

Via Nova

Location reference schemas

Author : Jan Vis

Version : 0.2 (Concept)

Date : 4-6-01

Amendment History

Version	Status	Date	Revised by	Reason
0.1	concept	April 99	JV	
0.2	concept	Juni 01	JV	New better Visual Express version (4.). Work around an error removed.

Table of contents

AMENDMENT HISTORY.....	2
TABLE OF CONTENTS.....	3
LIST OF TABLES.....	4
LIST OF FIGURES.....	4
1 SCOPE	5
1.1 IDENTIFICATION.....	5
1.2 SYSTEM OVERVIEW	5
1.3 DOCUMENT OVERVIEW	5
1.3.1 Document structure.....	5
1.3.2 Reading directions	5
2 REFERENCED DOCUMENTS.....	7
2.1 NORMATIVE REFERENCES	7
2.2 INFORMATIVE DOCUMENTS	7
3 SCHEMAS OVERVIEW.....	8
3.1 ROAD NETWORKS AND LOCATION REFERENCING	8
3.1.1 Use requirements.....	8
3.1.2 Network location schema's.....	8
3.1.3 Applications	9
4 DETAILED DESIGN OF THE DATABASE	11
4.1 NETWORK AND LOCATION REFERENCING SCHEMES	11
4.1.1 Road network geometry.....	Fout! Bladwijzer niet gedefinieerd.
4.1.2 Motorway network.....	19
4.1.3 Carriageway network	22
4.1.4 Lane network.....	26
4.1.5 RDS-TMC Locations	29
4.1.6 BPS Locations	34
4.1.7 Terrain object examples	39
4.1.8 Signaling Network	42
5 NOTES	45
5.1 ABBREVIATIONS.....	45
5.2 GLOSSARY	45

List of tables

Fout! Geen gegevens voor lijst met figuren gevonden.

List of figures

Fout! Geen gegevens voor lijst met figuren gevonden.

1 Scope

1.1 Identification

Name : Location Reference Schemas
Identifier : ViaNova.LocationReferenceSchemas

1.2 System overview

This document describes the conceptual data schemas for the description of road networks and references to location in those networks.

1.3 Document overview

1.3.1 Document structure

The structure of this document is based on (but not identical with) a [J-STD-016] DBDD document and contains the following chapters:

1. to provide the scope of the document
2. to list the documents referenced
3. to provide an overall overview of the various schemas
4. to specify the conceptual schemas using the Express language
5. to provide additional notes

If required the schemas can be copied to a section '4.1 Conceptual schemas' of a [J-STD-016] DBDD document.

1.3.2 Reading directions

1.3.2.1 General aspects

- [1] A requirement is marked with an requirement identification number between square brackets which is unique within the (sub)section in which its occurs.
- [2] An identification number shall not change in subsequent versions of a document.
- [3] A references to a requirement is written as <document identifier>.<section>.[<requirement identification number>], where the prefix parts of the document identifier may be omitted as far the are identical to those in the document which contains the reference.
- [4] Explanatory notes, examples and pictures are only used for explanation purposes and do not contain any requirements.
- [5] An explanatory notes is preceded by 'Note:'.
- [5] Where in this document *he* and *his* is used to refer to a user, this should be read as *he or she* and *his or her*.

1.3.2.2 Structure of a conceptual schema specification

- [1] Each conceptual schema description is as much as possible independent of the other sections and documents, and has the following structure :

- 4.1.x.1 Identification
- 4.1.x.2 Purpose and description
- 4.1.x.3 Conceptual schema
- 4.1.x.4 Entity descriptions
- 4.1.x.5 Type descriptions
- 4.1.x.6 Integrity constraints
- 4.1.x.7 Other security aspects

4.1.x.8	Performance aspects
4.1.x.9	Implementation aspects
4.1.x.10	Abbreviations
4.1.x.11	References

Note. A conceptual schema is only meant to convey a conceptual model. I.e. a specification of the characteristics of the so-called 'real world' which should be represented in the system. The conceptual model may be implemented in several ways by several means. A change to e.g. an object oriented database management system should not have any consequences for a conceptual schema. (end of note)

- [2] The conceptual model shall be specified in the EXPRESS language [ISO 10303-11].
- [3] Instances of entities shall be specified using the EXPRESS-I language [ISO 10303-12].
- [4] Section 4.1.x.6 may contain mainly explication of rules in the Express schema.
- [5] Section 4.1.x.7 may contain security specifications additional to the integrity constraints, i.e. access control, authentication, confidentiality, etc.
- [6] Section 4.1.x.8 may contain capacity and/or performance constraints. These constraints should be specified as much as possible in user oriented terms and units.
- [7] In case of any inconsistencies between the references in a section 4.1.x.11 and those in section 2, the text of the reference in section 2 prevails.

Note. The abbreviations and references in sections 4.1.x.10 and 4.1.x.11 are redundant with section 7.1, but are added in order to use each section 4.1.x as an independent schema document. It is recommended to use in a section 4.1.x.11 only short indicative references (e.g. only the title of a document) and put the details (especially version information only in section 2. (end of note)

2 Referenced Documents

2.1 Normative references

- [BPS94] Beschrijvende Plaatsaanduiding Systematiek
Rijkswaterstaat, Dienst Weg- en Waterbouwkunde
Rapport P-DWW-94-014, December 1994
ISBN 90-369-0006-9
- [GDF] Geographic Data File
CEN, Version 3.0, 12 October 1995
- [ISO3166-1] Codes for the representation of names of countries and their subdivisions -
- Part 1: Country codes
ISO, 1997.
- [ISO 10303-11] Industrial automation systems and integration - Product data representation and exchange - Part 11: Description methods: The EXPRESS language reference manual
ISO, ISO 10303-11:1994(E), first edition 15-12-95
- [ISO 10303-12] Industrial automation systems and integration - Product data representation and exchange - Part 12: EXPRESS-I language manual
ISO, ISO/CD 10303-12, 27 February 1995
- [prENV12313-3] Traffic and Traveller Information (TTI)
TTI Messages via Traffic Message Coding
Part 3: Location referencing for Alert C
Pink Paper TC278/N783, 10-10-97
- PS. As my copy of this document did not contain the explanatory table on page 27, I assumed that it was the same as in [prENV/278/7/3/0004].
- [prENV/278/7/3/0004] Geographic Road Database - Location Referencing -
Part 1: Location referencing rules for Radio Data System - Traffic Message Channel (RDS-TMC),
Version 1.0, July 1996

2.2 Informative Documents

- [CEN287011] prENV 287011:1995
Geographic Information - Referencing - Position
CEN/TC287/WG4
- [ILOCS] ...
- [J-STD-016] EIA/IEEE J-STD-016:1995 Standard for Information Technology - Software Life Cycle Processes - Software development: Acquirer-Supplier Agreement
- [prENV12160] Geographic Information - Data Description - Spatial schema
November 1996
- [WGS84] MIL-STD-2401
US Department of Defence World Geodetic System (WGS)
11 January 1994

3 Schemas overview

3.1 Road networks and location referencing

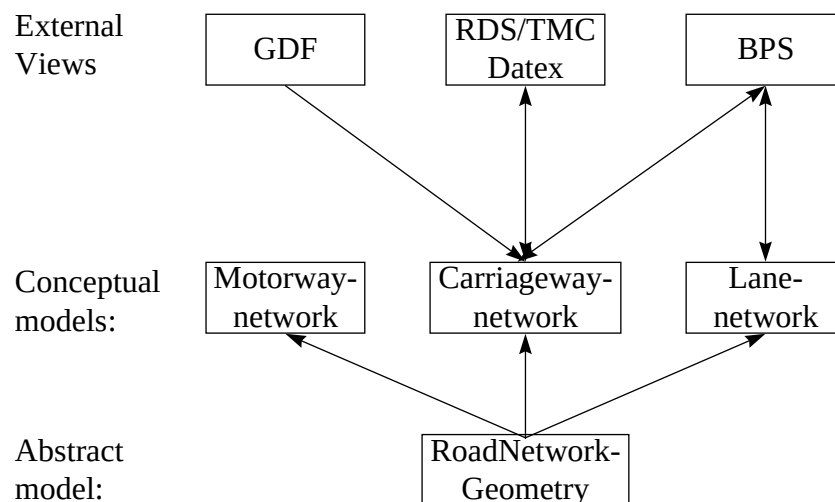
3.1.1 Use requirements

[1] The data model shall support:

1. a description of the topology of a network,
2. the use of geodetic co-ordinates (e.g. WGS84)
3. the use of topology related co-ordinates (e.g. the Dutch BPS)
4. the use of predefined Alert-C co-ordinates (to support of Datex and RDS/TMS)
5. descriptions on different level (lane, carriageway and motorway)

3.1.2 Network location schema's

The figure below gives an overview of the various schemas used the specification of road networks and locations in these networks.



3.1.2.1 Road Network Geometry

The Road Network Geometry schema provides an abstract specification of a road network as a non-planar, directed graph. The graph is non-planar to support crossing at different levels by means of bridges, tunnels etc. The graph is directed because almost all traffic properties are direction related. The Road Network Geometry schema provides also the definition of some related abstract entities like a route through the graph. A segment defined as a route where you always go straight ahead and never turns right or left. Upstream routes as a set of routes all ending in the intermediate nodes.

The abstract Road Network Geometry schema is the basis for three or more network schemas: the lane network to provide for a description on lane level, the carriageway network for a description on carriageway level and motorway network to provide for a even more aggregated view in which complex intersections may be modelled as single nodes.

3.1.2.2 The carriageway network

The carriageway network schema models a road network as a directed non planar graph of carriageway elements and junctions. A carriageway element may be bounded in longitudinal direction by means of a shoulder, a barrier or a 'blocked' line.

The basic idea is that if any two vehicles drove over the same a carriageway elements in the same order the necessarily drove the route.

A carriageway network description can be constructed on the basis of a GDF input file (see the section GDF).

3.1.2.3 The lane network

The lane network schema models a road network as a directed non planar graph of lane elements and junctions. A lane element may be bounded in longitudinal direction by means of a shoulder, a barrier, a 'blocked' line or a 'dashed' line.

A carriageway network description can be constructed on the basis of a GDF input file (see the section GDF) which also contains the number of lanes of the GDF road elements or GDF road element segments.

3.1.2.4 The motorway network

The motor network schema models an aggregation of the carriage way network. Most notably, it may be used to map complex intersection consisting of many carriageway elements into one motorway node.

Its purpose is to provide the facilities for producing overviews of a road network. Eventually one might create more the one motorway network description based on the same carriageway network.

Nevertheless, it is still unclear which meaningful attributes such a moterway network may have.

3.1.2.5 GDF

The carriageway network schema is consistent with the GDF standard for the exchange of road network descriptions. I.e. GDF is perfectly suited to be used as input to construct our carriageway network description.

Apart from technical reasons to split some GDF road elements into more carriageway elements, almost nay carriageway element corresponds to one and only one GDF road element. Hence any GDG road junction corresponds to one or more carriageway junction.

