DIN EN ISO 20524-2

ICS 03.220.20; 35.240.60

Mit DIN EN ISO 20524-1:2023-04
Ersatz für
DIN EN ISO 14825:2011-10

Intelligente Verkehrssysteme – Geografische Datendateien (GDF) GDF5.1 – Teil 2: Kartendaten, die in automatisierten Fahrsystemen, kooperativen ITS und multimodalem Transport verwendet werden (ISO 20524-2:2020); Englische Fassung EN ISO 20524-2:2022

Intelligent transport systems –
Geographic Data Files (GDF) GDF5.1 –
Part 2: Map data used in automated driving systems, Cooperative ITS, and multi-modal transport (ISO 20524-2:2020);
English version EN ISO 20524-2:2022

Systèmes de transport intelligents –
Fichiers de données géographiques (GDF) GDF5.1 –
Partie 2: Données cartographiques utilisées dans les systèmes de conduite automatisée, les ITS coopératifs et le transport multimodal (ISO 20524-2:2020);
Version anglaise EN ISO 20524-2:2022

Gesamtumfang 607 Seiten

DIN-Normenausschuss Automobiltechnik (NAAutomobil)

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Full document details: DIN EN ISO 20524-2:2023-04

Nationales Vorwort

Dieses Dokument (EN ISO 20524-2:2022) 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“ im DIN-Normenausschuss Automobiltechnik (NAAutomobil).

Dieses Dokument enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die Englische Fassung von EN ISO 20524-2:2022.

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

ISO 20524-1:2020	siehe	DIN EN ISO 20524-1:2023-04
ISO 8601 (alle Teile)	siehe	DIN ISO 8601 (alle Teile)
ISO 19148	siehe	DIN EN ISO 19148

GDF5.1 ist eine Weiterentwicklung von GDF5.0, welches das Konzept von „teilbaren Eigenschaften“ einführt. Dabei wurden kooperative ITS berücksichtigt und mit der Normenreihe EN 12896 (Transmodel) des öffentlichen Verkehrs harmonisiert.

Während der erste Teil dieser Normenreihe alle Änderungen aller herkömmlichen GDF-Anforderungen berücksichtigt, legt dieser Teil Konzeptergänzungen, ein Datenmodell und eine Spezifikation fest, um neue Anforderungen bezogen auf GDF5.1 abzudecken.

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

Änderungen

Gegenüber DIN EN ISO 14825:2011-10 wurden folgende Änderungen vorgenommen:

a) dieses Dokument wurde neu für automatische Fahrsysteme, kooperative ITS und den multimodalen Transport erstellt.

Frühere Ausgaben

DIN EN ISO 14825: 2005-11, 2011-10

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Nationaler Anhang NA
(informativ)

Begriffe

Reihenfolge und Inhalt der folgenden Begriffe sind identisch mit denen im Abschnitt Begriffe der Englischen Fassung.

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:

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

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

3.1
Bandeigenschaft
en **Belt Feature**
zweidimensionale Eigenschaft, begrenzt durch drei oder mehrere Kanten, oder vier oder mehrere NET-Koordinaten-Tupel

3.2
Band
en **belt**
Konfigurationskonzept zur Festlegung eines Bereiches, der von *Seitenlinien* (3.4) und *Anschlusslinien* (3.5) begrenzt ist, gekennzeichnet durch *Richtungen* (3.3) und dargestellt als eine oder mehrere lineare Achse(n), wenn skelettiert

Anmerkung 1 zum Begriff: Die Anzahl skelettierter Achsen variiert, abhängig von der Eigenschaftsklasse. Im Falle eines Bandes, das auf eine Einbahnstraße angewendet wird, ist die Anzahl eins. Wenn es auf eine Kreuzung angewendet wird, hat das Band Achsen, die der Anzahl von eindeutig erlaubten Verkehrsrichtungen entsprechen.

3.3
Richtung
en **direction**
Signatur eines *Bandes* (3.2), bestimmt durch eine zugelassene Verbindung zwischen einem Paar von *Anschlusslinien* (3.5)

3.4
Seitenlinie
en **side line**
Typ von Begrenzungslinien dargestellt durch *Bandeigenschaft* (3.1) anders als eine *Anschlusslinie* (3.5)

3.5
Anschlusslinie
en **terminal line**
Typ von Begrenzungslinien dargestellt durch *Band-Eigenschaften* (3.1) und vorgesehen als Abschluss einer *Richtung* (3.3) einer Band-Eigenschaft in Verbindung mit einer anderen Anschlusslinie

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Nationaler Anhang NB
(informativ)

Literaturhinweise

DIN EN ISO 20524-1:2023-03, *Intelligente Verkehrssysteme — Geografische Datendateien (GDF) GDF5.1 — Teil 1: Anwendungsunabhängige Kartendaten, die zwischen verschiedenen Quellen geteilt werden (ISO 20524-1:2020); Englische Fassung EN ISO 20524-1:2022*

DIN ISO 8601 (alle Teile), *Datum und Uhrzeit — Darstellung für den Informationsaustausch*

DIN EN ISO 19148, *Geoinformation — Lineares Bezugssystem*

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 20524-2

December 2022

ICS 03.220.20; 35.240.60

Supersedes EN ISO 14825:2011

English Version

Intelligent transport systems - Geographic Data Files (GDF) GDF5.1 - Part 2: Map data used in automated driving systems, Cooperative ITS, and multi-modal transport (ISO 20524-2:2020)

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Intelligente Verkehrssysteme - Geografische Datendateien (GDF) GDF5.1 - Teil 2: Kartendaten, die in automatisierten Fahrsystemen, kooperativen ITS und multimodalem Transport verwendet werden (ISO 20524-2:2020)

This European Standard was approved by CEN on 20 December 2022.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

The text of ISO 20524-2:2020 has been prepared by Technical Committee ISO/TC 204 "Intelligent transport systems" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 20524-2:2022 by Technical Committee CEN/TC 278 "Intelligent transport systems" the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2023, and conflicting national standards shall be withdrawn at the latest by June 2023.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 14825:2011.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Endorsement notice

The text of ISO 20524-2:2020 has been approved by CEN as EN ISO 20524-2:2022 without any modification.

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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.*

This first edition cancels and replaces ISO 14825:2011, which has been technically revised.

The main changes compared to the previous edition are as follows:

— this document is newly dedicated to automated driving systems, Cooperative ITS and multi-modal transport.

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

GDF5.0 (ISO 14825) defines the map database exchange format for ITS. Its primary application is in car navigation systems and it assumes the provision of the map database by a single provider. However, ITS applications have been expanding to Cooperative ITS and automated driving systems through the recent progress of technology. In addition, there is demand for capabilities such as the accommodation of map databases from multiple providers and cooperation with externally connecting databases, such as Transmodel (EN 12896-1 and EN 12896-2).

Given this environment, ISO 14296 was published in February 2016 as an extension of map database specifications for applications of Cooperative ITS. However, GDF5.0 (ISO 14825) does not define some elements used in this document and automated driving systems require additional elements based on their unique application requirements. Furthermore, because GDF5.0 (ISO 14825) does not define a method to connect with external databases, the formulation of GDF5.1 (the ISO 20524 series) has become indispensable.

On revising GDF, the changes of conventional GDF are applied in GDF5.1 Part 1 (ISO 20524-1). The addition of a concept, a data model and specifications to satisfy new requirements applies to GDF5.1 Part 2 (this document). The new GDF document (the ISO 20524 series) is accordingly composed of two separate volumes: Part 1(ISO 20524-1) and Part 2 (this document).

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

Part 2:
Map data used in automated driving systems, Cooperative ITS, and multi-modal transport

1 Scope

This document specifies the conceptual and logical data model in addition to the physical encoding formats for geographic databases for Intelligent Transport Systems (ITS) applications and services. This document includes a specification of potential contents of such databases (data dictionaries for Features, Attributes and Relationships), a specification of how these contents are to be represented, and how relevant information about the database itself can be specified (metadata). This document further defines map data used in automated driving systems, Cooperative-ITS, and Multi-modal transport.

The focus of this document is firstly on emerging ITS applications and services, such as Cooperative-ITS and automated driving systems, and it emphasizes road, lane and relevant information on road and lane. However, ITS applications and services also require other information in addition to road and road-related information, which are provided as external databases to connect with GDF and to complement each other. Highly defined public transport databases, for instance, are indispensable in multi-modal transport applications and services in particular. Thus, this document focuses secondly on an expansion of the specification to connect with externally existing databases. It is particularly designed to connect a Transmodel (EN 12896-1 and EN 12896-2) conformant public transport database.

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 specified here has a broader focus than ITS applications and services. It is application independent, allowing for future harmonization of this model 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 20524-1:2020, *Intelligent Transport Systems — Geographic Data Files (GDF) GDF5.1 — Part 1: Application independent map data shared between multiple sources*

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

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

3 Terms and definitions

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

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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
Belt Feature
two-dimensional Feature, bounded by three or more Edges or four or more NET coordinate Tuple

3.2
belt
configuration concept for specifying an area bounded by *side lines* (3.4) and *terminal lines* (3.5), characterized by *directions* (3.3) and represented as one or more linear axes when skeletonized

Note 1 to entry: The number of skeletonized axes differs depending on the feature class. In the case of a belt applied to a one-way lane, the number is one. When applied to an intersection, the belt has axes corresponding to the number of unique allowable traffic directions.

3.3
direction
signature of a *belt* (3.2), determined by an allowed connection between a pair of *terminal lines* (3.5)

3.4
side line
type of boundary line constituting a *Belt Feature* (3.1) other than a *terminal line* (3.5)

3.5
terminal line
type of boundary line constituting a *Belt Feature* (3.1) and designated for determining a *direction* (3.3) of a Belt Feature in combination with another terminal line

4 Abbreviated terms, symbols and notation elements

4.1 Abbreviated terms

AAA	attribute addition area
AAL	attribute addition line
AAP	attribute addition point
ADS	automated driving system
BOP	BeltOptionalPoint
BRL	BeltRepresentativeLine
C-ITS	cooperative intelligent transport systems
IB	IntersectionBelt
ICP	IntersectionConnectionPoint
LCP	LaneConnectionPoint
NET	non-explicit topology
PEA	potential evasion area

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RBE RoadBeltElement

RSC road structural component

TIN Triangulated Irregular Network

4.2 Symbols and notation elements

In this document, many of the basic concepts of GDF are expressed using data models diagrams. The Unified Modeling Language (UML)[1] has been adopted as the conceptual modelling language for GDF.

Annex H 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 for Geographic Data Files (GDF) is specified in the following models:

— Figure 1 — Overall Conceptual Data Model (5.2.1).

Topological simple features:

— Figure 3 — Conceptual data model of Planar Topological Simple Features (5.2.3);

— Figure 5 — Conceptual data model of Non-planar Topological Simple Features (5.2.3);

— Figure 6 — Conceptual data model of Non-Explicit Topological Simple Features (5.2.3).

Topological complex features:

— Figure 7 — Conceptual data model of Planar Topology Complex Features (5.2.4);

— Figure 8 — Conceptual data model of Non-planar Topology Complex Features (5.2.4);

— Figure 9 — Conceptual data model of Non-Explicit Topology Complex Features (5.2.4).

Models defining attributes, relationships, data management:

— Figure 11 — Conceptual data model for Attribute Types (5.3);

— Figure 12 — Conceptual data model for Attribute Values (5.3);

— Figure 13 — Conceptual data model for Relationships (5.4);

— Figure 14 — Conceptual data model for Feature Representation (5.6);

— Figure 15 — Organization of data in Albums, Datasets, Layers and Sections (5.8);

— Figure 16 — Composition of Sections (5.8);

— Figure 17 — Section Primitives (5.8);

— Figure 18 — Attribute and Relationship Partitioning Scope (5.8);

— Figure 19 — Feature Conversion (5.8).

Detailed sub-schemas are presented in the respective subclauses. The data models convey a range of dedicated terms defining concepts of the GDF model, and according to UML practice, these terms are formatted using "CamelCase" notation. Textual descriptions complementing the graphical descriptions are shown with the first letter in upper case for each constituent word of a given GDF term.

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The general data model, presented and explained in detail in the remainder of this clause,

— serves as meta-model for the respective semantic models of the individual Feature classes (Feature Catalogue, Clause 6),

— lists the individual Attribute types (Attribute Catalogue, Clause 7), and

— defines the individual Relationship Types (Relationship Catalogue, Clause 8).

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, this document explicitly includes them here due to their conceptual relevance. This refers to the fact that IDs provide a means of unique identification of elements regardless of a particular physical realization of the GDF conceptual model, despite the fact that certain physical realizations may not require the use of physical ID. Consequently, transition between different physical realizations will not result in loss of information.

5.2 General data model of GDF

5.2.1 Feature model

Feature, which is a database representation of a real-world geographic object, is visible in the centre of the model shown in Figure 1.

NOTE 1 In this model “Feature” has the meaning of "Feature instance", which is an individual occurrence of a geographic object, such as a road, a building, or a structure like the Eiffel Tower in Paris.

