RCA

Reference CCS Architecture

An initiative of the ERTMS users group and the EULYNX consortium

MAP Object Catalogue

Document id: RCA.Doc.69

Table of Contents

List of Figures

List of Tables

Version history

Version	Date	Author	Description
0.1	04.02.2022	Peter Eimann, Harish Narayanan	Initial release
0.2	16.03.2022	Peter Eimann, Harish Narayanan	First stable version after cross cluster A.P.M review for RCA BL0R4 release.
0.3	04.07.2022	Peter Eimann, Harish Narayanan	Updated version for cross cluster review: Added new ATO, IPM, PE, PER, and LOC specific objects
0.4	16.08.2022	Peter Eimann, Harish Narayanan	Post implementation of RCA cross cluster review comments.
1.0	18.08.2022	Peter Eimann, Harish Narayanan	Version for BL1R0

1 Introduction

1.1 Release information

Basic document information:

RCA-Document Number: RCA.Doc.69

Document Name: MAP Object Catalogue

Cenelec Phase: 1-4

Version: 1.0

RCA Baseline set: BL1

Approval date: 30.09.2022

1.2 Imprint

Publisher:

RCA (an initiative of the ERTMS Users Group and EULYNX Consortium)

Support and Feedback: For feedback, or if you have trouble accessing the material, please contact rca@eulynx.eu.

1.3 Purpose of the document

This document defines and describes the Object Model that will be used by MAP cluster to provide reliable and validated topology and topography data in the form of Map Data for all operational RCA / OCORA subsystems and the Planning System.

The content is based on the RCA candidate architecture and on derived assumptions regarding the functionalities and capabilities that are expected for the architectural target of RCA.

1.4 Terms and Abbreviations

For terms and definitions refer to the general RCA Terms and Abstract Concepts document [2].

1.4.1 Acronyms

AoC	Area of Control
APS	Advanced Protection System
AS	Allocation Section
ATO	Automatic Train Operation
BNT	Base Net element service Topology
CTA	Contiguous Track Area
DPS	Drive Protection Section
DPSG	Drive Protection Section Group
DTEP	Directed Track Edge Point
DTES	Directed Track Edge Section
IPM	Incident and Prevention Manager
LCTA	Linear Contiguous Track Area
LOC	Localisation
PAS	Planning System
PE	Plan Execution
PER	Perception
SSP	Static Speed Profile
SSSP	Specific Static Speed Profile
TA	Track Area
TE	Track Edge
TEP	Track Edge Point
TES	Track Edge Section
TMS	Traffic Management System
TN	Track Node

1.5 Scope

The MAP Object catalogue for the current release defines the data models used to derive data structure for the following different types of data as shown in the figure below (non-exhaustive list):

- Trackside Map Data (APS, PAS/TMS, ATO, PE, …)
- Onboard Map Data (LOC, PER, IPM …)

Note: See [3] for the detailed definition of the types of data

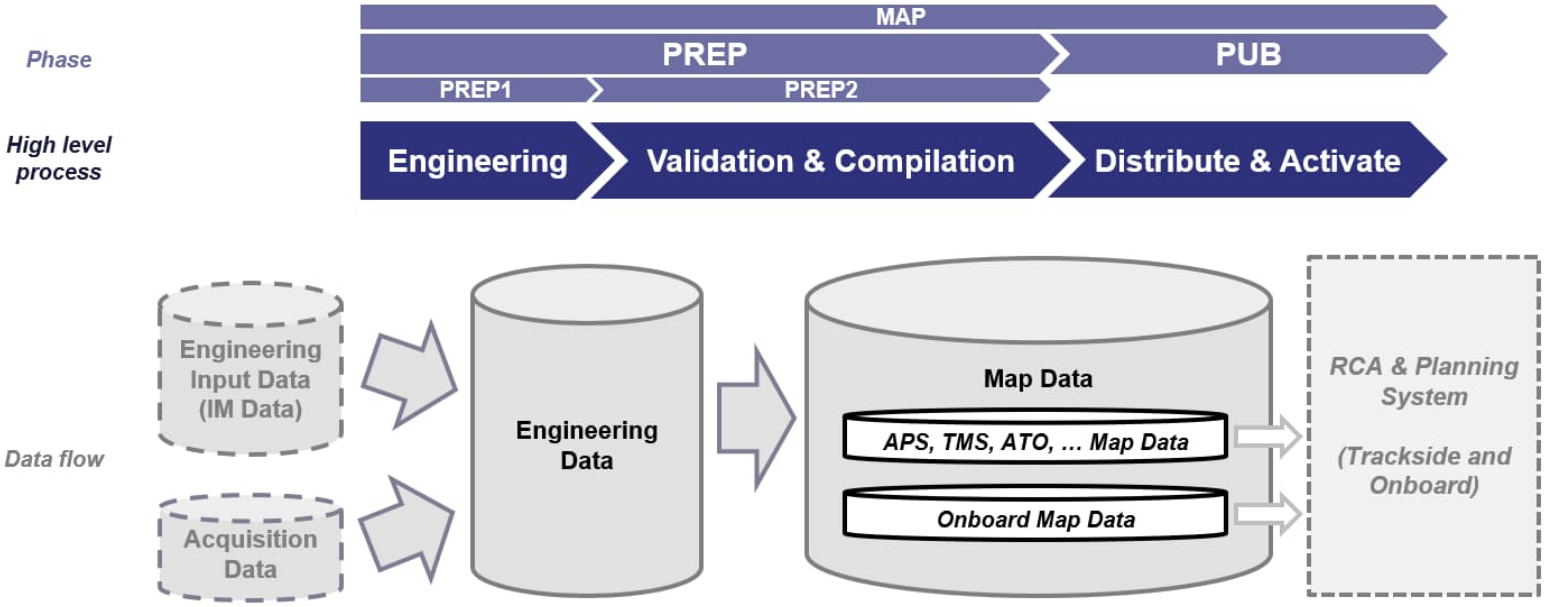


Figure 1: High level process of MAP

As shown in the figure above, the object model that is defined in this document focuses only on Map Data. The Map Data are created in the preparation phase and remain unchanged during operation phase until the next provisioning of Map Data.
Any Operational Data that will be transmitted between production systems and therefore changes if an operational state changes, has to be defined by the relevant subsystems. Operational Data may be overlaid on the Map Data and objects and attributes that are already available in the Map Data should not be redefined to model the Operational Data.

1.6 Target audience

The target group consists of members of the RCA/OCORA.

1.7 Legend

1.7.1 Object definition table

The following table defines the legend for the definition of the different data objects and their attributes.

Table 1: Legend for the data object definition

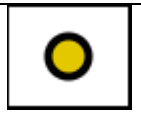
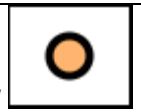
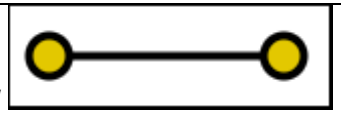
Column Name	Description
ID	Unique ID for each object and attribute. The ID is build using the tier number, an optional object group, an object specific identifier and a sequential number for each attribute in the format: T{0..3}-[{Object-Group ID}]-{Object ID}[-{Number}]
Object	Name of the object / class (in pascal case notation, starting with a capital letter) An object in italic defines an abstract object which is used to define common attributes that are equal in the inherited / specialised objects. An object name in the form {Name1}::{Name2} means, that the object {Name2} is inherited from object {Name1} (object {Name1} is the generalisation of object {Name2}). In this case object {Name2} will contain all the attributes defined in object {Name1} plus the attributes defined additionally in object {Name2}. *Note:* Hyphens in the object names are not part of the name but are caused by hyphenation.
Attribute	Name of the attribute of an object / class (in camel case notation, starting with a small letter) (The attributes belong to the object that is defined in column “Object”) *Note:* Hyphens in the attribute names are not part of the name but are caused by hyphenation.
Description	Description for either the object (if column object is filled) or the attribute (if column attribute is filled)
Type	Datatype of the attribute An italic datatype refers to an object that is defined within the document (in column object) ENUM defines an enumeration with pre-defined constants
Range	The range of an attribute if it is restricted (e.g. minimum and/or maximum value for numbers, special content for strings, the possible constants of enumerations)

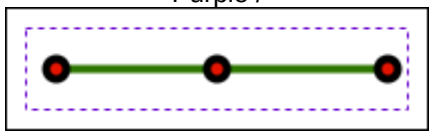
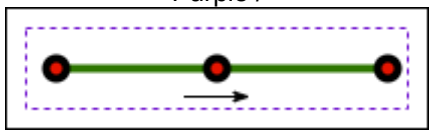
	For the data type Double (floating point numbers), the range also defines the maximum possible decimal places. UUID defines that the attribute contains an Universally Unique Identifier (e.g., `550e8400-e29b-11d4-a716-446655440000`).
Cardinality	Defines whether the attribute is optional, mandatory or if it might occur multiple times (as an array of the attribute). Commonly used definitions are: 1: Attribute is mandatory and shall only occur one time n: Attribute is mandatory and shall occur exactly 'n' times 0..1: Attribute is optional but when it is used, it shall only occur one time 1..*: Attribute is mandatory and shall occur multiple times (* = no upper limit) 0..*: Attribute is optional but when it is used, it shall occur multiple times (* = no upper limit) 1..n: Attribute is mandatory and shall occur maximum 'n' times 0..n: Attribute is optional but when it is used, it shall occur maximum 'n' times m..*: Attribute shall occur at minimum 'm' times (with m ≥ 1) and at maximum multiple times (* = no upper limit) m..n: Attribute shall occur at minimum 'm' times (m ≥ 1) and at maximum 'n' times (with n > m)
Unit	The unit of the attribute value (if applicable)

1.7.2 Colour coding for topology objects

The following colour codes and legends are applicable for the topology objects within the entire document.

Table 2: Legends for topology objects

Colour / Legend	Object
Yellow / 	Track Node of type 'Point'
Orange / 	Track Node of type 'System border' or 'End of track'
Black / 	Track Edge with Track Nodes (of type 'Point')

Red / 	Track Edge Point
Green / 	Track Edge Section with Track Edge Point(s)
Red / 	Track Edge Point at the same location as Track Node of type ‘point’
Purple / 	Area that includes several Track Edge Sections (Track Area, Contiguous Track Area, Linear Contiguous Track Area, Area of Control, Operational Point) *Note:* The dotted line rectangle is referred here.
Purple / 	Area that includes several Track Edge Sections with a given direction

1.7.3 Consumer table

The table under the section ‘Consumer’ indicate the RCA/OCORA subsystems that are possible consumers of the corresponding object to support certain functional needs of the respective subsystems. The following legends are applicable.

Table 3: Legends for consumer table

Aspect	Meaning
X	Indicates the corresponding subsystem as a consumer of the object
-	Indicates the corresponding subsystem as not a consumer of the object

1.8 Related Documents

The following documents provide related information:

[1] RCA Digital Map Evaluation Reference Model [RCA.Doc.57] - published with BL0R3
[2] RCA Terms and Abstract Concepts [RCA.Doc.14] - published with BL0R4
[3] RCA MAP Concept [RCA.Doc.54] - published with BL0R4
[4] 20180716_Abschlussbericht_BNT - BNT Study of SBB
[5] Guide on the application of the common specifications of the register of Infrastructure (RINF application guide, Version 1.5.2.6, 25.10.2021)
[6] ATO over ETCS Subset 141-0.0.7
[7] ETCS Subset 026-7 v360
[8] ETCS Subset 036 v310
[9] ETCS Subset 026-3 v360
[10] ATO over ERTMS Glossary v1.5
[11] Digital Map Concept – Track Geometry for ETCS Onboard Map, 21.07.2022
[12] APS Concept [RCA.Doc.51] – Published with BL0R4
[13] ATO over ETCS Subset 126-0.0.21

2 Context

The Data Model is based on the RCA Terms and Abstract Concepts [2] for the topology aspects. The model that is used in the Topology-Domain is an abstracted representation of the so called BNT (“Base Net element service Topology”). BNT has been developed by the Swiss Federal Railways (SBB) as common reference model for the railway infrastructure and is described in detail in [4].

2.1 Track network reference model

The track network reference model as the basis for engineering the topology is based on a node-edge model, the Base Net element service Topology (BNT) model with the following basic properties:

- Classic node-edge model
- Nodes represent branches (points), end of tracks, or system borders in the track network
- Edges (rail tracks) represent the connections between the nodes. For each edge it is defined which node is the start node and which is the end node, thus the edges also implicitly get a direction (from the start node to the end node)
- Navigability describes how the nodes can be navigated between the adjacent edges

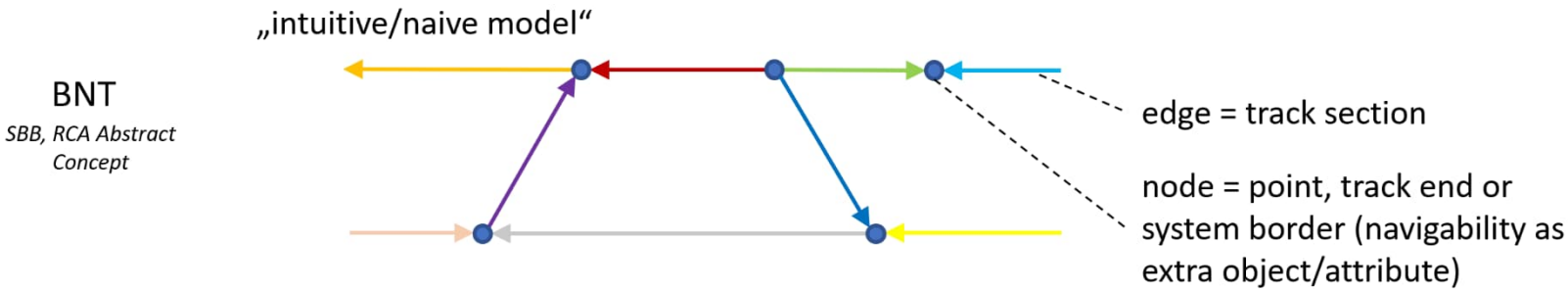


Figure 2: BNT model

Nodes represent:

- Points
- System borders / End of Tracks (e.g. Buffer Stops)

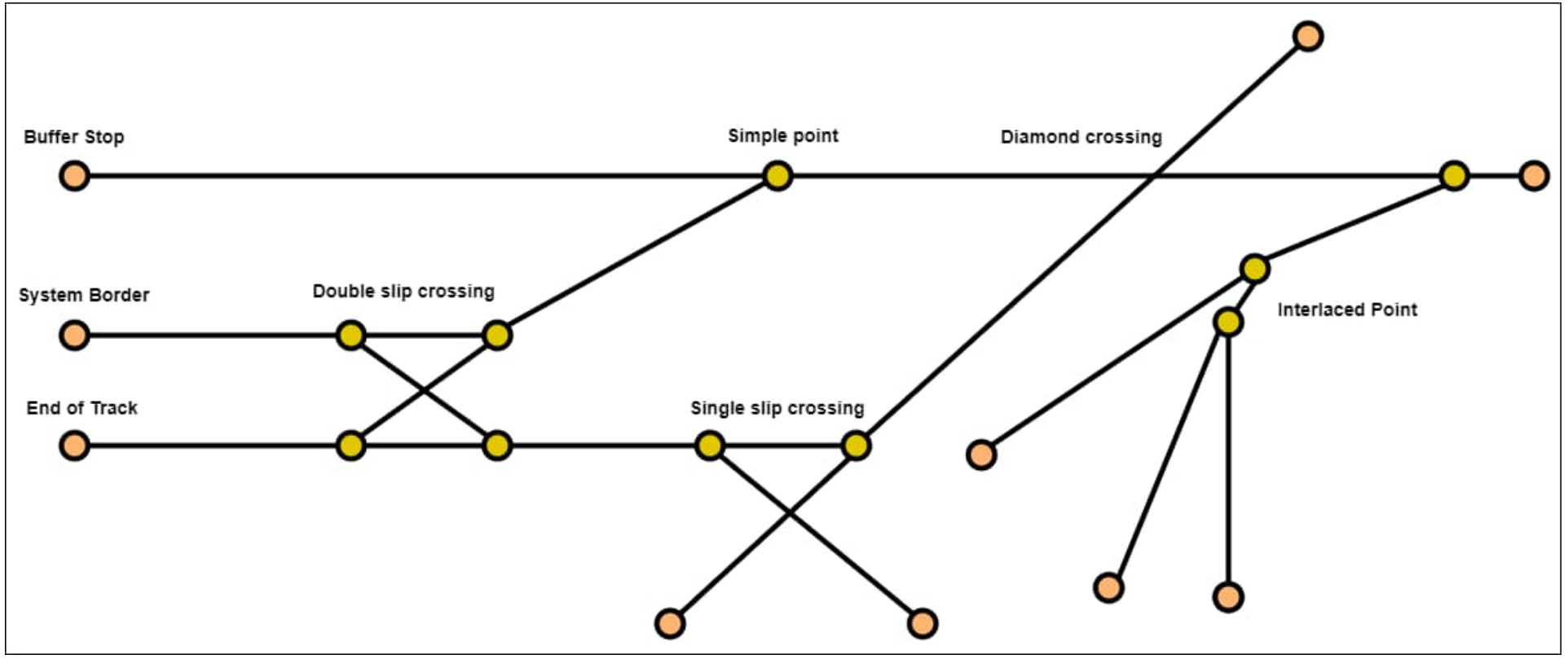


Figure 3: Nodes in BNT

Diamond crossings and derailer devices are not represented by a node, as there are no decision points for navigation at these elements (it is not possible to move from one edge to another).

3 Abstract Topology Concept

The topology domain currently defined in RCA Terms and Abstract Concepts [2] defines an abstract representation of how the generic topology elements relate to each other. These generic concepts can be further extended/detailed to reference infrastructure facilities like points, tracks, stations, etc.

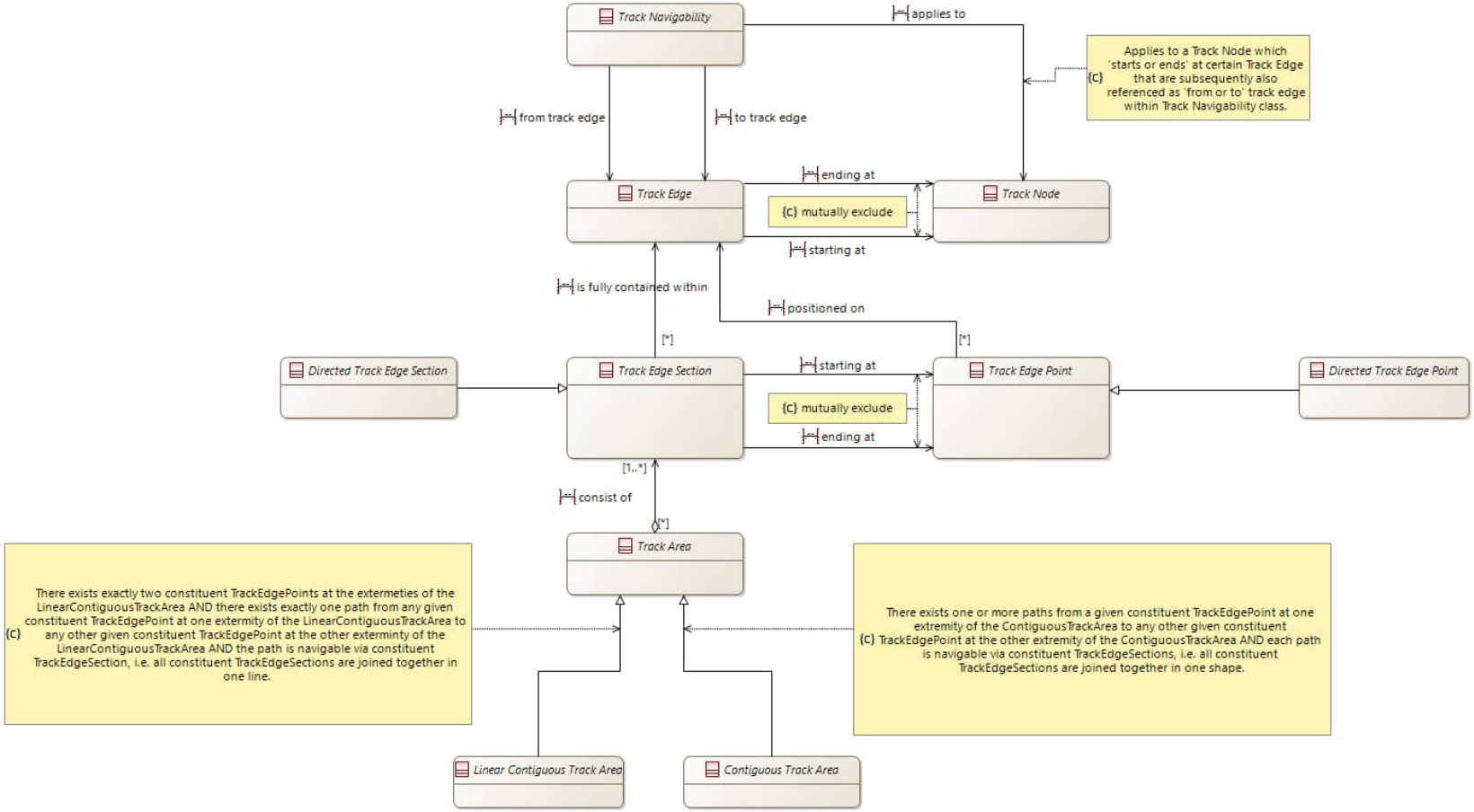


Figure 4: Topology Domain in the RCA Abstract Concepts

This class diagram shows the relationships between the abstract topology objects. Track Edges, Track Nodes and Navigability represent the base network topology of the railway which only changes when the infrastructure is physically changed. Track Edge Section and Track Edge Point, Track Area, Contiguous Track Area and Linear Contiguous Track Area represent the spatial topology of the track.

4 Tiers of the MAP Object Model

The MAP Object Model structures the various topology objects in 4 different tiers namely Tier 0, Tier 1, Tier 2, and Tier 3. Objects in each tier are referencing the objects either within them or the underlying tier(s).

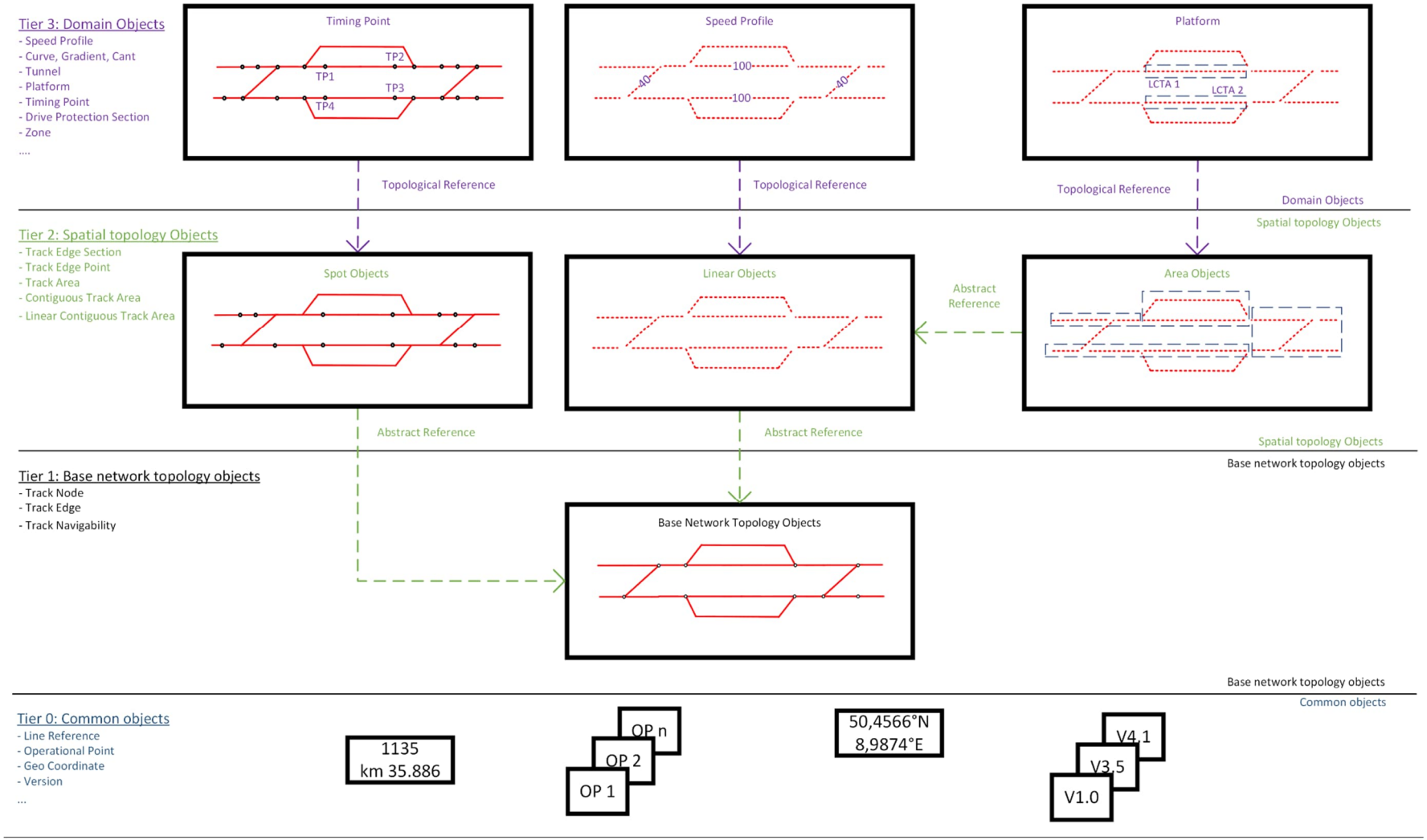


Figure 5: Tiers of the MAP Object Model

- ➔ Tier 0 consists of the common objects that specific applicability to other tiers. Hence, tier 0 has references to other tiers.
  Note: This reference is not shown here.
- ➔ Tier 1 consists of base network topology objects that define the basic node-edge model that describes the physical track.
- ➔ Tier 2 consists of spatial topology objects consisting of spot, linear, and area objects which have abstract references to tier 1. These references help locate the object on the base network topology.
- ➔ Tier 3 consists of domain objects from specific domains like ATO, IPM, APS, PE, PAS, LOC and PER (non-exhaustive list). In addition, tier 3 also includes objects related to other domains like track assets, track geometry, track properties, track conditions, and track infrastructure. Tier 3 objects have topological references to tier 2 objects. These references help locate the object on spatial topology.

5 Tier 0: Common objects

5.1 Version

The version is a unique piece of information to clearly distinguish between different states (version states) of an object during its complete lifecycle in the engineering, process, starting from the first creation of the object until it is finally deleted (either removed or replaced by a successor).