Note. The small differences between our use of carriageway elements and the GDF use of road elements stems from the different purposes of both. Our carriageway network is to be used for traffic management while GDF is developed for in car route guidance applications. Because of this a GDF intersection may also be much smaller than our motorway junction.

3.1.2.6 RDS/TMS and Datex

The RDS/TMC schema support the use of Alert-C location references and provides for a mapping of the pre-defined RDS/TMC references to the appropriate road network, which is in most cases the carriageway network.

3.1.2.7 BPS

The BPS schema models the location references as used by roadmen and other officers and as specified in [BPS94].

3.1.3 Applications

The applicability of the network location schemas as introduced above can be demonstrated with a few examples.

The basic idea behind this examples is that the phenomena (features) to be describes should *not* necessarily have fit with the granularity of the network description. Traffic signs and other equipment may be placed or removed anywhere along a carriageway or lane without impact on the description of the network on which they are used.

The basic modelling capabilities of the network location schemas are demonstrated in the following examples .

Application	schema
Porous asphalt	terrain object examples
100 km/hour roads	terrain object examples
incidents	terrain object examples
signalling	signalling network

Note that in all these examples only some typical location references are modelled and no other attributes.

3.1.3.1 Porous asphalt

For ice warning systems it is important to know whether not porous asphalt is used for the road surface. Model presented assumes that:

- all parallel lanes on a carriageway do have the same type of surface (as far as relevant for our applications)
- the use of porous asphalt may begin and end at each point on a carriageway element, i.e. not necessarily at its begin or end.

So the use of porous asphalt in a road network can be modelled a set of carriageway segments with a porous asphalt surface.

3.1.3.2 Max 100 km/hour roads

Carriageway with a 100 km/hour speed limit may be modelled in the same way as the use of porous asphalt, i.e. as a set of carriageway segments with a 100 km/hour speed limit.

3.1.3.3 Incidents

A little more complicated entity is an incidents. Restricting our view to the location, it happens at some location, it may cause upstream queues form both its own location and (secondary queues) on the carriageway in the other direction because of curious slowing-down traffic.

This can be modelled by means of:

- the point on a carriageway at which the incident occurred,
- a set of upstream queues (carriageway routes) ending at this point
- an optional secondary point at the carriageway in the other direction
- a set of upstream queues (carriageway routes) ending at this secondary point

3.1.3.4 Signalling

A most interesting application is signalling. As signalling used lane related traffic signs and also the notion of previous sign is very important, signalling is modelled as directed non-planar graph which is mapped on the lane network.

The location of the gantry carrying the sign display units is described by an intermediate node on a carriageway element.

4 Detailed design of the database

4.1 Network and location referencing schemes

In this section contains the following conceptual schema specifications.

1. Road network geometry
2. Motorway network
3. Carriageway network
4. Lane network
5. GDF (to be provided)
6. RDS/TMC location references
7. BPS location references

and 2 schemas to show how easy a traffic application can refer to locations:

8. Terrain object examples
9. Signalling network

4.1.1 Road network geometry

4.1.1.1 Identification

Name : Road network geometry
Identifier : ViaNova.Dbdd.ConceptualSchema.RoadNetworkGeometry

4.1.1.2 Description

[1] This schema describes the topology and geometry of generic road networks (e.g. motorway, carriageway or lane networks) in terms of a non-planar directed graph.

Note1 : Two-way roads may be modelled as two one-way roads.

Note2 : As roads may intersect at different levels, the graph is non-planar.

[2] The topological characteristics are modelled by means of edges and nodes. The geometric aspects by means of points and curves.

[3] The scheme is based on [prENV12160]. Notable differences are:

1. Underscore character are removed from the identifiers and capitals are used for readability (so the identifiers can be used in ASN.1 modules as well)
2. The point entity does not refer to an external Direct_Position, but uses WGS84 in stead
3. The entity Spatial_View is omitted
4. The entities Route and Segment are added.

4.1.1.3 Conceptual schema

SCHEMA ROADNETWORKGEOMETRY;
(*
This schema specifies the topology and geometry of an abstract road network in terms of a directed non-planar graph.
*)

```
TYPE interpolationMethod = ENUMERATION OF
  (SHORTEST_WAY,
   CIRCULAR_ARC,
   B_SPLINE,
   CLOTHOID);
END_TYPE;

TYPE direction = REAL;
WHERE
  MinMaxDirection : {-PI < Self <= PI};
END_TYPE;

TYPE microdegrees = INTEGER;
WHERE
  MinMax : {-360000000 <= SELF <= 360000000};
END_TYPE;
```

```
TYPE decimetre = INTEGER;
END_TYPE;
```

```
ENTITY GeometricPrimitive
  ABSTRACT SUPERTYPE OF (ONEOF(Point, Curve));
END_ENTITY;
```

```
ENTITY Point
  SUBTYPE OF(GeometricPrimitive);
  latitude : microdegrees;
  longitude : microdegrees;
  height : OPTIONAL decimetre;
  WHERE
    MinMaxLatitude : {-90000000 <= latitude <= 90000000};
    MinMaxLongitude : {-180000000 <= longitude <= 180000000};
END_ENTITY;
```

```
ENTITY Curve
  SUBTYPE OF(GeometricPrimitive);
  terrainPosition : LIST [2:?] OF Point;
  interpolation : interpolationMethod;
  tangentDirectionAtFirstEnd : OPTIONAL direction;
  tangentDirectionAtLastEnd : OPTIONAL direction;
```

```

        curveLength          : decimetre;
    DERIVE
        endsAt               : Point :=
TerrainPosition[hiIndex(TerrainPosition)];
        startsAt             : Point := TerrainPosition[1];
    END_ENTITY;

    ENTITY TopologicalPrimitive
        ABSTRACT SUPERTYPE OF (ONEOF(Node, Edge, Route));
    END_ENTITY;

    ENTITY Node
        ABSTRACT SUPERTYPE
        SUBTYPE OF(TopologicalPrimitive);
        terrainpoint : Point;
    END_ENTITY;

    ENTITY TerminatingNode
        ABSTRACT SUPERTYPE
        SUBTYPE OF(Node);
        INVERSE
            isStartNodeOf : SET OF Edge FOR startsAt;
            isEndNodeOf   : SET OF Edge FOR endsAt;
        WHERE
            StartsEndsSomeEdge : SIZEOF(isStartNodeOf) + SIZEOF(isEndNodeOf) > 0;
    END_ENTITY;

    ENTITY Edge
        ABSTRACT SUPERTYPE
        SUBTYPE OF(TopologicalPrimitive);
        startsAt      : TerminatingNode;
        endsAt        : TerminatingNode;
        continuingEdge : OPTIONAL Edge;
        terrainCurve   : Curve;
        INVERSE
            supports      : SET OF IntermediateNode FOR isCoincidentWith;
            previousEdge   : SET [0:1] OF Edge FOR continuingEdge;
        WHERE
            Continuity                : exists (continuingEdge) <= (continuingEdge in
endsAt.isStartNodeOf);
            CoincidentContinuationPoints : exists (continuingEdge) <= (
continuingEdge.terrainCurve.startsAt
            terrainCurve.endsAt =
            );
    END_ENTITY;

    ENTITY IntermediateNode
        ABSTRACT SUPERTYPE
        SUBTYPE OF(Node);
        isCoincidentWith : Edge;
        distance          : decimetre;
    END_ENTITY;

    ENTITY Route
        ABSTRACT SUPERTYPE
        SUBTYPE OF(TopologicalPrimitive);
        startsAt : IntermediateNode;
        endsAt   : IntermediateNode;
        alongEdges : LIST [1:?] OF Edge;
        WHERE
            StartsAtFirstEdge : alongEdges[1] = startsAt.isCoincidentWith;
            EndsAtLastEdge    : alongEdges[SIZEOF(alongEdges)] =
endsAt.isCoincidentWith;
            continuity        : RouteIsContinuous (alongEdges);
    END_ENTITY;

    ENTITY Segment
        ABSTRACT SUPERTYPE
        SUBTYPE OF(Route);
        WHERE
            IsStraightOnRoute : RouteIsStraightOn (alongEdges);
    END_ENTITY;

    ENTITY UpstreamRoutes;
        routes : SET [1:?] OF Route;
    DERIVE
        endsAt : IntermediateNode := routes[1].endsAt;
    END_ENTITY;

    (*
    Checks whether or not a list of edges is continuous
    *)

```

```

FUNCTION RouteIsContinuous
(route : LIST [1:?] OF Edge) : Boolean;
LOCAL ok : BOOLEAN := True; END_LOCAL;
REPEAT i := 1 TO SIZEOF(route)-1;
    IF route[i].EndsAt :<>: route[i+1].StartsAt THEN ok := FALSE; END_IF;
    IF not ok THEN ESCAPE; END_IF;
END_REPEAT;
Return (ok);
END_FUNCTION;

FUNCTION RouteIsStraightOn
(route : LIST [1:?] OF Edge) : Boolean;
LOCAL ok : BOOLEAN := True; END_LOCAL;
REPEAT i := 1 TO SIZEOF(route)-1;
    IF route[i].EndsAt :<>: route[i].ContinuingEdge.StartsAt THEN ok := FALSE;
END_IF;
    IF not ok THEN ESCAPE; END_IF;
END_REPEAT;
Return (ok);
END_FUNCTION;

FUNCTION EdgesAreConnected
(EdgeSet : AGGREGATE OF Edge) : BOOLEAN;
LOCAL
    Found : SET[0:?] OF Edge;
    ToDo : SET[0:?] OF Edge;
    Tnode : TerminatingNode;
    Cedge : Edge;
END_LOCAL;

Found := [EdgeSet[1]];
ToDo := [EdgeSet[1]];

REPEAT UNTIL sizeof(ToDo) = 0;

    Tnode := ToDo[1].startsAt;
    REPEAT i:= 1 to hiIndex (Tnode.isStartNodeOf);
        CEdge := Tnode.isStartNodeOf[i];
        IF (CEdge in EdgeSet) and (not (CEdge in Found)) THEN
            Found := Found + CEdge;
            ToDo := ToDo + CEdge;
        END_IF;
    END_REPEAT;

    REPEAT i:= 1 to hiIndex (Tnode.isEndNodeOf);
        CEdge := Tnode.isEndNodeOf[i];
        IF (CEdge in EdgeSet) and (not (CEdge in Found)) THEN
            Found := Found + CEdge;
            ToDo := ToDo + CEdge;
        END_IF;
    END_REPEAT;

    Tnode := ToDo[1].endsAt;
    REPEAT i:= 1 to hiIndex (Tnode.isStartNodeOf);
        CEdge := Tnode.isStartNodeOf[i];
        IF (CEdge in EdgeSet) and (not (CEdge in Found)) THEN
            Found := Found + CEdge;
            ToDo := ToDo + CEdge;
        END_IF;
    END_REPEAT;

    REPEAT i:= 1 to hiIndex (Tnode.isEndNodeOf);
        CEdge := Tnode.isEndNodeOf[i];
        IF (CEdge in EdgeSet) and (not (CEdge in Found)) THEN
            Found := Found + CEdge;
            ToDo := ToDo + CEdge;
        END_IF;
    END_REPEAT;

    ToDo := ToDo - ToDo[1];
END_REPEAT;

if SIZEOF (EdgeSet - Found) > 0 then
    return (FALSE);
else
    return (TRUE);
end_if;

END_FUNCTION;

FUNCTION SameRouteEndings
(routes: SET [1:?] OF ROUTE):BOOLEAN;

```

```

    REPEAT i:=2 TO hiIndex (routes);
      IF routes[i].endsAT <> routes[1].endsAT THEN
        return (False);
      END_IF;
    END_REPEAT;
    RETURN(True);
  END_FUNCTION;

  FUNCTION Distance2Point
    (c: Curve; d: INTEGER):Point;
  LOCAL
    p : Point;
  END_LOCAL;
  (* calculate the point co-ordinates for the point on the curve at distance d
  from Curve.startsAt *)
  RETURN(p);
  END_FUNCTION;

END_SCHEMA;

```

Schema 4-1 Road network geometry schema

4.1.1.4 Entity descriptions

The various entities together with some auxiliary definitions are described below.

