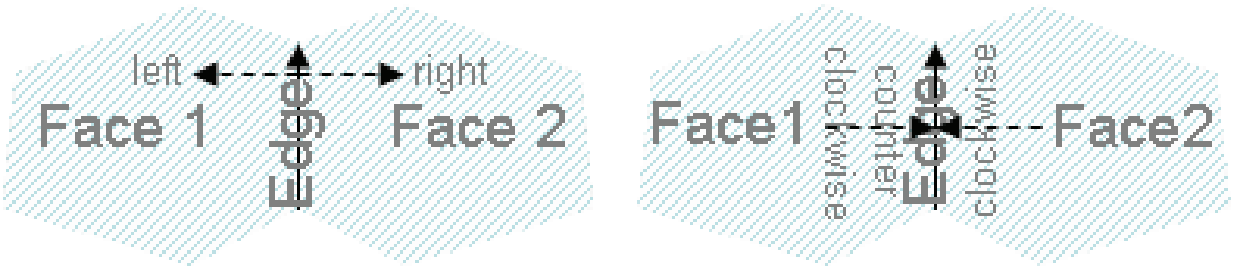


Figure 3 — Relation between Faces and bounding Edges

In non planar topology the Nodes and Edges together form a non-planar graph. That is, where in reality two Line Features cross at different levels (e.g. two roads crossing via a bridge), the Edges which represent these Line Features cross without forming a Node on the point of crossing. Also, in special cases where in reality two Point Features are located above each other, two Nodes are being defined (possibly

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