5.1.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	X	X	X

5.1.2 Definition

Table 4: Definition Version

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T0-VER	**Version**						
T0-VER-1		version	Sequence number, starting at 1	Integer	1 – 999999	1	
T0-VER-2		created	Time at which this object version is created	Datetime		1	
T0-VER-3		modified	Time at which this object version is replaced by a subsequent version.	Datetime		0..1	
T0-VER-4		deleted	Time at which this object version is deleted (no subsequent version is following)	Datetime		0..1	
T0-VER-5		status	Level of maturity of the information stored in this dataset.	ENUM	- engineered - validated - ready for test - ready for operation - preloaded - activated	1	
T0-VER-6		successor	Successor object (only filled if deleted is filled, points to the successor(s) of this object)	UUID		0..*	

T0-VER-7		hashValue	SHA-3 512-bit hash to prevent undetected changes (hash needs to be calculated using all attributes of this object and the object containing the version information)	String	Hexadecimal representation (0-9, a-f)	128	

5.1.3 Basis / rules and regulations

- Datetime: According to ISO8601 with the following format:
  - YYYY-MM-DDThh:mm:ss.fff ±hh:mm (the part “±hh:mm” specifies the difference to the UTC time)

5.1.3.1 Historisation

The historisation is a log of the storage of the objects, wherein each intermediate state is recorded. Each class is completely historicised. This is done as follows:

- When an object is instantiated, the first data set is created.
  - version is set to 1
  - created is set to the timestamp when the object has been instantiated
  - modified, deleted are not set
  - successor is not set
- Each time an object is updated, the most recent data record is duplicated and the update is then carried out on this copy. This means that you know the data inventory before and after the update.
  - version in the follow-up object is increased by one
  - modified on the original object is set to the created timestamp of the follow-up object
  - deleted on the original object is not set
  - the ID of the underlying object must not change, i.e. the original and the follow-up object will still have the same ID
- Each time an object is deleted, the attribute deleted will be set to the timestamp of the time when the object is deleted. If there are any successors for this object (e.g. one TrackEdge is split into two by adding a new TrackNode), they will be referenced in the successor attribute of the deleted object.

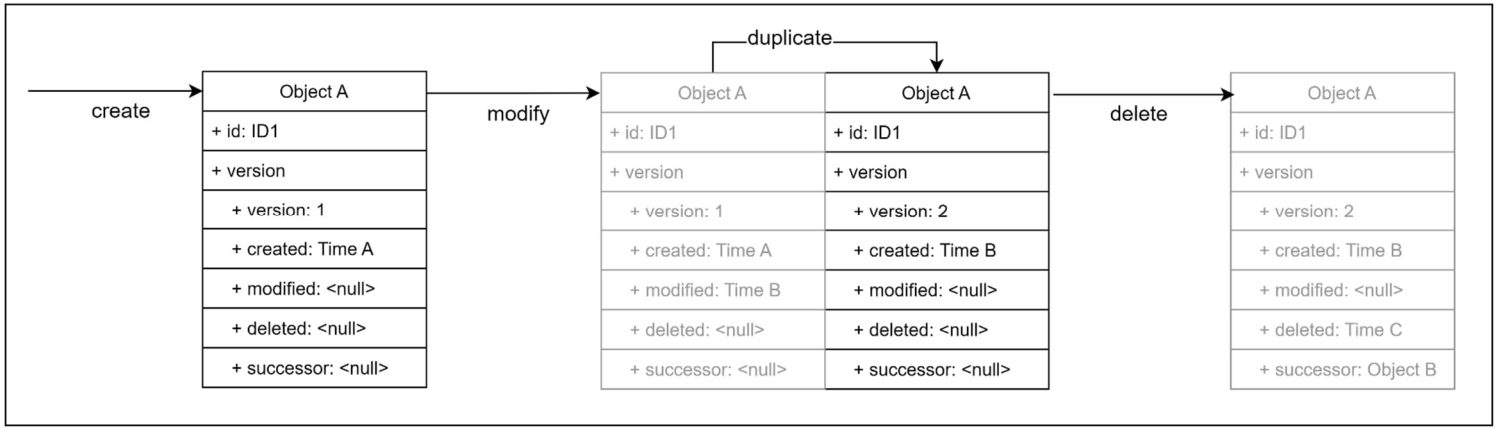


Figure 6: Historisation

5.1.3.2 Status

Each class is equipped with the attribute status. The status indicates the maturity of the information stored in this data set, i.e. the probability of occurrence or the reliability. For example, it can take the following values (the exact values are still to be defined):

- engineered
- validated
- ready for test
- ready for operation
- preloaded
- activated

For more information on the respective statuses refer to [3].

5.1.4 Dependencies

By inserting e.g. a TrackNode in the middle of a Track Edge, one TrackEdge ceases to exist and two others are created to replace it. Conversely, when a TrackNode is removed, two Track Edges cease to exist and a new one is created to replace them. To ensure traceability in these two cases, a predecessor-successor relationship is established using the “successor” attribute.

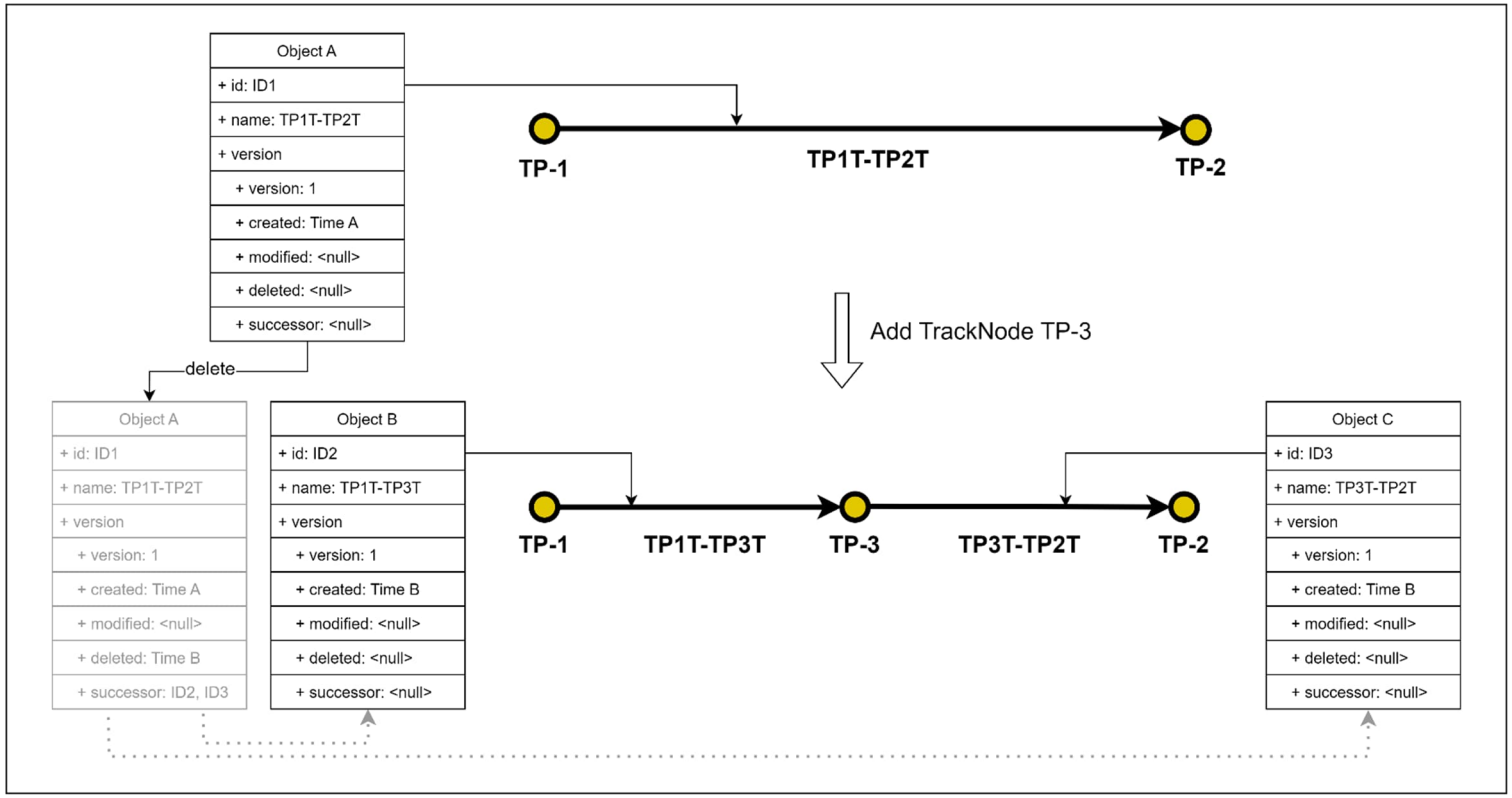


Figure 7: Successor add TrackNode

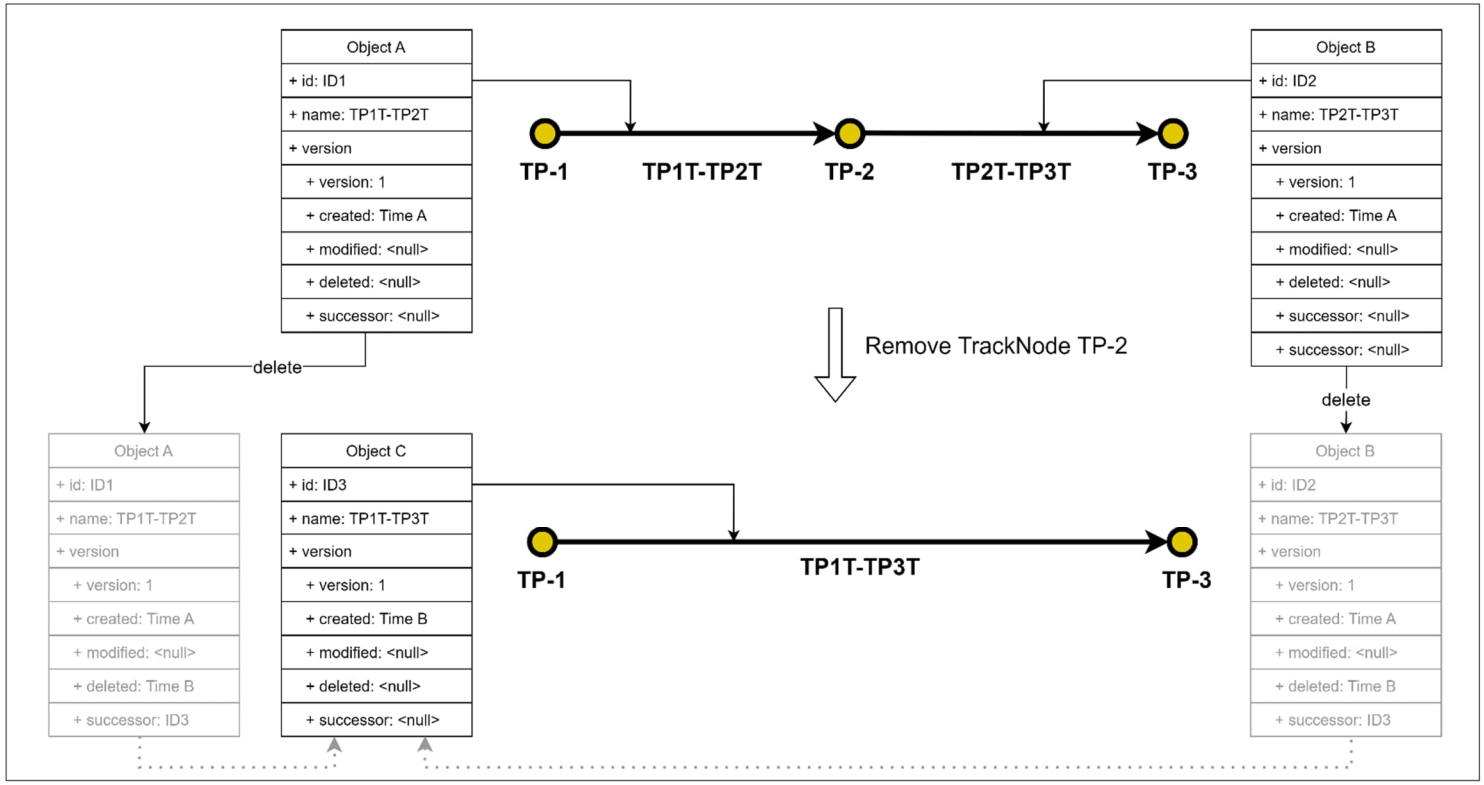


Figure 8: Successor remove TrackNode

In more complicated situations, the determination of predecessors / successors is usually not possible unambiguously but depends on subjective judgement (example: conversion of a 3-track to a 4-track: which track is the successor of which?). There is no central administration of predecessor-successor relationships here. However, consumers are free to manage such relationships by using the referencing mechanism described above.

5.2 Map Data

The Map Data is a collection of all the relevant objects corresponding to different tiers of Map Object Model and for the Area of Control of a subsystem.

5.2.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	X	X	X

5.2.2 Definition

Table 5: Definition Map Data

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T0-MD	**MapData**						
T0-MD-1		id	Unique generated ID	String	UUID	1	
T0-MD-2		name	Name of the Map Data	String	alphanumeric	1	
T0-MD-3		version	Reference to the version information	*Version*	-	1	
T0-MD-4		belongsTo AreaOfControl	The Area of Control for this Map Data Container	*AreaOfControl*		1	
T0-MD-5		consistsOfTier0Objects	Container for all the Tier 0 Map Data Objects	*(Tier 0 Objects)*	-	1..*	
T0-MD-6		consistsOfTier1Objects	Container for all the Tier 1 Map Data Objects	*(Tier 1 Objects)*	-	1..*	
T0-MD-7		consistsOfTier2Objects	Container for all the Tier 2 Map Data Objects	*(Tier 2 Objects)*	-	1..*	
T0-MD-8		consistsOfTier3Objects	Container for all the Tier 3 Map Data Objects	*(Tier 3 Objects)*	-	1..*	
T0-MD-9		containsReleaseInformation	Reference to the release definition, if one specific version of the Map Data should be released and provided to the sub-systems.	*Release*	-	0..1	

Note: This structure of Map Data is only applicable for the trackside subsystems. The On-Board Map Data structure might vary from the trackside one. LOC/IPM/PER as consumers only indicate that these subsystems need Map Data but does not imply that they receive the Map Data in the same structure as trackside subsystems.

5.2.3 Basis / rules and regulations

The following figure shows the composition of the Map Data:

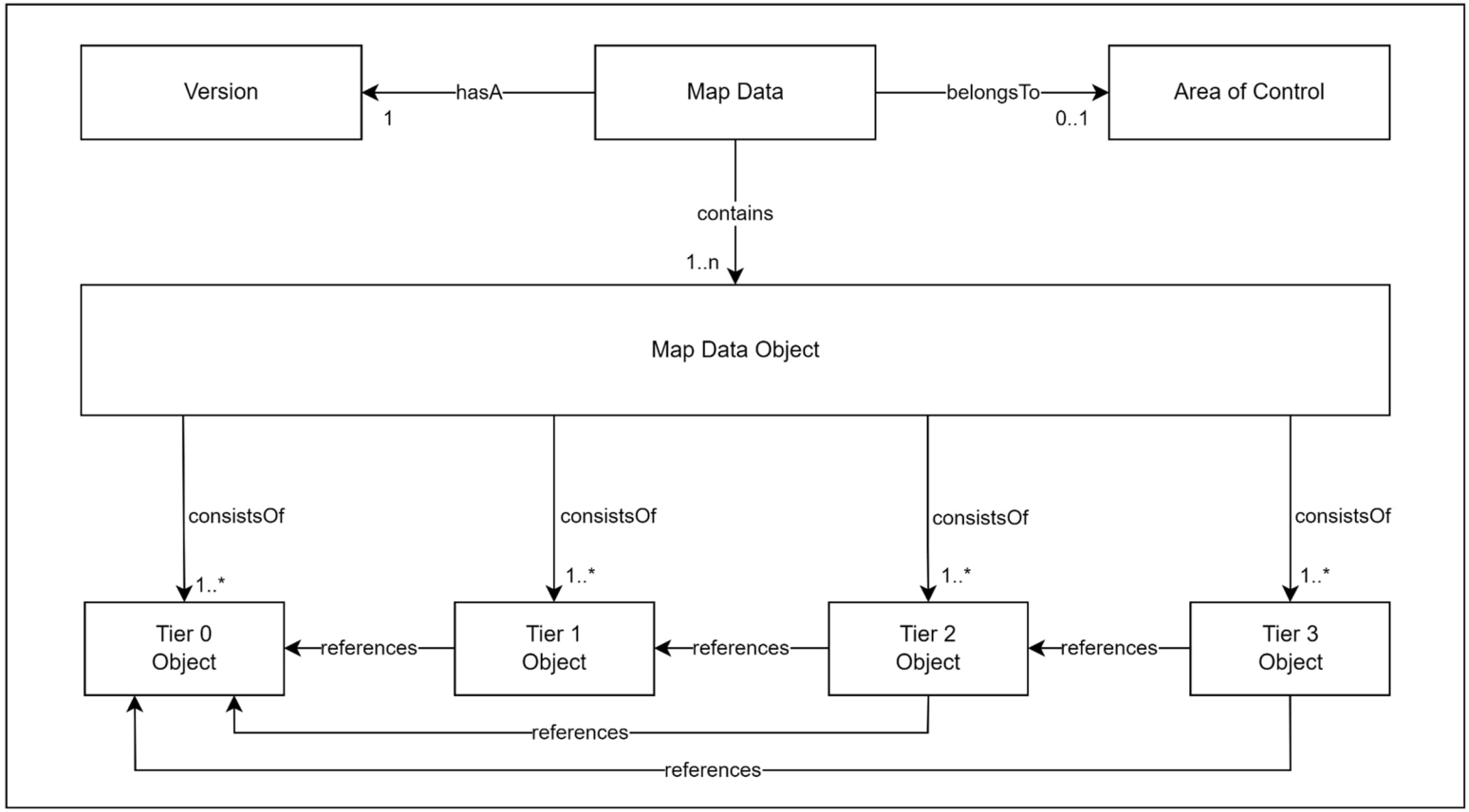


Figure 9: Map Data

Each Map Data manages its own version for one Area of Control. There are three possible scenarios, how the version number for the Map Data will be managed:

1. Increase the version number every time one or more Map Data Objects will be updated (regardless how small or big the update will be).
2. There be an explicit commit of one or more updated Map Data Objects which will then update the Map Data version.
3. The Map Data version is used like a tag for all the related Map Data Objects, where as many Map Data Objects as required can be updated, but before a new release is provided, a tag has to be made for the Map Data Container (which is then the corresponding version number).

5.3 Release

A release defines a set of Map Data Objects that are published to the relevant sub-systems for a specific area. The area is either a subset of or the full Area of Control. A release has a one-to-one relationship to one specific Map Data version.

5.3.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	-	-	-

5.3.2 Definition

Table 6: Definition Release

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T0-REL	**Release**						
T0-REL-1		id	Unique generated ID	String	UUID	1	
T0-REL-2		name	Name of the Release	String	alphanumeric	1	
T0-REL-3		refersToMapDataVersion	Reference to the version of the Map Data for this Release	*Version*		1	
T0-REL-4		insertsMapDataObjects	The list of new Map Data Objects (compared to the previous Release)	*(Map Data Object)*	-	0..*	
T0-REL-5		modifiesMapDataObjects	The list of modified/changed Map Data Objects (compared to the previous Release)	*(Map Data Object)*	-	0..*	
T0-REL-6		deletesMapDataObjects	The list of deleted/removed Map Data Objects (compared to the previous Release)	*(Map Data Object)*	-	0..*	

5.3.3 Basis / rules and regulations

Each release should contain three containers, one **for new**, one **for modified** and one **for deleted** objects, compared to the previous version. The containers might be empty if there are no changes for one specific container, but at least one container shall be filled with at least one Map Data Object.

One release shall be published to every subsystem that is a consumer of the Map Data to guarantee that they all use the same version of the Map Data (all subsystems should have the same version of Map Data activated).

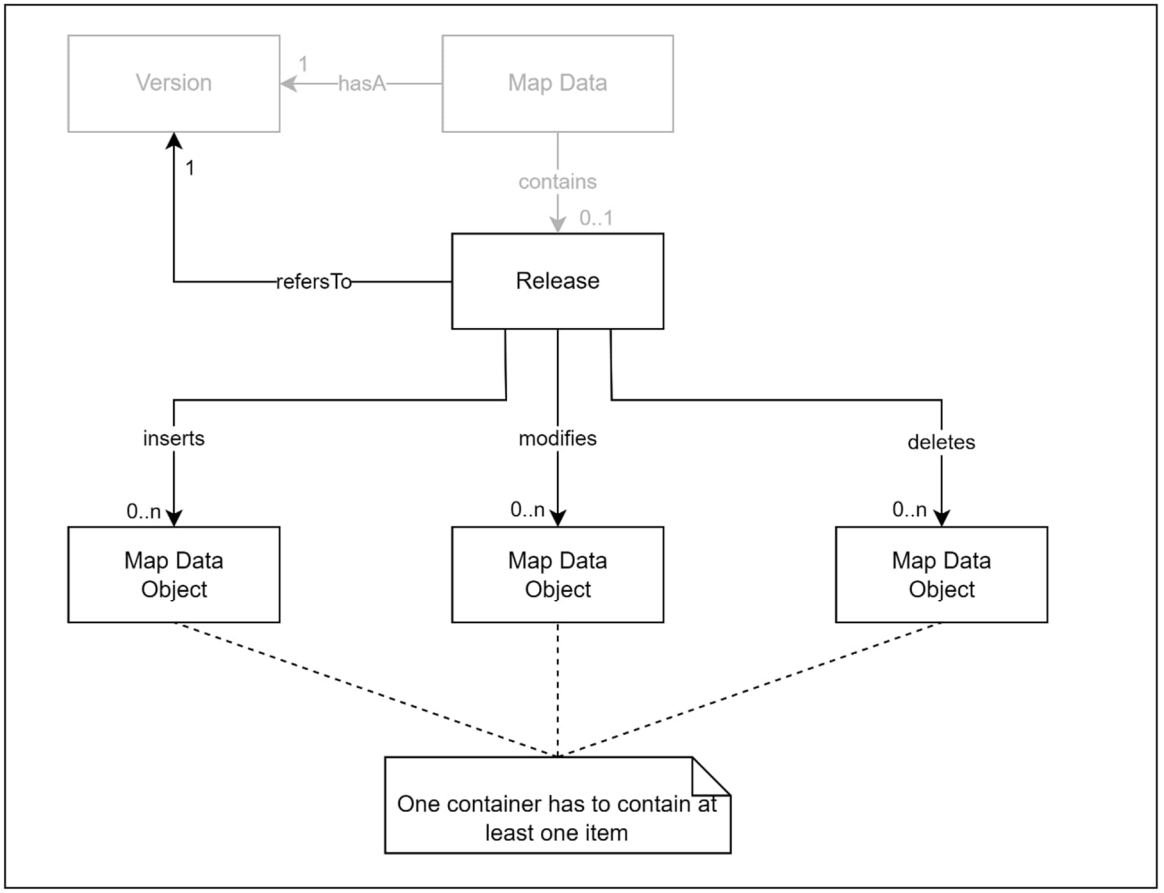


Figure 10: Release

Note: Since the release is an independent object with a UUID, the map data version to which the release refers was also included in the release object.

5.4 Geo-Coordinates

Geo-Coordinates are used to locate topology objects (like Track Nodes and Track Edge Points) on or alongside track. They provide pure absolute positioning. The topology objects are also relatively positioned within respect to Track Edges and Track Nodes.

5.4.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	X	-	-	X	X	X

5.4.2 Definition

Table 7: Definition Geo-Coordinates

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T0-GC	**GeoCoordinates**						
T0-GC-1		id	Unique generated ID	String	UUID	1	
T0-GC-2		name	Name for the geo-coordinate.	String	alphanumeric	1	
T0-GC-3		xCoordinate	Value of x-coordinate. The semantic meaning is specific to the ETRS89 coordinate system (with 6 decimal places).	Double	-9999999.999999 - +9999999.999999	1	
T0-GC-4		yCoordinate	Value of y-coordinate. The semantic meaning is specific to the ETRS89 coordinate system (with 6 decimal places).	Double	-9999999.999999 - +9999999.999999	1	
T0-GC-5		zCoordinate	Value of z-coordinate. The semantic meaning is specific to the ETRS89 coordinate system (with 6 decimal places).	Double	-9999999.999999 - +9999999.999999	1	

5.4.3 Basis / rules and regulations

MAP uses the European Terrestrial Reference System 1989 (ETRS89 – SRID 4258) as the geodetic Cartesian reference frame.

The SRID is a unique value used to unambiguously identify projected, unprojected, and local spatial coordinate system definitions. EPSG Geodetic Parameter Dataset (also EPSG registry) is a public registry of geodetic datums, spatial reference systems, Earth ellipsoids, coordinate transformations and related units of measurement. Most geographic information systems (GIS) and GIS libraries use EPSG codes as Spatial Reference System Identifiers (SRIDs) and EPSG definition data for identifying coordinate reference systems.

5.4.4 Engineering rules

Undefined coordinates are not foreseen on purpose, i.e., all objects referencing an object of type GeoCoordinates must have valid x,y and z coordinate values.

5.4.5 Dependencies

Each object, that does not have a spatial extension and is represented similar to a spot object on the topology (e.g. Track Node, Track Edge Point, Operational Point) shall contain a reference to a corresponding geo-coordinate locating the object in space.

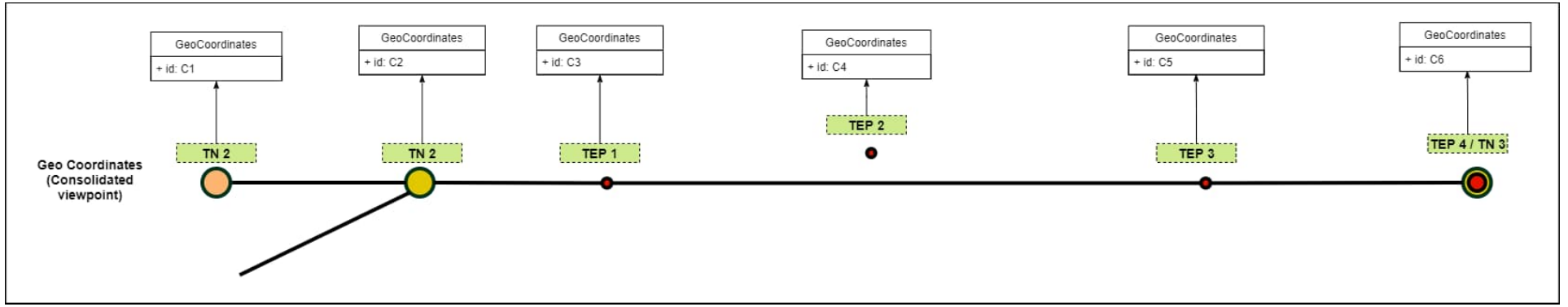


Figure 11: Geo-Coordinates

5.5 Line Reference

The line reference is used to link the location of a spot object to a reference point on the line indicated by a line number, a line kilometre and optional a track number.