Carrigeway Intermediate Node0, CwIntermediateNode0

A node on an edge in the carriageway network which may or may not coincide with a terminating node.

Curve

Bounded continuous 1-dimensional geometric primitive. [CEN prENV12160]

Edge

1-dimensional topological primitive being an oriented connection between two terminating nodes, which may be the same. [CEN prENV12160]

The continuing edge, if exists, is a next edge which can be reached without tuning right or left. The terrain curve represents the centreline of the edge.

Geometric primitive

Description, partial or total, of the spatial aspects of an object by means of co-ordinates and mathematical functions. [CEN prENV12160]

Geometry

Metric spatial aspects of Geographic Information [CEN prENV12160].

Intermediate node

A node coincident with an edge without terminating it. [CEN prENV12160]

The distance is the distance along the terrainCurve of the edge from its startsAt point.

Node

0-dimensional topological primitive. [CEN prENV12160]

Within this context each node is a connected node, i.e. a node related to one or more edges.

Point

A 0-dimensional geometric primitive. [CEN prENV12160]

The geodetic position of a node is described in WGS geodetic co-ordinates [WGS].

RdCoordinates

The cartesian coordinates of a point with respect to the Dutch Stereographic Grid (New Numbering), called 'Rijksdriehoek coördinaten' in dutch.

Route

A route through a network. A route may encompass one or more edges and starts and ends with an intermediate node on the first and last edge respectively.

Segment

A route for which each non-first edge is the continuing edge of its predecessor.

Terminating node

A node terminating an edge. [CEN prENV12160]

Topological primitive

Description, partial or total, of the topological aspects of an object. [CEN prENV12160]

Topology

Non-metric discrete spatial aspects of Geographic Information. [CEN prENV12160]

Upstream Routes

A set of routes all ending in the same intermediate node.

Wgs Geodetic Coordinates

Geodetic coordinates of a point with respect to the WGS84 coordinate system (see [WGS84])
The attribute latitude represents the geodetic latitude and the attribute longitude the geodetic longitude (see CEN287011]). The height is ellipsoidal height.

4.1.1.5 Type descriptions

The various types together with some auxiliary definitions are described below.

Decimetre

One tenth of a metre.

Note1 : The decimetre is also used in GDF as a unit measurement. So GDF information can be obtained without loss of accuracy.

Note: As 40.000 km = 40 million metres = 400 million decimetres < 2.000 million, any distance on earth can be represented by a four bytes integer if measured in decimetres. At the same time the decimetre is more then accurate for all known traffic applications.

Direction

An angle measured in radials defining the direction of a straight curve.

Ellipsoidal height (h)

The distance of a point from the geodetic ellipsoid measured along the perpendicular to the ellipsoid at that point, with the heighth of points outside the ellipsoid being treated as positive [CEN287011], called geodetic height (h) in [WGS84].

Microdegrees

One millions of a degree.

Note1 : The unit microdegrees is also used by GDF and ILOCS uses 10 microdegrees as its unit of measurement. So information on angles can be obtained form both sources without loss of accuracy.

Note2: As 360 million is less then 2.000 million, any value between -360 and 360 degrees can be represented by a four byte integer if measured in microdegrees.

Interpolation method

Defines the different allowed interpolation methods

4.1.1.6 Integrity constraints

- [1] A route shall be continuous, each end of a road edge within a route coincides with the start of its successor on the route. This is formally described by the function `RoutelsContinuous`.
- [2] A segment shall be a route on which the successor for each road edge on the route shall be the continuing edge of its predecessor. This is formally described by the function `RoutelsStraightOn`

[3] The carriageway edges of a motorway edge or node shall form a connected graph. This is formally described by the function EdgesAreConnected

[4] A set of upstream routes shall all end at the same point. This is formally described by the function SameRouteEndings

4.1.1.7 Other security aspects

There are no additional security requirements

4.1.1.8 Performance aspects

There are no additional performance requirement

4.1.1.9 Implementation aspects

There are no additional implementation requirements.

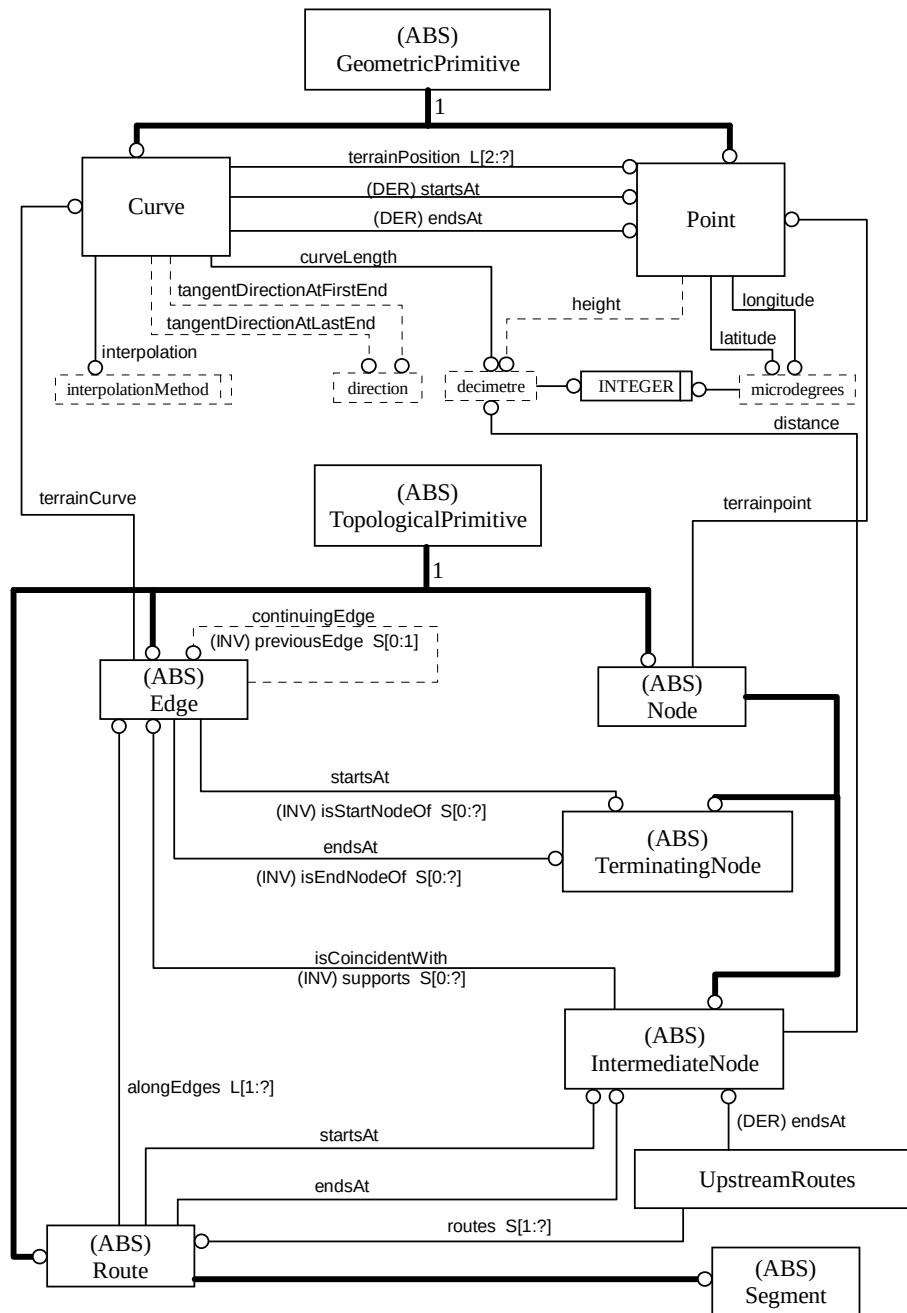
4.1.1.10 Abbreviations

CEN	Comité Européen de Normalisation (European Committee for Standardization)
GDF	Geographic Data File
ILOCS	Intersection LOCationS
prENV	European Prestandard
WGS	World Geodetic System

4.1.1.11 References

See section 2 for a complete reference description.

[prENV12160]	Geographic Information - Data Description - Spatial schema November 1996
[CEN287011]	prENV 287011:1995 Geographic Information - Referencing - Position CEN/TC287/WG4
[GDF]	...
[ILOCS]	...
[WGS84]	MIL-STD-2401 US Department of Defence World Geodetic System (WGS) 11 January 1994



4.1.2 Motorway network

4.1.2.1 Identification

Name : Motorway network
Identifier : ViaNova.Dbdd.ConceptualSchema.MotorwayNetwork

4.1.2.2 Description

In this schema a road network is described as network of carriageway.

The network of carriageways is modelled as a non-planar directed graph. See the schema Road network Geometry.

A carriageway element consists of a list parallel lane elements numbered from the inside out.

A carriageway element may be part of a motorway element or motorway junction.

4.1.2.3 Conceptual schema

```
SCHEMA MOTORWAYNETWORK;  
  
REFERENCE FROM ROADNETWORKGEOMETRY  
  (TerminatingNode,  
   Edge,  
   IntermediateNode,  
   Route,  
   Segment);  
  
REFERENCE FROM CARRIAGEWAYNETWORK  
  (CwElement);  
  
ENTITY MwJunction  
  SUBTYPE OF(TerminatingNode, MwElementOrJunction);  
  name : STRING;  
END_ENTITY;  
  
ENTITY MwElementOrJunction  
  ABSTRACT SUPERTYPE OF (ONEOF(MwElement, MwJunction));  
  consistsOf : SET [1:?] OF CwElement;  
END_ENTITY;  
  
ENTITY MwElement  
  SUBTYPE OF(Edge, MwElementOrJunction);  
  SELF\Edge.endsAt : MwJunction;  
  SELF\Edge.startsAt : MwJunction;  
  SELF\Edge.continuingEdge : OPTIONAL MwElement;  
END_ENTITY;  
  
ENTITY MwIntermediateNode  
  SUBTYPE OF(IntermediateNode);  
  SELF\IntermediateNode.isCoincidentWith : MwElement;  
END_ENTITY;  
  
ENTITY MwRoute  
  SUBTYPE OF(Route);  
  SELF\Route.endsAt : MwIntermediateNode;  
  SELF\Route.startsAt : MwIntermediateNode;  
  SELF\Route.alongEdges : LIST [1:?] OF MwElement;  
END_ENTITY;  
  
ENTITY MwSegment  
  SUBTYPE OF(Segment, MwRoute);  
END_ENTITY;  
  
END_SCHEMA;
```

Schema 4-2 Motorway network schema

4.1.2.4 Entity descriptions

The various entities together with some auxiliary definitions are described below.