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

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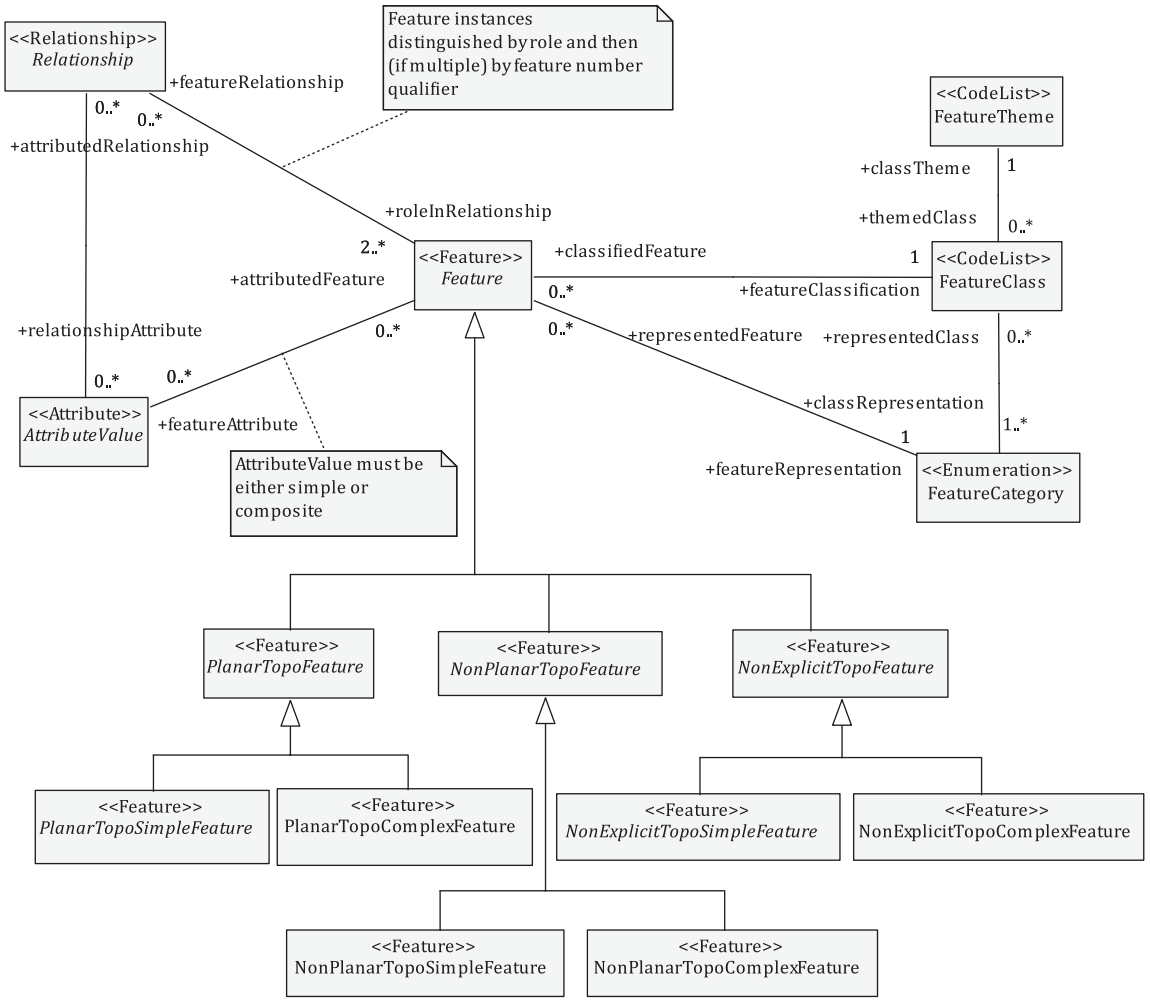


Figure 1 — Overall Conceptual Data Model

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 a member of exactly one Feature Category. A Feature Category is uniquely referenced by a Name and a Code. GDF defines both Simple Features and Complex Feature types. A Complex Feature is an aggregation of other Features, either Simple, Complex, or a combination of both.

In the previous version of GDF 5.0, (ISO 14825), roads and road related objects were described by a basic data model. Roads and intersections were expressed by lines and points. A level Attribute was used to unify bidirectional road elements into a single road feature. The data model of GDF 5.0 was necessary and sufficient to express roads and ferry data as a network usable for routing, positioning and map display in conventional navigation systems.

However, in emerging ITS applications, lane keeping for Cooperative-ITS and automated driving systems requires highly defined information that enables a vehicle to identify where it is driving in a lane and to identify which lane of a road the vehicle is presently travelling in. To acquire this information, roads and

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road related objects (e.g. lanes) shall be expressed in a specific Area Feature that may be "skeletonized" or degenerated into a line shape to represent a general direction of vehicular movement, such as a reference line, centre line of a lane and/or a usual vehicle trajectory in a lane. Although the basic data model defined in GDF 5.0 enables the vehicle to identify in which road and lane it is driving, GDF 5.0's Area Feature may be degenerated in a point shape. Thus, the conventional GDF 5.0 Area Feature is not able or extendible to meet the requirements of emerging ITS applications.

NOTE 2 The following UML class names shown in Figure 1, (simple: PlanarTopoSimpleFeature, NonPlanarTopoSimpleFeature and NonExplicitTopoSimpleFeaure; complex: PlanarTopoComplexFeature, NonPlanarTopoComplexFeature and NonExplicitTopoComplexFeature) are simplified and written as Simple Feature or Complex Feature in the rest of this document to simplify and clarify their descriptions.

5.2.2 Belt concept

The "belt concept" introduces a specific Area Feature, referred to as a belt, that can be degenerated into a line shape. This encompassing belt-like Area Feature is used to express roads and road related objects which have directional characteristics and actual width to meet the requirements of emerging ITS applications. As illustrated in Figure 2, a belt shall consist of side lines and terminal lines. The area represented by the belt shall be bounded by side lines and terminal lines.

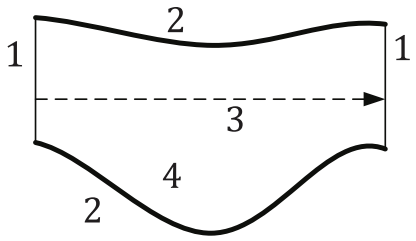
A terminal line represents the logical linear feature where a Belt Feature is separated from other Belt Feature for logical reasons. A terminal line logically intersects the degenerated line shape representing the Belt Feature.

NOTE Terminal lines normally have no real-world representation. Side lines are often represented by real-world features such as lane dividing road markings, edges of the carriageway, kerbs, etc.

In the case of a road (Figure 2a), a belt has at least one directional characteristic, the “direction”. Additionally, the belt may have other characteristics which include the widths of the belt which shall be calculated as the distance between a pair of side lines for this belt. The value width shall be associated with a measure on the degenerated line shape representing the Belt Feature.

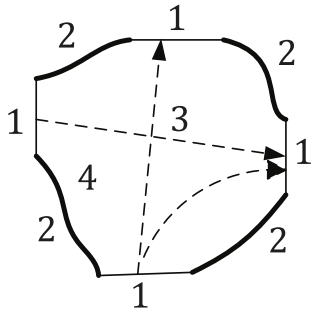
The terminal lines define the characteristics of belt direction. In the case of an intersection (Figure 2b), a belt has at least two directional characteristics. Widths of a belt are calculated as the distance between a pair of side lines which determine both sides of the belt except in an intersection.

In the belt data model, terminal lines are conceptually represented and assumed to function as "directional control valves" at both ends of a flow. Side lines are also conceptually represented and may refer to real road related objects (e.g. lane markings, flow-markings, kerbs, guardrails, etc.).



a) Road

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b) Intersection

Key

1	terminal line	3	direction
2	side line	4	belt

Figure 2 — Example of belt structure

5.2.3 Graph topology

The first subdivision of Features relates to an underlying topological graph in which the Features are defined. GDF supports three types of graph topologies:

— Planar topology: Topological relations are explicitly defined; objects shall not coincide either fully or partially, and those objects shall not intersect or overlap each other. Intersecting objects or overlapping objects are broken-up into object fragments, whereby common parts are present only once.

— Non-planar topology: Topological relations are explicitly defined; objects may fully or partially coincide, intersect, or overlap each other.

— Non-explicit topology: No topological relations between objects are explicitly defined; topological relations are only defined via coordinate values.

In exceptional cases, this document also supports the explicit definition of topology on the Feature level[1)].

Non-explicit topology enables the possibility to define and process data for which topological relations are less relevant (e.g. map display data) in an efficient way.

Non-planar topology enables 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 used for planar topology is the *full integration method*, and for non-planar topology the *connectivity method* is used.

Since planar topology is a special case of non-planar topology it is quite possible to use the *connectivity method* to render planar topology. However, it is even conceivable, although less likely, to make use of the *full integration method* to render non-planar topology. Thus, it is important not to confuse the rendering method with the topology type.

In planar topology, the basic building blocks of zero-dimensional Nodes and one-dimensional Edges form a graph. In special cases where, in reality, two Point Features are located directly above each

1) 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,

— using relationships (5.4).

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other, a single Node is defined and can be connected by a vertical Edge of zero-length representing a line feature, such as an elevator between different building levels.

A Belt Feature, which is a feature representing a belt shown as PlanarTopoBeltFeature in the conceptual data model of Planar Topological Simple Features (Figure 3), shall be composed of Edges and have the following properties:

— BoundingDirection,

— EdgeDirection,

— BeltElementInfo,

— BeltDirection.

Edges constituting side lines and terminal lines, which encompass the PlanarTopoBeltFeature, shall be referred to in an ordered direction either clockwise or counterclockwise. Thus, each Edge is identifiable by the ordinal number assigned in the order referenced when generating a Belt Feature.

The startNode of the (i+1)th Edge shall be located on the endNode of the (i)th Edge (in case of the (n)th Edge, the endNode shall be located on the startNode of the 1st Edge), where n is the number of Edges.

The Bounding Direction represents the referencing direction when the border of a Belt is composed. Edge Direction represents each direction of the edge when it is referenced to generate the boundary of a Belt Feature.

A belt element represents a unit of the border of a belt feature. A belt element shall be an Edge or a series of Edges functioning as either a side line or a terminal line.

Belt Element Info provides Belt Element Ordinal Number, Belt Element Pointer and Belt Element Type. Belt Element Ordinal Number represents an ordinal number allocated to respective belt elements for identification. Belt Element Pointer represents an ordinal number allocated to respective Edges for identifying the last Edge of a belt element. Belt Element Type represents the distinction between side line and terminal line.

EXAMPLE In the case that the n-th belt element is designated as a side line and generated by the i-th to k-th Edges, Belt Element Info provides “Belt Element Ordinal Number = n”, “Belt Element Pointer = k” and “Belt Element Type = side line”.

Belt Direction represents the direction of the belt feature. The direction shall be identified by a pair of ordinal numbers assigned to the origin and destination Belt Elements which are designated as terminal lines.

Additionally, 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 comprise a specific Area Feature (Figure 3).

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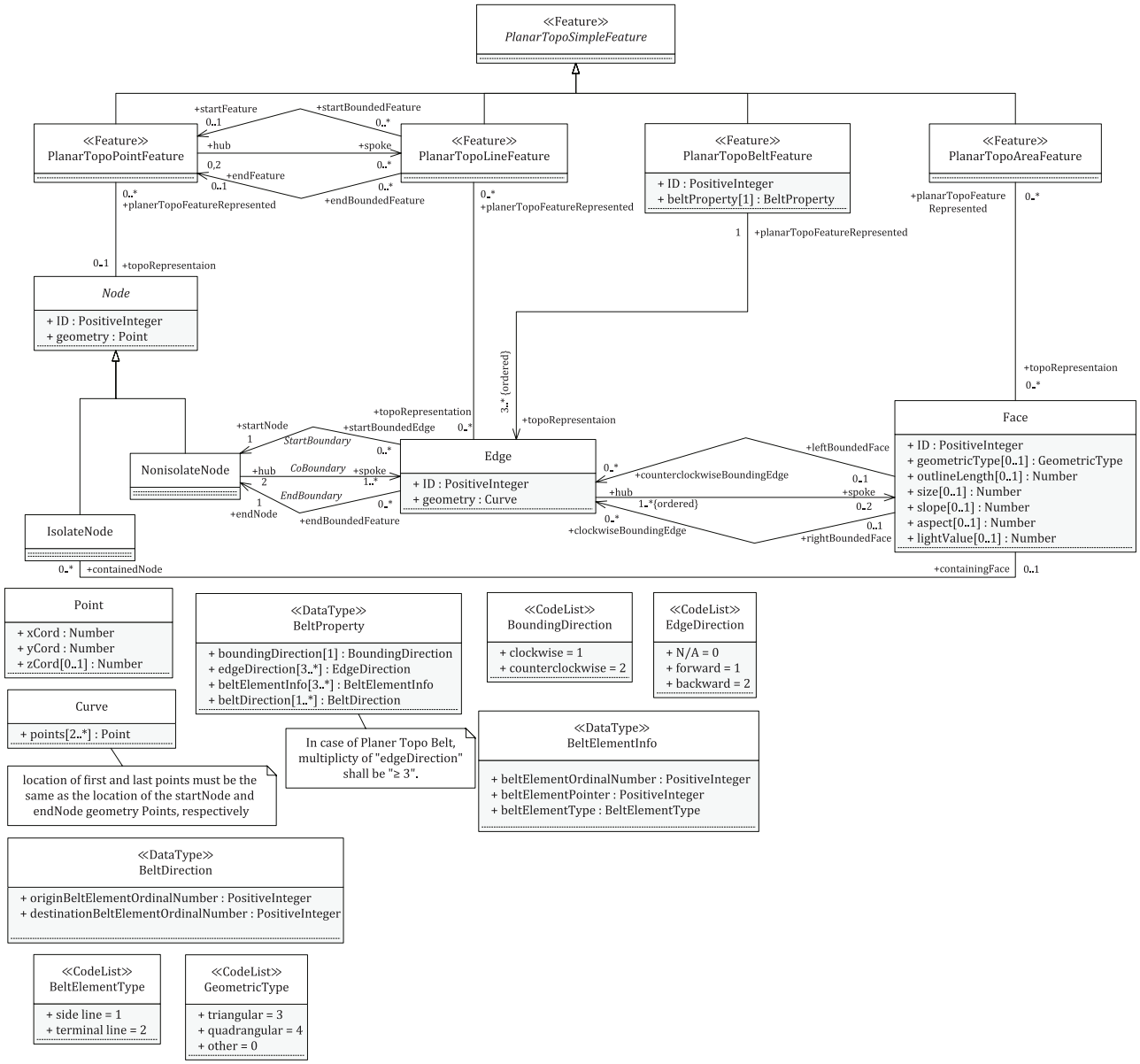


Figure 3 — Conceptual data model of Planar Topological Simple Features

An Area Feature shall have at least one Face and a Face at least one Edge. This constraint is depicted in Figure 4 by a hub and spoke association between a Face and an 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 counterclockwise) when viewed 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 counterclockwise orientation in the definition of the other Face, as depicted in Figure 4.

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Figure 4 — 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 connected by a vertical Edge representing a Line Feature, e.g. an elevator between different building levels).

NonPlanarTopoBeltFeature, which is a Belt Feature in the conceptual data model of Non-Planar Topological Simple Features (Figure 5), shall be composed of Edges composing side lines and terminal lines, which shall bound all the way around NonPlanarTopoBeltFeature. These shall be referred to in a certain order, either clockwise or counterclockwise direction.

In the GDF model of topological non-planarity, Faces do not exist, therefore only topological connectivity is represented. Two-dimensional Features are defined by referencing the Edges making up this boundary (Figure 5).