5.5.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	-	X	-	-	-

5.5.2 Definition

Table 8: Definition Line Reference

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T0-LR	**LineReference**						
T0-LR-1		id	Unique generated ID	String	UUID	1	
T0-LR-2		lineKilometre	Reference to the line kilometrage (with 3 decimal places).	Double	-9999.999 - +9999.999	1	km
T0-LR-3		lineNumber	Reference to the line number.	String	-	1	
T0-LR-4		trackNumber	Optional reference to the track number.	String	-	0..1	

5.5.3 Basis / rules and regulations

The line reference is intended to allow spot objects like Track Nodes, Track Edge Points or Operational Points to have a reference to existing line numbers, line kilometres and specific track and numbers. It's not used to elaborately define line reference data for a complete line.

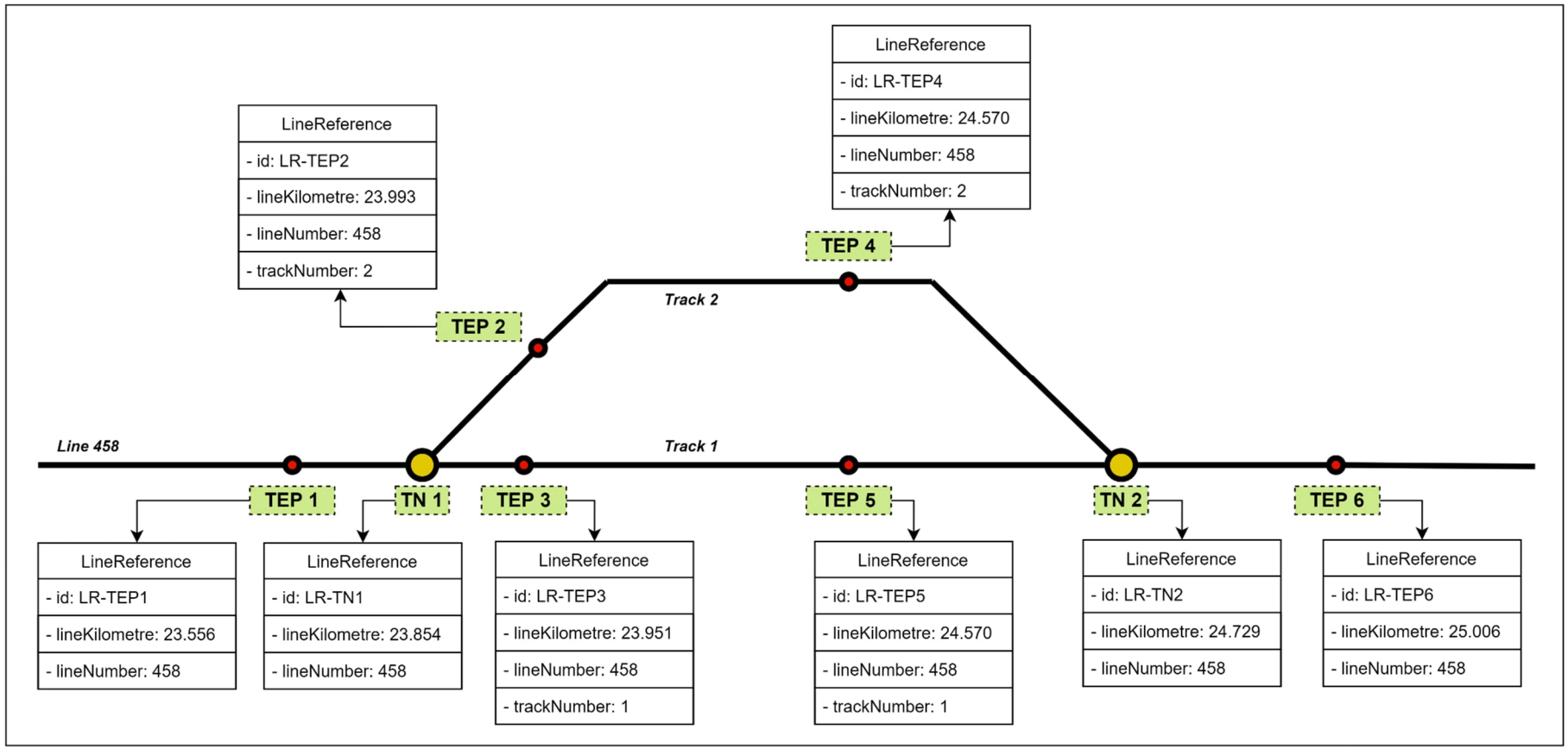


Figure 12: Line Reference

5.6 Operational Point

The operational points are used to provide a macroscopic viewpoint of the railway network. It is understood as a point without dimensions with some generic parameters (as defined in Table 9). The operational points define the primary element of the network and selection of operational points is the first task for Infrastructure Managers (IMs) in procedure of presenting its network.

The following types of operational points have been defined in [5]:

1. Station – big or huge station with several functions, important for international traffic, basic for national railway system
2. Small station – multifunctional station not so big and not so important like “Station”
3. Passenger terminal – station with dominating function of service for passenger traffic
4. Freight terminal – station dominantly serving for loading and unloading of freight trains
5. Depot – group of tracks used by depot or workshop for RST maintenance
6. Train technical services – group of tracks for servicing trains (parking, washing, etc.)
7. Passenger stop – small operational point consisting of at least one platform, normally serving mostly for local passenger services
8. Junction – operational point consisting of at least one turnout, normally used for changing direction along the route for trains, with reduced or not existing other functions
9. Border point – located in the point where a border between Major States meets a railway line
10. Shunting yard – group of tracks used for shunting trains, mostly related to freight traffic
11. Technical change - to describe a change on CCS or a type of contact line or a Gauge changeover facility – fixed installation allowing a train to travel across a break of gauge where two railway networks with different track gauges meet
12. Point - operational point consisting of only one point. It describes a single point without any extension contrary to a junction that has a real spatial extension and is generally delimited by entry signals
13. Private siding - operational point that describes the embranchment located on the main line that leads to the private siding with the information regarding the embranchment characteristics
14. Domestic border point – located exactly in the point where a border between IMs meets a railway line

The illustration below provides an example of section of track with different operational points.

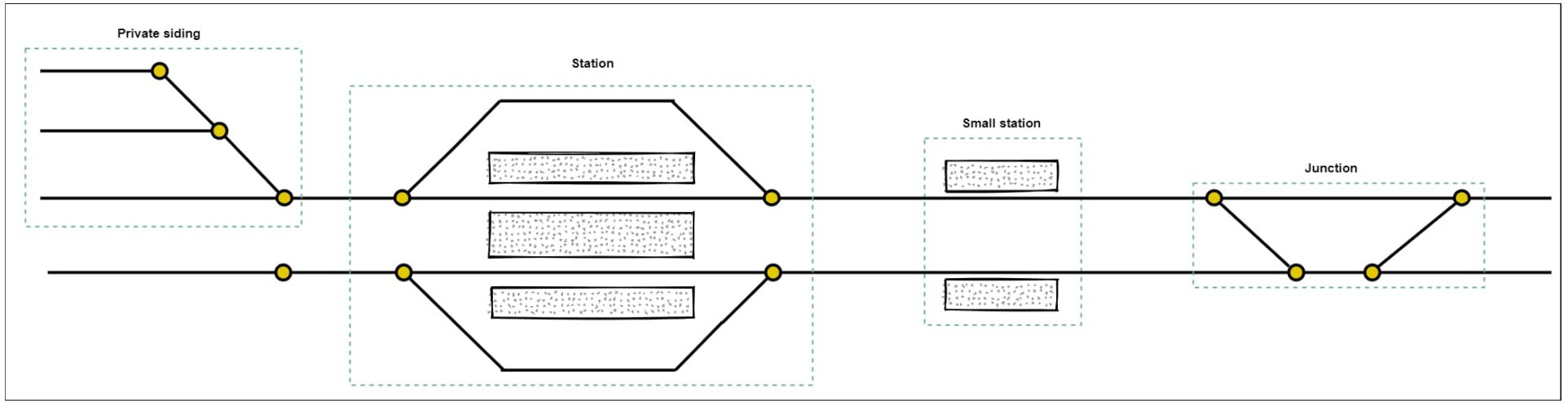


Figure 13: Operational Points illustrating station, junction, small station, and private siding

Note: The operational points also represent certain aspects of topology like Point, System Border (Border point in this case), Platform (Station in this case), etc. This might impart a certain level of overlapping in the concepts, but the detailed definition of these topological aspects is not to be confused with macroscopic representation of the same. For instance, the detailed topological definitions provide concrete references to a Track Edge and the macroscopic view only represents them on the network with a centre geo-coordinate.

5.6.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X[1]	X[1]	-	X[1]	-	-	-

[1] The Operational Point is required only for the workbench to depict the track layout along with the names of the operational points. The stated subsystems are not direct consumers of this object, rather can indirectly consume the data through the GUI offered by workbench.

5.6.2 Definition

Table 9: Definition Operational Point

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T0-OP	**OperationalPoint**						
T0-OP-1		id	Unique generated ID	String	UUID	1	
T0-OP-2		name	Name of the operational point, normally related to the town or village or to traffic control purpose	String	alphanumeric	1	
T0-OP-3		identifier	Identifier of the operational point	String	alphanumeric	1	
T0-OP-4		type	Type of the operational point:	ENUM	- station - small station - passenger terminal - passenger stop - freight terminal - depot - train technical services - junction - point - shunting yard - technical change - private siding - border point - domestic border point	1	
T0-OP-5		lineReference	Reference to the line(s) which are connected to the operational point.	*LineReference*	-	0..*	
T0-OP-6		isLocatedAtGeo-Coordinates	Geo-Coordinates of this operational point (in a specific coordinate system)	*GeoCoordi-nates*	-	1	
T0-OP-7		isWith-inAreaOfControl	Identification of the Area of Control, by which the operational point is controlled.	*AreaOfControl*	-	1..*	

5.6.3 Basis / rules and regulations

The rules for the definition of operational points are IM specific. The IMs shall provide a list of operational points in the above format based on the definition in [5].

5.6.4 Engineering rules

An operational point shall be located by a so called ‘centre point’ on a global map. This centre point is defined by relevant IM and it includes the geographical coordinates along with the kilometrage from the start of the railway line.

Note: The centre point is not always located in the centre of the operational point area.

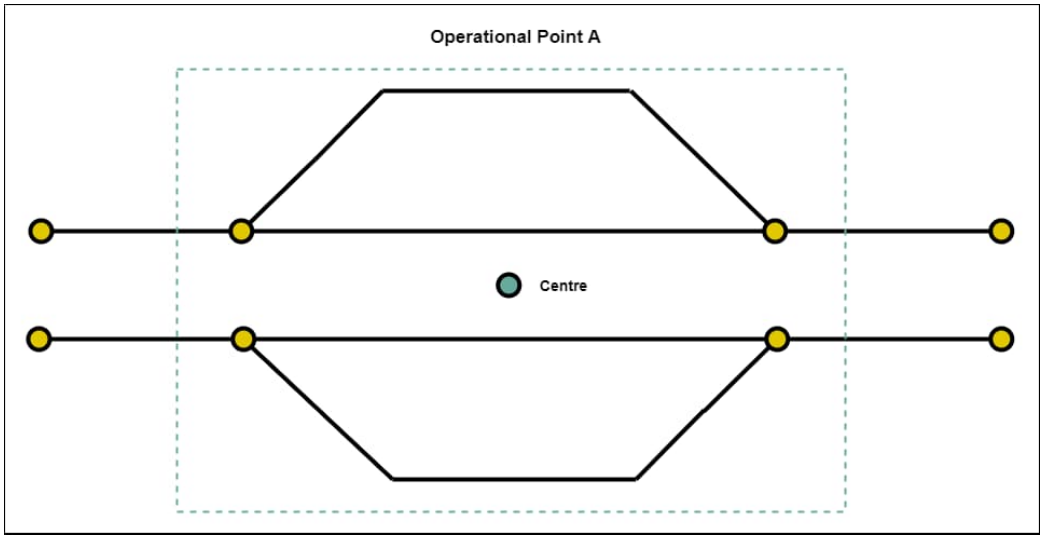


Figure 14: Location of Operational Point

5.6.5 Dependencies

Operational Points can be assigned once the following objects are created:

- Track Node
- Track Edge Point

The identifier of an operational point shall be used as a prefix for the attribute "name" of the individual objects in order to establish an unambiguous assignment of an object to an operational point (e.g. for point numbers and other designations of track assets).

The operational point shall be mapped to a corresponding Area of Control, which is defined in chapter 8.1 later in this document.

6 Tier 1: Base network topology objects

This chapter defines and describes the base network topology objects with the following taxonomy:

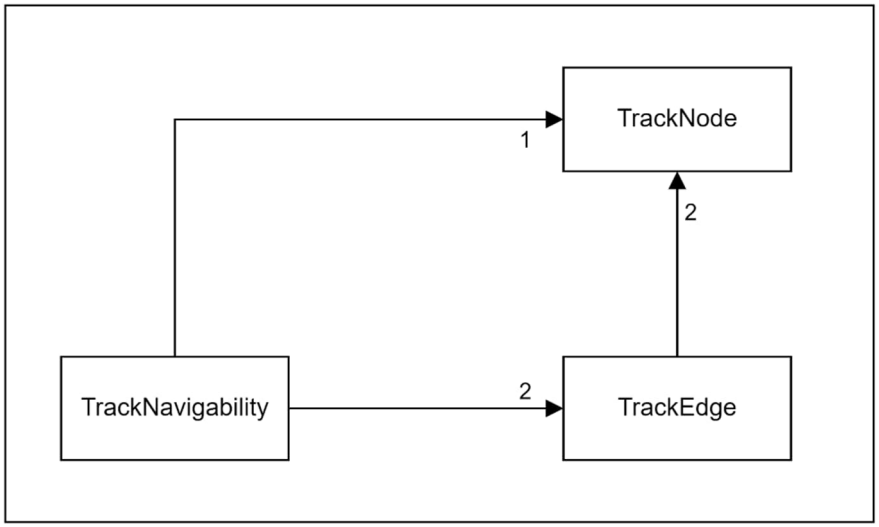


Figure 15: Taxonomy for base network topology objects

6.1 Track Node

A Track Node is a position on the topological model of the track network where a Track Edge begins or ends. There are several situations where a Track Edge begins or ends, and all are modelled as Track Node (list is not exhaustive):

- Points – It is a location of the track network where trains coming from one direction and have more than one possible Track Edge to continue driving.

  Note: Even if one Track Edge begins while another passes through the point, the Track Node that represents the point splits the passing track into two Track Edges

- End Of Track – The position on the track network where the physical track ends or a Buffer Stop is located.
- System borders – The position defining a system border (i.e. between two infrastructure operators, between two areas of control or between a controlled and a non-controlled area)

  Note: Even if the physical track continues, on this location one track edge ends and another begins

6.1.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	X	X	X

6.1.2 Definition

Table 10: Definition Track Node

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T1-TN	**TrackNode**						
T1-TN-1		id	Unique generated ID	String	UUID	1	
T1-TN-2		name	Name of the Track Node, proposal: {operational point identifier}-{node number}, with {node number}: - Identifier/number of the point for type ‘Point’ - Operational track number for type ‘End of Track’ and type ‘System Borders’ e.g. BAZ-8 or HO-9016	String	alphanumeric	1	
T1-TN-3		version	Reference to the version information	*Version*	-	1	

T1-TN-4		nodeType	ENUM value indicating the Track Node type	ENUM	- Point - System Border - End of Track	1	
T1-TN-5		isLocatedAtGeo-Coordinates	Geo-Coordinates of this Track Node (in a specific coordinate system)	*GeoCoordinates*	-	1	
T1-TN-6		hasOperational-Point	Reference to the operational point to which this Track Node is related.	*OperationalPoint*	-	0..1	
T1-TN-7		lineReference	Reference to line to which this Track Node is related.	*LineReference*		0..*	

6.1.3 Basis / rules and regulations

- Simple points and high-speed points are represented by one Track Node of the type ‘point’.
- Interlaced points and single slip crossings are represented by two Track Nodes of the type ‘point’.
- Double slip crossings are represented by four Track Nodes of the type ‘point’.
- Track ends and buffer stops are represented by one Track Node of the type ‘End of Track’ depending on their existence on the physical track.
- Border between two infrastructure operators or between two areas of control or between a controlled and a non-controlled area are represented by one Track Node of type ‘System Border’
- Diamond crossings (with or without movable blades) and derailment devices are not represented as Track Nodes (i.e. Points or track ends). These are rather represented by a Track Edge point and thus have a reference to Track Edges and not to Track Nodes.

6.1.4 Engineering rules

The position of the Track Node for points corresponds to the location of the point tip (the start of the point) which normally refers to the tangent or secant intersection point. The location of the point tip is not identical with the location of the point tongues. Depending on the engineering parameters of the point, the point tip can be located 0.5 – 2 m away from the point tongue.

Note: The point tongue is visible and can be measured much better than the geometrical point tip. In addition, it is the more relevant information from operational / safety / supervision perspective and must be configured anyway for a Drive Protection Section (DPS, see chapter 8.7). However, the point tip is the information that is engineered and used by track alignment / track geometry data. Additional discussions are needed to decide if in RCA it can be configured to use the point tongue instead of the point tip as general reference point. This decision must either be an output of alignment with other Map consuming systems of RCA (i.e. PAS) or an impact / safety analysis must be performed in case of accepted deviations of reference points (tip vs. tongue).

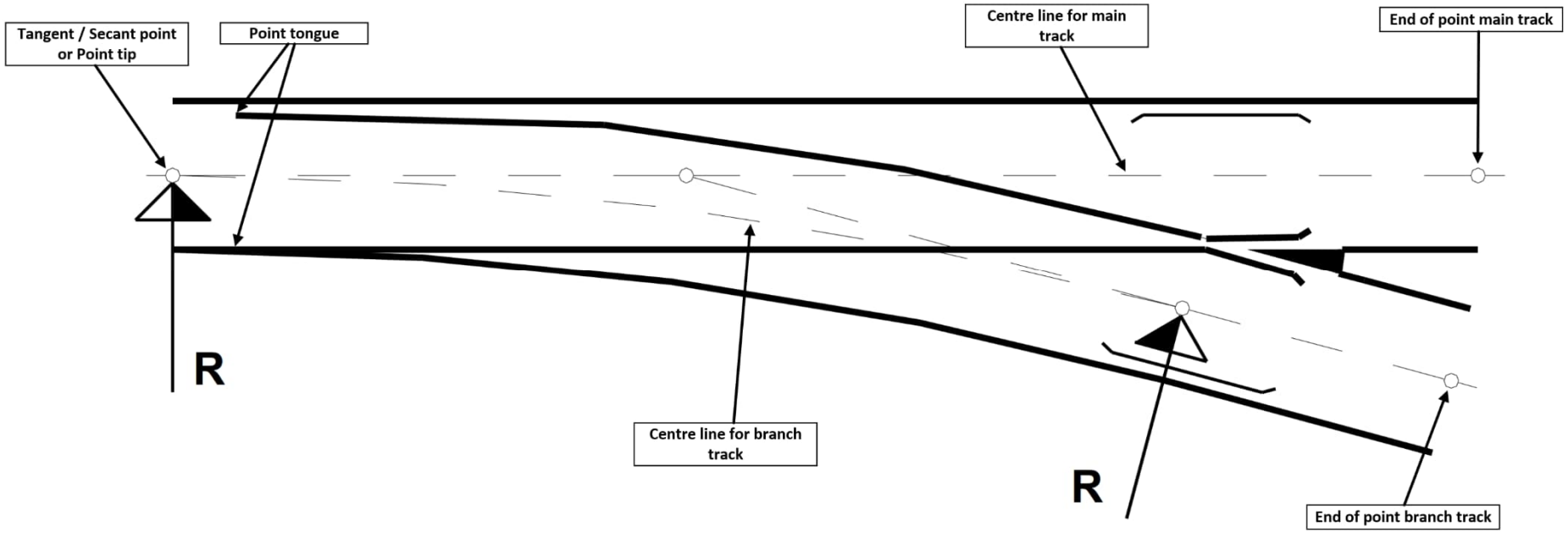


Figure 16: Position of tangent / secant point for simple points

The tangent or secant point refers to the point of intersection between the track centre lines of main and branch tracks.

The position or the location (geo-coordinates) of the nodes at slip crossing corresponds to the respective point tips at each side of the slip crossing:

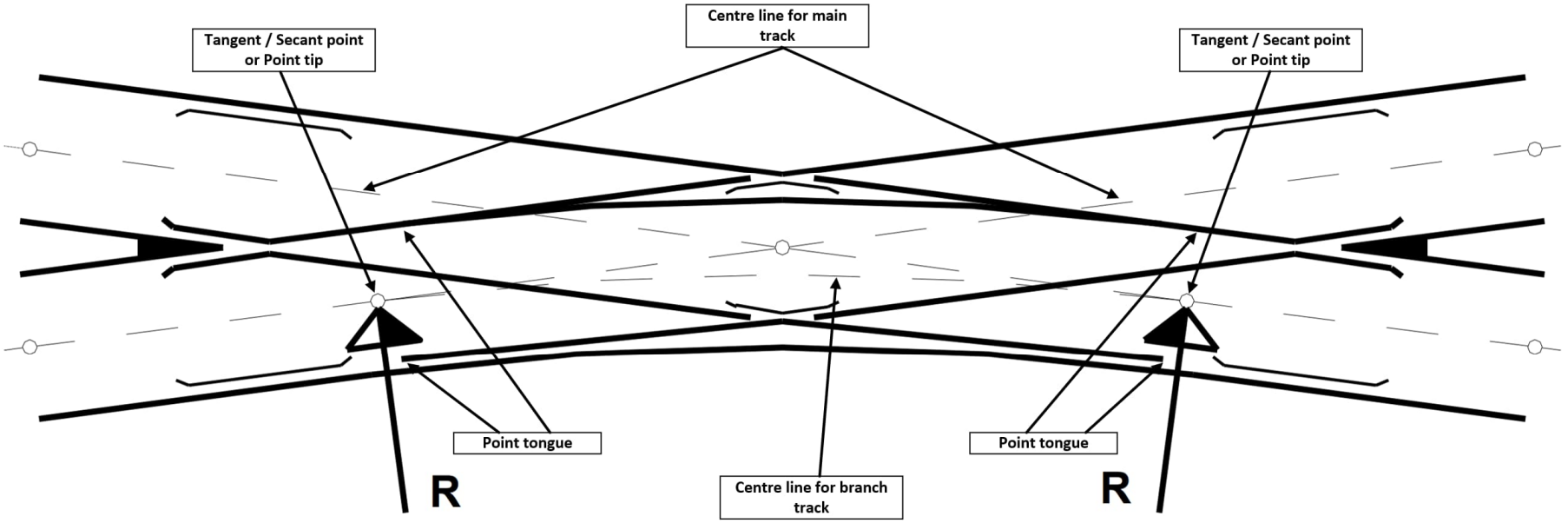


Figure 17: Position of tangent / secant point for a single slip crossing

The single slip crossing therefore has 2, the double slip crossing 4 track positions and geo-coordinates to map the nodes. In addition, the position of the point intersection point should also be engineered when defining the derived point object.

6.1.5 Dependencies

- When a Track Node is represented as a Point, then it shall have 3 Track Edges connected to it.

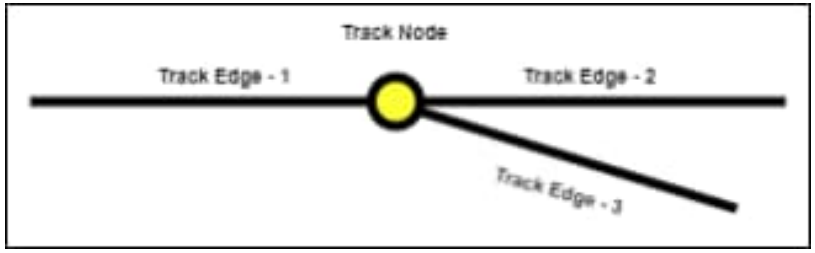


Figure 18: Track Node of type Point – Single track gauge

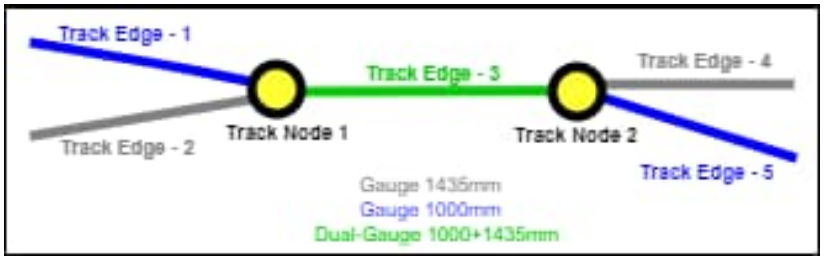


Figure 19: Track Node of type Point – Multiple track gauge

- When a Track Node is represented as a System Border, then it shall have 2 Track Edges connected to it.

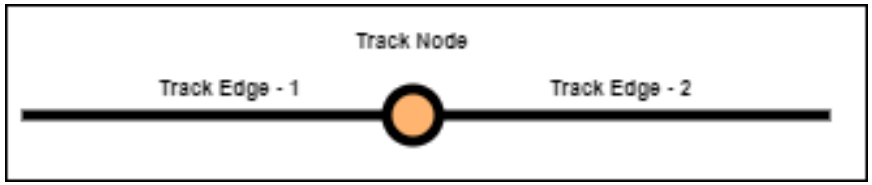


Figure 20: Track Node of type System Border

A System border can be realised as the followings,

1. Border between two major Infrastructure Managers
2. Border between two states
3. Border between two Areas of Control

- When a Track Node is represented as an End of Track, then it shall have 1 Track Edge connected to.

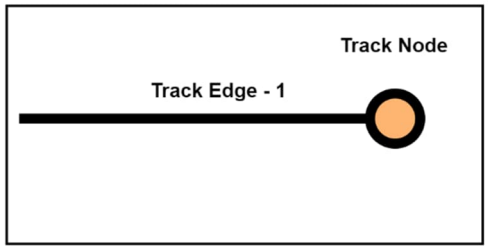


Figure 21: Track Node of type End of Track

6.2 Track Edge

A Track Edge is a linear object that connects exactly two Track Nodes. One of these Track Nodes is defined as the Start Track Node, the other is defined as the End Track Node, which gives an implicit direction to the Track Edge. The implicit Track Edge direction does not specify the drivability of a Track Edge.