Motorway element

An edge between two nodes (motorway junctions) in a motorway network.

Motorway element or junction

The supertype of motorway element and motorway junction.

Motorway Intermediate Node

A node on an edge (motorway element) in a motorway network.

Motorway junction

A node in a motorway network at which one or more edges (motorway elements) start or end.

Motorway route

A route through a motorway network. A route may encompass one or more motorway elements and starts and ends with an intermediate node on the first and last element respectively.

Motorway segment

A route through a motorway network where each next motorway element is the continuing element of its predecessor.

4.1.2.5 Type descriptions

The various types together with some auxiliary definitions are described below.

4.1.2.6 Integrity constraints

This schema is based on constraints specified in RoadNetworkGeometry.

4.1.2.7 Other security aspects

There are no additional security requirements

4.1.2.8 Performance aspects

There are no additional performance requirements

4.1.2.9 Implementation aspects

There are no additional implementation requirements.

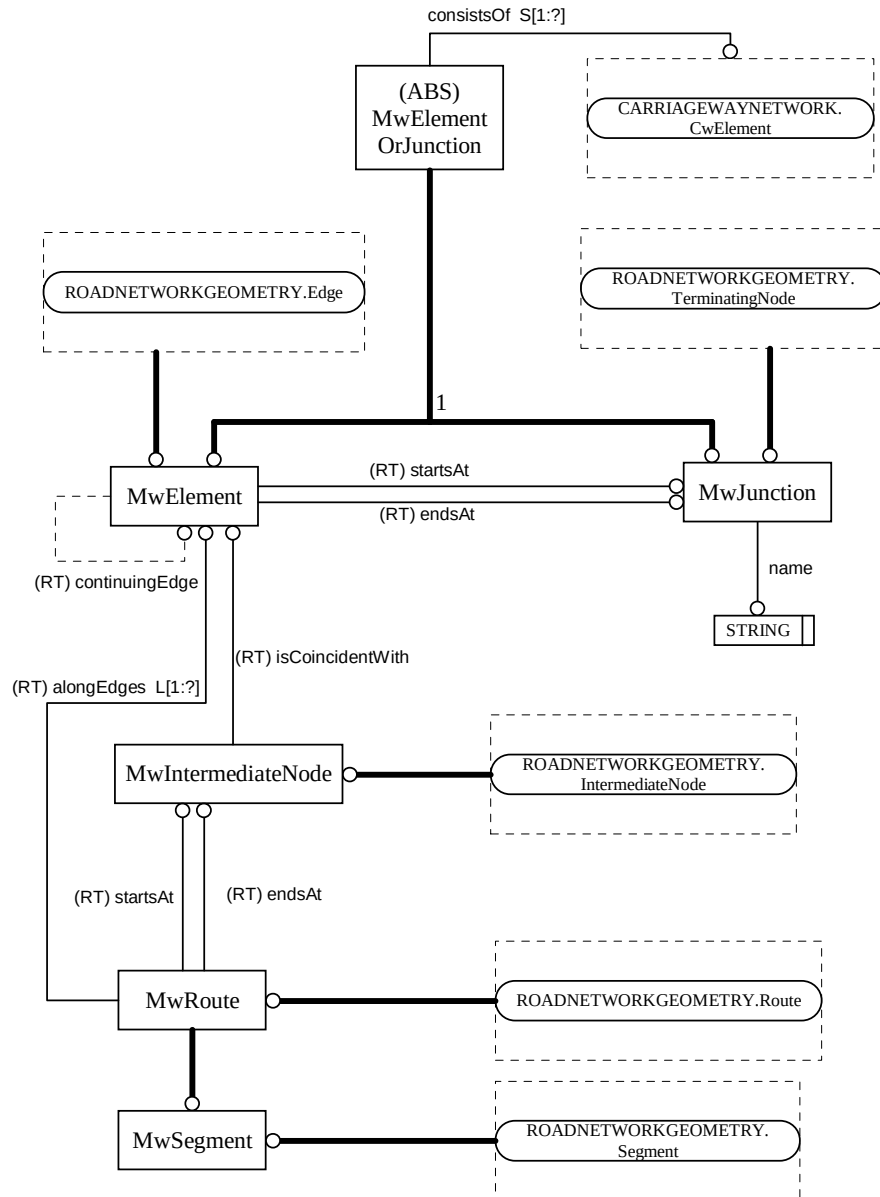
4.1.2.10 Abbreviations

Cw	Carriageway
Ln	Lane
Mw	Motorway

4.1.2.11 References

See section 2 for a complete reference description.

[...] ...



4.1.3 Carriageway network

4.1.3.1 Identification

Name : Carriageway network
Identifier : ViaNova.Dbdd.ConceptualSchema.CarriagewayNetwork

4.1.3.2 Description

In this schema a road network is described as network of carriageway.

The network of carriageways is modelled as a non-planar directed graph. See the schema Road network Geometry.

For a dual carriageway network a carriageway element is almost the same a GDF road element. However for technical reasons a GDF road element may be split into two or more carriageway elements.

Technical reasons for splitting a GDF road element into two or more carriageway elements are the following:

1. the number of lanes changes within a road element,
a carriage element simply consist of one or more parallel lane elements.
2. the road element crosses the border of administrative areas
a carriageway element lies always within only one administrative area.
3. the road element consists of two or more parallel carriageways (separated by a 'locked line').

A carriageway element consists of a list parallel lane elements numbered from the inside out.

A carriageway element may be part of a motorway element or motorway junction.

4.1.3.3 Conceptual schema

```
SCHEMA CARRIAGEWAYNETWORK;  
  
REFERENCE FROM ROADNETWORKGEOMETRY  
(Edge,  
TerminatingNode,  
IntermediateNode,  
Segment,  
Route,  
UpstreamRoutes);  
  
REFERENCE FROM LANENETWORK  
(LnElement);  
  
TYPE PlusMin = INTEGER;  
WHERE  
TwoValues : (self = -1) OR (self = 1);  
END_TYPE;  
  
TYPE Decimetre = INTEGER;  
END_TYPE;  
  
ENTITY CwElement  
SUBTYPE OF(Edge);  
RoadName : STRING;  
Lanes : LIST [1:?] OF LnElement;  
SubGdfIdentifier : INTEGER;  
GdfRoadElementId : INTEGER;  
HmDirection : PlusMin;  
SELF\Edge.startsAt : CwJunction;  
SELF\Edge.endsAt : CwJunction;  
SELF\Edge.continuingEdge : OPTIONAL CwElement;  
END_ENTITY;  
  
ENTITY CwJunction  
SUBTYPE OF(TerminatingNode);  
END_ENTITY;
```

```

ENTITY CwIntermediateNode
  SUBTYPE OF(IntermediateNode);
  SELF\CwIntermediateNode.isCoincidentWith : CwElement;
END_ENTITY;

ENTITY HmPost
  SUBTYPE OF(CwIntermediateNode);
  HmLegend : Decimetre;
  WHERE
    isHectometre : (hmLegend mod 1000) = 0;
END_ENTITY;

ENTITY CwSegment
  SUBTYPE OF(Segment, CwRoute);
END_ENTITY;

ENTITY CwRoute
  SUBTYPE OF(Route);
  SELF\Route.endsAt      : CwIntermediateNode;
  SELF\Route.startsAt    : CwIntermediateNode;
  SELF\Route.alongEdges : LIST [1:?] OF CwElement;
END_ENTITY;

ENTITY CwUpstreamRoutes
  SUBTYPE OF(UpstreamRoutes);
  SELF\UpstreamRoutes.routes : SET [1:?] OF CwRoute;
END_ENTITY;

END_SCHEMA;

```

Schema 4-3 Carriageway network schema

4.1.3.4 Entity descriptions

The various entities together with some auxiliary definitions are described below.

Carriageway element

An edge between two nodes (carriageway junctions) in a carriageway network.

A carriageway element consists of a list on parallel lane elements numbered from the inside out. The road name is the same as used along the road. If no road name id assigned the so-called 'DVK-letter' will be used.

The GDF identifier is the identifier of the corresponding GDF road element or the one of which is carriageway element is a part of.

The GDF subidentifier is a positive number if the carriageway element is part of a subdivided GDF road element and zero if it corresponds to a complete road element.

Carriageway intermediate node

A node on an edge in a carriageway network.

Carriageway junction

A node in a carriageway network at which one or more edges (carriage elements) start or end.

Carriageway route

A route through a carriageway network. A route may encompass one or more carriageway edges and starts and ends with an intermediate node on the first and last edge respectively.

Carriageway segment

A route through a carriageway network where each next carriageway element is the continuing element of its predecessor.

Carriageway upstream routes

A set of routes through a carriageway network all ending in the same intermediate node.

Hm post

A hectometre post.

The hm legend contains the distance as written on the post but measured in decimetres.

An hm post is a subtype of an carriage intermediate node. So it has also a position on the carriageway element.

4.1.3.5 Type descriptions

The various types together with some auxiliary definitions are described below.

PlusMin

PlusMin indicates the direction of numbering of the hectometre posts is relation to the traffic direction. It is 1 if the are the same and -1 if not..

4.1.3.6 Integrity constraints

There are no integrity rules specified.

4.1.3.7 Other security aspects

There are no additional security requirements

4.1.3.8 Performance aspects

There are no additional performance requirements

4.1.3.9 Implementation aspects

There are no additional implementation requirements.