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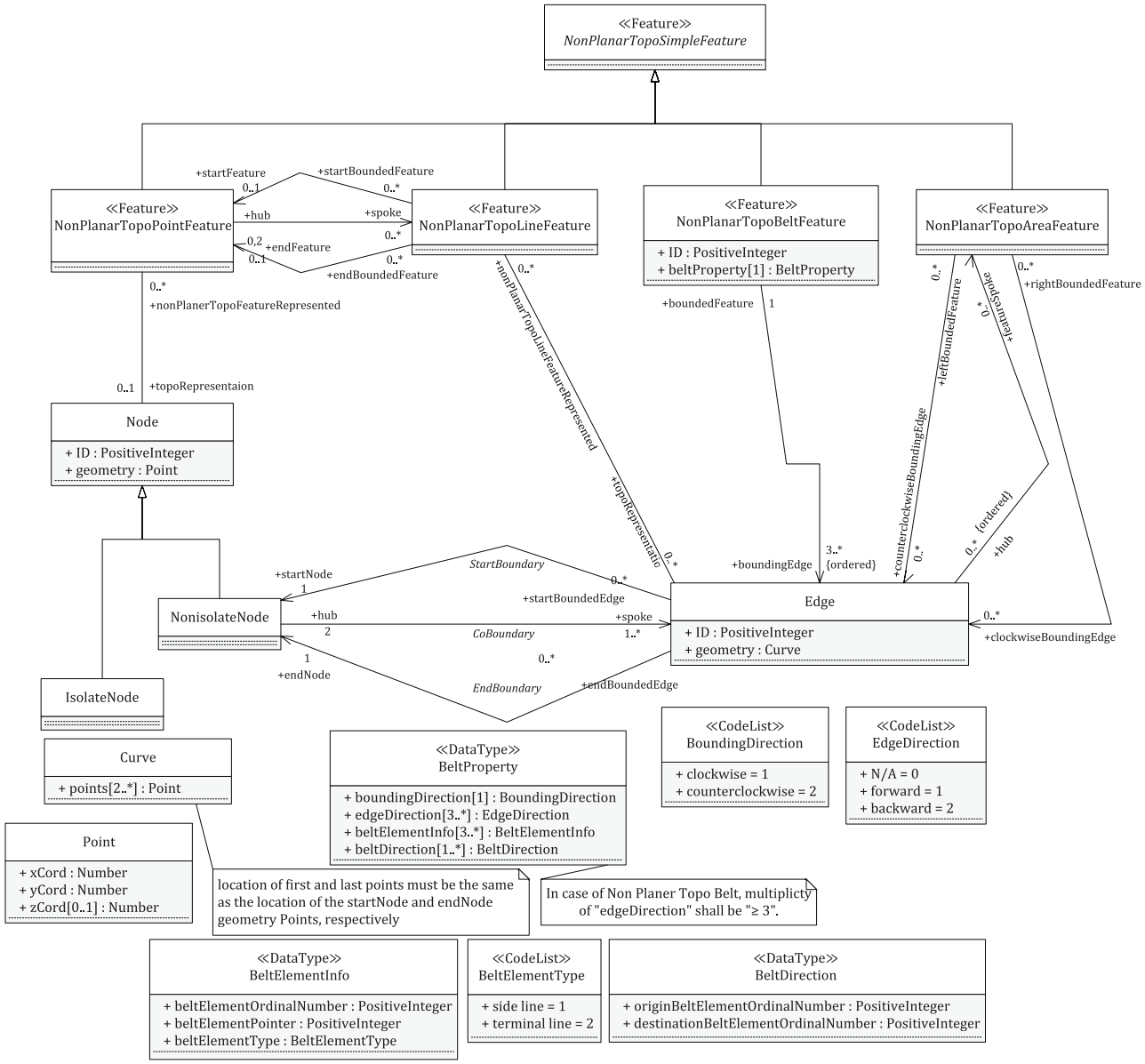


Figure 5 — Conceptual data model of Non-planar Topological Simple Features

In planar topology, the basic graph represents objects in a single plane. Reality however is not planar. Roads for instance may cross each other at different grades. This non-planarity shall be introduced on the Feature level[2)].

In non-explicit topology the basic building blocks of zero-, one-, and two-dimensional Features are, respectively, Dots, Polylines, and Polygons. Dots, Polylines and Polygons are defined without explicit topological relations.

In the remainder of this clause, both planar topology and non-planar topology will be referred to as “topology” and the corresponding Features as topological Features, while the non-explicit topological constructs will be referred to as non-explicit topology or "NET" and the corresponding Features as non-explicit topological or "NET Features”.

In topology, Features are defined by the basic building blocks Nodes, Edges and Faces. Figure 3 and Figure 5 specify that a topological Point Feature shall be represented by exactly one Node, a topological Line Feature by one or more Edges, and a topological Area Feature either by one or more Faces or by

2) In addition to this, this document allows the definition of the height level of Edges.

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one or more Edges forming one or more closed boundaries. The lower sections of Figure 3 and Figure 5 illustrates how the basic building blocks Node, Edge and Face (planar topology only) are mutually related in each of the supported topologies.

Within the conceptual model Nodes may be separated into two types:

— Isolated Nodes – nodes that do not coincide with other geometry,

— Non-isolated Nodes – nodes that are connected to one or more Edges.

In non-explicit topology, Features are defined by the basic building blocks Dots, Polylines and Polygons. Figure 6 specifies that a NET Point Feature shall be represented by exactly one Dot, a NET Line Feature by exactly one Polyline, a NETBeltFeature by exactly one NETBelt and a NET Area Feature by exactly one Polygon. No relationships are defined between these basic building blocks, thus signifying their non-explicit topological nature. An important distinction from topology is there is no reuse within the building blocks. Polylines do not reuse (reference) Dots, nor do Polygons reuse Polylines. Thus, shared geometry never occurs and overlapping Features need to have their building blocks replicated. In non-explicit topology, reuse may occur in the definition of Complex Features.

NOTE 1 NETBeltFeature is a Belt Feature in the conceptual data model of Non-Explicit Topology Simple Features.

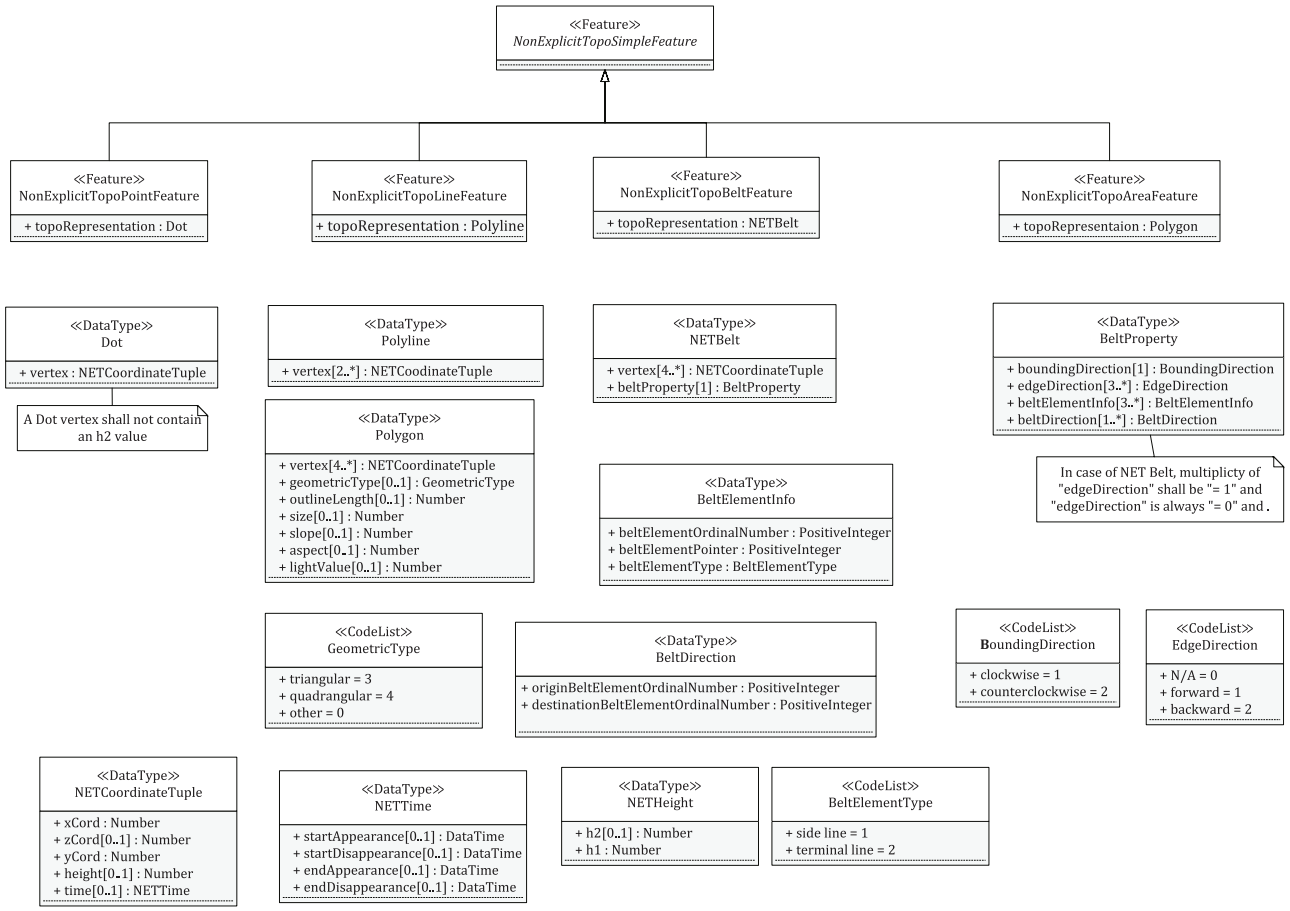


Figure 6 — Conceptual data model of Non-Explicit Topological Simple Features

In GDF, the mixing of topologies is not allowed, meaning that a GDF Layer may only contain data from one type of topology (see Figure 16 and Figure 17).

One should note that the multiplicity of classes representing the basic geometric building blocks (Nodes, Edges and Faces) in the associations with the classes representing Features with the different Feature Categories (Point, Line Belt and Area) in planar and non-planar topology have zero as the begin-value.

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This indicates that geometry-less Features are allowed, and this document allows for the definition of Features in which the geometry is not defined.

The "multiplicity" value indicates the number of instances of the class nearest the adornment that may participate in each instance of the association. Multiplicity is specified as a range with a format of "begin-value, end-value". The begin-value is any positive integer, and the end-value is an integer greater than the begin-value. If only a begin-value is specified, then exactly that number of instances of the class shall exist for this association. For example, a multiplicity of '1' at the Type1 side of the association specifies that every instance of Type2 shall have this association with one and only one instance of Type1. A multiplicity of '0..1' specifies that every instance of Type2 shall have this association with zero or one instances of Type1. A multiplicity of '0..*' specifies that every instance of Type2 shall have this association with zero or more instances of Type1. A multiplicity of '1..*' specifies that every instance of Type2 shall have this association with one or more instances of Type1.

NOTE 2 In the rest of this document, a PlanarTopoSimple [Point | Line | Belt | Area] Feature can be simplified and written as [Point | Line | Belt | Area] Feature or Simple [Point | Line | Belt | Area] Feature. This notation also applies to NonPlanarTopoSimple Feature and Non-ExplicitTopoSimple Feature. The notation [A | B | ...] indicates a replacement of A or B or ... and so forth.

NOTE 3 In the rest of this document, a PlanarTopoComplex [Point | Line | Area] Feature can be simplified and written as Complex [Point | Line | Area] Feature. This notation also applies to NonPlanarTopoComplex Feature and Non-ExplicitTopoComplex Feature. The notation [A | B | ...] indicates a replacement of A or B or ... and so forth.

5.2.4 Levels in GDF

The different objects together making up a GDF are conceptually divided over three different levels, Level-0, Level-1 and Level-2. The topological primitive building blocks, Node, Edge, and Face reside on Level-0. The Simple Features, as referred to in the previous paragraph and in the data models there together make up Level-1. Simple Features may form aggregated Features which are called Complex Features. Complex Features comprise Level-2. Figure 7, Figure 8, and Figure 9 give the data model of Complex Features for the three different types of topologies. As may be seen in these figures, Complex Features may only consist of Features defined with the same topology.

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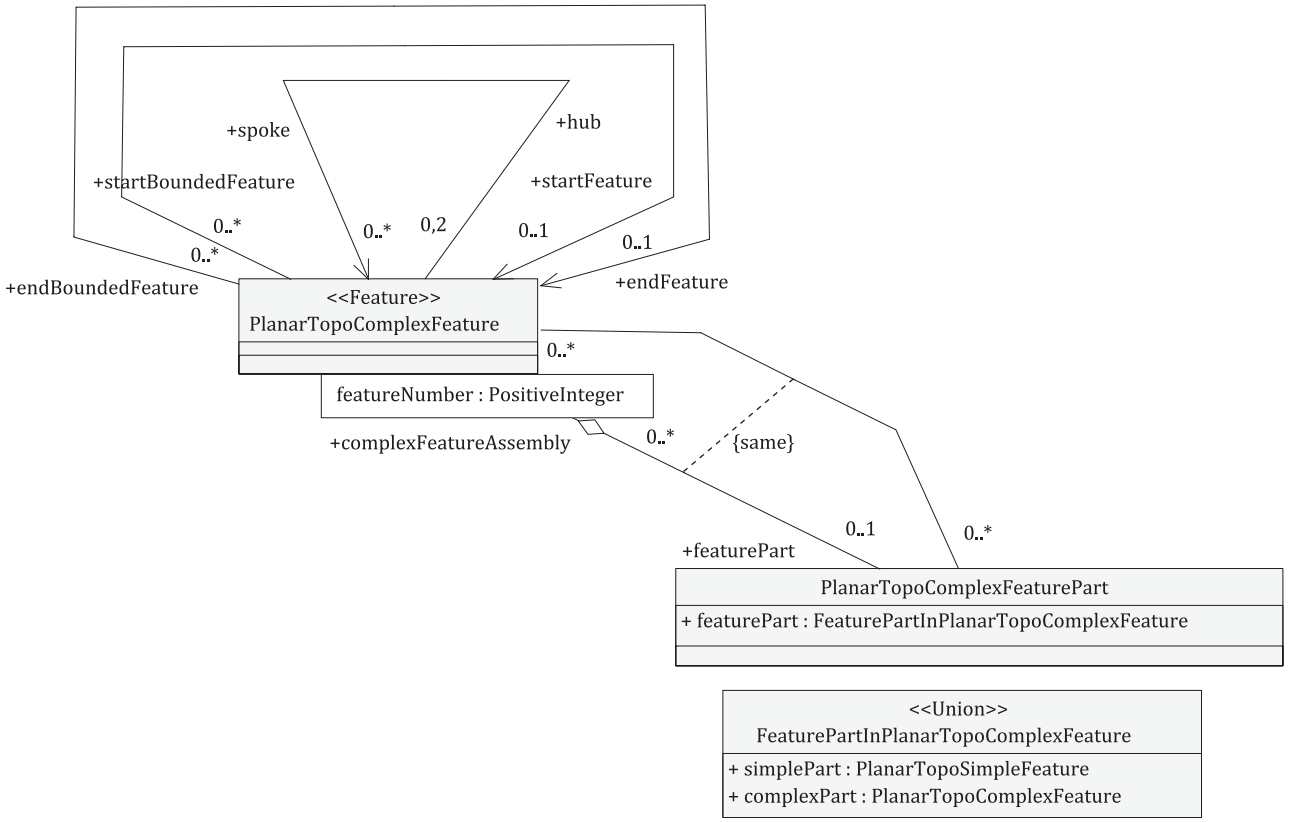