6.2.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	X	X	X

6.2.2 Definition

Table 11: Definition Track Edge

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T1-TE	**TrackEdge**						
T1-TE-1		id	Unique generated ID	String	UUID	1	
T1-TE-2		name	Name of the Track Edge, proposal: {start node}-{branch side}_{end node}-{branch side}, with {branch side}: L → left branch (**L**eft) R → right branch (**R**ight) M → middle branch (**M**iddle, for points with 3 branches) T → start of point, system border or end of track (**T**op) e.g. AD-2-L_AD-3-R	String	alphanumeric	1	
T1-TE-3		version	Reference to the version information	*Version*	-	1	

T1-TE-4		length	Real length of Track Edge in meters (with 3 decimal places)	Double	0.001 [2] - 999999.999	1	m
T1-TE-5		gauge	Gauge(s) of the Track Edge, depending on whether the edge refences a single, dual or even multiple gauge track. Possible gauge values in mm (taken from [5]).	ENUM	- 750 - 1000 - 1435 - 1520 - 1524 - 1600 - 1668	1..*	mm
T1-TE-6		hasStart-TrackNode	Track Node where Track Edge starts	*TrackNode*	-	1	
T1-TE-7		hasEnd-TrackNode	Track Node where Track Edge ends	*TrackNode*	-	1	

[2] The range is set to start from 0.001 to explicitly avoid track edges to be defined with length as 0.

6.2.3 Basis / rules and regulations

The Track Edge has no explicit direction, but rather it shall be derived implicitly from the start and end Track Edge Points, i.e.

Start to End → **from start Track Node to end Track Node**

End to Start → **from end Track Node to start Track Node**

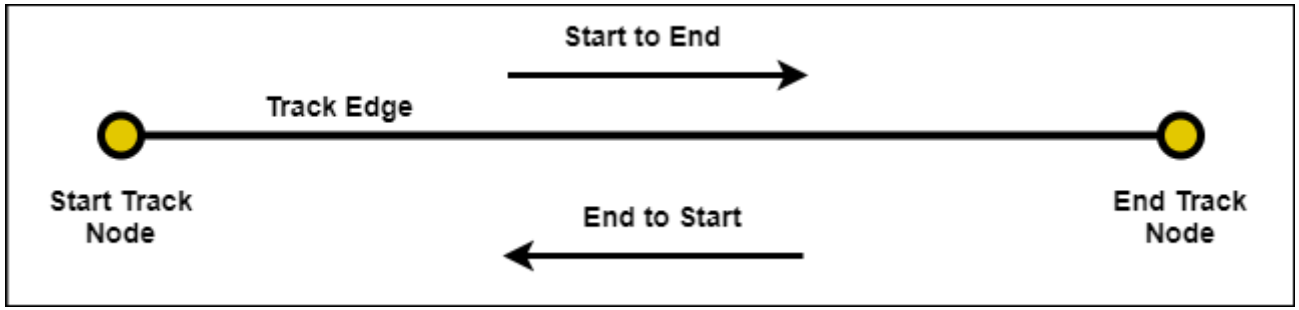


Figure 22: Direction of a Track Edge

6.2.4 Engineering rules

The start and end Track Node must not refer to the same Track Node.

A node is set as start Track Node such that it lies on the lower route kilometrage and vice-versa for the end Track Node.

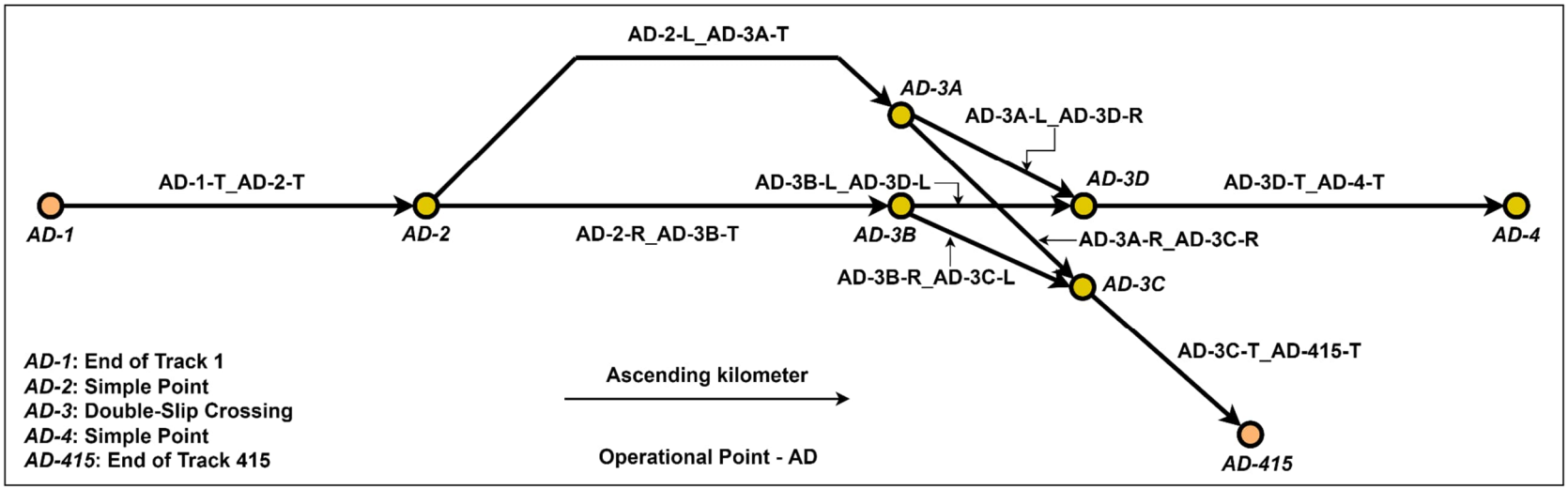


Figure 23: Definition of the start and end track node for Track Edge direction

Table 12: Definition of the start and end track node for Track Edge direction

Track Edge	Start Track Node	End Track Node
AD-1-T_AD-2-T	End of track (T) AD-1	Top of point (T) AD-2
AD-2-R_AD-3B-T	Right branch of point (R) AD-2	Top of point (T) AD-3B
AD-2-L_AD-3A-T	Left branch of point (L) AD-2	Top of point (T) AD-3A
AD-3A-L_AD-3D-R	Left branch of point (L) AD-3A	Right branch of point (R) AD-3D
AD-3A-R_AD-3C-R	Right branch of point (R) AD-3A	Right branch of point (R) AD-3C
AD-3B-R_AD-3C-L	Right branch of point (R) AD-3B	Left branch of point (L) AD-3C
AD-3B-L_AD-3D-L	Left branch of point (L) AD-3B	Left branch of point (L) AD-3D
AD-3D-T_AD-4-T	Top of point (T) AD-3D	Top of point (T) AD-4
AD-3C-T_AD-415-T	Top of point (T) AD-3C	End of the track (T) AD-415

6.3 Track Navigability

Track Navigability describes how to navigate between the adjacent Track Edges at Track Nodes. The Track Navigability determines which travel options are permitted at points and which are excluded. They are necessary to eliminate the physically impossible train movements (e.g. a movement from the left to the right branch of a point) and define the practically possible movements in the node-edge model.

6.3.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	X	X	X

6.3.2 Definition

Table 13: Definition Track Navigability

ID	Object	Attribute	Description	Type	Range	Cardinal-ity	Unit
T1-TNV	**TrackNavigability**						
T1-TNV-1		id	Unique generated ID	String	UUID	1	
T1-TNV-2		name	Name of navigability (combination of the names of the neighbouring Track Edges).	String	alphanu-meric	1	
T1-TNV-3		version	Reference to the version information	*Version*	-	1	
T1-TNV-4		fromTrackEdge	Track Edge where the Track Navigability starts.	*TrackEdge*	-	1	
T1-TNV-5		fromTrackEdgeSide	Side of the starting Track Edge for which the navigability is described.	ENUM	- Start - End	1	
T1-TNV-6		toTrackEdge	Track Edge where the Track Navigability ends.	*TrackEdge*	-	1	
T1-TNV-7		toTrackEdgeSide	Side of the ending Track Edge for which the navigability is described.	ENUM	- Start - End	1	
T1-TNV-8		appliesToTrackNode	Track Node to which the Track Navigability in-stance applies.	*TrackNode*	-	1	

6.3.3 Basis / rules and regulations

Track Navigability represents ordered pairs of navigable Track Edges, referenced by Track Edge attributes. The Track Navigability always refers to one direction only, meaning if navigation between two Track Edge A and B in both directions is possible, two Track Navigabilities (“from Track Edge A to Track Edge B” and “from Track Edge B to Track Edge A”) have to be defined.

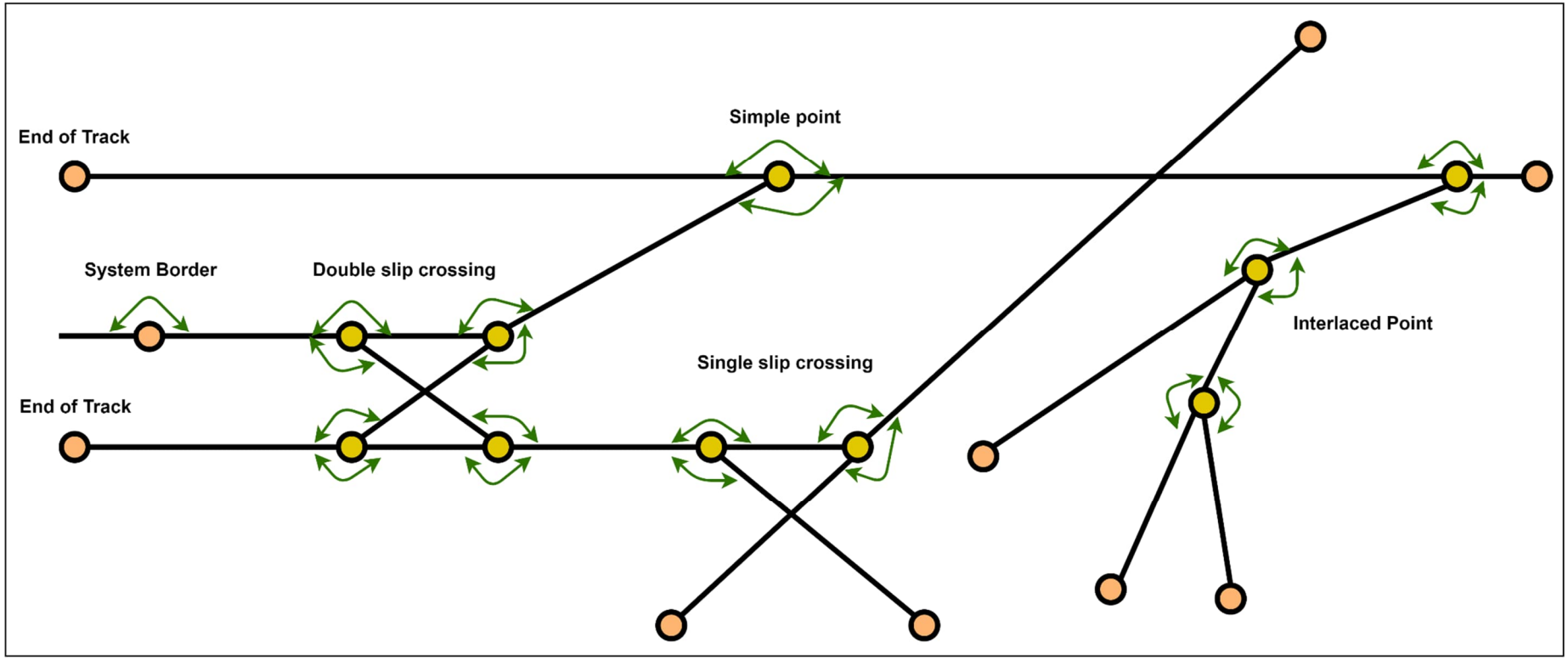


Figure 24: Navigabilities

6.3.4 Engineering rules

Track Navigabilities shall be engineered at Track Nodes to describe the possible branching options for both directions of travel. For

- a simple point 2 pairs (in total 4)
- a single slip crossing 4 pairs (in total 8)
- a double slip crossing 8 pairs (in total 16)
- a system border 1 pair (in total 2)
- a track end or buffer stop none (0)

of Track Navigabilities must be configured.

6.3.5 Dependencies

Track Navigability depends on the type of Track Nodes for which they are engineered, so that the different driving possibilities in the track network are represented.

As Track Edges might have multiple gauges, routing algorithms have to take into account that only Navigabilities between Track Edges that define the same gauge are valid.

7 Tier 2: Spatial topology objects

This chapter defines and describes the spatial topology objects which have the following taxonomy:

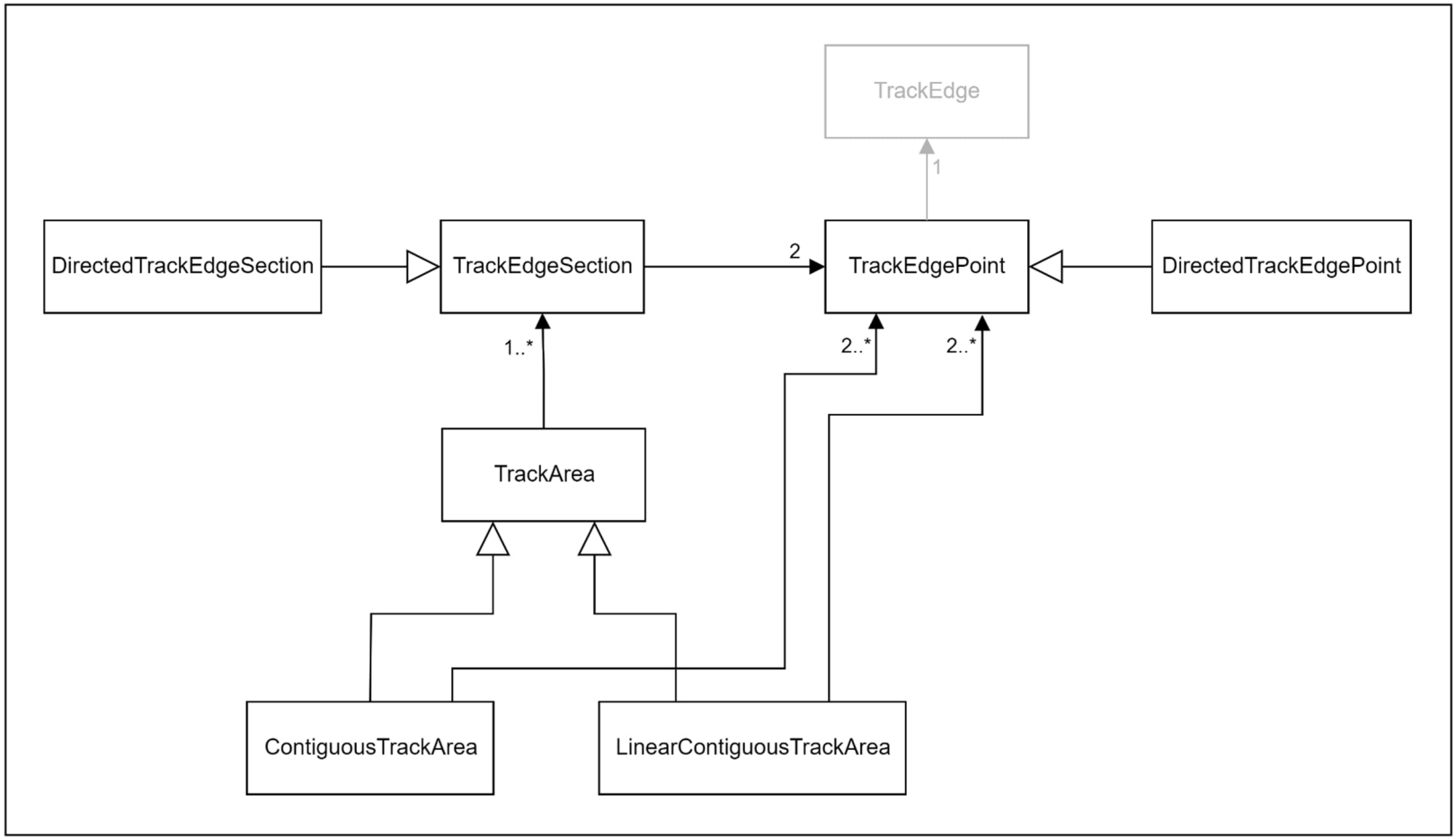


Figure 25: Taxonomy for spatial topology objects

In addition, this chapter contains objects which have implicit and explicit directions definitions. The following clarifications are provided for better understanding of these concepts.

Implicit directions: These directions can be simply derived from the start and end points of the corresponding object e.g. a Track Edge. These are provided for the objects that do not have any explicit requirement based on the usage direction of the Track Edge. Meaning these elements are valid of any/all usage directions of the Track Edge. Objects falling under this category is: Linear Contiguous Track Area

Explicit directions: These directions are specified using a predefined ENUM list. These are provided for the objects with explicit requirements based on the usage direction of the Track Edge. Meaning these elements are valid only for a particular usage direction of the Track Edge based on the specified ENUM value. Objects falling under this category are: Directed Track Edge Sections and Directed Track Edge Points.

7.1 Spot objects

7.1.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	X	X	X

7.1.2 Track Edge Point

Base-element to describe non-directed spot objects (without spatial expansion) and to locate them on (or alongside) a Track Edge with additional attributes.

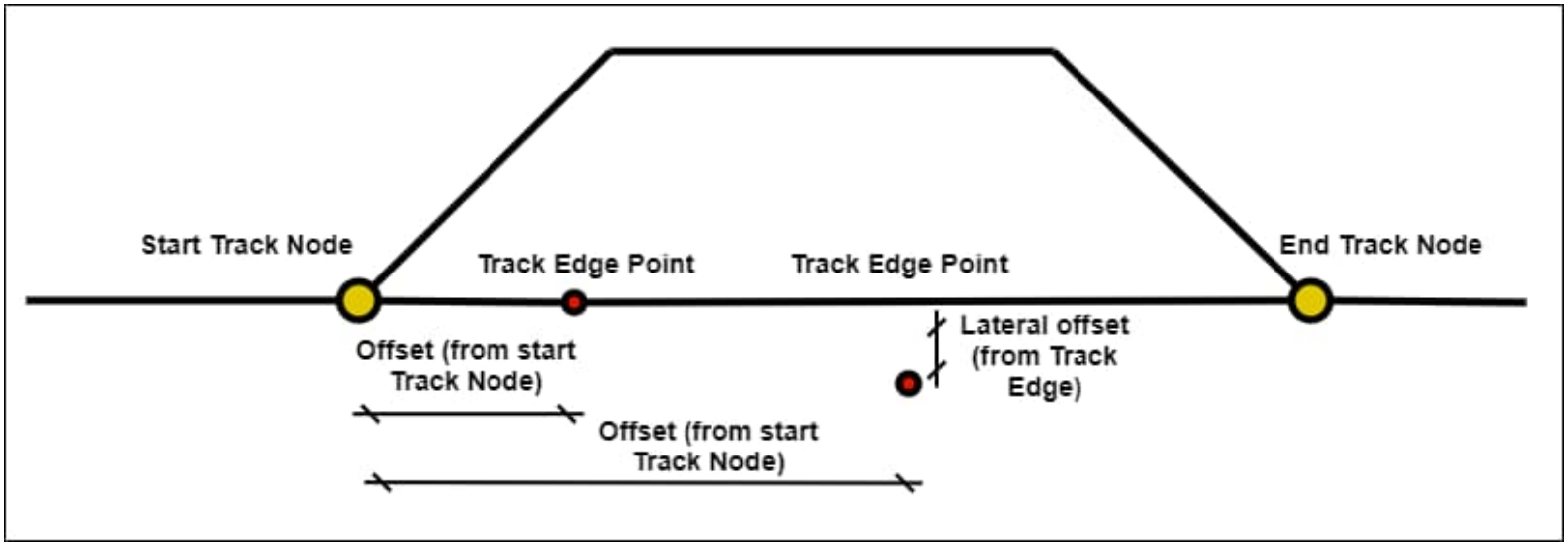


Figure 26: Track Edge Point

7.1.2.1 Definition

Table 14: Definition Track Edge Point

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T2-SO-TEP	**TrackEdgePoint**						
T2-SO-TEP-1		id	Unique generated ID	String	UUID	1	
T2-SO-TEP-2		name	Name of Track Edge point	String	alphanumeric	1	
T2-SO-TEP-3		version	Reference to the version information	*Version*	-	1	
T2-SO-TEP-4		isPositioned OnTrackEdge	Reference to the Track Edge	*TrackEdge*	-	1	
T2-SO-TEP-5		offset	Represents the longitudinal offset value in meters from start Track Node (with 3 decimal places). Offset cannot exceed the end node of the referenced edge. Offset value of 0 m means, the Track Edge Point is located at the start Track Node of the referenced Track Edge. Offset value equal to length of reference Track Edge means, the Track Edge Point is located on the end Track Node.	Double	0.000 - 999999.999	1	m
T2-SO-TEP-6		isLocatedAtGeoCoordinates	Geo-Coordinates of the track position (in a specific coordinate system)	*GeoCoordinates*	-	1	
T2-SO-TEP-7		lateralOffset	Represents the lateral offset value in meters from the Track Edge (with 3 decimal places). Positive values represent a distance to the right and negative values a distance to the left, in relation to the Track Edge direction.	Double	-99.999 - 99.999	0..1	m

T2-SO-TEP-8		verticalOffset	Represents a vertical offset value throughout the Track Edge Point in meters from the Track Edge (with 3 decimal places).	Double	0.000 – 99.999	0..1	m
T2-SO-TEP-9		hasOperationalPoint	Reference to the operational point which is relevant for this position.	*Operational Point*	-	0..1	
T2-SO-TEP-10		lineReference	Reference to the line which is relevant for this position.	*LineReference*		0..*	

7.1.2.2 Basis / rules and regulations

Track Edge Points shall be used to provide references to elements representing **track assets** like (non-exhaustive list):

- Balise
- Landmark
- Tunnel Portal
- Derailer
- Generic Spot Object

7.1.2.3 Dependencies

If a usage direction is required for the Track Edge Point, the Directed Track Edge Point shall be used instead (see next chapter 7.1.3. Directed Track Edge Point).

7.1.3 Directed Track Edge Point

Directed Track Edge Point is a specialised class of Track Edge Point which provides an explicit usage direction in relation to the referenced Track Edge.

7.1.3.1 Definition

Table 15: Definition Directed Track Edge Point

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T2-SO-DTEP	**TrackEdgePoint :: DirectedTrackEdgePoint**						
T2-SO-DTEP-1		direction	Direction in relation to Track Edge direction	ENUM	- Start to End - End to Start - Both	1	

7.1.3.2 Basis / rules and regulations

A Directed Track Edge Point shall be used to provide topological references to a direction dependent track properties like (non-exhaustive list):

- Timing Point
- Movement Permission Target Marker
- Signal

which are valid only in one direction or other relevant domain objects which are valid for both directions.

7.1.3.3 Engineering rules

Directed Track Edge Points (DTEP) are **direction dependent points,** i.e. different instances of Directed Track Edge Points can be defined depending on its applicability towards underlying track Edge usage direction. (Refer to direction attribute from the above table).

- Start to End
  - Directed Track Edge Points that are valid for travel from start Track Node to end Track Node are set with direction **'Start to End'**.
- End to Start
  - Directed Track Edge Points that are valid for travel from end Track Node to start Track Node are set with direction **'End to Start'**.
- Both
  - Directed Track Edge Points that are valid for both directions of travel with respect to the referenced Track Edge are set with direction **'Both'**. Rationale: Although Track Edge Points (TEP) with no definite direction and the DETP with 'both' as direction are same. The reason for using the DTEP' lies on the fact that it offers us an optimised separation from the TEPs referencing start / end points of Track Edge Section (TES). This would eventually simplify the algorithms used by systems to fetch Track Edge and travel direction specific data.

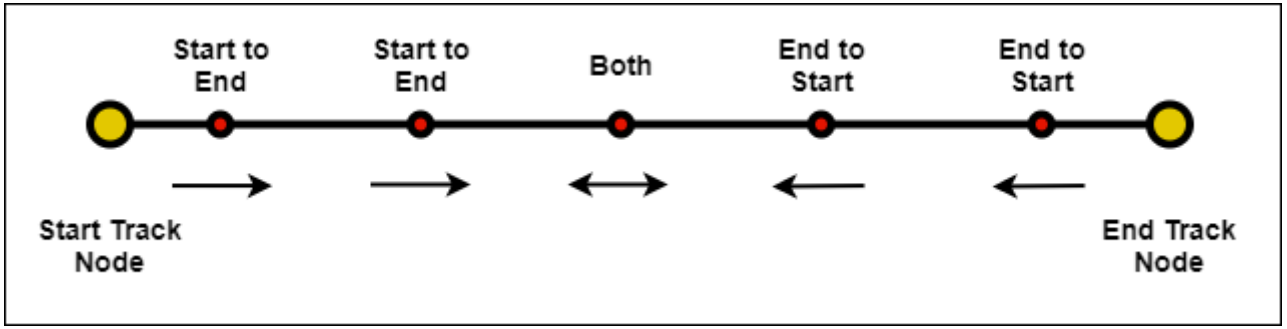


Figure 27: Direction of Directed Track Edge points

7.2 Linear objects

7.2.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	X	X	X

7.2.2 Track Edge Section

Base-element to describe non-directed linear objects (with a linear extension) and to place them on (or at the side of) a Track Edge. A Track Edge Section can only refer to exactly one Track Edge. Sections across multiple Track Edges must be defined as multiple Track Edge Sections, each specific to respective Track Edge.

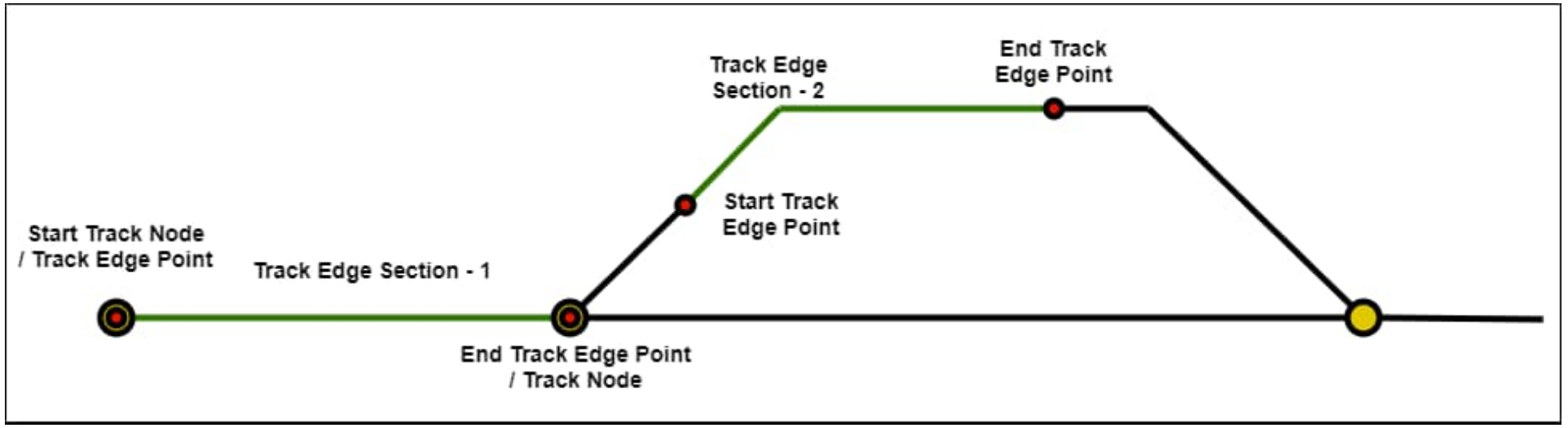


Figure 28: Track Edge Section

7.2.2.1 Definition

Table 16: Definition Track Edge Section

ID	Object	Attribute	Description	Type	Range	Cardi-nality	Unit
T2-LO-TES	**TrackEdgeSection**						
T2-LO-TES-1		id	Unique generated ID	String	UUID	1	
T2-LO-TES-2		name	Name of Track Edge Section	String	alphanu-meric	1	
T2-LO-TES-3		version	Reference to the version information	*Version*	-	1	
T2-LO-TES-4		hasStartTrackEdgePoint	Reference to the Track Edge Point, where the Tack Edge Section starts.	*TrackEdge-Point*	-	1	
T2-LO-TES-5		hasEndTrackEdgePoint	Reference to the Track Edge Point, where the Tack Edge Section ends.	*TrackEdge-Point*	-	1	
T2-LO-TES-6		length	Real length of Track Edge Section in meters (with 3 decimal places).	Double	0.001 [3] - 999999.999	1	m
T2-LO-TES-7		lateralOffset	Represents a constant lateral offset value throughout the Track Edge Section in meters from the Track Edge (with 3 decimal places). Positive values represent a distance to the right and negative values a distance to the left, in relation to the Track Edge direction.	Double	-99.999 – 99.999	0..1	m

[3] The range is set to start from 0.001 to explicitly avoid track edge sections to be defined with length as 0.