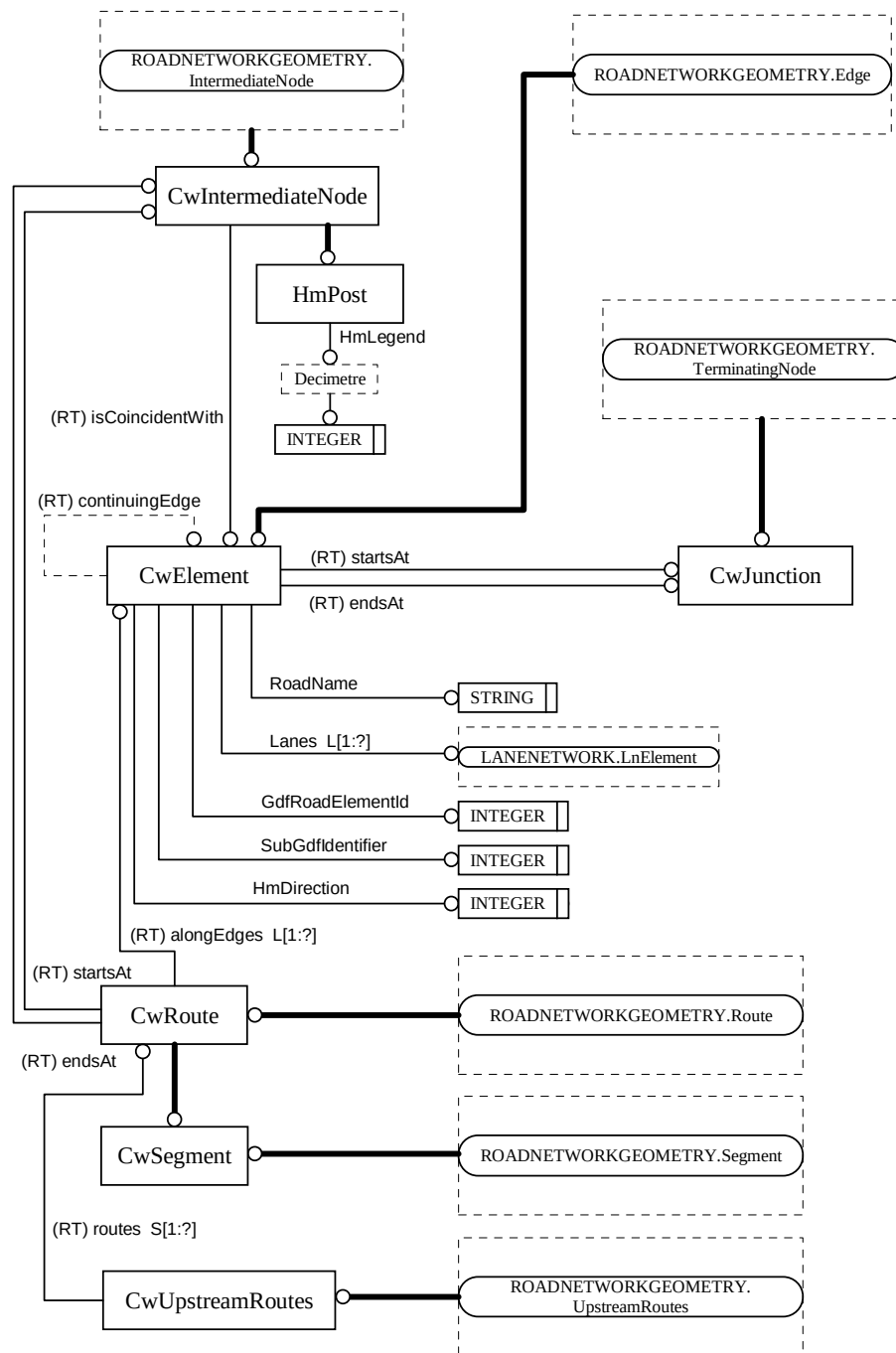
4.1.3.10 Abbreviations

Cw	Carriageway
GDF	Geographic Data Files (a CEN standard for the exchange of road data)
Ln	Lane
Mw	Motorway

4.1.3.11 References

See section 2 for a complete reference description.

[GDF]	Geographic Data Files CEN, version 3.0 draft, 12 October 1995
-------	--



4.1.4 Lane network

4.1.4.1 Identification

Name : Lane network
Identifier : ViaNova.Dbdd.ConceptualSchema.LaneNetwork

4.1.4.2 Description

In this schema a road network is described as network of lanes.

The network of lanes is modelled as a non-planar directed graph. See the schema Road network Geometry.

A lane element is considered to be a part of one and only one carriage element.

4.1.4.3 Conceptual schema

```
SCHEMA LANENETWORK;  
  
    USE FROM ROADNETWORKGEOMETRY  
        (decimetre,  
         Edge,  
         TerminatingNode,  
         IntermediateNode,  
         Route,  
         Segment);  
  
    ENTITY LnElement  
        SUBTYPE OF(Edge);  
        width : decimetre;  
        SELF\Edge.startsAt : LnJunction;  
        SELF\Edge.endsAt : LnJunction;  
        SELF\Edge.continuingEdge : OPTIONAL LnElement;  
    END_ENTITY;  
  
    ENTITY LnJunction  
        SUBTYPE OF(TerminatingNode);  
    END_ENTITY;  
  
    ENTITY LnIntermediateNode  
        SUBTYPE OF(IntermediateNode);  
        SELF\IntermediateNode.isCoincidentWith : LnElement;  
    END_ENTITY;  
  
    ENTITY LnRoute  
        SUBTYPE OF(Route);  
        SELF\Route.startsAt : LnIntermediateNode;  
        SELF\Route.endsAt : LnIntermediateNode;  
        SELF\Route.alongEdges : LIST [1:?] OF LnElement;  
    END_ENTITY;  
  
    ENTITY LnSegment  
        SUBTYPE OF(Segment, LnRoute);  
    END_ENTITY;  
  
END_SCHEMA;
```

Schema 4-4 Lane network schema

4.1.4.4 Entity descriptions

The various entities together with some auxiliary definitions are described below.

Lane element

A lane element is an edge between two nodes (lane junctions) in a lane network.

Lane Intermediate Node

A node on an edge (lane element) in the lane network.

Lane junction

A node in a lane network at which one or more edges (lane elements) start or end.

Lane Route

A route through a lane network. A route may encompass one or more lane elements and starts and ends with an intermediate node on the first and last element respectively.

Lane Segment

A route through a lane network where each next lane element is the continuing element of its predecessor.

Note: a lane segment is thus a route where you only drive straight on and never switch to a co-lateral lane.

4.1.4.5 Type descriptions

The various types together with some auxiliary definitions are described below.

4.1.4.6 Integrity constraints

This schema is based on constraints specified in RoadNetworkGeometry.

Some constraint has to be formulated to prevent twisting lane connections on continuing carriageway elements. I.e. if

1. Carriageway element Cw2 is a continuing element of carriageway element Cw1 and
2. Lane Ln1a and Ln1b are part of Cw1 and lane Ln2a and Ln2b are part of Cw2 and
3. Ln1a is left of Ln1b then
Ln2a should also be left of Ln2b.

4.1.4.7 Other security aspects

There are no additional security requirements

4.1.4.8 Performance aspects

There are no additional performance requirements.

4.1.4.9 Implementation aspects

There are no additional implementation requirements.

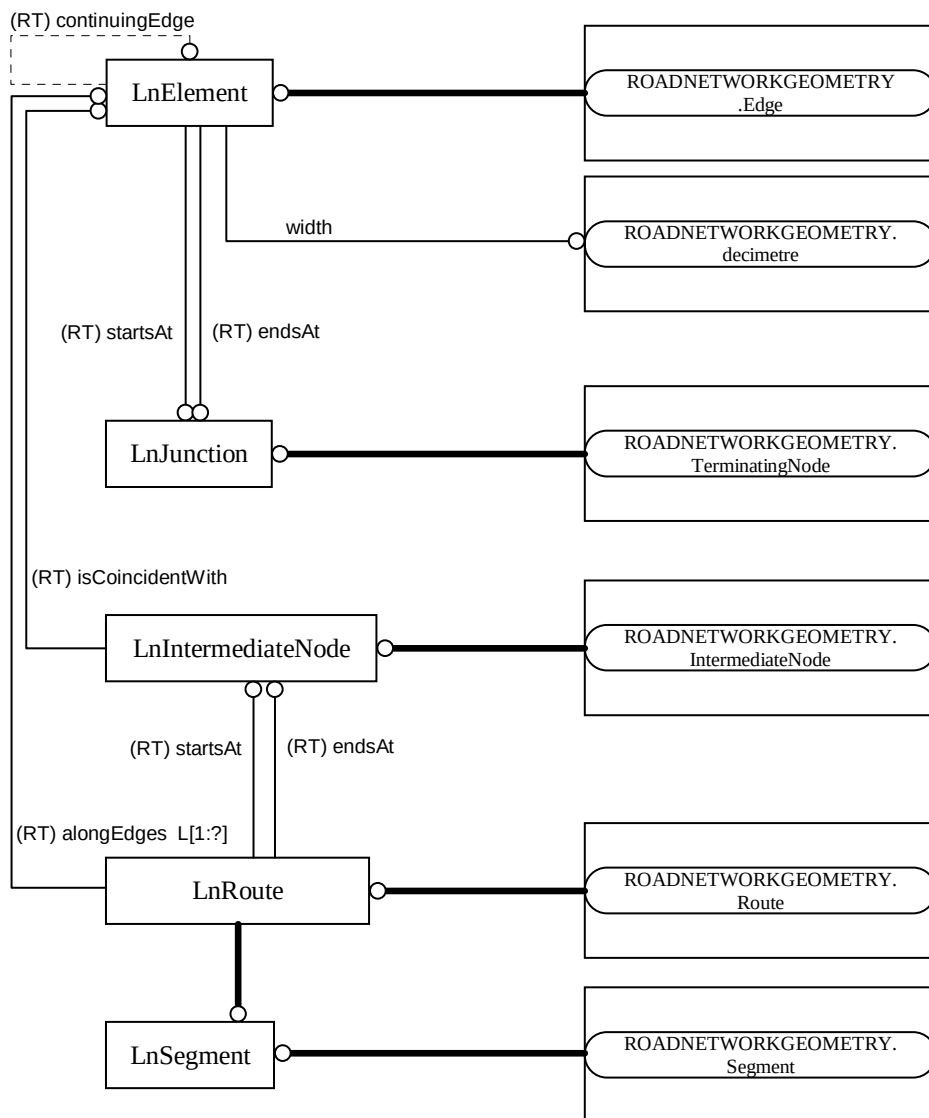
4.1.4.10 Abbreviations

Cw	Carriageway
Ln	Lane
Mw	Motorway

4.1.4.11 References

See section 2 for a complete reference description.

[...] ...



4.1.5 RDS-TMC Locations

4.1.5.1 Identification

Name : RDS-TMC Locations
Identifier : ViaNova.Dbdd.ConceptualSchema.RdsTmcLocations

4.1.5.2 Description

This schema defines the pre-defined Alert-C (RDS-TMC) location references conform [prENV12313-3].

Note : It is expected that [prENV12313-3] will be replaced by a new version in April or May 1999 !

The predefined Alert-C location are also mapped to carriageway location references.