Figure 7 — Conceptual data model of Planar Topology Complex Features

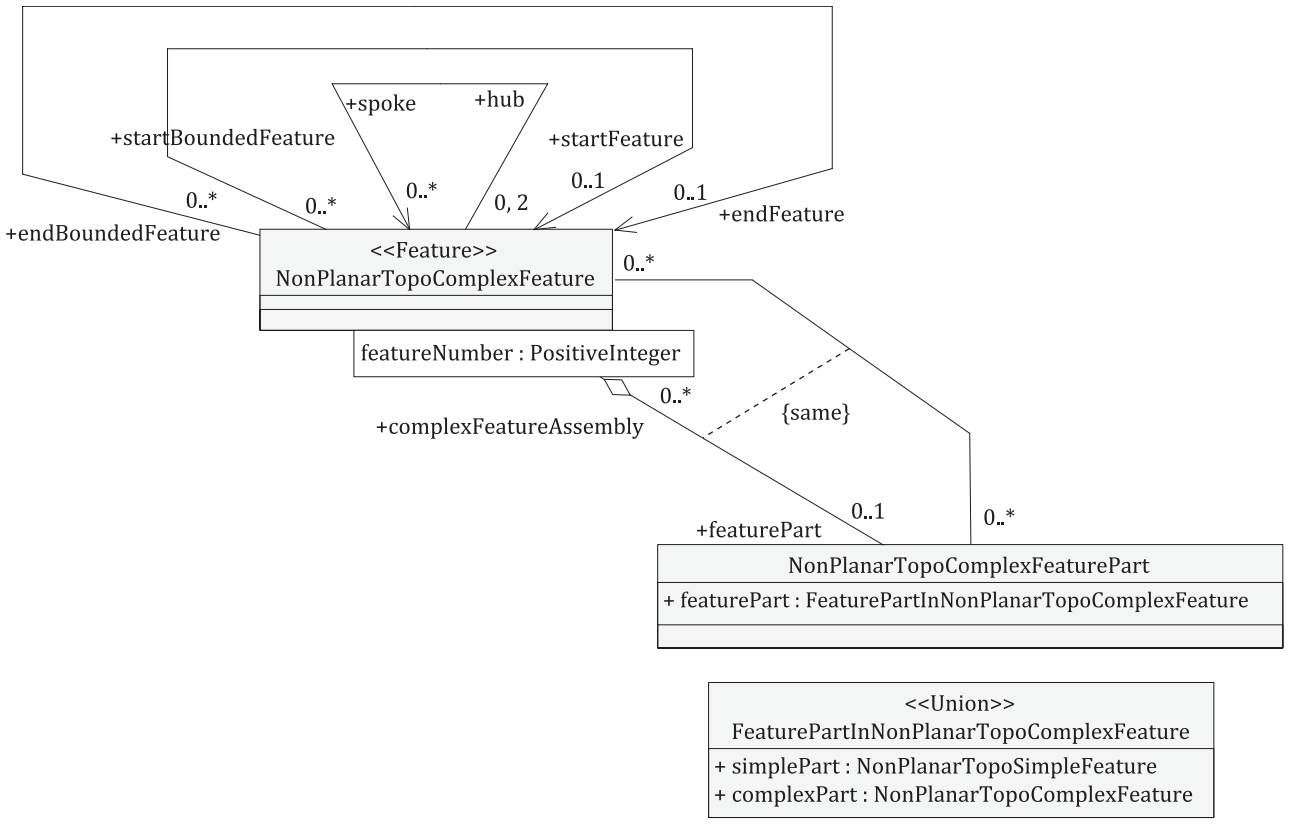


Figure 8 — Conceptual data model of Non-planar Topology Complex Features

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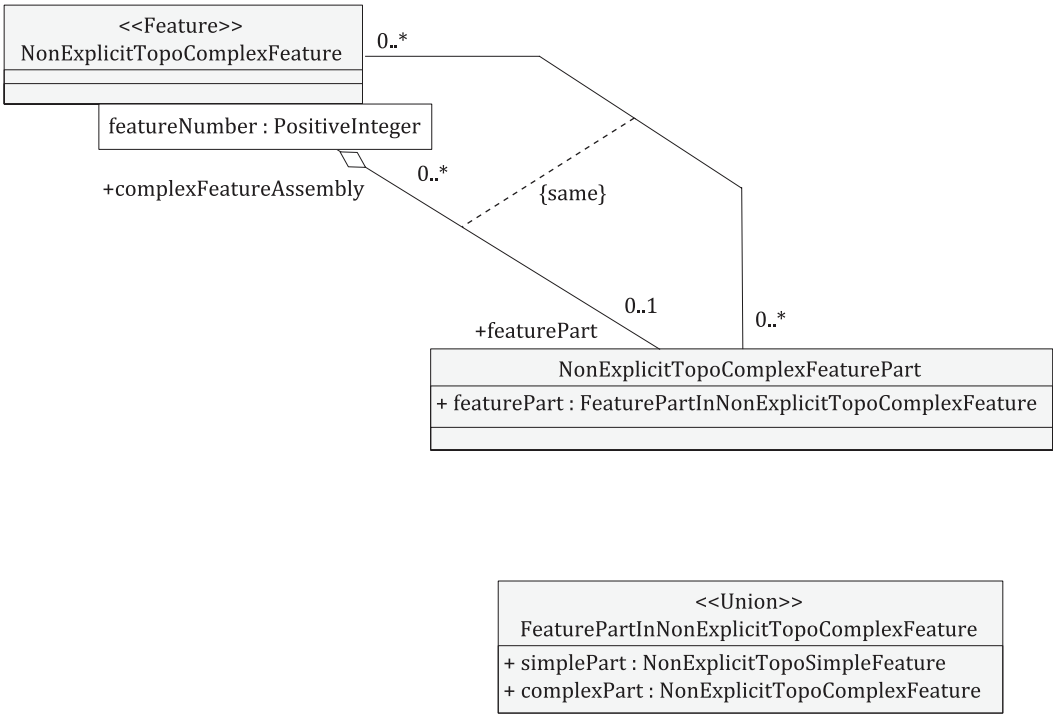


Figure 9 — Conceptual data model of Non-Explicit Topology Complex Features

5.2.5 Height modelling and time modelling

So far, the different types of topology have been described in terms of their ability to define two-dimensional objects. This document, however, supports various levels of three-dimensional modelling and includes the possibility to model objects in a space-time continuum.

All different types of topology assume a two-dimensional plane to which the different Features are referred. This document also supports the definition of elevation above this plane in the sense that all geometries defined (by Nodes, Edges, Faces, Dots, Polylines or Polygons) may be given an elevation value representing terrain height.

In addition to this, non-explicit topology supports the three-dimensional representation of Features. Next to their horizontal and elevation geometrical definition, Features are represented three-dimensionally by a specification for each horizontal position of their minimum height and their maximum height above the terrain. In most cases, the minimum height will be zero, representing a Feature which extends from the ground to a certain height vertically. This refers for instance to the case in which a normal building, located on the terrain with a certain height is represented. However, in certain cases, a Feature will extend from a certain height above the ground to a certain height vertically. This refers for instance to arch shaped buildings which have a certain part starting a certain height above the ground and extending further upward (see Figure 10).

In non-planar and planar topology, three-dimensional aspects may be modelled via an Attribute solution. If a given Non-Explicit Topology Feature is subject to both three-dimensional representation models (namely three-dimensional characteristics on Feature level as well as three-dimensional characteristics of Attributes of the Feature in question), the three-dimensional characteristics on Feature level shall be given priority over the three-dimensional characteristics on Attribute level.

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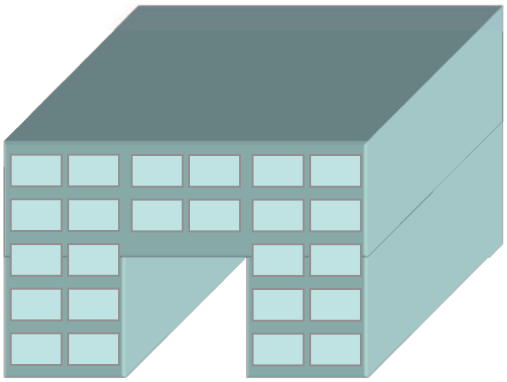


Figure 10 — Example of an arch shaped building

This document also supports terrain modelling in which a three-dimensional representation of the terrain can be defined. Three different methods are provided, which include support for Triangulated Irregular Networks (TINs), contour lines, and point grids. For TINs Faces and Polygons have been extended with enhanced geometric properties such as triangle size and slope. Contour lines and point grids are both modelled as Features and Attributes.

This document also supports the representation of temporal characteristics of Features. This is supported for Non-Explicit Topology Features. This is done by extending each horizontal position of a Feature with four temporal definitions. These definitions stand for the moment of start of appearance (construction start), the moment of end appearance (opening), the moment of start of disappearance (closure) and the end of disappearance (demolition end). In this way, the existence of a Feature over time may be represented. In non-planar and planar topology, temporal aspects may be modelled via an Attribute solution. Here, the Time Domain Model of GDF (5.7) is applied, whereby the start time and the duration of a certain construction status may be defined.

If a given Non-Explicit Topology Feature is subject to both time models (namely temporal characteristics on Feature level as well as temporal characteristics of Attributes of the Feature in question), the temporal characteristics on Feature level shall be given priority over the temporal characteristics on Attribute level.

5.3 The Attribute model

Characteristics of Features which are independent of other Features are modelled as Attributes. Attributes are of a certain Attribute Type identified by a name and code. The value of an Attribute instance is called an Attribute Value. Attribute data types include a code, text, an ID, or number. This document defines Attributes relevant for ITS applications and specifies which Attributes may be used in combination with which Features. For Complex Features, Attributes may be defined for a Complex Feature as a whole (assembly) or for a particular Feature part on an instance by instance basis.

In certain cases, Attribute Values are defined within the GDF itself. In other cases, only the domain of the Attribute Value is specified. This is the case when the Attribute Value is a measure (e.g. Average Speed) or is defined by a string of characters (e.g. Official Street Name Text). Another case relates to user defined Attributes. User defined Attributes are defined by the user within the context of a particular GDF. Certain Attributes that have been defined in the GDF do not have their Attribute Values defined. For example, the Attribute Value of Multimedia File Attachment is the reference to external files rendered in binary, XML, or other physical encodings.

The Attribute Catalogue defines a set of Attribute Types and corresponding reference names and codes. It also defines the Feature Class and/or the Relationship Type to which a particular Attribute Type may be attached. Figure 11 and Figure 12 give the conceptual data model for this. The diagram shows that an Attribute may be an aggregation of other Attributes. Such an Attribute is called a Composite Attribute, as opposed to a normal (non-aggregated) or Simple Attribute. A Composite Attribute consists of a number of Sub-Attributes. Semantically, a Composite Attribute specifies an aggregated value,

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which is composed of a number of values, specified by the value of the respective Sub-Attribute. Their appearance in a Composite Attribute specifies the fact that they represent partial information and that the complete information may be found in the other Sub-Attributes of the Composite Attribute.