T2-LO-TES-8		verticalOffset	Represents a constant vertical offset value throughout the Track Edge Section in meters from the Track Edge (with 3 decimal places).	Double	0.000 – 99.999	0..1	m
T2-LO-TES-9		isPartOfTrackEdge	Reference to the Track Edge	*TrackEdge*	-	1	

7.2.2.2 Basis / rules and regulations

Track Edge Sections shall be used to provide references to elements representing **track properties or track assets** like (non-exhaustive list):

- Track Geometry
  - Curve
  - Gradient
  - Cant
- Drive Protection Section
- Track Condition
- Traction System
- Current Limitation
- Permitted Braking Distance
- Track Properties
- Train Detection Section

7.2.2.3 Engineering rules

The start Track Edge Point shall be defined as the one that lies on the lower route kilometrage of the Track Edge Section and vice-versa for the end Track Edge Point.

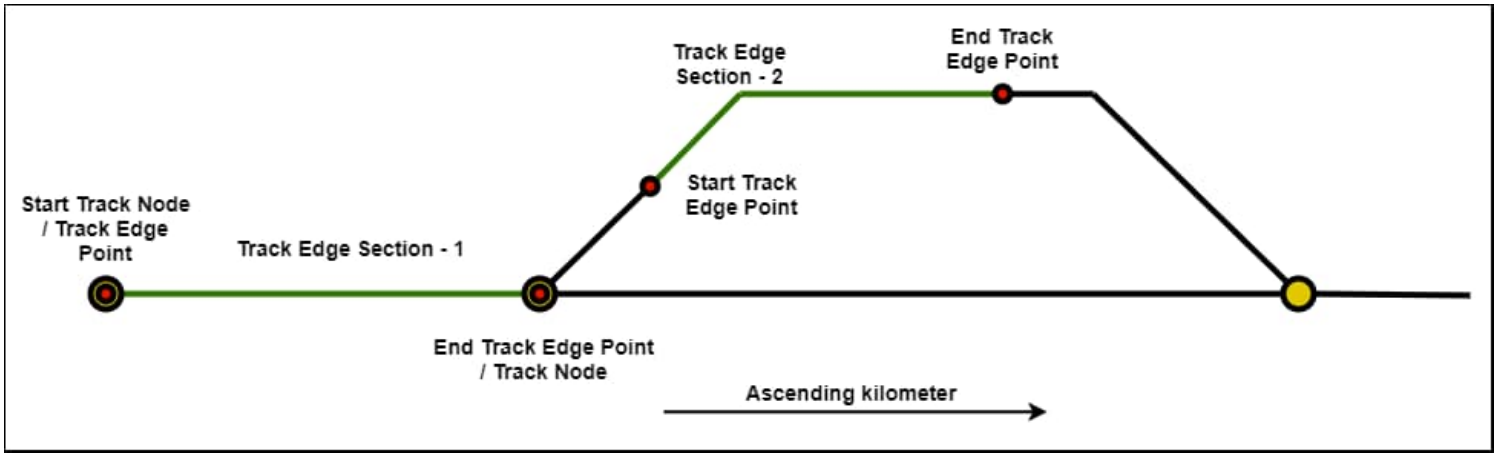


Figure 29: Position of the start and end Track Edge Point

7.2.2.4 Dependencies

If a usage direction is required for the Track Edge Section, the Directed Track Edge Section shall be used instead (see next chapter 7.2.3 Directed Track Edge Section

7.2.3 Directed Track Edge Section

Directed Track Edge Section is a specialised class of Track Edge Section which provides an explicit usage direction in relation to the referenced Track Edge.

7.2.3.1 Definition

Table 17: Definition Directed Track Edge Section

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T2-LO-DTES	**TrackEdgeSection :: DirectedTrackEdgeSection**						
T2-LO-DTES-1		direction	Direction in relation to Track Edge direction	ENUM	- Start to End - End to Start - Both	1	

7.2.3.2 Basis / rules and regulations

A Directed Track Edge Section shall be used to provide topological references to direction dependent track properties like (non-exhaustive list):

- Speed Profile
    - Static Speed Profile
    - Specific Static Speed Profile
    - Axle Load Speed Profile
- Segment Profile

which are valid only in one direction and vary in the other.

Similar to the Directed Track Edge Points, the Directed Track Edge Sections are also defined based on the track usage direction, i.e. for Start to End and End to Start direction.

7.2.3.3 Engineering rules

A Directed Track Edge Section shall always have an effective direction in relation to the underlying Track Edge.

- *Start to End* → from start Track Edge Point to end Track Edge Point
  - Directed Track Edge Sections that are valid for 'Start to End' direction of travel with respect to Track Edge are set with direction **'Start to End'**.
- *End to Start* → from end Track Edge Point to start Track Edge Point
  - Directed Track Edge Sections that are valid for 'End to Start' direction of travel with respect to Track Edge are set with direction **'End to Start'**.
- Both → from end Track Edge Point to start Track Edge Point (or) from start Track Edge Point to end Track Edge Point
  - Directed Track Edge Sections that are valid for both directions of travel with respect to Track Edge are set with direction **'Both'**.

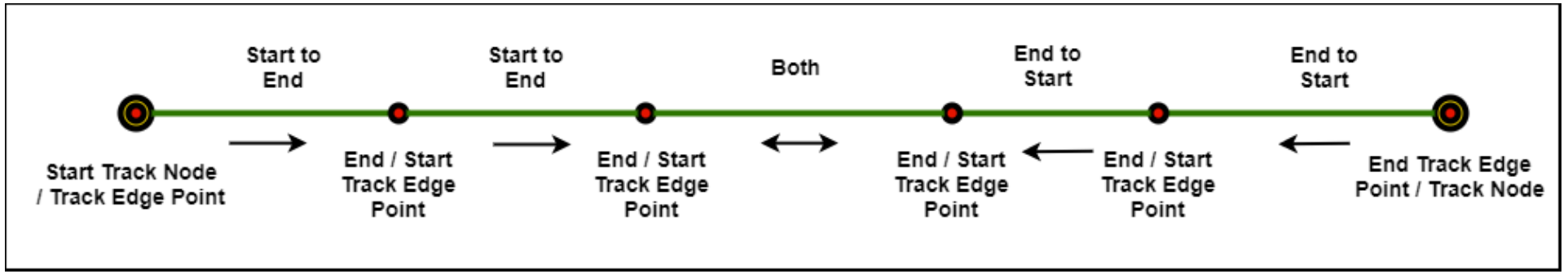


Figure 30: Direction of Track Edge Sections

7.3 Area Objects

7.3.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	X	X	X

7.3.2 Track Area

A Track Area groups an arbitrary number of Track Edge Sections. The sections don't have to be connected / adjacent to each other. The Track Area groups the sections to a logical entity, usually to illustrate a technical or functional context.

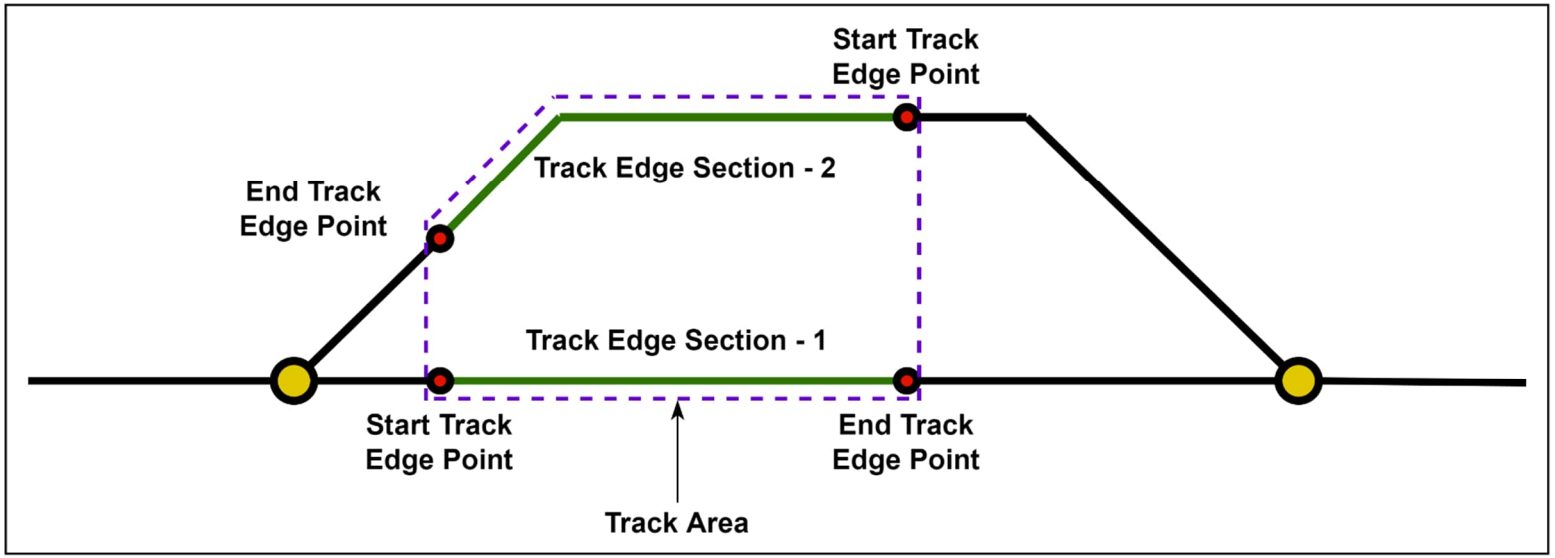


Figure 31: Track Area

7.3.2.1 Definition

Table 18: Definition TrackArea

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T2-AO-TA	**TrackArea**						
T2-AO-TA-1		id	Unique generated ID	String	UUID	1	
T2-AO-TA-2		name	Name of the Track Area	String	alphanu-meric	1	
T2-AO-TA-3		version	Reference to the version information	*Version*	-	1	
T2-AO-TA-4		consistsOfTrackEdge-Section	List of (directed) Track Edge Sections to be grouped.	*TrackEdgeSection*	-	1..*	

7.3.2.2 Basis / rules and regulation

Track Areas shall be used to provide references to elements representing logically (and not directly) connected track edge sections like (non-exhaustive list):

- Tunnel Tube
- Diamond Crossing
- Level Crossing
- Zone
- Generic Linear Object

7.3.2.3 Dependencies

Depending on whether a usage direction for the containing Track Edge Sections is required or not, the attribute “consistsOfTrackEdgeSection” shall either contain a list of Track Edge Section or Directed Track Edge Section objects. It shall not contain a mixture of both variants.

Note: Track Area(s) (TA) (and their derived classes Contiguous Track Area (CTA) and Linear Contiguous Track Area (LCTA)) can also be built up of just one Track Edge Section. Despite the fact it shall be classified as a TA/LCTA/CTA and not as a Track Edge Section.

7.3.3 Contiguous Track Area

The Contiguous Track Area is a specialised class of Track Area to group a number of Track Edge Sections, which are topologically connected to each other such that they form one or more paths. The illustrations below show different types of CTAs.

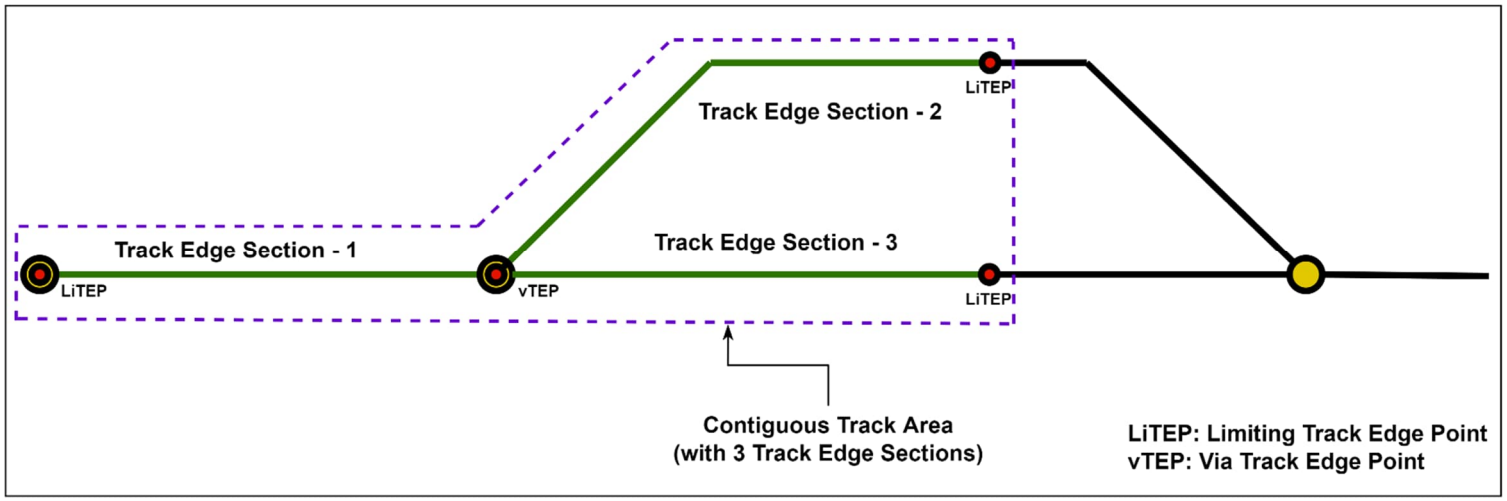


Figure 32: Contiguous Track Area – 1

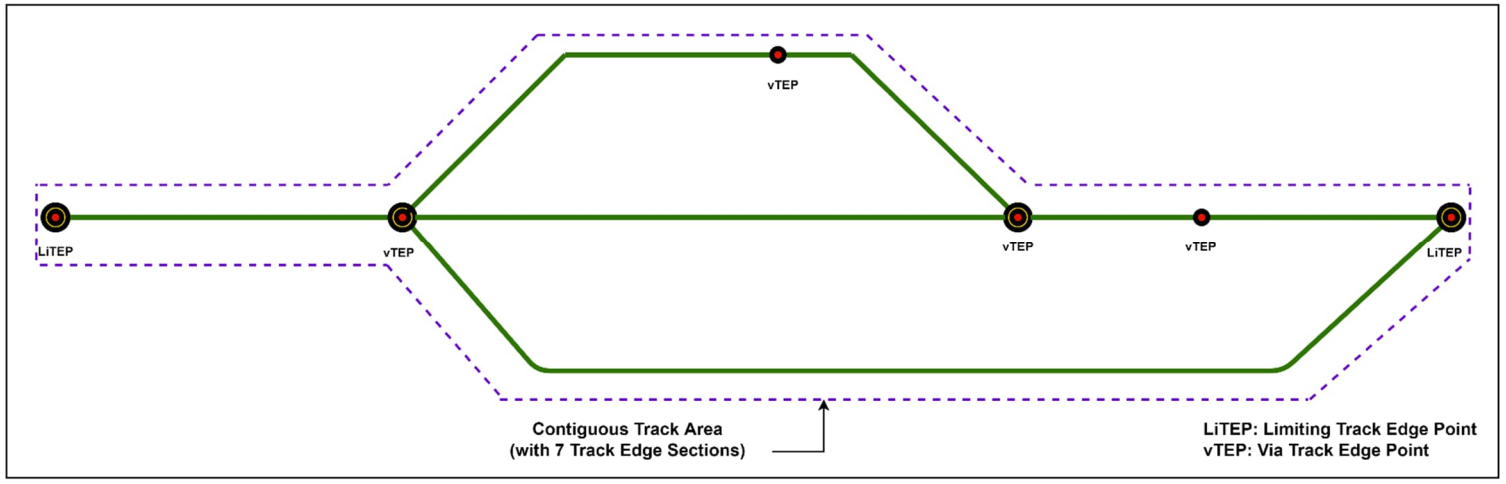


Figure 33: Contiguous Track Area – 2

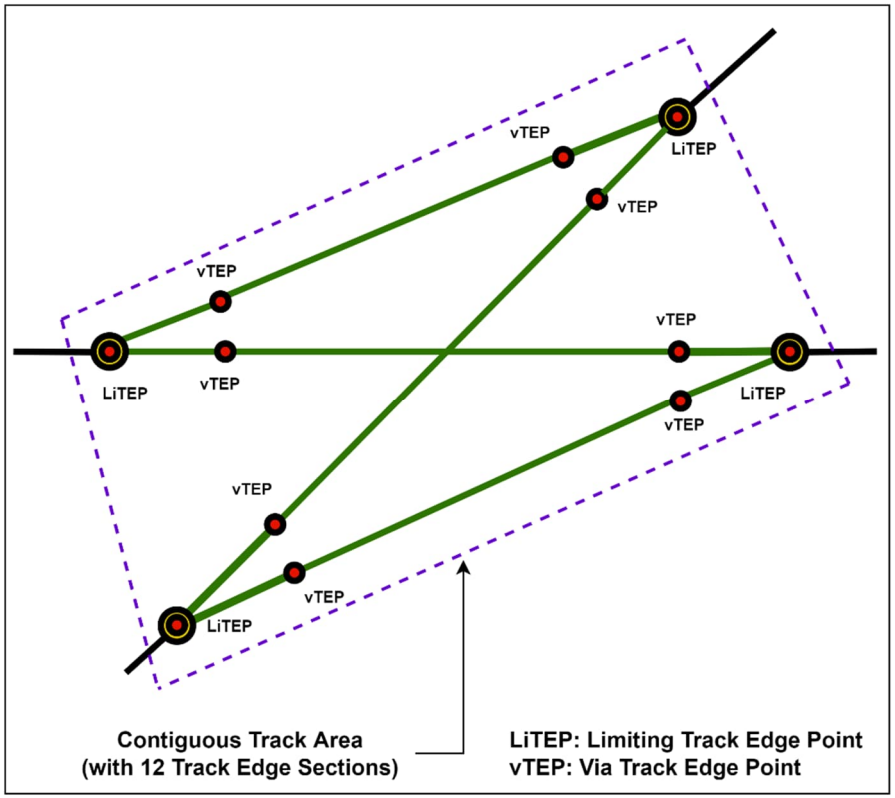


Figure 34: Contiguous Track Area – 3

7.3.3.1 Definition

Table 19: Definition Contiguous Track Area (CTA)

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T2-AO-CTA	**TrackArea :: Contiguous TrackArea**						
T2-AO-CTA-1		limitingTrackEdgePoint	List of Track Edge Points limiting the defined CTA at the extremities.	*TrackEdgePoint*	-	2..*	
T2-AO-CTA-2		viaTrackEdgePoint	List of interconnected Track Edge Points between the Track Edge Sections that are part of defined CTA.	*TrackEdgePoint*	-	0..*	

7.3.3.2 Basis / rules and regulations

There exists one or more paths from given limiting Track Edge Point at one extremity of the Contiguous Track Area to any other given limiting Track Edge Point at the other extremity of the Contiguous Track Area AND each path is navigable via constituent Track Edge Sections, i.e. all constituent Track Edge Sections are joined together in one shape.

Contiguous Track Areas shall be used to provide references to elements representing connected track edge sections like (non-exhaustive list):

- Point
    - Simple Point
    - Slip Crossing

7.3.4 Linear Contiguous Track Area

The Linear Contiguous Track Area is a specialised class of Track Area to group an ordered and/or directional number of topologically connected Track Edge Sections such that they form exactly one path.

The sequence of sections needs to be unambiguously navigable along the track network. Meaning that, each end of a Track Edge Section coincides with the start / end of the immediately succeeding section in the sequence.
The sequence can be travelled without change of direction in start to end and end to start order given that Track Navigability between Track Edges allows it.

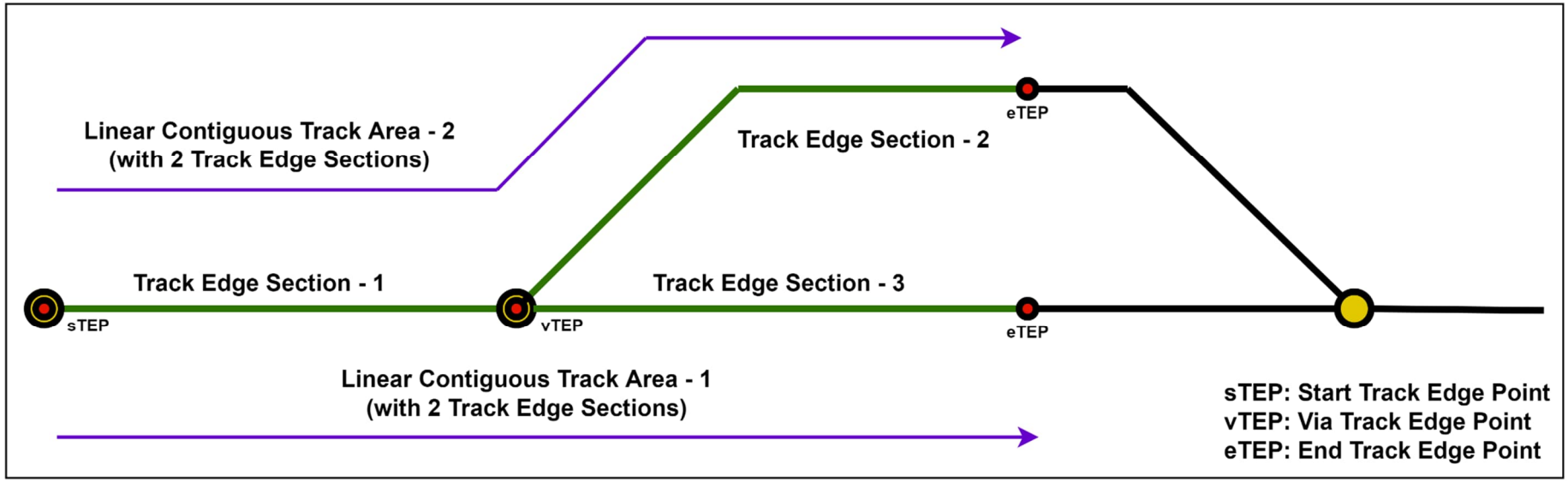


Figure 35: Linear Contiguous Track Area

7.3.4.1 Definition

Table 20: Definition Linear Contiguous Track Area (LCTA)

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T2-AO-LCTA	**TrackArea :: LinearContiguous TrackArea**						
T2-AO-LCTA-1		startTrackEdgePoint	Start Track Edge Point of the first Track Edge Section within the LCTA.	*TrackEdgePoint*	-	1	
T2-AO-LCTA-2		viaTrackEdgePoint	List of interconnected Track Edge Points between the Track Edge Sections that are part of the defined LCTA.	*TrackEdgePoint*	-	0..*	
T2-AO-LCTA-3		endTrackEdgePoint	End Track Edge Point of the last Track Edge Section within the LCTA.	*TrackEdgePoint*	-	1	

7.3.4.2 Basis / rules and regulations

There exists exactly two constituent and mutually exclusive Track Edge Points at the extremities of the Linear Contiguous Track Area AND there exists exactly one path from any given constituent Track Edge Point at one extremity of the Linear Contiguous Track Area to the other given constituent Track Edge Point at the other extremity of the Linear Contiguous Track Area AND the path is navigable via constituent Track Edge Section, i.e. all constituent Track Edge Sections are joined together in one line. It shall be possible to reach the end Track Edge Point of the Linear Contiguous Track Area without changing direction on the path to it.

Linear Contiguous Track Areas shall be used to provide references to elements representing connected track edge sections like (non-exhaustive list):

- Allocation Section
- Platform Edge

7.3.4.3 Engineering rules

The LCTA do not have an explicit direction, but rather are derived implicitly from the start and end Track Edge Points, i.e.

- *Start to End* → from start Track Edge Point to end Track Edge Point
- *End to Start* → from end Track Edge Point to start Track Edge Point

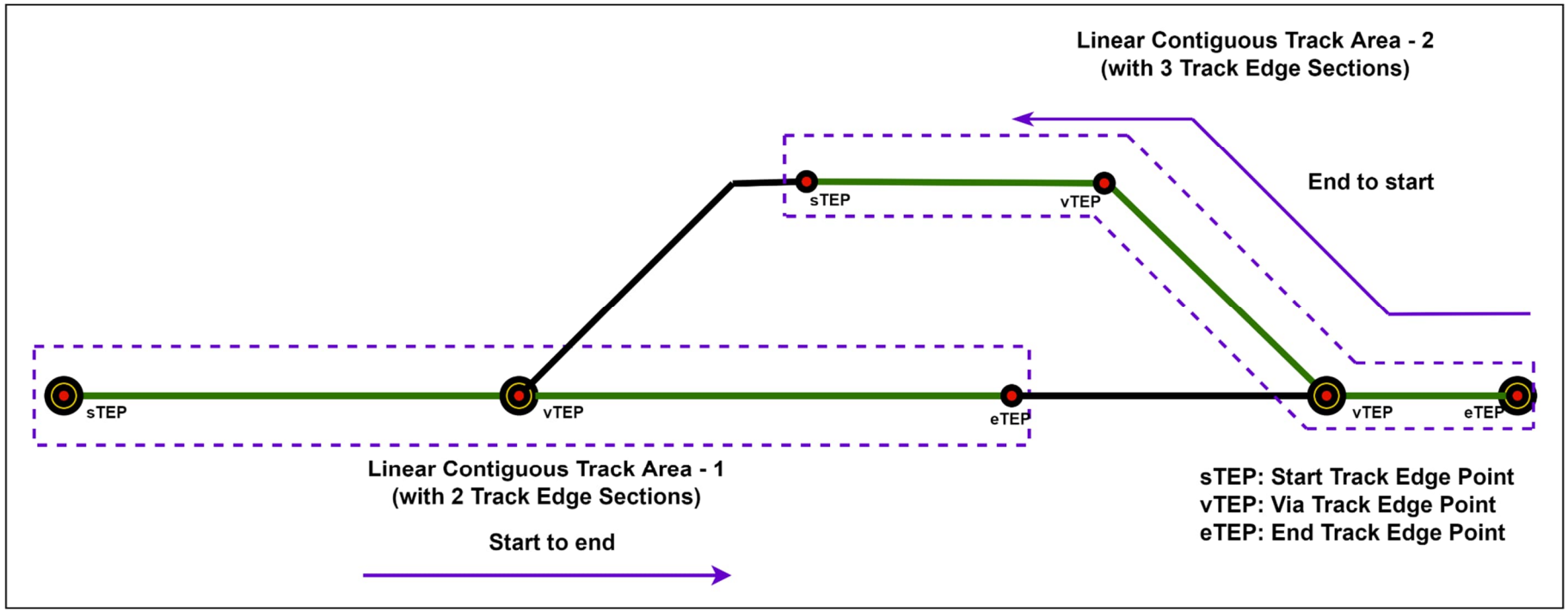


Figure 36: Linear Contiguous Track Area direction

7.3.4.4 Dependencies

In case a LCTA is built up of Directed Track Edge Section*(s)*, the direction of the contained Directed Track Edge Section*(s)* have no relation to the direction of the actual LCTA per se and shall not be considered for topological usage purposes.