4.1.5.3 Conceptual schema

```
SCHEMA RDSTMCLOCATIONS;

REFERENCE FROM CARRIAGEWAYNETWORK
  (CwJunction,
   CwSegment,
   CwIntermediateNode);

TYPE RdsCountryCode = INTEGER;
WHERE
  MinMax : {1 <= self <= 15};
END_TYPE;

TYPE RdsLocationTableNumber = INTEGER;
WHERE
  MinMax : {1 <= self <= 63};
END_TYPE;

TYPE RdsLocationCode = INTEGER;
WHERE
  MinMax : {1 <= self <= 63487};
END_TYPE;

TYPE RdsName = STRING;
END_TYPE;

TYPE RoadNumberString = STRING (5);
END_TYPE;

TYPE Iso3166CountryCode = STRING (3);
END_TYPE;

ENTITY RdsLocationTable;
  countryCode : RdsCountryCode;
  locationTableNumber : RdsLocationTableNumber;
  isoCountryCode : Iso3166CountryCode;
  localCountryName : STRING;
  UNIQUE
  NODUPLICATETABLES : countryCode, locationTableNumber;
END_ENTITY;

ENTITY RdsPredefinedLocations
  ABSTRACT SUPERTYPE OF (ONEOF(RdsAreaLocation, RdsPointLocation,
  RdsLinearLocation));
  table : RdsLocationTable;
  locationCode : RdsLocationCode;
  locationType : RdsLocationType;
  firstName : OPTIONAL RdsName;
  upwardAreaRef : OPTIONAL RdsAreaLocation;
  UNIQUE
  NoDuplicateReferences : table, locationCode;
END_ENTITY;

ENTITY RdsAreaLocation
  SUBTYPE OF(RdsPredefinedLocations);
  nextAreaSouth : OPTIONAL RdsAreaLocation;
```

```

        nextAreaEast : OPTIONAL RdsAreaLocation;
    WHERE
        AreaCategory : locationType.categoryCode = 'A';
END_ENTITY;

ENTITY RdsPointLocation
    ABSTRACT SUPERTYPE OF (ONEOF(RdsOtherPoint, RdsIntermediatePoint,
RdsJunction))
    SUBTYPE OF(RdsPredefinedLocations);
    urbanTraffic : BOOLEAN;
    interSectionCode : OPTIONAL RdsPredefinedLocations;
    WHERE
        PointCategory : locationType.categoryCode = 'P';
END_ENTITY;

ENTITY RdsOtherPoint
    SUBTYPE OF(RdsPointLocation);
    upwardsLinearReference : OPTIONAL RdsLinearLocation;
    negativeOffset : OPTIONAL RdsPointLocation;
    positiveOffset : OPTIONAL RdsPointLocation;
    terrainLocation : Wgs84Coordinates;
    carriagewayLocation : SET OF CwIntermediateNode;
    WHERE
        OtherPointType : locationType.typeCode = 3;
END_ENTITY;

ENTITY RdsLinearLocation
    SUBTYPE OF(RdsPredefinedLocations);
    roadNumber : OPTIONAL RoadNumberString;
    roadName : OPTIONAL RdsName;
    secondName : OPTIONAL RdsName;
    upwardLinearReference : OPTIONAL RdsLinearLocation;
    negativeOffset : OPTIONAL RdsLinearLocation;
    positiveOffset : OPTIONAL RdsLinearLocation;
    terrainLocation : CwSegment;
    WHERE
        LinearCategory : locationType.categoryCode = 'L';
END_ENTITY;

ENTITY Wgs84Coordinates;
END_ENTITY;

ENTITY RdsIntermediatePoint
    SUBTYPE OF(RdsPointLocation);
    upwardsLinearReference : RdsJunction;
    negativeOffset : OPTIONAL RdsPointLocation;
    positiveOffset : OPTIONAL RdsPointLocation;
    SELF\RdsPredefinedLocations.firstName : RdsPointLocation;
    terrainLocation : CwIntermediateNode;
    WHERE
        IntermediatePointType : locationType.typeCode = 2;
END_ENTITY;

ENTITY RdsJunction
    SUBTYPE OF(RdsPointLocation);
    IntersectingRoadNumber : OPTIONAL RoadNumberString;
    upwardsLinearReference : RdsLinearLocation;
    negativeOffset : OPTIONAL RdsJunction;
    positiveOffset : OPTIONAL RdsJunction;
    roadJunction : CwJunction;
    JunctionNumber : STRING (5);
    WHERE
        JunctionType : locationType.typeCode = 1;
END_ENTITY;

ENTITY RdsLocationType;
    cenName : STRING;
    localName : STRING;
    categoryCode : STRING (1);
    typeCode : INTEGER;
    subtypeCode : INTEGER;
    description : STRING;
    WHERE
        CategoryCodes : (CategoryCode = 'A') OR (CategoryCode = 'L') OR
(CategoryCode = 'P');
END_ENTITY;

END_SCHEMA;

```

Schema 4-5 RDS-TMC Locations schema

4.1.5.4 Entity descriptions

The various entities together with some auxiliary definitions are described below.

Location reference

A reference to a location which is unique throughout Europe and the surrounding countries when fully specified by a RDS country reference, a RDS table number and a RDS location code [prENV12313-3] .

RDS Location Table

A location table conform [prENV12313-3] with some additional attributes :

- the three character ISO 3166-1 country code (because the RDS country code is not unique)
- a local language name of a country
- per table entry a terrain location, i.e. geographical location or a location in a carriageway network, is added as well.

RDS Junction

a point in a road or ring-road where other road(s) and/or ring-road(s) connect [prENV12313-3] .

RDS Intermediate Point

a point between two junctions which is a reference in traffic/travel messages [prENV12313-3].

RDS other point

another point (i.e. not a junction or intermediate point) of interest in traffic/travel messages [prENV12313-3] .

The terrain location of an other point is expressed in WGS84 geodetic co-ordinates, the location relative to a carriageway network as a set of intermediate nodes.

Note: RDS other points like a bridge or tunnel are usually part of two carriageway elements (one in each direction).

4.1.5.5 Type descriptions

The various types together with some auxiliary definitions are described below.

Category (code)

One of the following three: area (A), linear (L) or point (P).

RDS Country Code

A numerical code for a country conform [prENV12313-3] annex A2.

Note: a number will be shared by more then one country.

RDS Location Table Number

A number for a location table conform [prENV12313-3].

RDS location code

the number of a row in a RDS location table.

RDS name

A local language name a referenced location for human comprehension.

Road Number String

A road number conform [prENV12313-3].

ISO 3166 Country Code

A three or less character country code conform [ISO3166-1]

Upward reference (linear or area)

A reference to

4.1.5.6 Integrity constraints

There are no integrity rules specified.

Note : As the standard uses the word 'reference' instead of 'location' in phrases like upward reference it is assumed that this may be a reference to a location in another table.

4.1.5.7 Other security aspects

There are no additional security requirements

4.1.5.8 Performance aspects

There are no additional performance requirements

4.1.5.9 Implementation aspects

There are no additional implementation requirements.

4.1.5.10 Abbreviations

RDS	Radio Data System
TMC	Traffic Management Channel

4.1.5.11 References

See section 2 for a complete reference description.

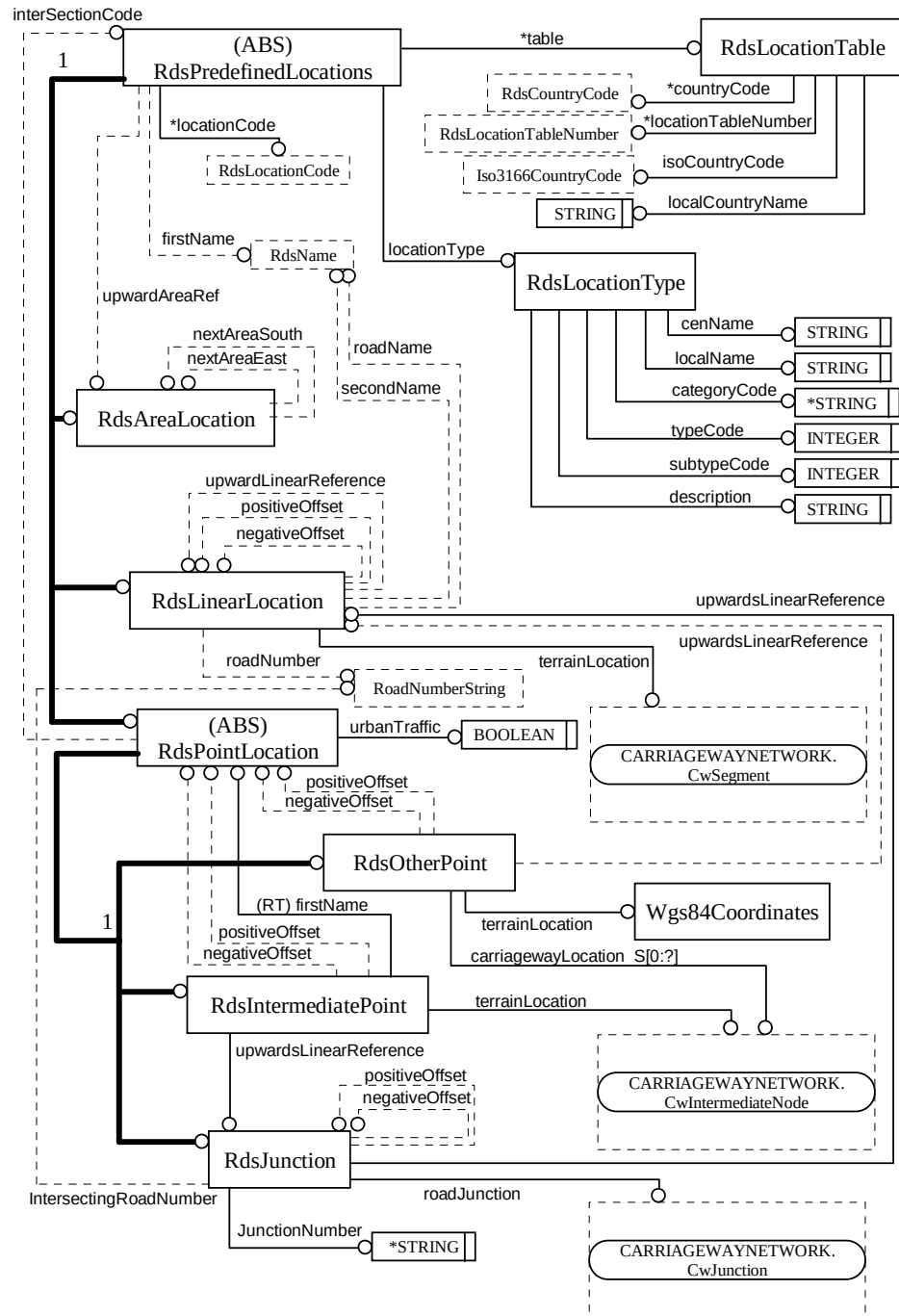
[ISO3166-1]	Codes for the representation of names of countries and their subdivisions - - Part 1: Country codes ISO, 1997.
-------------	--

[prENV12313-3]	Traffic and Traveller Information (TTI) TTI Messages via Traffic Message Coding Part 3: Location referencing for Alert C Pink Paper TC278/N783, 10-10-97
----------------	---

PS. As my copy of this document did not contain the explanatory table on page 27, I assumed that it was the same as in [prENV/278/7/3/0004].

[prENV/278/7/3/0004]	Geographic Road DataBase - Location Referencing - Part 1: Location referencing rules for Radio Data System - Traffic Message Channel (RDS-TMC), Version 1.0, July 1996
----------------------	---

[WGS84]	MIL-STD-2401 US Department of Defence World Geodetic System (WGS) 11 January 1994
---------	---



4.1.6 BPS Locations

4.1.6.1 Identification

Name : BPS Locations
Identifier : ViaNova.Dbdd.ConceptualSchema.BpsLocations

4.1.6.2 Description

This schema defines the location references conform the ' Beschrijvende Plaatsaanduiding Systematiek' (descriptive location reference system) [BPS94] as used by Rijkswaterstaat.