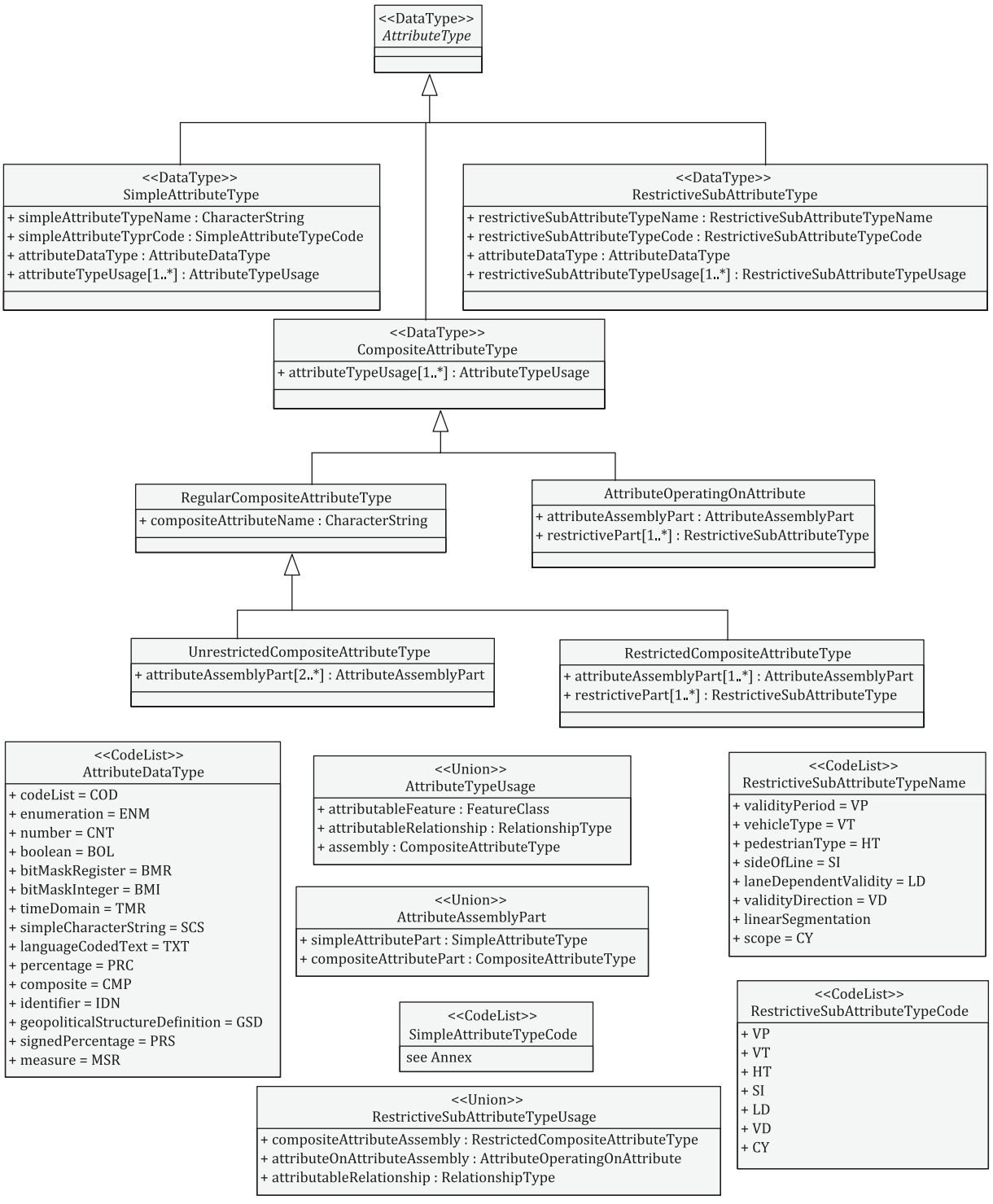


Figure 11 — Conceptual data model for Attribute Types

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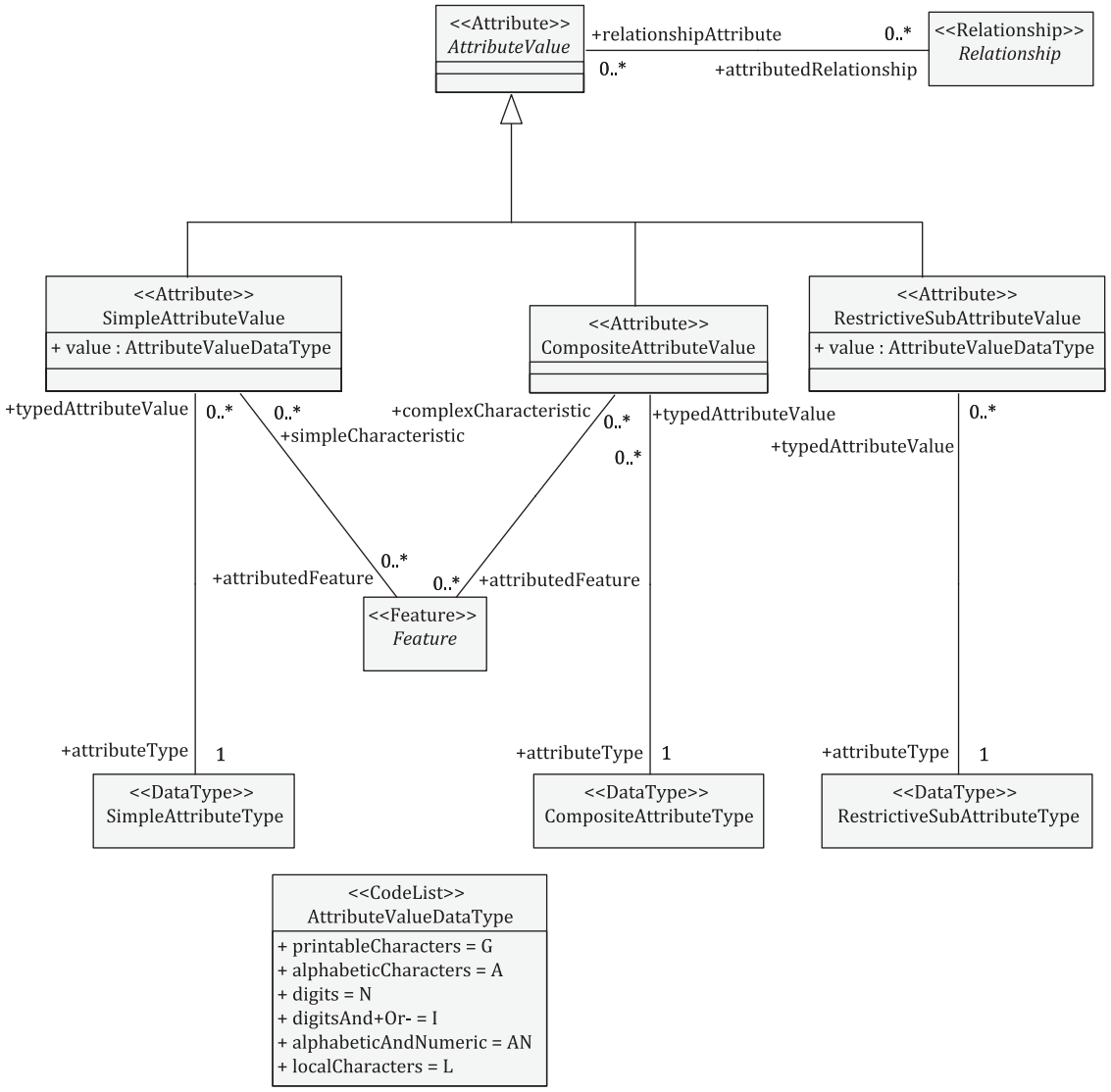


Figure 12 — Conceptual data model for Attribute Values

In most cases, like values of normal Attributes, Sub-Attributes values are independent. Cases where Sub-Attribute Values are not independent are cases where an Attribute (Simple or Composite) is combined with a so-called Restrictive Sub-Attribute operating in said Attribute. In these cases, the validity of the Attribute is restricted to the value specified in the Restrictive Sub-Attribute. Restrictive Sub-Attribute values may never be attached to a Feature individually. They shall always appear in combination with the Attribute they restrict. Restrictive Sub-Attribute Values may be attached individually to a Relationship. In these cases, they restrict validity of the Relationship.

Each Sub-Attribute of a Composite Attribute is either a Simple Attribute, a Composite Attribute, or a Restrictive Sub-Attribute. Any Sub-Attribute being a Composite Attribute recursively builds a hierarchical tree of Sub-Attribute sets at different hierarchical scope level. In case a Restrictive Sub-Attribute operates on a (Simple or Composite) Attribute, it implies representing a different scope level than said Attribute.

5.4 The Relationship model

A Semantic Relationship specifies a meaningful relation between two or more Features, which are not necessarily of different classes. Furthermore, the Features in a Semantic Relationship may be in the same or in different Sections or Layers.

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Semantic Relationships with a common structure (e.g. linking Feature A to Feature B, where the instances of A are always of the same class and where the instances of B are always of the same class) and with a common meaning, are grouped into a Relationship Type. A particular Relationship Type is uniquely referred to by a Name and Code, as defined in Figure 13.

Relationships are in many cases binary, i.e. involving two Features. However, there are instances when three or more Features are involved in a Relationship. For example, the Relationship Prohibited Manoeuvre requires a Road Element, a Junction and at least one other Road Element, each playing a pre-defined and recognizable role.

A Relationship may be further qualified by means of Attributes. Similar to Attributes attachable to Complex Features assemblies and attachable to their parts, Attributes of a Relationship may be attached to a Relationship as a whole or to a particular Feature partner (per role). The set of attached Attributes may or may not be an ordered set. Whether the Attributes of a particular Relationship need to be an ordered sequence is explicitly specified.

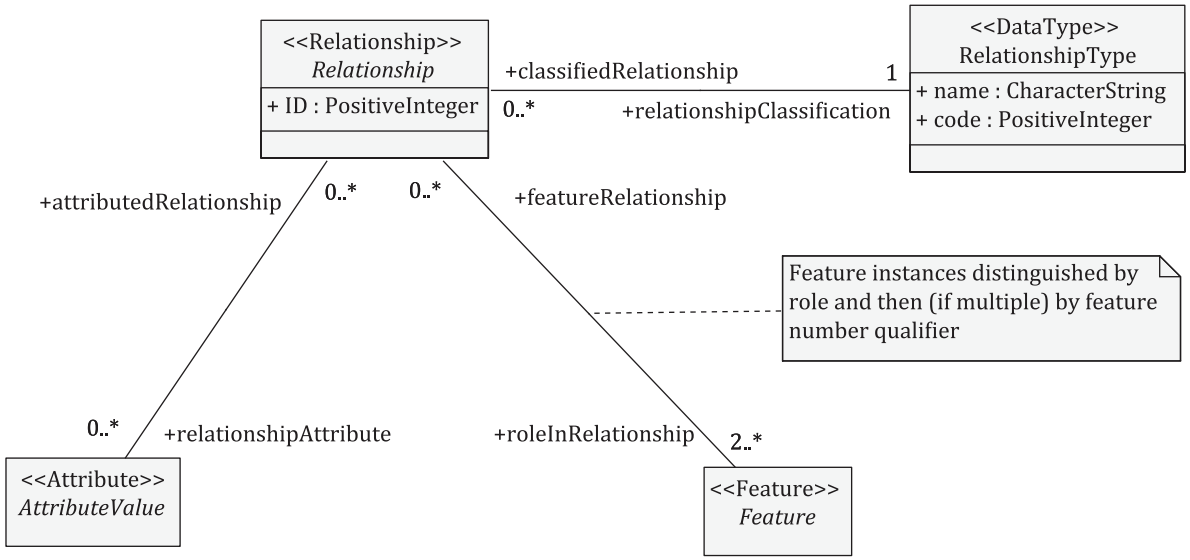


Figure 13 — Conceptual data model for Relationships

5.5 Linear referencing

GDF supports an ISO 19148[2] compatible mechanism of linear referencing of positions along Line Features. This allows mapping of different sets of corresponding Line Features to each other (such as Road Elements on one hand and Anchor Sections embodying a Linear Datum on the other hand) by means of linear assignments, to position Point Features along Line Features by means of point assignments, and to designate the validity of Attribute properties to a confined linear extent along a Line Feature in terms of dynamic linear segmentation.

NOTE Many existing road databases use link-node models and linear referencing for the representations of road Features and attribution. To maintain the ability to utilize this road network data against models built using the belt concept, it is critical that there is a means to reliably translate attribution and feature representation between the link-node model and the belt concept model and applying linear referencing appropriately. These concepts are explained in more detail in later clauses, with Clause 8 containing the primary description.

5.6 The Feature representation scheme

The Feature Model, the Attribute Model and the Relationship Model may be considered as being valid for a wide range of applications. The Feature Representation Scheme is application specific in the sense that it specifies the representation needs of applications that share the same representation needs. The Feature Representation Scheme contained in this document specifies the needs of ITS applications. From these needs it follows for instance that a Road Element shall always be represented by a Line

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Feature. Another Feature Representation Scheme (not contained) may specify that a Road Element shall be represented by an Area Feature.

The most important role of the Feature Representation Scheme is to specify to which Feature Category or categories a particular Feature Class shall or may belong. Seven different categories are distinguished: Topological Point, Line and Area Features, Complex Features and non-explicit Topological Point, Line and Area Features.

In Figure 14, two different possibilities are conceivable for a particular Feature Class:

— all instances shall be of one and the same category;

— some instances may be of one category, other instances of another one.

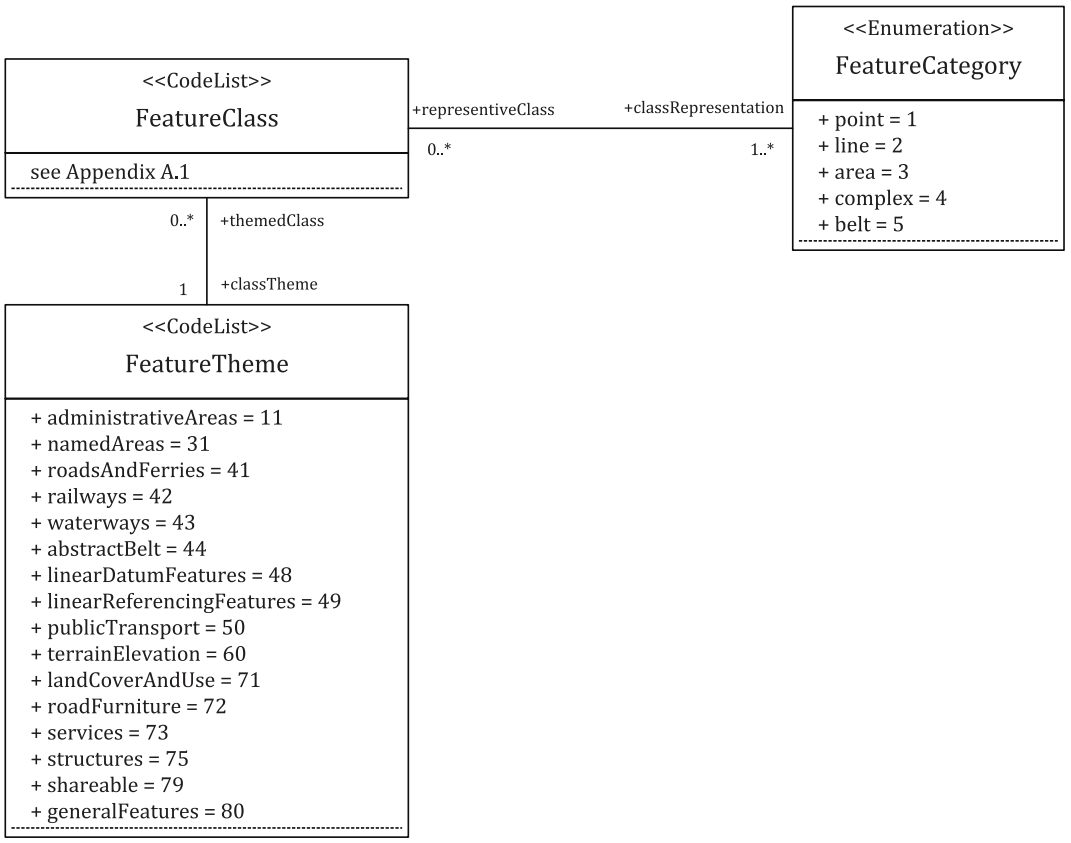


Figure 14 — Conceptual data model for Feature Representation

5.7 Time modelling

GDF supports the definition of temporal aspects. These may relate to Features, Attributes or Relationships. Temporal aspects of Features already have been conceptually described in 5.2.5. In this paragraph reference was made to the GDF Time Domain Model. The GDF Time Domain Model is also used to define temporal aspects of Attributes and Relationships. The model uses starting time, ending time and duration as basic elements to describe a specific period. Time expressions may either be modelled as a starting time and an ending time, or as a starting time and a duration. In special cases, Time expressions may consist of a starting time alone or a duration alone. In addition to sharply defined time components (e.g. January 1, 2009 at 0h:00), this document also supports the definition of more fuzzy time components (e.g. after sunrise). The time domain model is applied in certain “time-relevant” Attributes. Through this mechanism, the time during which a certain Attribute or Relationship is valid may be modelled.