8 Tier 3: Domain Objects

8.1 Area of Control

The Area of Control (AoC) is a special subclass of Track Area to define the common topologically delimited area of control of the subsystems (the system borders).

8.1.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	-	-	-

8.1.2 Definition

Table 21: Definition Area of Control

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-AOC	**TrackArea :: AreaOfControl**						
T3-AOC-1		areaOfControlIdentifier	Identifier of the Area of Control	String	alphanumeric	1	
T3-AOC-2		adjacentAreaOfControl	Reference to the adjacent Area of Controls	*Adjacent AreaOfControl*	-	0..*	

8.1.2.1 Adjacent Area of Control

The Adjacent Area of Control is used to link one Area of Control at the system borders with its neighbours.

Table 22: Definition Adjacent Area of Control

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-AAOC	**Adjacent AreaOfControl**						
T2-AAOC-1		id	Unique generated ID	String	UUID	1	
T3-AAOC-2		name	Name of the Adjacent Area of Control	String	alphanumeric	1	
T3-AAOC-3		version	Reference to the version information	*Version*	-	1	
T3-AAOC-4		locatedAtSystemBorder	Reference to the Track Node of type “System Border” where the adjacent Area of Control is located	*TrackNode*	-	1	

8.1.3 Basis / rules and regulations

The Track Area defining Area of Control shall not be redundantly defined for subsystems like APS or PE which are responsible for controlling the same area on the track network. In such cases, subsystems shall use the same Area of Control references.

8.1.4 Engineering rules

The Track Edge Sections within an Area of Control shall always cover complete Track Edges, an Area of Control must not change somewhere on the Track Edge at a specific Track Edge Point.

An Area of Control shall be delimited by Track Nodes of type System Border (if at least the first adjacent Track Edge is known) or End of Track (if the topology outside the Area of Control is unknown).

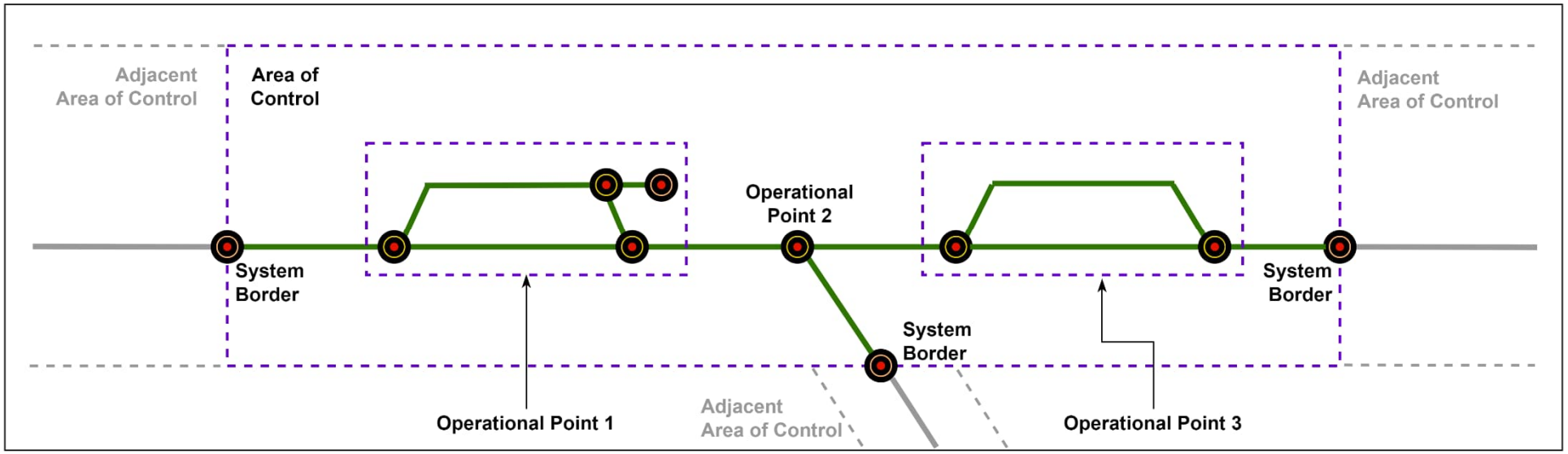


Figure 37: Area of Control

8.1.5 Dependencies

After defining the Area of Control, the Operational Points shall be assigned to the respective AoC (see chapter 5.6) and the linking to the adjacent Area of Controls should be defined.

8.2 Speed Profiles

The permitted speed at which the train is allowed to travel is defined by different kinds of speed restrictions:

- Static Speed Profile
- Specific Static Speed Profile
- Axle Load Speed Profile

The speed restriction categories are independent of each other. This means that one speed restriction category cannot affect, nor be affected by, any other category of speed restrictions.

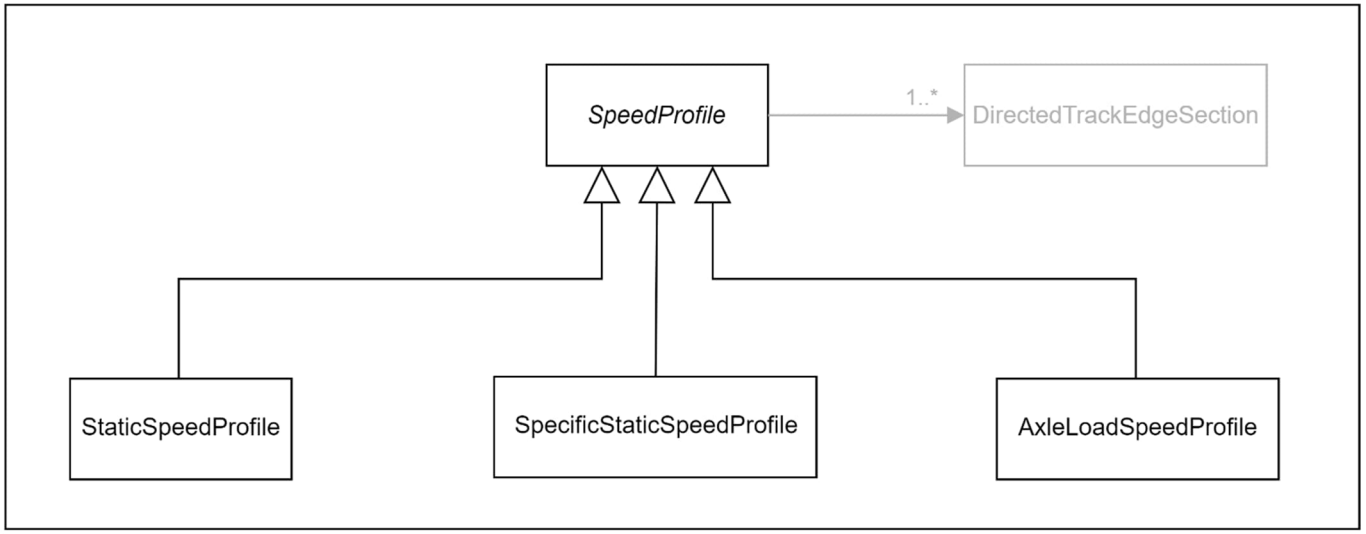


Figure 38: Taxonomy for Speed Profile

8.2.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	-	-	-

8.2.2 Speed Profile

Base definition of a speed profile with properties, which are applicable to all speed profile categories. Specific speed profiles are defined as an extension to this base object.

8.2.2.1 Definition

Table 23: Definition Speed Profile

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-SP	***SpeedProfile***						
T3-SP-1		id	Unique generated ID	String	UUID	1	
T3-SP-2		name	Name of the speed profile	String	alphanumeric	1	
T3-SP-3		version	Reference to the version information	*Version*	-	1	
T3-SP-4		appliesToTrackEdge-Section	Directed Track Edge Sections which apply to the defined speed profile.	*Directed TrackEdgeSection*	-	1..*	
T3-SP-5		speed	Speed in km/h	Integer	0 – 600	1	km/h
T3-SP-6		trainEndApplicability	ENUM to indicate if a speed limit given for a profile element is to be applied until the front of the train (no train length delay) or the end of the train (train length delay) has left the element. (Section 7.5.1.109 [7]).	ENUM	- Train length delay on validity end point of profile element. - No Train length delay on validity end point of profile element.	0..1	

Note: The Speed Profile is an *abstract object*, which cannot be used standalone. Only the derived objects must be used to define a specific speed profile.

8.2.2.2 Basis / rules and regulations

The Speed Profile always defined with a direction for the containing Track Edge Sections. If the Speed Profile is applicable to both directions, the direction of the Track Edge Section has to be set to “Both” (rather than defining just a Track Edge Section).

The cardinality 1..* for the referenced Track Edge Sections is not to be confused with instantiation of TA(s). In case of speed profiles, this cardinality allows us to use the same object instantiation for several Track Edge Sections that exist on the network with same speed profile values.

Note: This speed profile does not define a continuous profile, rather only discrete profiles for relevant Track Edge Sections.

8.2.3 Static Speed Profile

The Static Speed Profile (SSP) is a description of the fixed speed restrictions of a given piece of track. The speed restrictions can be related to e.g. maximum line speed, curves, points, tunnel profiles, bridges. (as defined in Section 3.11.3.1.1 in [9])

8.2.3.1 Definition

Table 24: Definition Static Speed Profile

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-SSP	***SpeedProfile* ::** **StaticSpeedProfile**						

Note: The Static Speed Profile does not define additional attributes as already contained in the derived based class.

8.2.3.2 Basis / rules and regulations

The Static Speed Profiles shall be represented as TES with constant speed profile throughout the section. They shall be provided for the entire track network without breaks.

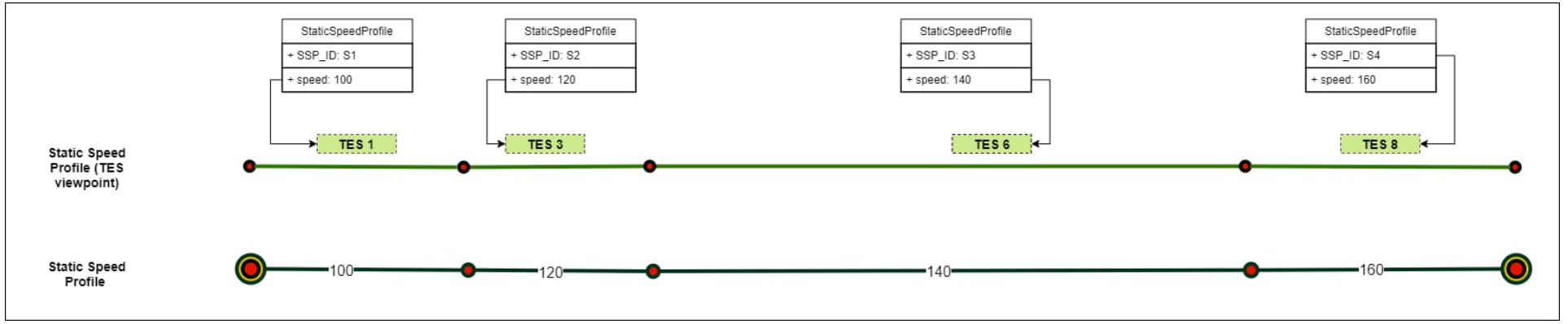


Figure 39: Static Speed Profiles

8.2.3.3 Dependencies

The Static Speed Profiles (if needed) can also be converted to a point-based reference system (TEPs) using the section-based reference (TESs).

It shall be possible to use several Static Speed Profile Categories; one Basic SSP category (defined in this chapter) and specific SSP categories related to the international train categories (described in the next chapter 8.2.4 Specific Static Speed Profile).

8.2.4 Specific Static Speed Profile

The specific SSP categories are decomposed into two types:

- The “Cant Deficiency” SSP categories: the cant deficiency value assigned to one category shall define the maximum speed, determined by suspension design, at which a particular train can traverse a curve and thus can be used to set a specific speed limit in a curve with regards to this category.
- The “other specific” SSP categories: it groups all other specific SSP categories corresponding to the other international train categories.

8.2.4.1 Definition

Table 25: Definition Specific Static Speed Profile

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-SSSP	***SpeedProfile* :: SpecificStatic SpeedProfile**						
T3-SSSP-1		specificStat-icSpeedProfileType	ENUM value indicating the type of specific static speed profile.	ENUM	- Cant Deficiency - Other Specific SSP	1	
T3-SSSP-2		otherSpecificStat-icSpeedProfileCategory	*When (specificStaticSpeedProfile-Type == Other Specific SSP)*: ENUM value indicating the suitable other specific static speed profile category applicable for SSP. See column range for an elaborative list (Section 7.5.1.83 [7]).	ENUM	- Specific Freight Train P - Specific Freight Train G - Specific Passenger Train	0..1	
T3-SSSP-3		cantDeficiencyCategory	*When (specificStaticSpeedProfile-Type == Cant Deficiency)*: ENUM value indicating the suitable cant deficiency category applicable for SSP. See column range for an elaborative list (Section 7.5.1.82.1 [7]).	ENUM	- 80mm - 100mm - 130mm - 150mm - 165mm - 180mm - 210mm - 225mm - 245mm	0..1	

					- 275mm - 300mm		

8.2.4.2 Basis / rules and regulations

The Specific Static Speed Profiles (SSSP) shall be represented as TES with constant speed profile throughout the section. They do not need to be defined continuous throughout the track network but defined on track network where needed.

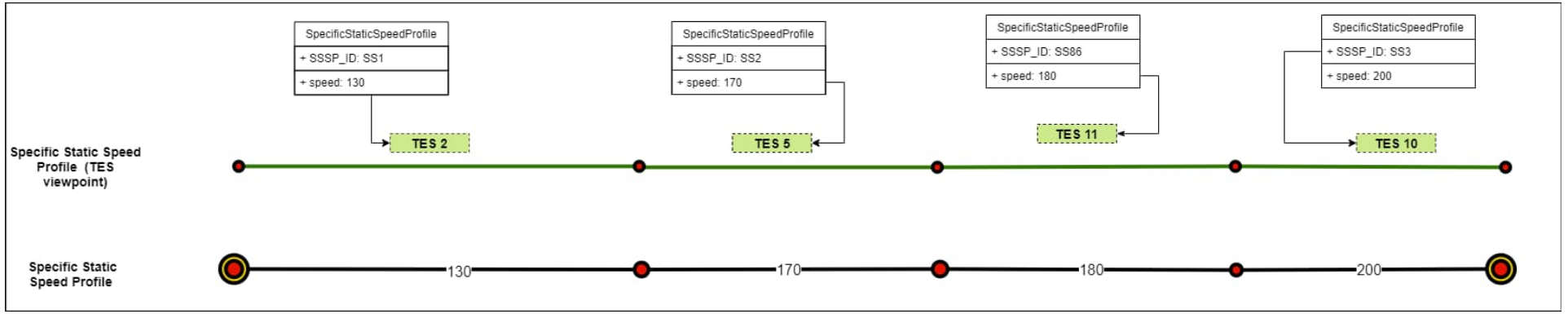


Figure 40: Specific Static Speed Profiles

8.2.4.3 Dependencies

The specific static speed profiles (if needed) can also be converted to a point-based reference system (TEPs) using the section-based reference (TESs).

8.2.5 Axle Load Speed Profile

Definition of speed profile for axle load categories.

8.2.5.1 Definition

Table 26: Definition Axle Load Speed Profile

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-ALSP	***SpeedProfile* ::** **AxleLoadSpeedProfile**						
T3-ALSP-1		axleLoadCategory	ENUM value indicating the suitable Axle load category. See column range for an elaborative list (Section 7.5.1.62 [7]).	ENUM	- A - HS17 - B1 - B2 - C2 - C3 - C4 - D2 - D3 - D4 - D4XL - E4 - E5	1	

8.2.5.2 Basis / rules and regulations

The Axle Load Speed Profiles shall be represented as TES with constant speed profile throughout the section. They do not need to be defined continuous throughout the track network but defined on track network where needed.

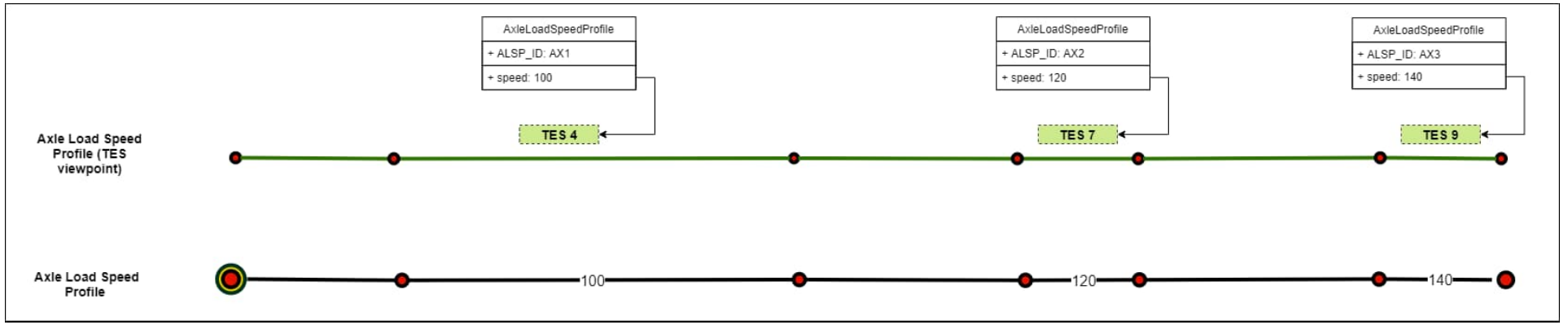


Figure 41: Axle Load Speed Profiles

8.2.5.3 Engineering rules

For each section with a speed restriction due to axle load, the different speed value(s) and for which minimum axle load category this speed value(s) applies shall be specified.

Different speed restrictions depending on the axle load category can be applicable for the same section.

8.2.5.4 Dependencies

The axle load speed profiles (if needed) can also be converted to a point-based reference system (TEPs) using the section-based reference (TESs).

8.3 Gradient

Gradient describes the vertical alignment of the track with the use of the following geometric primitives (vector-based approach):

- Lines: Used for ramps or flat track sections
- Circle sections: Used for transitions between different line sections

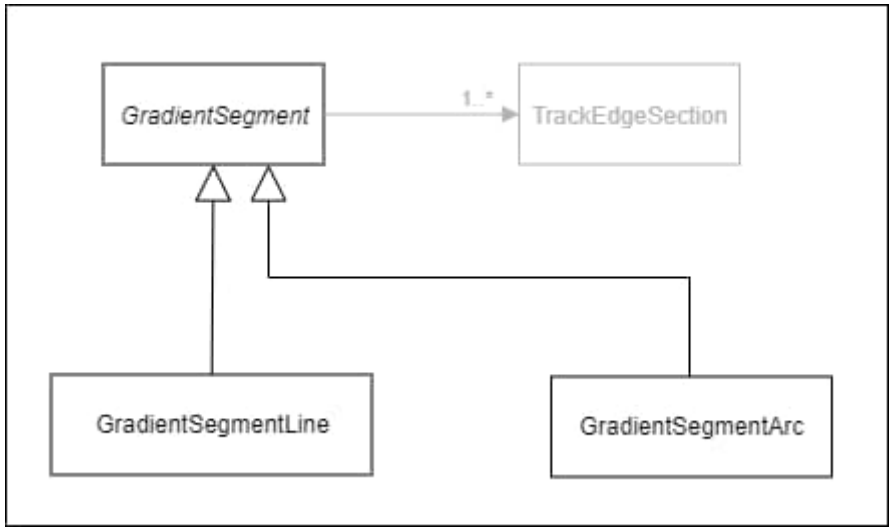


Figure 42: Taxonomy for Gradient

8.3.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	X	X	X

8.3.2 Gradient Segment

Base definition of a gradient with properties, which are applicable to all derived elements of the gradient. The specific elements of a gradient are defined as an extension to this base object.

8.3.2.1 Definition

Table 27: Definition GradientSegment

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-GS	***GradientSegment***						
T3-GS-1		id	Unique generated ID	String	UUID	1	
T3-GS-2		name	Name of the gradient profile	String	alphanumeric	1	
T3-GS-3		version	Reference to the version information	*Version*	-	1	
T3-GS-4		startAltitude	Altitude at the start of the gradient in meter (with 3 decimal places)	Double	-999.999 - +9999.999	1	m
T3-GS-5		appliesToTrackEdge-Section	Track Edge Sections which apply to the defined gradient profile.	*TrackEdgeSection*	-	1..*	

Note: The Gradient Segment is an *abstract object*, which cannot be used standalone. Only the derived objects must be used to define a specific gradient element.

8.3.2.2 Basic / rules and regulations

The Gradient Segments always have an implicit direction given by the referenced Track Edge Sections, which is from the start Track Edge Point to the end Track Edge Point.

The cardinality 1..* for the referenced Track Edge Sections is not to be confused with instantiation of TA(s). In case of Gradient Segments, this cardinality allows us to use the same object instantiation for several Track Edge Sections that exist on the network with same Gradient Segment values.

8.3.3 Gradient Segment Line

The Gradient Segment Line defines the ramps or flat track sections of a gradient section.

8.3.3.1 Definition

Table 28: Definition Gradient Segment Line

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-GSL	***GradientSegment* :: GradientSegmentLine**						
T3-GSL-1		gradient	Inclination of the track in "per mill" (with 3 decimal places)	Double	-99.999 - +99.999	1	per mill (‰)

8.3.3.2 Engineering rules

The representation of the ramps or flat track sections using the geometric primitive line is shown in the following figure:

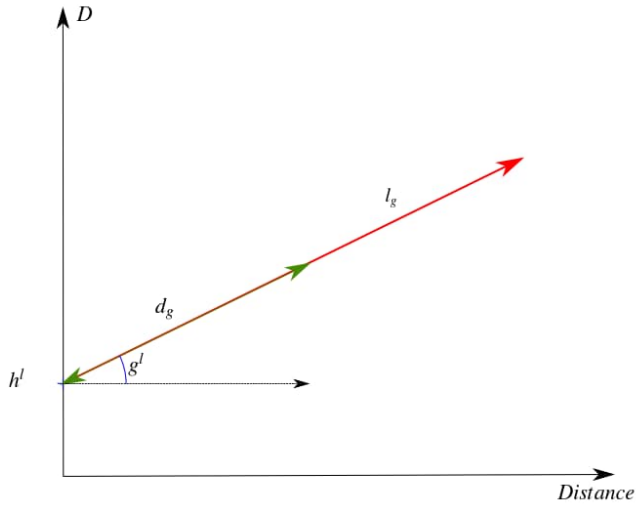


Figure 43: Representation of a Gradient Segment Line

The line has the following parameters:

- h^l: Altitude at the start Track Edge Point of the referenced Track Edge Section
- g^l: Inclination of the track in permille
  - o < 0: Downhill in the direction from the start to the end Track Edge Point
  - o 0: Plane
  - o > 0: Uphill in the direction from the start to the end Track Edge Point
- l_g: Length of referenced Track Edge Section

The desired features at an arbitrary point can be derived using the following equations:

- For line sections, the gradient at an arbitrary point along the Track Edge Section is always constant and equal to the initial gradient.
- The altitude (h_p) at an arbitrary point can be calculated using the formula:

$$h_p = h^l + \frac{g^l}{1000} d_g$$

Where d_g is the distance from start of Track Edge Section to the arbitrary point.

8.3.4 Gradient Segment Arc

The Gradient Segment Arc defines the transitions between different line sections.

8.3.4.1 Definition

Table 29: Definition Gradient Segment Arc

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-GSA	***GradientSegment* :: GradientSegmentArc**						
T3-GSA-1		radius	Radius of the arc in meter (with 3 decimal places)	Double	-9999.999 - 9999.999	1	m
T3-GSA-2		initialGradientAngle	Angle (θ) in degrees (°) between the north-east plane and the track at starting point (with 3 decimal places)	Double	0.000 - 359.999	1	Degree (°)

8.3.4.2 Engineering rules

The representation of the transition sections using the geometric primitive circle is shown in the following figure:

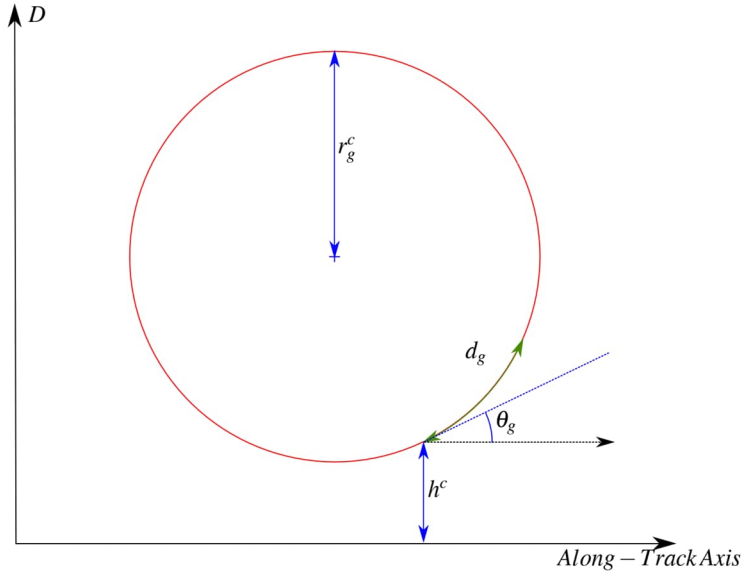


Figure 44: Representation of a Gradient Segment Arc

The circle has the following parameters:

- h^c: Altitude at the start Track Edge Point of the referenced Track Edge Section
- r^c_g: Radius of the arc resp. circle
    - A circle section of the gradient layer having its centre point above the track has a positive radius, whereas a circle section having its centre point below the track has a negative radius. In this case the track direction is defined in azimuth direction.
- l_g: Length of referenced Track Edge Section (This is not shown in the illustration)
- θ_g: Gradient angle at the start Track Edge Point of the referenced Track Edge Section.
- d_g: Distance from start of Track Edge Section to the arbitrary point.