4.1.6.3 Conceptual schema

SCHEMA BPSLOCATIONS;

TYPE BpsRoadType = STRING (2);
END_TYPE;

TYPE BpsPathType = STRING (2);
END_TYPE;

TYPE BpsLaneType = STRING (2);
END_TYPE;

TYPE lmrPosition = ENUMERATION OF
(LEFT,
MIDDLE,
RIGHT);
END_TYPE;

ENTITY BpsLocationReference;
road : BpsRoadName;
location : BpsCsLocation;
path : OPTIONAL BpsPathId;
report : OPTIONAL STRING;
lane : OPTIONAL BpsLaneId;
WHERE
laneOnlyIfPath : exists(path) > exists(lane);
END_ENTITY;

ENTITY BpsRoadName;
roadType : BpsRoadType;
roadNumber : INTEGER;
WHERE
positiveRoadNumber : roadNumber > 0;
END_ENTITY;

ENTITY BpsCrossSection;
hmPoleNumber : REAL (1);
offset : REAL (1);
WHERE
PositiveHmPoleNumber : hmPoleNumber > 0;
offsetRange : {-100 < offset < 100};
END_ENTITY;

(*
Attribute definitions
<hmPoleNumber>
Number as written on the hectometre pole

<offset>
distance in metres form the hectometer pole
*)

ENTITY BpsPathId
ABSTRACT SUPERTYPE OF (ONEOF(BpsParallelPathId, BpsNonParallelPathId));
pathType : BpsPathType;
END_ENTITY;

ENTITY BpsParallelPathId
SUBTYPE OF(BpsPathId);
pathNumber : INTEGER;
position : lmrPosition;
WHERE

```

        PositivePathNumber : pathNumber > 0;
    END_ENTITY;

    ENTITY BpsNonParallelPathId
        SUBTYPE OF(BpsPathId);
        DvkCharacter : STRING (1);
    END_ENTITY;

    ENTITY BpsLaneId;
        laneType : BpsLaneType;
        laneNumber : INTEGER;
        position : lmrPosition;
    WHERE
        PositiveLaneNumber : laneNumber > 0;
    END_ENTITY;

END_SCHEMA;

```

Schema 4-6 BPS Locations schema

4.1.6.4 Entity descriptions

The various entities together with some auxiliary definitions are described below.

BpsCrossSection

the representation of a cross section (dutch 'dwarsraai') location consisting of the identification number of an hectometre pole and an offset to that pole, see [BPS94].

BpsLocationReference

A representation of a BPS location reference consisting of a road name, a cross section identification, an optional location on this cross section and an optional report, see [BPS94].

BpsNonParallelPathId

The representation of a BPS non-parallel path (dutch 'niet parallelle baan') consisting of a path type and a DVK-character (dutch 'DVK-letter'), see [BPS94].

BpsParallelPathId

The representation of a BPS parallel path (dutch 'parallelle baan') consisting of a path type, a path number and its position (left, middle or right), see [BPS94].

BpsPathId

An abstract supertype representing the type (dutch 'baansoort' of parallel and non parallel paths (dutch 'banen')

BpsRoadName

A name of a road consisting of a road type identifier and a road number, see [BPS94].

4.1.6.5 Type descriptions

The various types together with some auxiliary definitions are described below.

BpsLaneNumber

The number of a lane (dutch 'volgnummer strook') as defined within [BPS94] (from the right side to the left).

BpsLaneType

The type of a lane (dutch 'strooksoort') as defined within [BPS94]. The following types of lanes are distinguished (in Dutch):

- Bereden banen
 - 'R-' -- Rijstrook
 - 'V-' -- Vluchtstrook
 - 'C-' -- Correctiestrook
 - 'U-' -- Uitrijstrook
 - 'I-' -- Invoegstrook
 - 'W-' -- Weefstrook

- 'B-' -- Busstrook
- 'F-' -- Fietsstrook
- 'S-' -- Suggestiestrook
- 'P-' -- Parkeerstrook
- 'L-' -- Kruipstrook
- Markeringen
 - 'K-' -- Kantstreep
 - 'D-' -- Deelstreep
 - 'A-' -- Asstreep
- Niet verharde stroken
 - 'BB' -- Bovenberm
 - 'TA' -- Talud
 - 'OB' -- Onderberm
 - 'WG' -- Watergang
 - 'BG' -- Berm tussen watergang en weggrens
- Overige stroken
 - 'T-' -- Voetstrook
 - 'G-' -- Gootstrook
 - 'O-' -- Kantopsluiting
 - 'X-' -- Overige strook

BpsPathType

The type of a path (dutch 'baansoort') as defined within [BPS94]. The following types of paths are distinguished (in Dutch):

- Verharde banen
 - 'HR' -- Hoofdrijbaan
 - 'VW' -- Verbindingsweg
 - 'PW' -- Parallelweg
 - 'FP' -- Fietspad
 - 'RB' -- Rotondebaan
 - 'VB' -- Verzorgingsbaan
 - 'TN' -- Tussenbaan
 - 'VP' -- Voetpad
- Niet verharde banen
 - 'MB' -- Middenberm
 - 'BB' -- Buitenberm
 - 'TB' -- Tussenberm
 - 'IB' -- Ingesloten berm
- Overige banen
 - 'YY' -- Overige baan

BpsRoadJunctionName

The name of an road junction as used in inter human communication.

<< Not used in the schema >>

BpsRoadType

The type of a road (dutch 'wegsoort') as defined within [BPS94]. The following types of roads are distinguished (in Dutch):

- 'RW' -- Rijksweg
- 'PW' -- Provinciale weg
- 'GW' -- Gemeenteweg
- 'WW' -- Waterschapsweg
- 'PA' -- Particuliere weg

LmrPosition

The position (dutch 'positie') relative to the orientation line (dutch 'oriëntatielijn') as used within [BPS94]. The possible values are Left , Middle, or Right.

4.1.6.6 Integrity constraints

There are no integrity rules specified.

4.1.6.7 Other security aspects

There are no additional security requirements

4.1.6.8 Performance aspects

There are no additional performance requirements

4.1.6.9 Implementation aspects

There are no additional implementation requirements.

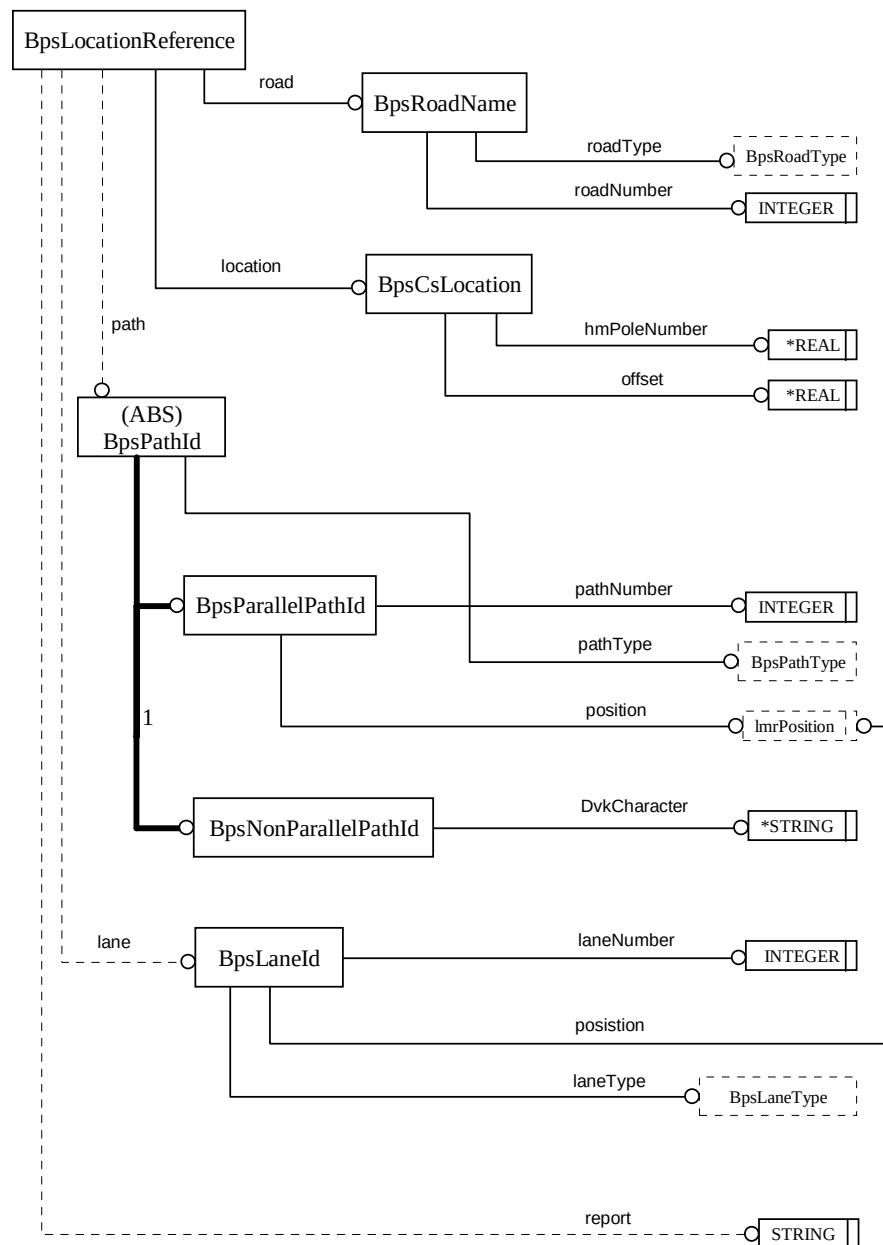
4.1.6.10 Abbreviations

BPS	Beschrijvende Plaatsaanduiding Systematiek
DWW	Dienst Weg- en Waterbouwkunde

4.1.6.11 References

See section 2 for a complete reference description.

[BPS94]	Driessen, J. e.a., Beschrijvende Plaatsaanduiding Systematiek Rijkswaterstaat DWW, rapport P-DWW-94-014, December 1994 ISBN 90-369-0006-9
---------	---



4.1.7 Terrain object examples

4.1.7.1 Identification

Name : Terrain object examples
Identifier : ViaNova.Dbdd.ConceptualSchema.TerrainObjectExamples

4.1.7.2 Description

In this schema the location reference aspects of some terrain objects are modelled as examples of the applicability of the road network schemas.

The terrain object examples are:

- the porous asphalt locations
- the max 100 km/hour roads
- incidents.

4.1.7.3 Conceptual schema

```
SCHEMA TERRAINOBJECTEXAMPLES;  
  
  USE FROM CARRIAGEWAYNETWORK  
    (CwSegment,  
     CwIntermediateNode,  
     CwUpstreamRoutes);  
  
  ENTITY PorousAsphalt;  
    onCarriageways : SET [1:?] OF CwSegment;  
  END_ENTITY;  
  
  ENTITY Max100roads;  
    onCarriageways : SET [1:?] OF CwSegment;  
  END_ENTITY;  
  
  ENTITY Incident;  
    terrainLocation : CwIntermediateNode;  
    secondaryLocation : OPTIONAL CwIntermediateNode;  
    upstreamQueues : CwUpstreamRoutes;  
    secondaryQueues : OPTIONAL CwUpstreamRoutes;  
  WHERE  
    QueueEnds : upstreamQueues.endsAt = terrainLocation;  
    SecondaryEnds : secondaryQueues.endsAt = secondaryLocation;  
  END_ENTITY;  
  
END_SCHEMA;
```

Schema 4-7 Terrain object examples schema

4.1.7.4 Entity descriptions

The various entities together with some auxiliary definitions are described below.