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5.8 Data management: organization of Feature data into Layers and Sections

The contents of a digital road map may be thought of as being structured spatially and according to the Feature content. This document identifies the need to define a GDF as a set of different independent chunks of data. For this, the following conceptual model is provided.

Figure 15 to Figure 19 depict the overall structure under which Features are organized within a GDF. Figure 15 shows that one complete GDF is contained in an Album. An Album shall be composed of one or more Datasets, whereby each Dataset contains a certain aerial subset of the total area covered by the GDF. Each Dataset shall be composed of one or more Layers (see Figure 15 for more on Albums and Datasets). Generally, the area covered by a Dataset and a Layer coincides. A Layer represents a division according to the Feature contents. It contains Feature data of one or more Feature Themes, of a uniform topology. Thus, a Layer may contain exclusively Features represented under planar topology, non-planar topology or non-explicit topology, but not a mixture (Figure 16). This also means that PlanarTopoSection comprises Nodes, Edges and Faces as its primitives, whereas NonPlanarTopoSection comprises only Nodes and Edges (Figure 17).

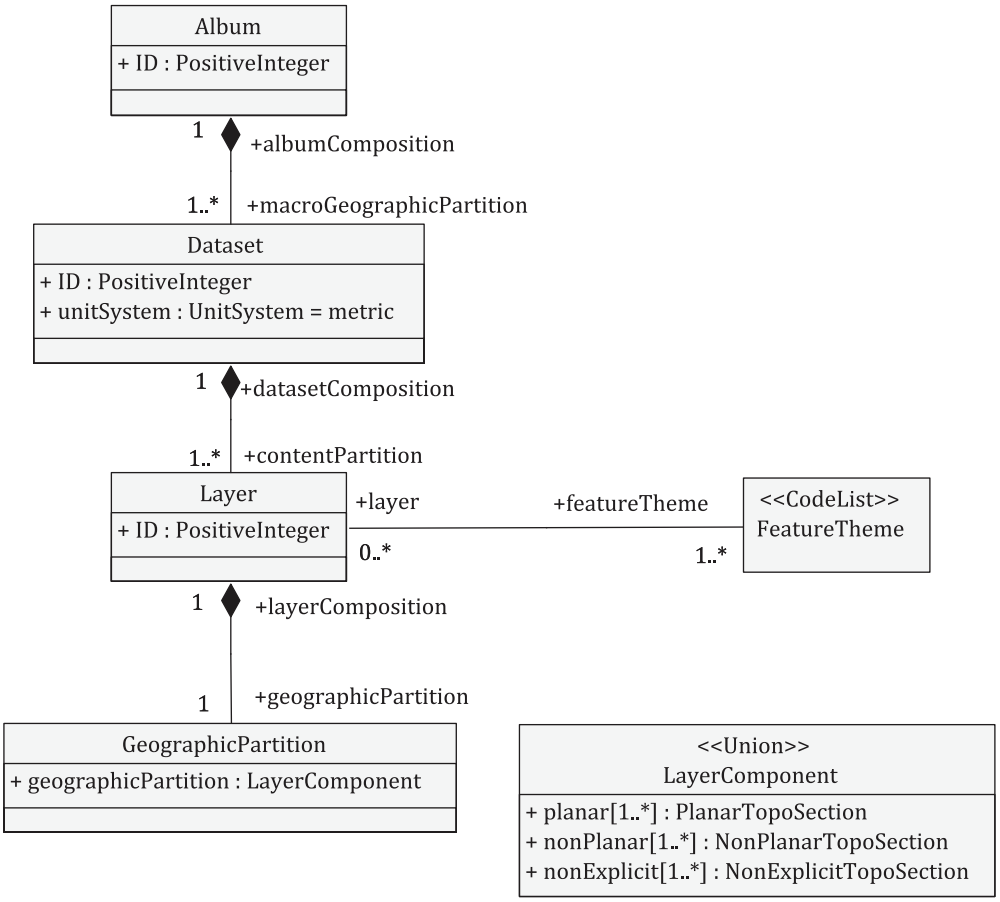


Figure 15 — Organization of data in Albums, Datasets, Layers and Sections

A Layer shall be composed of one or more Sections, each of which represents a different geographic area. Figure 16 shows that the topology-based Sections of Figure 15 are composed of Features of their corresponding topologies. Thus a Planar Topo Section shall be composed of one or more Planar Topo Features and so on. Sections may take the form of rectangular meshes or more natural areas like Administrative Areas. All Layers in a Dataset may have Sections with the same spatial extend or Sections with a Layer specific spatial subdivision may be defined.

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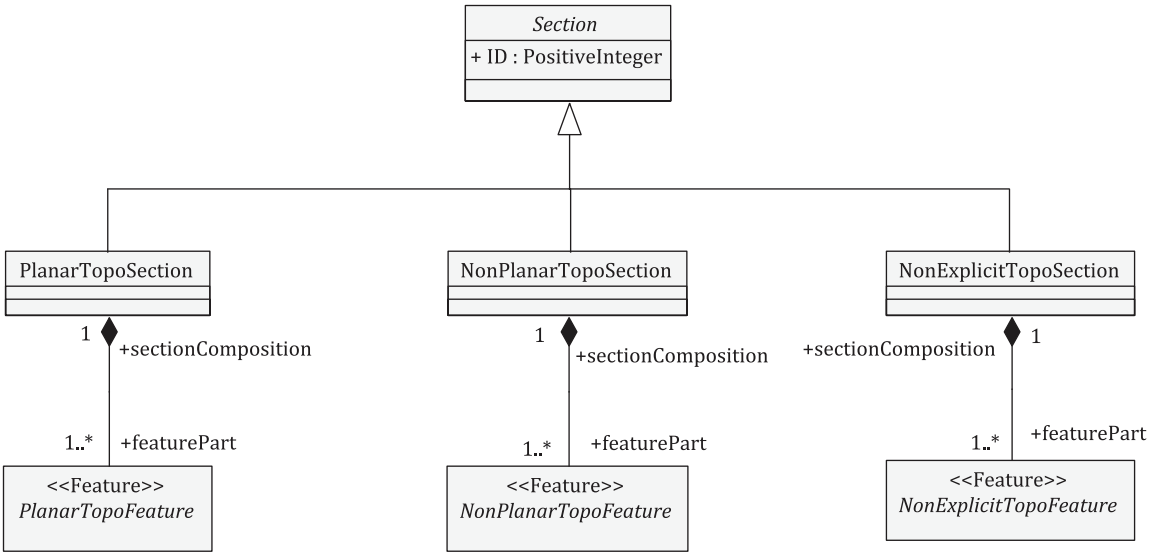


Figure 16 — Composition of Sections

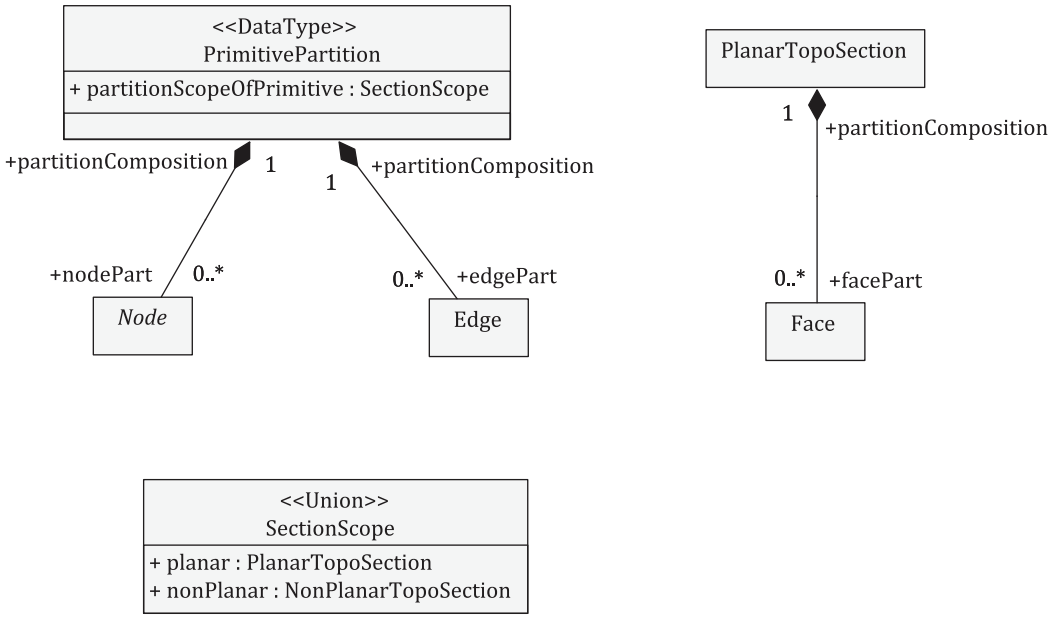


Figure 17 — Section Primitives

Each instance of an Attribute or a Relationship, respectively, may exist locally (partition scope is the Section), semi-globally (partition scope is the Layer), or globally (partition scope is the Dataset). This is depicted in Figure 18.

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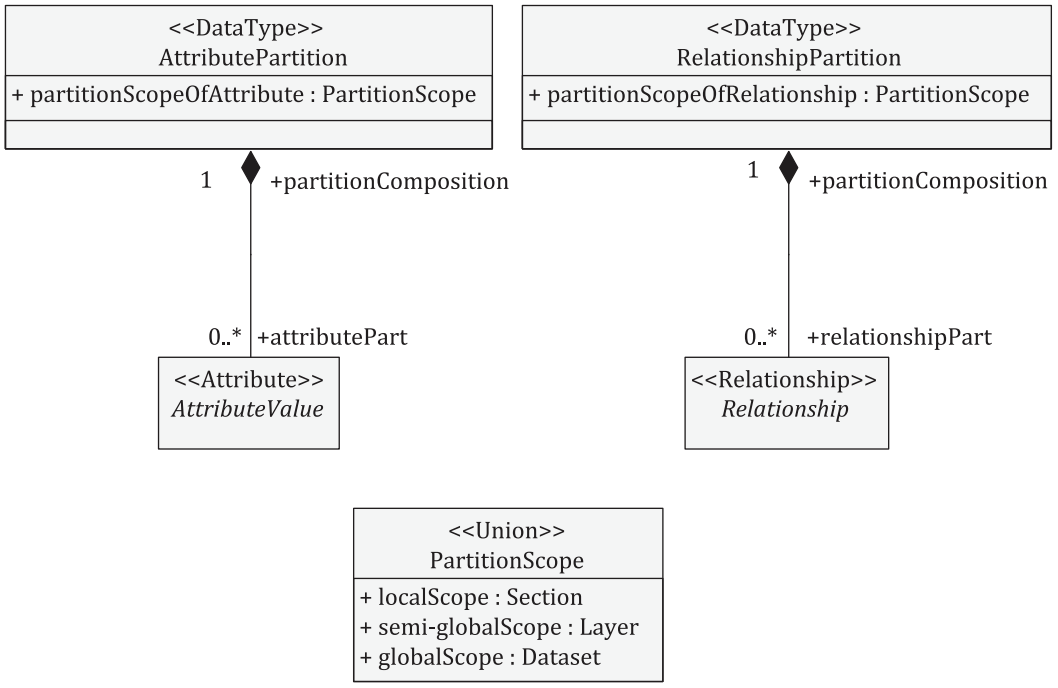


Figure 18 — Attribute and Relationship Partitioning Scope

At Section borders and Dataset borders (i.e. where a Section borders coincides with the Dataset border), Feature continuity is given by conversion information in terms of "translation" of Feature IDs (Figure 19). The local instance of a Feature is logically connected to a foreign instance of the Feature that resides in an adjacent Section or Dataset. Figure 19 provides further details about this principle of GDF segmentation.

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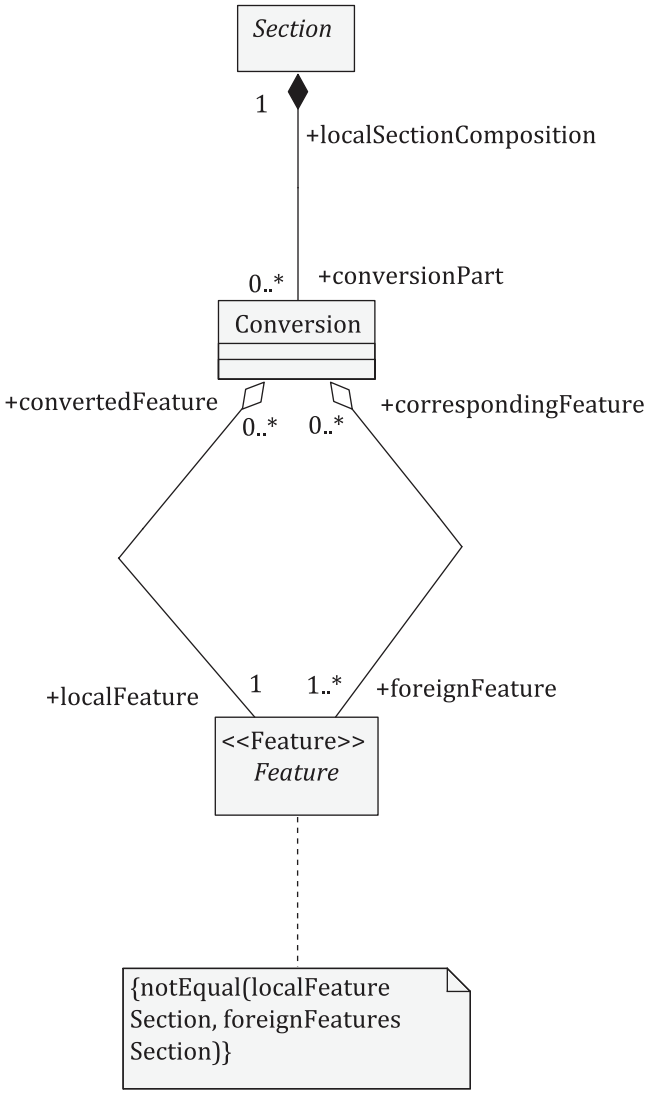


Figure 19 — Feature Conversion

6 Feature Catalogue

6.1 Generic specifications

6.1.1 Features and Feature Themes

The real-world objects and/or activities described in this document are represented by additional Features regarding lanes and potential evading areas. The additional features such as RoadBelt, RoadBeltElement, IntersectionBelt, LaneBeltElement, LaneBeltJoint, PotentialEvadingArea, are grouped together into Feature Themes (for instance, AbstractBeltFeature).