The desired features at an arbitrary point refer to formula provided in Section 4.2.2 in [11].

8.3.5 Example

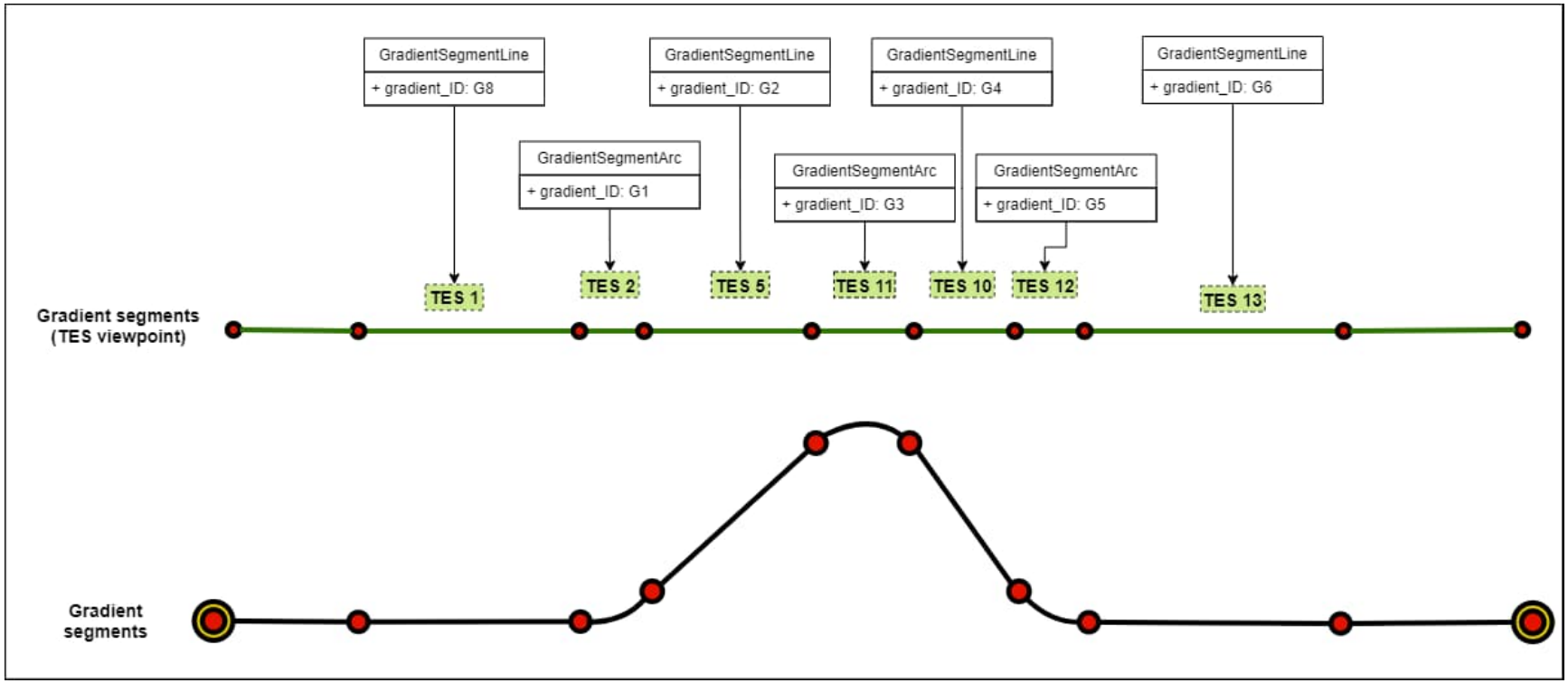


Figure 45: Gradient segments

8.4 Curve

Curve describes the horizontal alignment of the track with the use of the following geometric primitives (vector-based approach):

- Lines (for straight sections)
- Circle sections (for curves)
- Clothoids (for track transition curves)

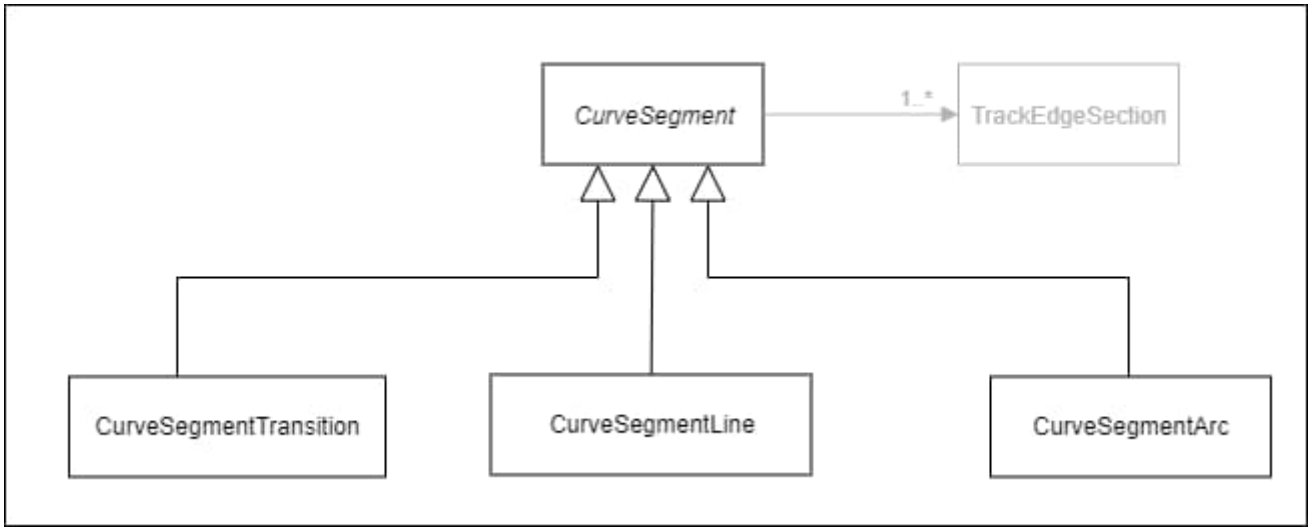


Figure 46: Taxonomy for Curve

8.4.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	X	X	X	X	X	X

8.4.2 Curve Segment

Base definition of a curve with properties, which are applicable to all derived elements of the curve. The specific elements of a curve are defined as an extension to this base object.

8.4.2.1 Definition

Table 30: Definition Curve Segment

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-CUS	***CurveSegment***						
T3-CUS-1		id	Unique generated ID	String	UUID	1	
T3-CUS-2		name	Name of curve profile	String	alphanumeric	1	
T3-CUS-3		version	Reference to the version information	*Version*	-	1	
T3-CUS-4		appliesTo TrackEdgeSection	Track Edge Sections which apply to the defined curve profile.	*TrackEdgeSection*	-	1..*	

Note: The Curve Segment is an *abstract object*, which cannot be used standalone. Only the derived objects must be used to define a specific curve element.

8.4.2.2 Basic / rules and regulations

The Curve Segments always have an implicit direction given by the referenced Track Edge Sections, which is from the start Track Edge Point to the end Track Edge Point.

The cardinality 1..* for the referenced Track Edge Sections is not to be confused with instantiation of TA(s). In case of Curve Segments, this cardinality allows us to use the same object instantiation for several Track Edge Sections that exist on the network with same Curve Segment values.

8.4.3 Curve Segment Line

The Curve Segment Line defines the straight parts of a Track Edge.

8.4.3.1 Definition

Table 31: Definition Segment Line

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-SL	***CurveSegment* :: CurveSegment-Line**						
T3-SL-1		azimuthAngle	Angle (Ψ) in degrees (°) between the north direction and the line (with 3 decimal places).	Double	0.000 - 359.999	1	Degree (°)

8.4.3.2 Engineering rules

The representation of the straight sections using the geometric primitive line is shown in the following figure:

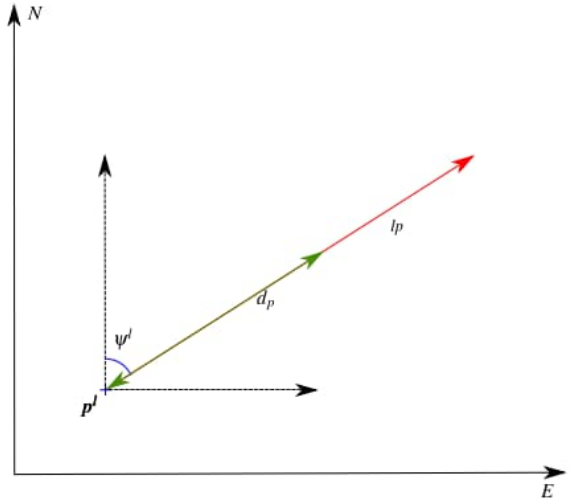


Figure 47: Representation of a Segment Line

The line has the following parameters:

- p^l: Starting Point, Geocoordinate of the start Track Edge Point of the referenced Track Edge Section
- l_p: Length of referenced Track Edge Section
- Ψ^l: Azimuth angle

The desired features at an arbitrary point can be derived using the following equations:

- For a line section, the azimuth remains constant throughout the section. Hence, the azimuth at any arbitrary point is equal to the initial azimuth.
- North coordinates of arbitrary point, $p_n = p^l_n + d_a * \cos(\Psi^l)$
- East coordinates of arbitrary point, $p_e = p^l_e + d_a * \sin(\Psi^l)$

d_p is the distance from start of Track Edge Section to the arbitrary point.

8.4.4 Curve Segment Arc

The Curve Segment Arc defines the curved parts of a Track Edge with a constant radius over the whole curve.

8.4.4.1 Definition

Table 32: Definition Curve Segment Arc

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-CSA	***CurveSegment* :: CurveSegmentArc**						
T3-CSA-1		radius	Radius of the curve arc in meter.	Double	-99999.999-+99999.999	1	m
T3-CSA-2		initialArcLength	Distance from the north pole of the circle to starting point (with 3 decimal places)	Double	0 - 99999.999	1	m
T3-CSA-3		hasCenterAtGeoCoordinates	Geo-Coordinates of the centre point of the arc	*GeoCoordinates*	-	1	

8.4.4.2 Engineering rules

The representation of the curve sections using the geometric primitive circle is shown in the following figure:

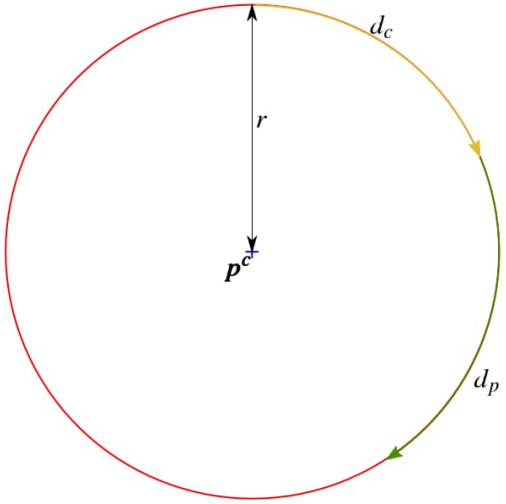


Figure 48: Representation of a Curve Segment Arc

The circle has the following parameters:

- p^c: Geocoordinates of the centre point of the arc resp. circle
- r: Radius of the arc resp. circle (the radius of the curve)
  Note: A circle section having its centre point to the right of the track has a positive radius, whereas a circle section having its centre point to the left of the track has a negative radius. In this case the track direction is defined in azimuth direction.
- l_p: Length of referenced Track Edge Section (This is not shown in the illustration)
- d_c: Initial arc length from the north pole of the circle to the start Track Edge Point of the referenced Track Edge Section
- d_p: Distance from start of Track Edge Section to the arbitrary point.

The desired features at an arbitrary point can be derived using the following equations:

- The radius of the arc section at an arbitrary point along the Track Edge Section is always equal to the radius of the initial radius of the arc.

For other desired features like coordinates or azimuth at an arbitrary point refer to formula provided in Section 4.1.2 in [11].

8.4.5 Curve Segment Transition

The Curve Segment Transition defines the transitions from the straight to the curved (circle) sections. Currently only clothoids are supported as transition elements.

8.4.5.1 Definition

Table 33: Definition Curve Segment Transition

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-CST	***CurveSegment* :: CurveSegmentTransition**						
T3-CST-1		hasCenterAtGeo-Coordinates	Geo-Coordinates of the centre point of the clothoid	*GeoCoordinates*	-	1	
T3-CST-2		clothoidParameter	Clothoid parameter, a fixed and positive constant (with 3 decimal places).	Double	0.001 – 99999.999	1	
T3-CST-3		initialArcLength	Distance from the centre point of the clothoid to the starting point (with 3 decimal places)	Double	0 - 99999.999	1	m
T3-CST-4		azimuthAngle	Angle (Ψ) in degrees (°) between the north direction and the orientation of the clothoid center (with 3 decimal places).	Double	0.000 - 359.999	1	Degree (°)

8.4.5.2 Engineering rules

The representation of the transition sections using the geometric primitive clothoid is shown in the following figure:

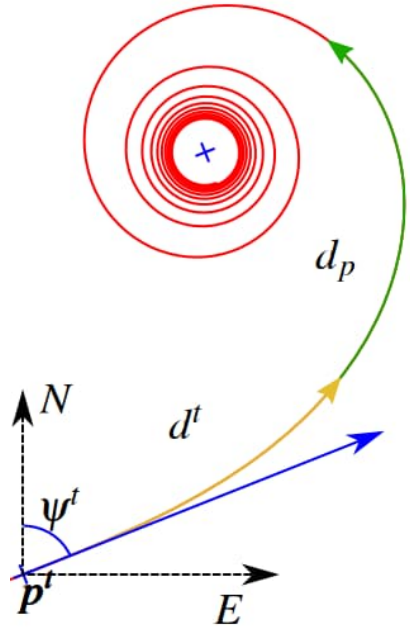


Figure 49: Representation of a Curve Segment Transition

The clothoid has the following parameters:

- p^t: Geocoordinates of the centre point of the clothoid
- l_p: Length of referenced Track Edge Section (This is not shown in the illustration)
- d_t: Initial arc length from centre of clothoid to the start Track Edge Point of the referenced Track Edge Section
- Ψ: Azimuth angle at the centre of clothoid

The desired features at an arbitrary point can be derived using the following equations:

- The rate of change of radius (r) with respect to the distance (d) or a radius along an arbitrary point along the transition section is provided by the equation:

  $r(d) = \frac{(k^t)^2}{dp+d^t}$

  where,

  k^t is the clothoid parameter. A clothoid with k = 1 is called a standard clothoid.

  r is radius at the arbitrary point

  d_p is the distance from start of Track Edge Section to the arbitrary point

For desired features at an arbitrary point refer to formula provided in Section 4.1.3 in [11].

8.4.6 Example

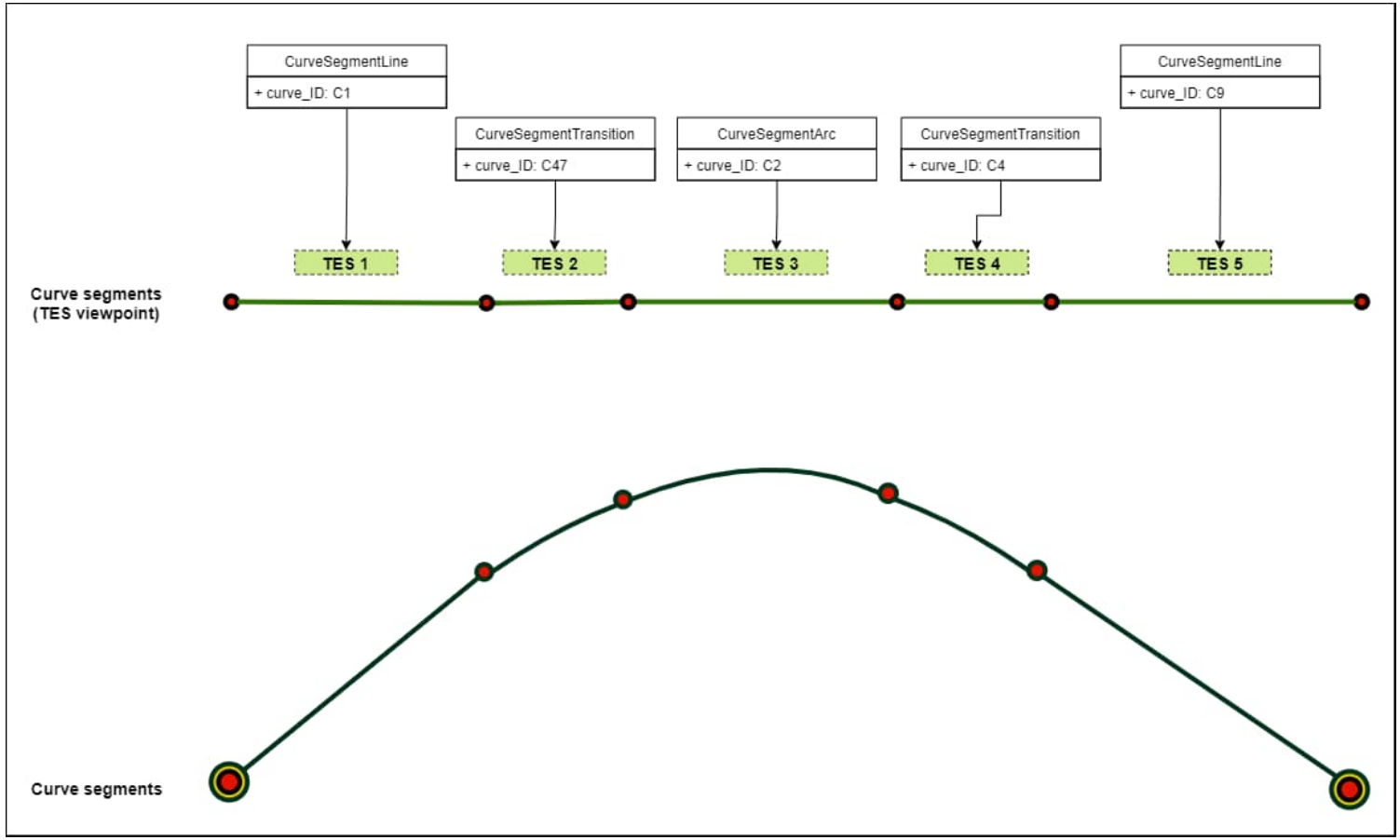


Figure 50: Curve segments

8.5 Cant

Cant describes the rate of change in elevation (height) between the two rails of a railway track with the use of the following geometric primitives (vector-based approach):

- Line: Used for constant cant segments and transitions between constant cant segments

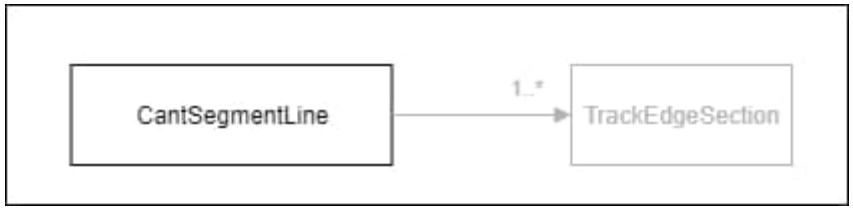


Figure 51: Cant

8.5.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	X	X	X	X	X	X

8.5.2 Cant Segment Line

Base definition of cant with properties. The Cant Segment Line defines both constant cant segments and transitions between constant cant segments.

8.5.2.1 Definition

Table 34: Definition CantSegmentLine

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-CAS	**CantSeg-mentLine**						
T3-CAS-1		id	Unique generated ID	String	UUID	1	
T3-CAS-2		name	Name of cant profile	String	alphanumeric	1	
T3-CAS-3		version	Reference to the version information	*Version*	-	1	
T3-CAS-4		applie-sToTrackEdgeSec-tion	Reference to the Track Edge Sections for which the defined cant profile applies.	*TrackEdgeSection*	-	1..*	
T3-CAS-5		startCant	Cant value in mm at the start of the Track Edge Section	Integer	-999 - +999	1	mm
T3-CAS-6		endCant	Cant value in mm at the end of the Track Edge Section	Integer	-999 - +999	1	mm

8.5.2.2 Basic / rules and regulations

The Cant Segments always have an implicit direction given by the referenced Track Edge Sections, which is from the start Track Edge Point to the end Track Edge Point.

The cardinality 1..* for the referenced Track Edge Sections is not to be confused with instantiation of TA(s). In case of Cant Segments, this cardinality allows us to use the same object instantiation for several Track Edge Sections that exist on the network with same Cant Segment values.

8.5.2.3 Engineering rules

The representation of the cant sections using the geometric primitive line is shown in the following figure:

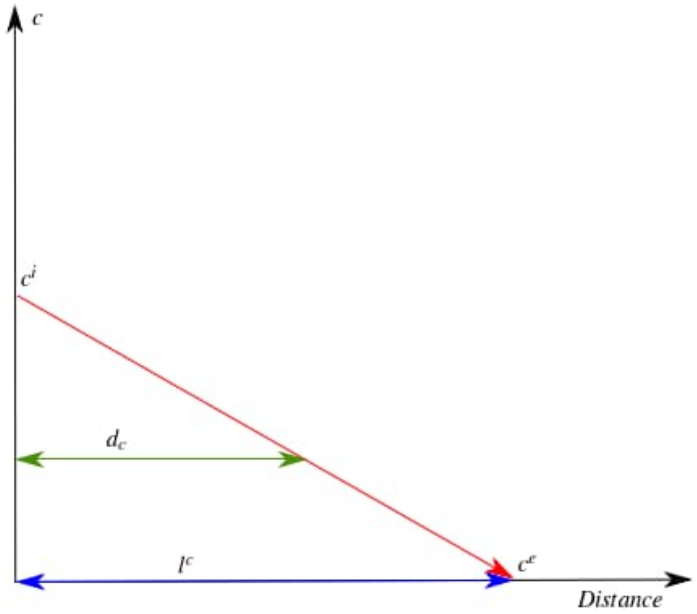


Figure 52: Representation of a Cant Segment Line

The line has the following parameters:

- c^i: Cant at the start Track Edge Point of the referenced Track Edge Section
- c^e: Cant at the end Track Edge Point of the referenced Track Edge Section
- l^c: Length of referenced Track Edge Section

If a section has a constant cant segment, then c^i and c^e are equal. For transition sections the values of c^i and c^e are different.

The desired features at an arbitrary point can be derived using the following equations:

- Cant at an arbitrary point along the section can be calculated using the formula,

  $$c = c^i + \frac{c^e - c^i}{l^c} d_c$$

  Where d_c is the distance from start of the Track Edge Section to an arbitrary point on the section.

- Roll angle ϕ at an arbitrary point can be calculated using the formula,

  $\phi = \arctan\left(\frac{c}{t^c}\right)$

  where t^c is the track gauge between the centre of the running rails.

The reference for the cant value is the right rail in the implicit direction of the referenced track edge section. Positive values indicate that the left rail is higher than the right one (right curve), negative values that the left rail is lower than the right one (left curve).

8.5.3 Example

The curves shall be represented as TES with appropriate constant cant throughout the section.

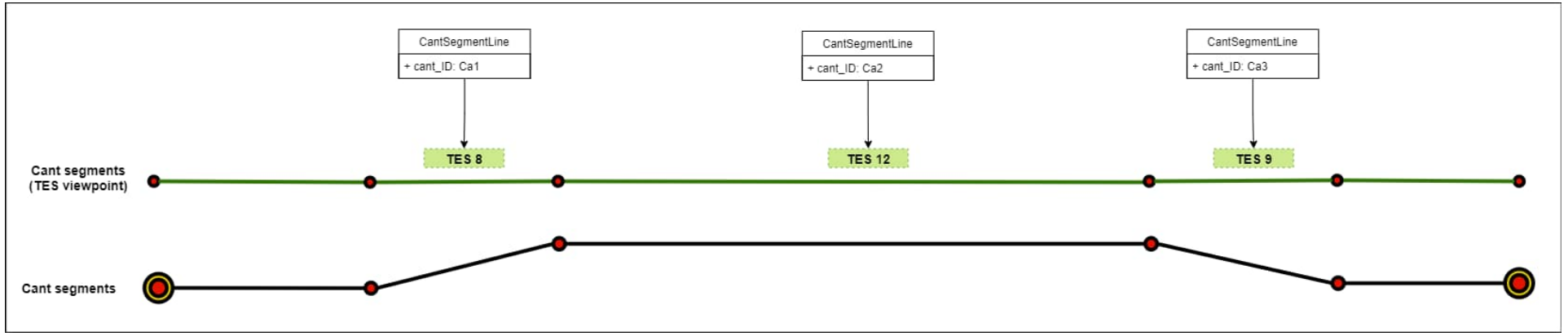


Figure 53: Cant segments

8.6 Allocation Section

Allocation Sections are located as Linear Contiguous Track Areas (LCTA) where one or more clearance gauge conflicts between different tracks arise. The conflict arises when the clearance gauges of different tracks overlap each other. Out of this conflict an exclusive, symmetric interdependency between two or more Allocation Sections can be deduced.

8.6.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	-	X	-	-	-

8.6.2 Definition

Table 35: Definition Allocation Section

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-ALS	**AllocationSection**						
T3-ALS-1		id	Unique generated ID	String	UUID	1	
T3-ALS-2		name	Name of the allocation section	String	alphanumeric	1	
T3-ALS-3		version	Reference to the version information	*Version*	-	1	
T3-ALS-4		appliesToTrackArea	Reference to the LCTA, which defines the extend of this allocation section. The LCTA should contain references to Track Edge Sections. The effective direction of the LCTA can be derived from the start and end TEPs of the LCTA. The direction always leads away from conflict area to non-conflict area of clearance gauge (needed for the risk path search).	*LinearContiguous TrackArea*	-	1	
T3-ALS-5		isDependentOnAllocationSection	This is an exclusive dependency to other Allocation Sections. The dependency refers to the adjacent allocation sections, which might	*AllocationSection*	-	1..*	

			be affected by a moveable object or movement permission extent when the current allocation section is fully or partially occupied by a moveable object or movement permission extent.				

8.6.3 Basis / rules and regulations

Exclusive dependency means that if one Allocation Section is fully or partially occupied by a track-bound moveable object or if it is fully or partially contained in a granted movement permission, no movement permission may be granted over any dependent Allocation Section.

A non-complete list of usages is:

- Points, interlaced points
- Diamond crossings
- Single and double slip crossings
- Three rail dual gauge tracks and gauntlet tracks.

All use cases and the according modelling principles can be affiliated to three basic assets:

- a diverging of Track Edges in a Track Node (point)
- a crossing of Track Edges (diamond crossing)
- an interlacing Track Edge or clearance profile (gauntlet).