Porous asphalt

For ice warning systems it is important to know whether not porous asphalt is used for the road surface. Model presented assumes that:

- all parallel lanes on a carriageway do have the same type of surface (as far as relevant for our applications)
- the use of porous asphalt may begin and end at each point on a carriageway element, i.e. not necessarily at its begin or end.

Max 100 km/hour roads

Carriageway with a 100 km/hour speed limit is modelled in the same way as the use of porous asphalt, i.e. as a set of carriageway segments with a 100 km/hour speed limit.

Incidents

A little more complicated entity is an incidents. Restricting our view to the location, it happens at some location, it may cause upstream queues form both its own location and (secondary queues) on the carriageway in the other direction because of curious slowing-down traffic.

This is modelled by means of:

- the point on a carriageway at which the incident occurred,
- a set of upstream queues (carriageway routes) ending at this point
- an optional secondary point at the carriageway in the other direction
- a set of upstream queues (carriageway routes) ending at this secondary point

4.1.7.5 Type descriptions

The various types together with some auxiliary definitions are described below.

4.1.7.6 Integrity constraints

There are no integrity rules specified.

4.1.7.7 Other security aspects

There are no additional security requirements

4.1.7.8 Performance aspects

There are no additional performance requirements

4.1.7.9 Implementation aspects

There are no additional implementation requirements.

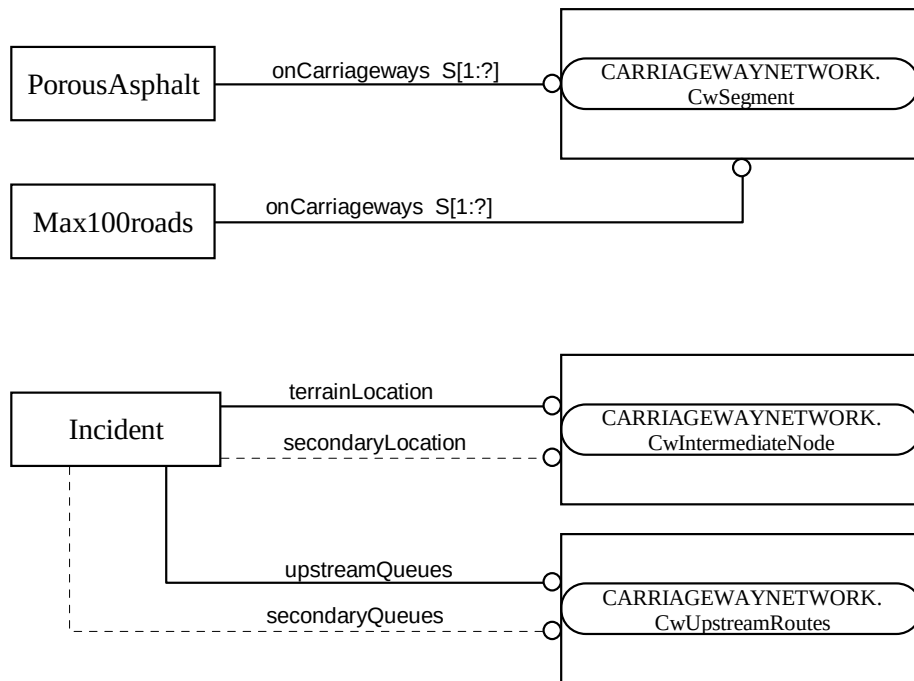
4.1.7.10 Abbreviations

... ..

4.1.7.11 References

See section 2 for a complete reference description.

[...] ...



4.1.8 Signaling Network

4.1.8.1 Identification

Name : Signaling Network
Identifier : ViaNova.Dbdd.ConceptualSchema.SignalingNetwork

4.1.8.2 Description

..

4.1.8.3 Conceptual schema

```
SCHEMA SIGNALINGNETWORK;  
  
    REFERENCE FROM ROADNETWORKGEOMETRY  
        (Edge,  
         Node);  
  
    REFERENCE FROM LANENETWORK  
        (LnIntermediateNode);  
  
    REFERENCE FROM CARRIAGEWAYNETWORK  
        (CwIntermediateNode);  
  
    TYPE SignalingSigns = ENUMERATION OF  
        (REDCROSS,  
         LEFTARROW,  
         RIGHTARROW,  
         SEVENTY,  
         ETC);  
    END_TYPE;  
  
    ENTITY SgLaneSegment  
        SUBTYPE OF(Edge);  
    END_ENTITY;  
  
    ENTITY SgSign  
        SUBTYPE OF(Node);  
        LnLocation : LnIntermediateNode;  
        trafficSign : SignalingSigns;  
        residesOn   : DisplayUnit;  
    END_ENTITY;  
  
    ENTITY DisplayUnit;  
    END_ENTITY;  
  
    ENTITY SgCrossSection;  
        SgSigns      : LIST [1:?] OF SgSign;  
        CwLocation   : CwIntermediateNode;  
        controlledFrom : RoadSideStation;  
        mountedOn    : Gantry;  
    END_ENTITY;  
  
    ENTITY RoadSideStation;  
    END_ENTITY;  
  
    ENTITY Gantry;  
    END_ENTITY;  
  
END_SCHEMA;
```

Schema 4-8 Signaling networkschema

4.1.8.4 Entity descriptions

The various entities together with some auxiliary definitions are described below.

Gantry

A construction used to mount display units or other equipment above a carriageway.

Display unit

A piece of equipment used to display a (traffic) sign or message.

Signalling cross section

A set of signalling signs at a cross section of (intermediate node on) a carriageway element.

Signalling lane segment (SgLaneSegment)

A segment of the lane network between two successive signalling signs.

Signalling Sign (SgSign)

A traffic sign used for signalling purposes.

Road side station

A piece of equipment along the road side used to control a set of signalling signs at carriageway cross section and possible other equipment in its neighbourhood.

4.1.8.5 Type descriptions

The various types together with some auxiliary definitions are described below.

Signalling signs

The sign repertoire of a signalling display unit.

4.1.8.6 Integrity constraints

There should be a rule formulated to specify that the order of the Signalling Signs is the same as the order of the lane elements in a carriageway element and all intermediate lane nodes within one Signalling Cross Section are coincident with lane elements which are part of the carriageway element to which the intermediate carriageway node of the signalling cross section is coincident with.

4.1.8.7 Other security aspects

There are no additional security requirements

4.1.8.8 Performance aspects

There are no additional performance requirements

4.1.8.9 Implementation aspects

There are no additional implementation requirements.

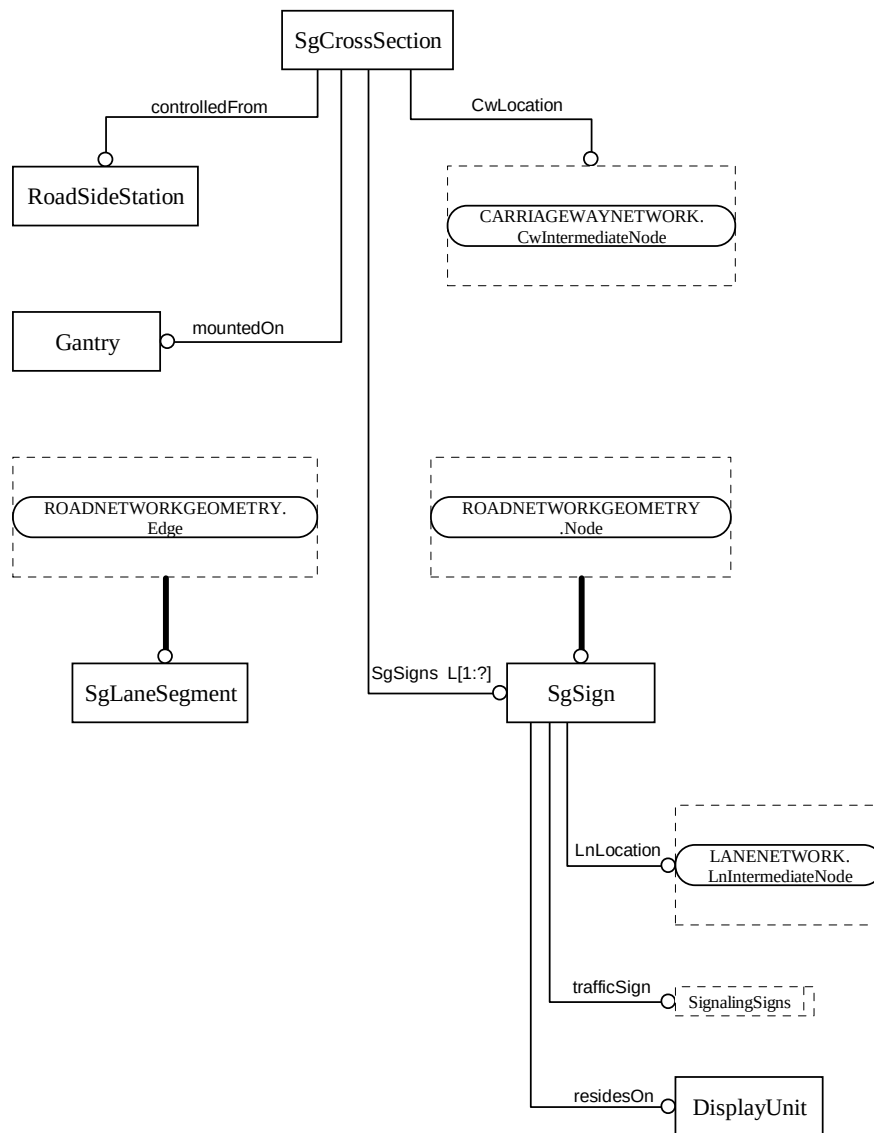
4.1.8.10 Abbreviations

Sg	Signalling
----	------------

4.1.8.11 References

See section 2 for a complete reference description.

[...]	...
-------	-----



5 Notes

5.1 Abbreviations

BPS	Beschrijvende Plaatsaanduiding Systematiek
CEN	Comité Européen de Normalisation (European Committee for Standardisation)
Cw	Carriageway
DBDD	Data Base Design Description
DWW	Dienst Weg- en Waterbouwkunde
GDF	Geographic Data Files (a CEN standard for the exchange of road data)
Ln	Lane
Mw	Motorway
prENV	European Prestandard
RDS	Radio Data System
RWS	Rijkswaterstaat
TMC	Traffic Management Channel
V&W	Verkeer en Waterstaat
WGS	World Geodetic System
ZOAB	Zeer Open Asfalt Beton (a Dutch abbreviation for porous asphalt)

5.2 Glossary

See the various schema descriptions.