All additional Features and Feature Themes are referenced throughout this document by a Feature name or Feature Theme Name in the same way as in ISO 20524-1. Most of these names are derived from terms commonly used in daily life, such as road or building. In order to distinguish a GDF Feature Name from these commonly used terms, the names of the Features and Feature Themes are written with an uppercase character at the beginning of each word (for instance “Lane”).

NOTE Feature names, including their attribute names and association names, are written without spacing according to UML notation when denoting UML class names.

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6.1.2 Feature Class Codes

For the data exchange the Features and Feature Themes of new objects are not referenced by their names but by a numeric code:

— a four-digit code is used for Features, and

— a two-digit code for Feature Themes.

A strict one-to-one relationship exists between both Feature names and Feature Class Codes and also between Feature Theme Names and Feature Theme Codes. The list of codes specified in A.1 applies.

6.1.3 Simple and Complex Features

This document makes a distinction between Simple Features and Complex Features in the same way as in ISO 20524-1, meaning a Simple Feature is a Feature not composed of other Features.

A Complex Feature is composed of Simple Features and/or other Complex Features.

In cases where complex aggregations are subject to constraints (identifiable parts, ordered parts), they are explicitly specified.

6.1.4 Feature hierarchy

This document supports the need to define a Feature hierarchy. In a Feature hierarchy definition, a certain Feature Class may be defined as a sub-type of a more generically defined super-type. In this way, an instance of a sub-type may be considered on its own generalization level as an instance of that sub-type while at a higher generalization level as an instance of its super-type.

6.1.5 Data model for the Feature Catalogue

Figure 20 illustrates the data model that is relevant for the Feature Catalogue. In addition to the Features defined in ISO 20524-1, this document further adds definitions for AbstractBeltFeature, ShareableFeature, PublicTransportFeature and subfeatures for RoadFurnitureFeature.

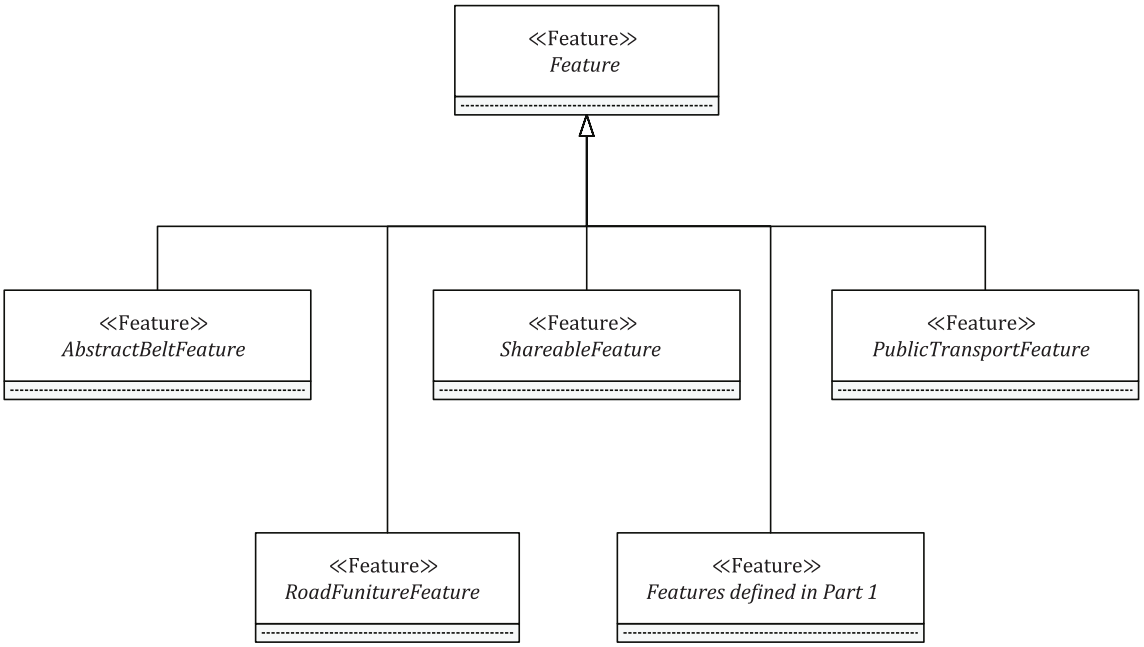


Figure 20 — Conceptual data model of Feature Catalogue

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6.1.6 Shareable Feature

6.1.6.1 General

The ShareableFeature model, Figure 21, is a conceptual feature designed to specify the association between GDF objects such as a Road Element Feature with relevant objects provided by other sources, such as public transport stops in the public transport domain. The necessity of such an association appears when public transport objects are displayed on a map. This association, for example, enables the display of public transport stops on a road map by setting the association of the stop with a RoadElement Feature, or the depiction of the exact vehicle path along the road network of a bus route, not only as a schematic graph.

To describe the mechanism allowing for the association of the objects provided by the different sources, GDF specifies these objects as ShareableFeatures that shall comply with the following ShareableFeature model. In this document, PublicTransportFeature is defined as specialization of ShareableFeature.

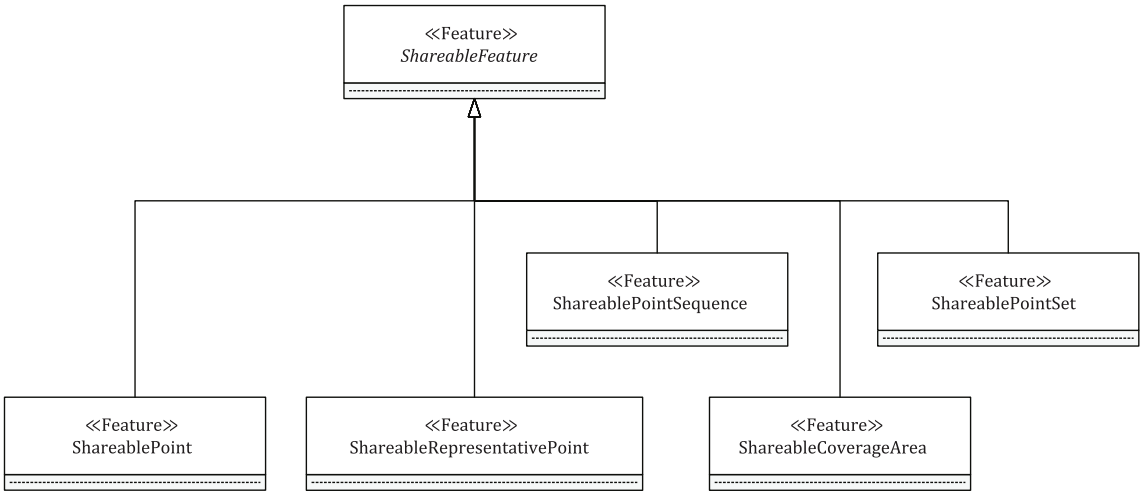


Figure 21 — Conceptual data model for ShareableFeature

As shown in Figure 21, ShareableFeature is a generalization of ShareablePoint, ShareablePointSequence, ShareablePointSet, ShareableRepresentativePoint, and ShareableCoverageArea.

ShareablePoint, ShareableRepresentativePoint, and ShareableCoverageArea are Level-1 Features. ShareablePointSequence and ShareablePointSet are Level-2 Features.

Every map has an inherent margin caused by metrical error. To ensure a connection with relevant objects residing in other sources, a ShareableFeature shall be defined with either a position tolerance (e.g. minimum tolerance and maximum tolerance) or a coverage area in which it is located.

In this document, Level-2 Features (e.g. ShareablePointSequence and ShareablePointSet) shall have at least one Level-1 Feature or Level-2 Feature. To allow for flexibly, ShareableCoverageArea and ShareableRepresentativePoint provide the coverage area and representative location of Level-2 Features respectively.

6.1.6.2 ShareablePoint

ShareablePoint is a Level-1 Feature used to connect to objects in an external database. ShareablePoint can have a relationship with ShareableCoverageArea to express a possible location and a margin of error.

Figure 22 shows the relationship between ShareablePoint and ShareableCoverageArea.

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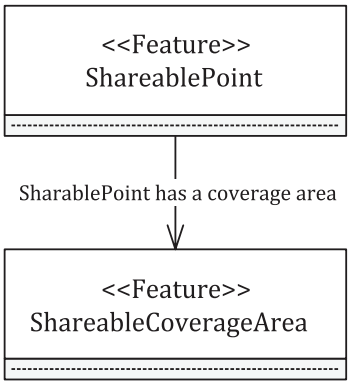


Figure 22 — Relationship between ShareablePoint and ShareableCoverageArea

Figure 23 illustrates an example of the association between a ShareablePoint and objects presented by other databases, taking into account the precision tolerance and coverage area. ShareablePoint has a given tolerance, a coverage area, and a specific context for association with the objects in other databases. In Figure 23, a relevant object in the public transportation database is indicated by an anchor point with a given tolerance. Figure 23 also depicts the relevant object in the public transportation database is valid and available for connection, because it is located within the tolerance of both the ShareablePoint and the Anchor point tolerance, even though the positional coordinates of the ShareablePoint and the Anchor point are not exactly the same.

If an object in another shareable database also has a tolerance, a connection may be created if the ShareablePoint is located within that tolerance, even when the object is located on the outside. On the other hand, in the case of an object presented with a coverage area in another sharable database, it may be distinguishable, allowing for the ShereblePoint's tolerance and/or the Anchor point's coverage area.

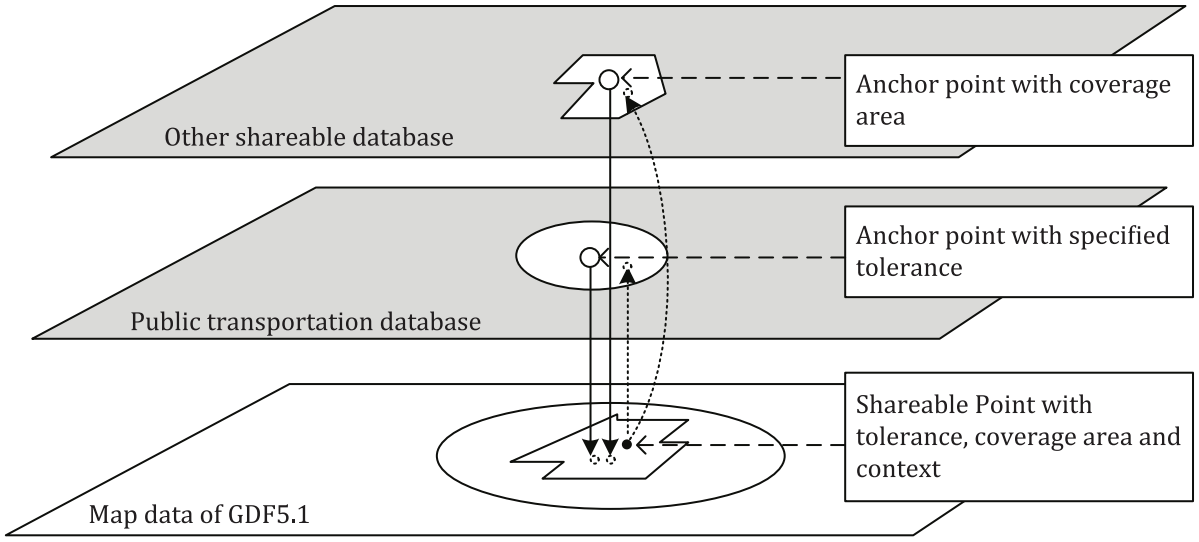


Figure 23 — Example of associations between a ShareablePoint and object in other databases

6.1.6.3 ShareablePointSequence

A ShareablePointSequence is a Complex Feature composed of ordered ShareablePointSequenceParts. A ShareablePointSequence may relate to a ShareableRepresentativePoint and a ShareableCoverageArea.

Figure 24 shows a relationship between a ShareablePointSequence and an associated Feature.

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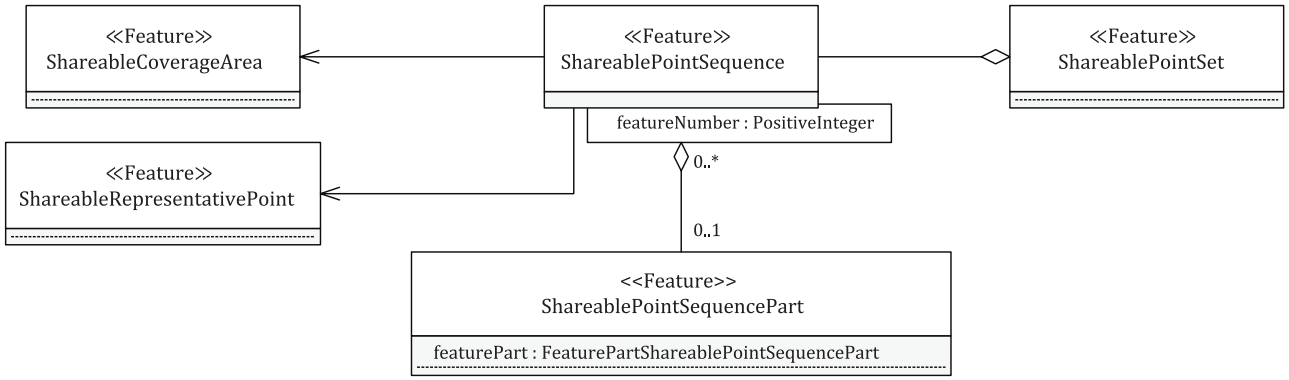
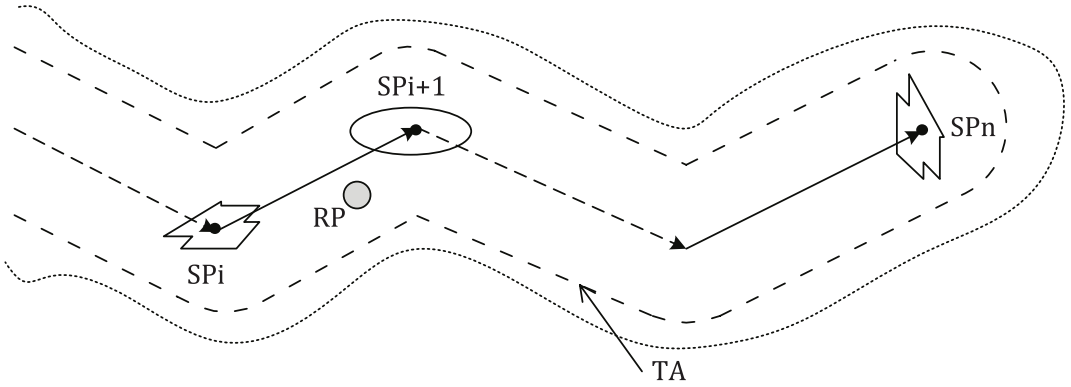


Figure 24 — Relationship between a ShareablePointSequence and an associated Feature

An example of a ShareablePointSequence is depicted in Figure 25.



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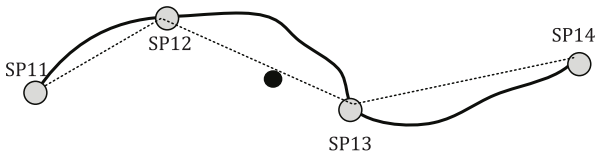
SharablePointSequence	composed of ShareablePoint (SP) Array
·····	coverage area
RP	representative point
TA	tolerance area (zone)

Figure 25 — Example of ShareablePointSequence

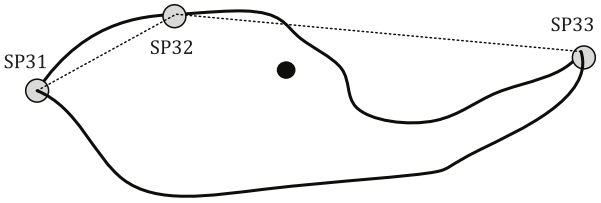
Each SP (ShareablePoint) in Figure 25 is described according to the specification of ShareablePoint.

Figure 26 depicts the possible relationships between a ShareablePointSequence and a ShareablePoint.

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a) ShareablePointSequence composed of multiple ShareablePoint



b) ShareablePointSequence composed of 3 ShareablePoint to specify a line feature

Key

geometry
ShareablePoint
ShareablePointSequence
RepresentativePoint of ShareablePointSequence

Figure 26 — Possible relationship between ShareablePointSequence and ShareablePoint

6.1.6.4 ShareablePointSeaquencePart

A ShareablePointSequencePart is a component of a ShareablePointSequence.

A ShareablePoint and/or a ShareablePointSequence are used by a ShareablePointSequencePart.

6.1.6.5 ShareablePointSet

A ShareablePointSet is a Complex Feature composed of a ShareablePointSetPart. A ShareblePointSet may relate to a ShareableRepresentativePoint and a ShareableCoverageArea.

Figure 27 shows the relationship between a ShareablePointSet and associated Features.

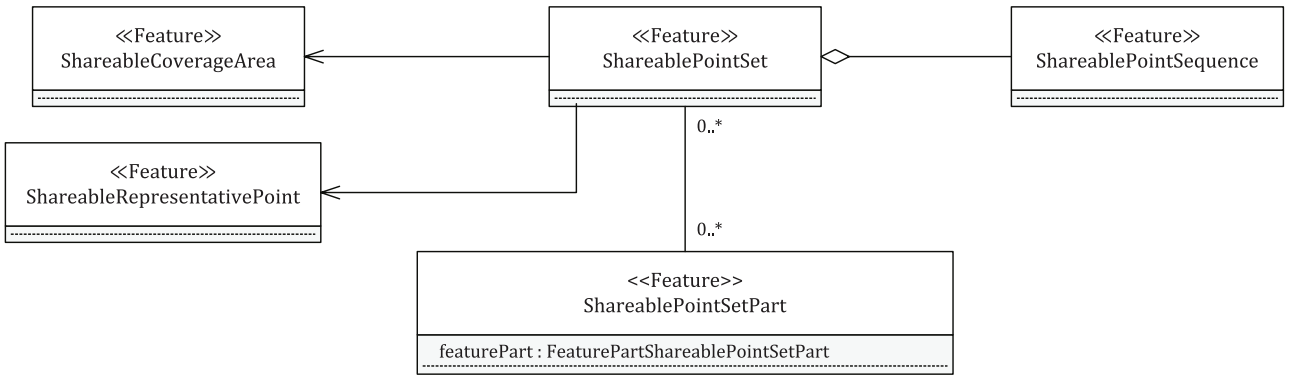
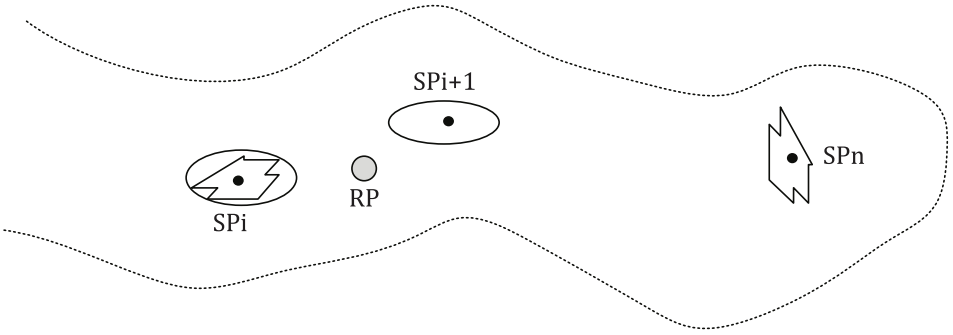


Figure 27 — Relationship between ShareablePointSet and associated Feature

Figure 28 depicts an example of a possible relationship between a ShareablePointSet and a ShareablePoint.

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Key

SharablePointSet composed of ShareablePoint (SP) Array

..... coverage area

RP representative point

Figure 28 — Possible relationship between ShareablePointSet and ShareablePoint

6.1.6.6 ShareablePointSetPart

A ShareablePointSetPart is a component of a ShareablePointSet.

A ShareablePoint and/or a ShareablePointSet are used by a ShareablePointSetPart.

6.1.6.7 ShareableRepresentativePoint

A ShareableRepresentativePoint is a Point Feature that shows the representative location of a ShareablePointSequence and a ShareablePointSet.

6.1.6.8 ShareableCoverageArea

A ShareableCoverageArea is an Area Feature that defines the area where an external object exists.

6.2 Abstract Belt Feature

6.2.1 General

6.2.1.1 Data model for Abstract Belt Feature

Features supporting the belt concept are defined in this clause. AbstractBeltFeature is a generalization of:

— RoadBelt (6.2.2),

— RoadBeltElement (6.2.3),

— IntersectionBelt (6.2.4),

— RoundaboutBelt (6.2.5),

— LaneBeltElement (6.2.6),

— LaneBeltJoint (6.2.7),

— PotentialEvadingArea (6.2.8),

— BeltRepresentativeLine (BRL) (6.2.9),

— IntersectionConnectionPoint (ICP) (6.2.10),

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— LaneConnectionPoint (LCP) (6.2.11),

— BeltOptionalPoint (BOP) (6.2.12), and

— BeltPartitionLine (6.2.13).

Figure 29 shows the data model for an AbstractBeltFeature.

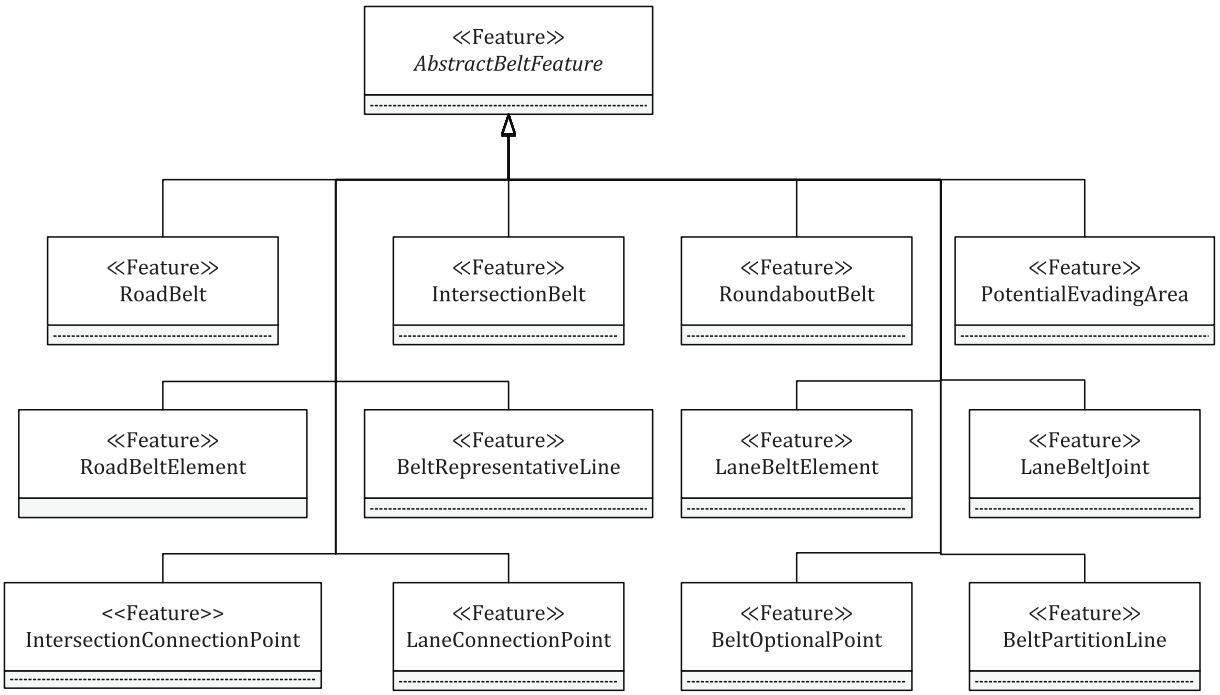


Figure 29 — Data model of AbstractBeltFeature

Figure 30 depicts a typical cross-section of a road structure.

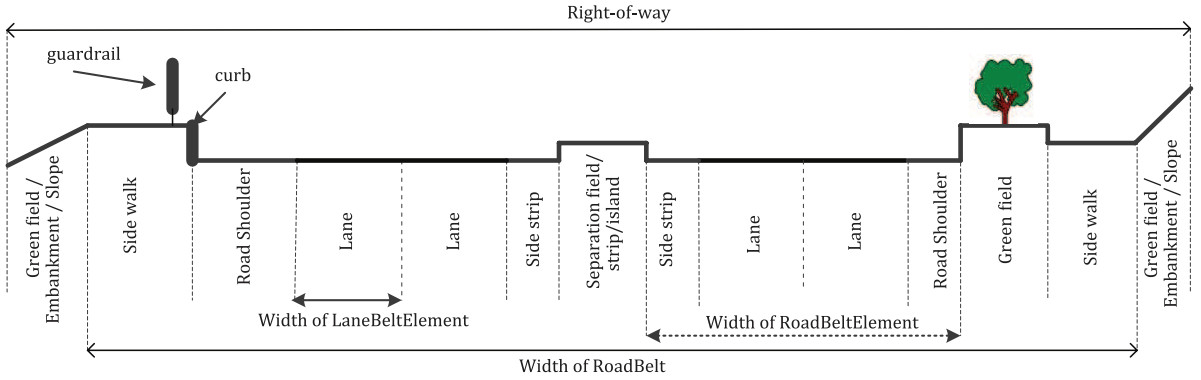
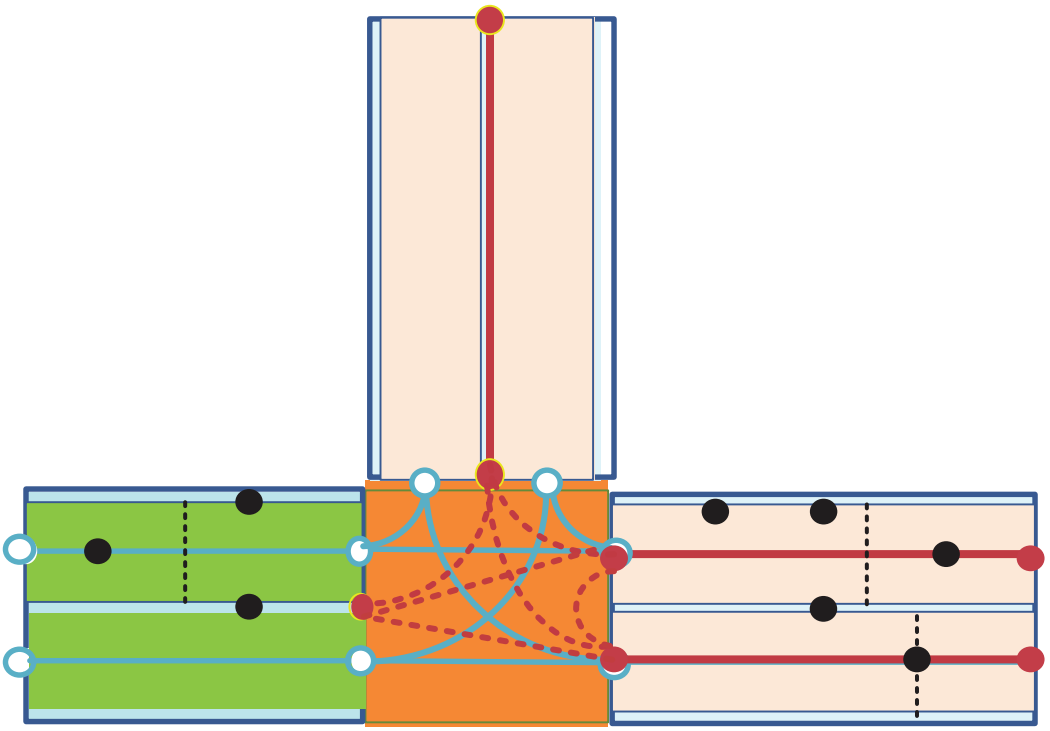


Figure 30 — Typical cross-section of road structure

Figure 31 depicts a combination of subfeatures of the AbstractBeltFeature.

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Key

- IntersectionBelt
- RoadBeltElement
- LaneBeltElement
- BeltRepresentativeLine (RoadBeltElement)
- BeltRepresentativeLine (IntersectionBelt)
- BeltRepresentativeLine (LaneBeltElement)
- InterSectionConnectionPoint
- LaneConnectionPoint
- BeltPartitionLine
- BeltOptionalPoint

Figure 31 — Example of AbstractBeltFeature

6.2.1.2 Lane Belt Element structure in the carriageway

In general, a carriageway is considered to have at least one lane corresponding to each traffic direction. In the case of a single-carriageway two-way road, a LaneBeltElement shall be defined for each traffic direction. The number of lanes is a key property of an automated driving system. LaneSection is defined for each traffic direction of the carriageway and provides information regarding the lane structure.

LaneSection consists of approximately parallel lanes in the carriageway, and is bounded by:

— the border between a carriageway and an intersection;

— the border where a carriageway merges or branches;

— the border where the number of lanes increases or decreases;

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