8.6.4 Engineering rules

- Allocation Sections may overlap each other.
- Each Allocation Section has 1..* dependent Allocation Section.
- Allocation Sections that share a common piece of track (with length > 0) shall not have an exclusive interdependency.
- Allocation Sections are directed using the start and end Track Edge Point of the LCTA to enable the risk path search. The direction always leads away from the dependent Allocation Section (from conflict area to non-conflict area of clearance gauge).
- If the track diverges within an Allocation Section in the direction of the Allocation Section (interlaced points / crossings), both branches need their own Allocation Sections.

An example representation of allocation sections is illustrated below:

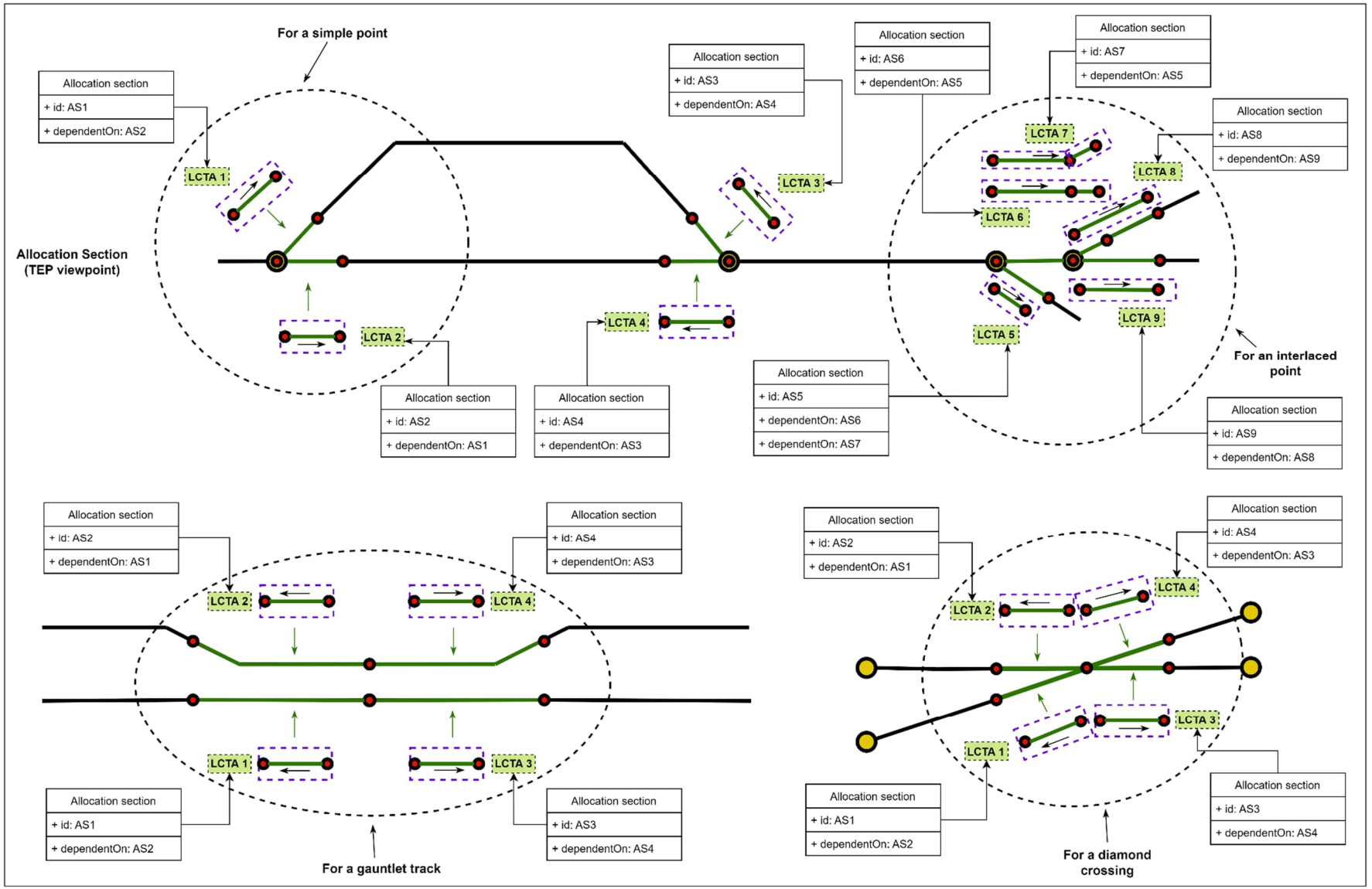


Figure 54: Allocation Sections

8.7 Drive Protection Section

A Drive Protection Section (DPS) represents a track section that can be brought to different drivability states to ensure the drivability or safety of a track route. As such, it is an abstraction for any location on the railway network that may adopt different states due to controllable trackside assets (e.g. points or level crossings).

8.7.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	-	X	-	-	-

8.7.2 Definition

Table 36: Definition Drive Protection Section

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-DPS	**DriveProtection-Section**						
T3-DPS-1		id	Unique generated ID	String	UUID	1	
T3-DPS-2		name	Name of the Drive Protection Section	String	alphanumeric	1	
T3-DPS-3		version	Reference to the version information	*Version*	-	1	
T3-DPS-4		applie-sToTrackEdgeSec-tion	Reference to Track Edge Section, for which the drive protection is valid.	*TrackEdgeSection*	-	1	
T3-DPS-5		flankProtectionDi-rection	Static configuration of the direction (in rela-tion to the TrackEdgeSection) in which the DPS is able provide flank protection (only relevant for points and derailers). This at-tribute does not imply any explicit usage di-rections for the DPS.	ENUM	- None - Start to End - End to Start - Both	1	
T3-DPS-6		minimalDrivability	Minimal default drivability state if no feed-back from element is available.	ENUM	- None - Full - Limited	1	

8.7.3 Basis / rules and regulations

Drive Protection Sections (DPS) must be engineered as a Track Edge Section at all locations in the track network where external assets with switchable field elements are present.

In detail, these are (non-exhaustive list):

- Simple points (with and without movable frogs)
- Slip crossings (single and double)
- Diamond crossings with movable frogs
- Derailment devices
- Level crossings (including level crossings to protect the access to platforms)
- Turntables and Traversers
- Gates
- Movable bridges

8.7.4 Engineering rules

- Simple points:
    - Two DPSs, one for each end position (right and left position).
    - Naming convention: DPS-{point number}-{L|R}
    - Minimal default trafficability will be “None”
- Double slip crossings:
    - Eight DPSs, four on each side.
    - Naming convention: DPS-{point number}-{A|B}-{L|R}-{1-2}
    - Minimal default trafficability will be “None”
- Single slip crossings:
    - Four DPSs, two on each side.
    - Naming convention: DPS-{point number}-{A|B}-{L|R}
    - Minimal default trafficability will be “None”
- Diamond crossing with moveable frogs:
    - Four DPSs, two on each side.
    - Naming convention: DPS-{point number}-{A|B}-{L|R}
    - Minimal default trafficability will be “None”
- Derailer:
    - One DPS.

- Naming convention: DPS-{point number}
- Minimal default trafficability will be “None”

- Level crossings:
  - One DPS, for each track that passes over the level crossing.
  - Naming convention: DPS-{level crossing number}-{1..n} (1..n represents the number of tracks)
  - Minimal default trafficability will be “None”
- All other elements:
  - The engineering of a DPS for other elements such as turntables, ramp tracks, gates, lifting platforms and movable bridges must be individually analysed and carried out depending on the situation, as these elements do not have a standardised shape and extension.

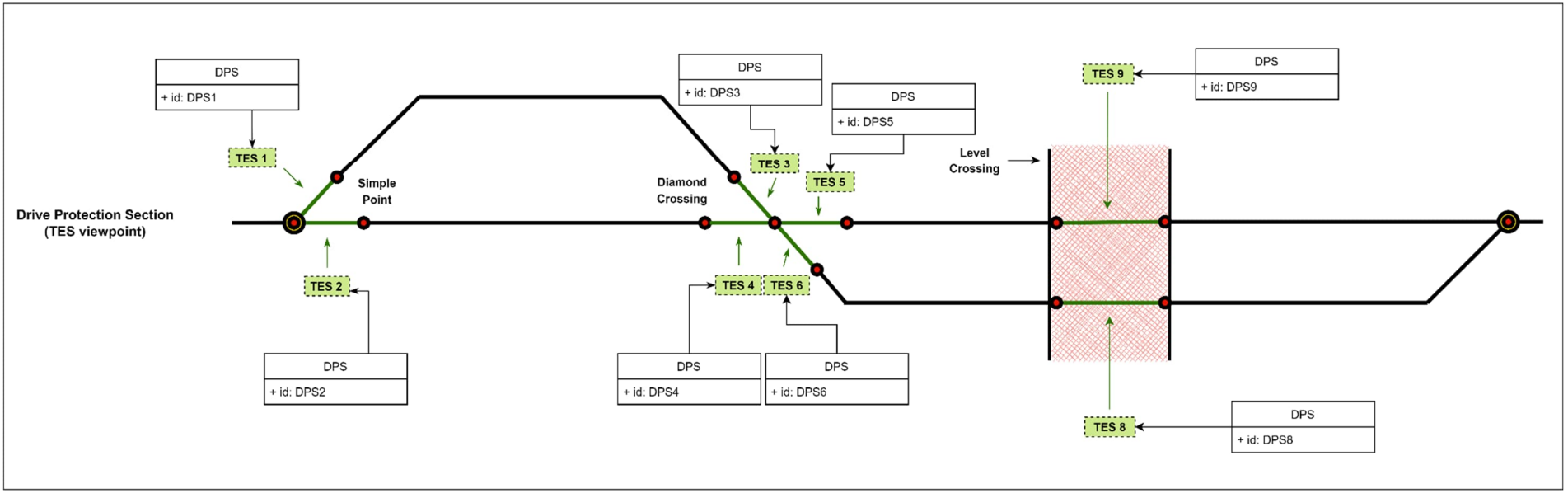


Figure 55: Drive Protection Sections for simple points, diamond crossings and level crossings

Note: The exact length of a DPS is subject to CCS considerations and will be clarified and defined there.

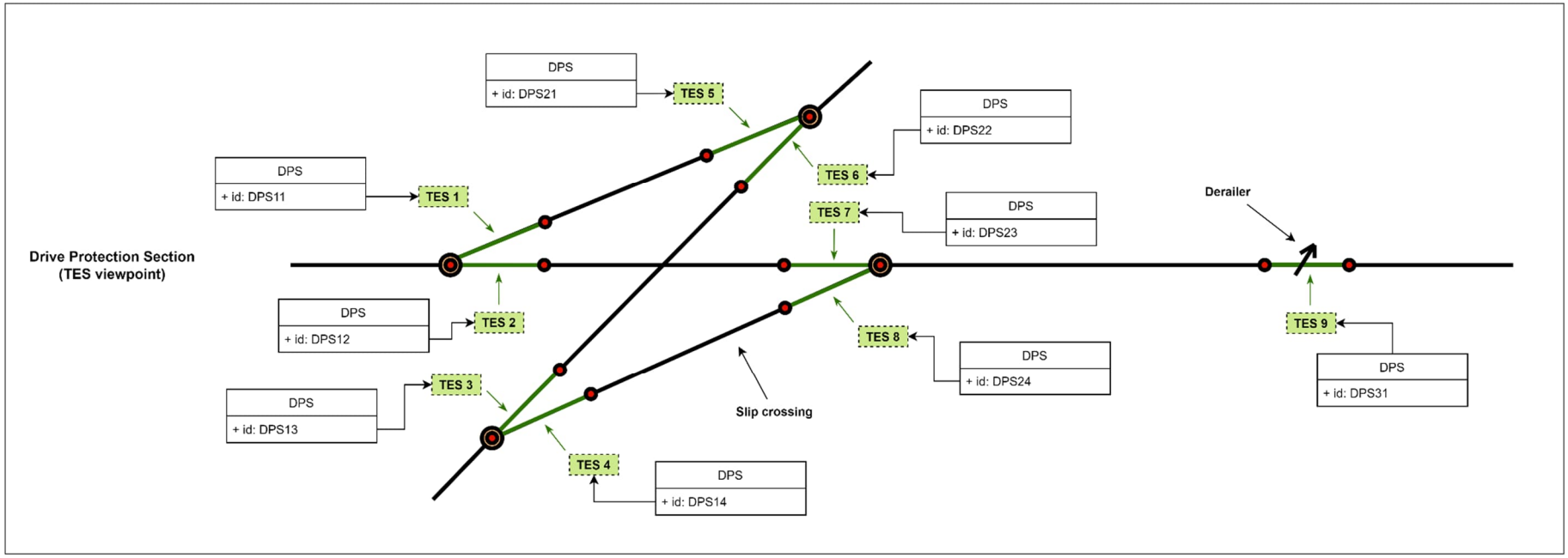


Figure 56: Drive Protection Sections slip crossings and derailer

8.7.4.2 Flank Protection

A DPS representing a point might be used to provide flank protection, but only in the direction from the point tip to the point end. In the other direction, the flank protection cannot be provided, as the point can be trailed. A DPS representing a derailer can provide flank protection in the intended derailment direction.

The attribute "flankProtectionDirection" is used to generally determine for a DPS whether it can be used for a flank protection request or not. This is particularly relevant to determine the position and direction of a point for a DPS group which could provide flank protection if it is operationally required. The value of the attribute should normally be set automatically during the engineering process, depending on the track layout and on underlying engineering rules.

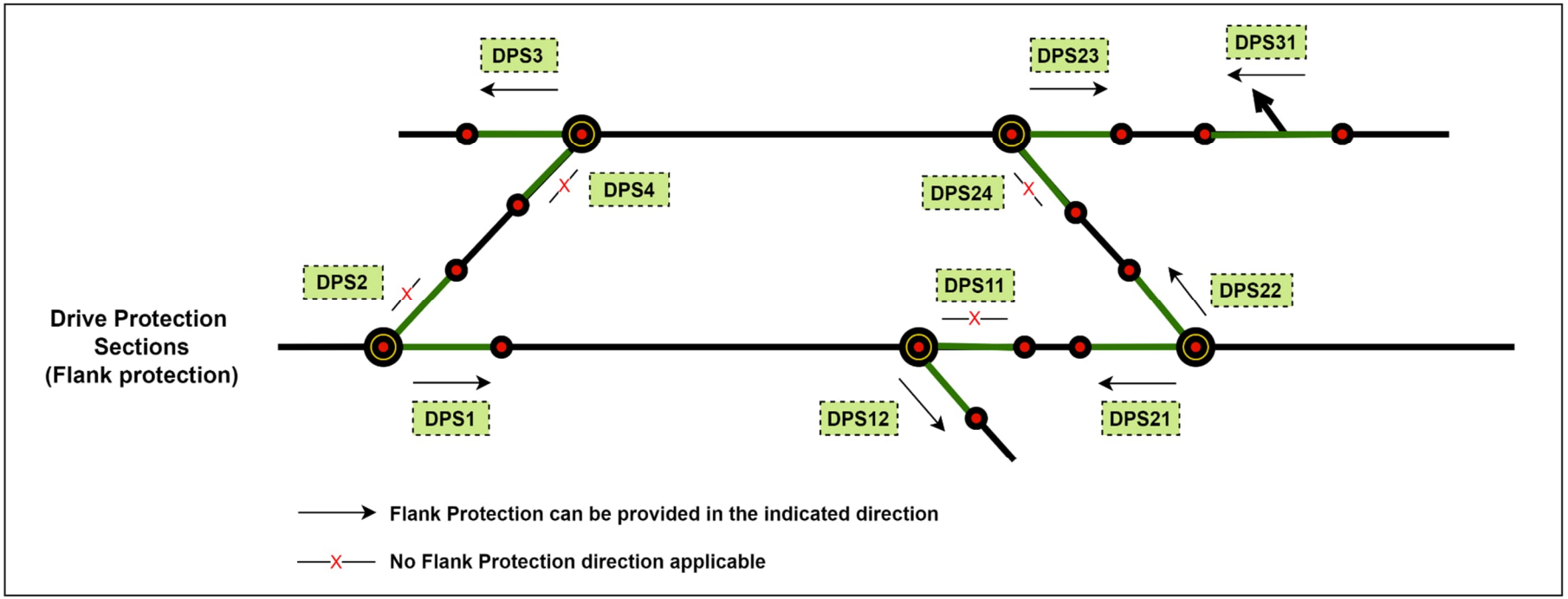


Figure 57: DPS and Flank Protection

8.7.5 Dependencies

After all the DPSs for an element have been created, the resulting Drive Protection Section Groups must be created (see next chapter 8.8 Drive Protection Section Group).

Comparison between Drive Protection Section and Allocation Section to highlight the difference between both concepts:

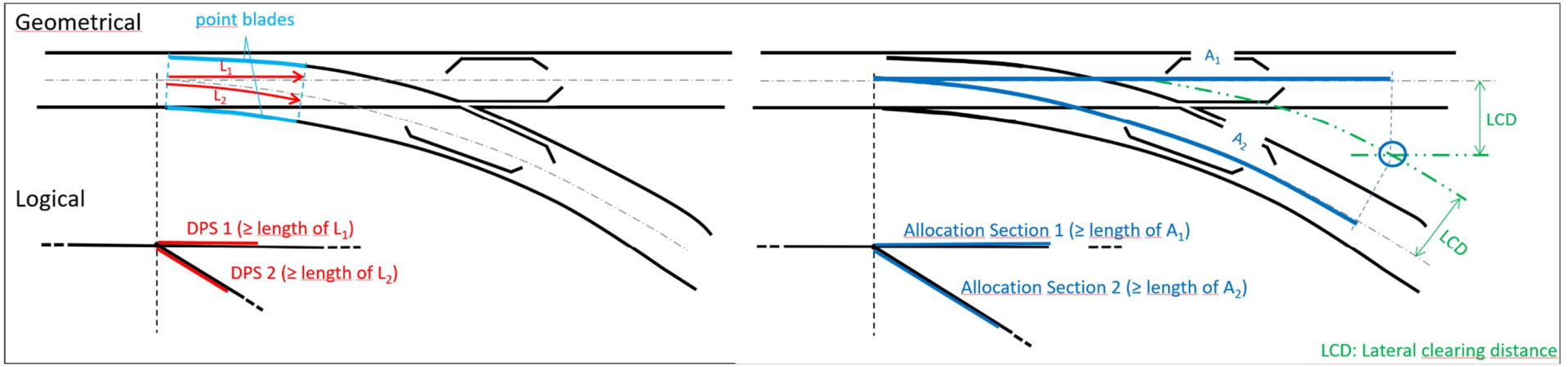


Figure 58: Drive Protection Section and Allocation Section

- DPS
  - Track Edge Section that is as long as the movable parts of the point (length of L_1 and L_2 from the point tip to the end of the movable section of the tongues)
- Allocation Section
  - Track Edge Section that is as long as the clearance gauge violation area (length of A_1 and A_2 from the point tip to the fouling point). The Allocation Sections depend on each other i.e. as long as Allocation Section 1 is occupied, Allocation Section 2 must remain clear and vice versa.

8.8 Drive Protection Section Group

A Drive Protection Section Group (DPS Group) groups all DPSs that can only change their state depending on each other, meaning that a request for a different trafficability state on one DPS will affect any other DPS in the group.

8.8.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	-	X	-	-	-

8.8.2 Definition

Table 37: Definition Drive Protection Section Group

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-DPSG	**DriveProtection SectionGroup**						
T3-DPSG-1		id	Unique generated ID	String	UUID	1	
T3-DPSG-2		name	Name of the DPS Group.	String	alphanumeric	1	
T3-DPSG-3		version	Reference to the version information	*Version*	-	1	
T3-DPSG-4		consistsOf DriveProtectionSection	List of all interdependent Drive Protection Sections.	*DriveProtection Section*	-	1..*	

8.8.3 Basis / rules and regulations

A DPS must always be assigned to a DPS group, even if the group only contains exactly one DPS.

8.8.4 Engineering rules

- Simple points:
  - The two associated DPSs are combined into one DPS group.
  - Naming convention: DPSG-{point number}
- Double slip crossings:
  - The four DPSs on each side are combined into a separate DPS groups (in total two DPS groups).
  - Naming convention: DPSG-{point number}-{A|B}

- Single slip crossings:
  - The two DPSs on each side are combined into a separate DPS groups (in total two DPS groups).
  - Naming convention: DPSG-{point number}-{A|B}
- Diamond crossing with moveable frogs:
  - All four DPSs are combined into one DPS group.
    Note: Although this diamond crossing usually has two separate point machines (and therefore two DPS groups might be assumed), both sides are not independent from each other and must always operate together.
  - Naming convention: DPSG-{point number}
- Derailer:
  - The one DPS is combined into one DPS group.
  - Naming convention: DPSG-{point number}
- Level crossings:
  - All DPSs are combined into one DPS group.
  - Naming convention: DPSG-{level crossing number}
- All other elements:
  - DPS groups for other movable elements, such as lifting bridges, gates, or turntables must be configured manually, as the dimensions of these elements are not standardised and therefore the number and grouping of the DPSs cannot be configured automatically.

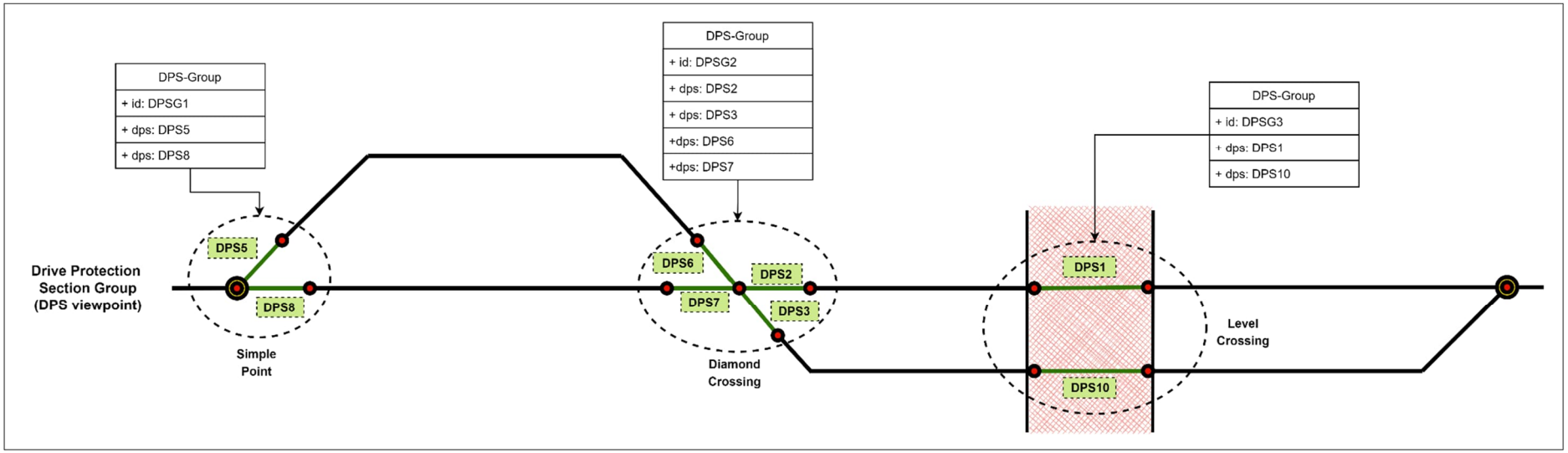


Figure 59: Drive Protection Section Groups for simple points, diamond crossings and level crossings

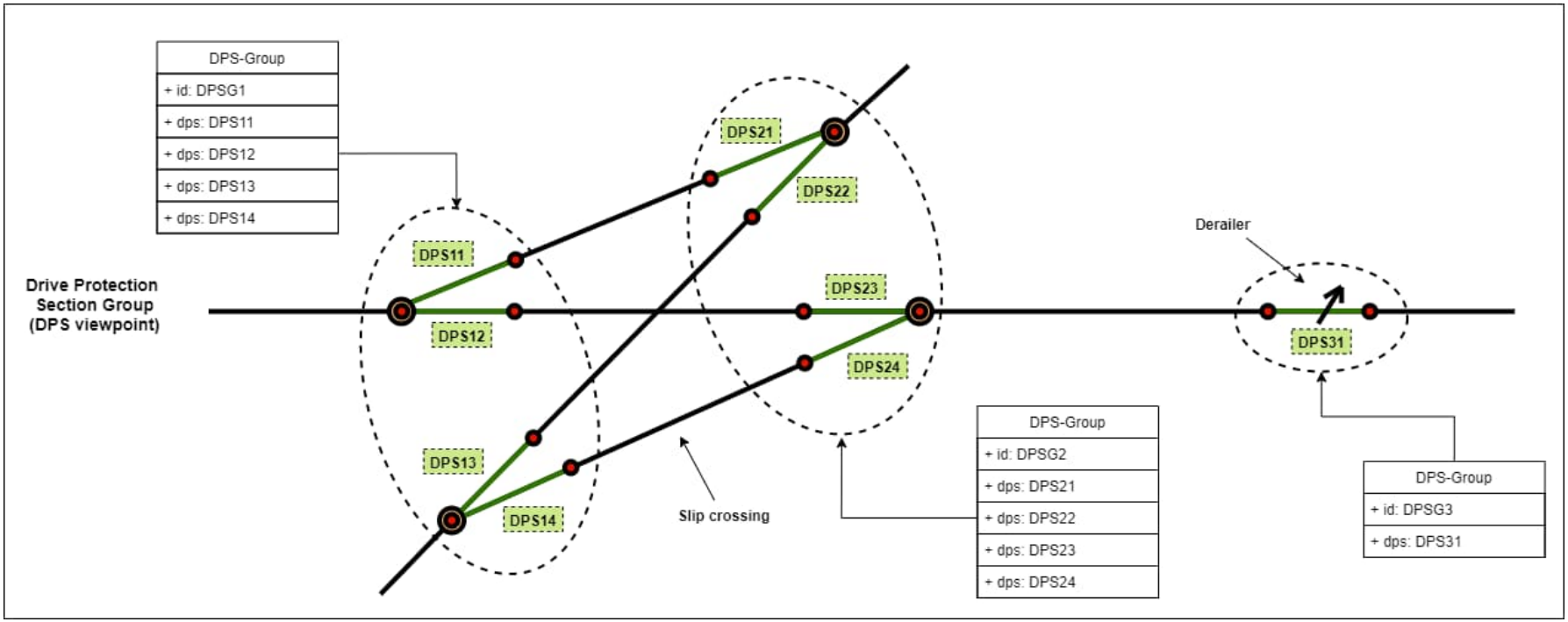


Figure 60: Drive Protection Sections Groups for slip crossings and derailer

8.8.5 Dependencies

Before configuring the DPS group, the associated DPSs must have been created.

8.9 Balise

Balises (resp. Eurobalises in the context of ETCS) are technical devices in the railway track bed that store information (telegram) and transmit it to rail vehicles passing the location of the Balise.

8.9.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X[4]	X	X	X	-	-	X

8.9.2 Definition

Table 38: Definition Balise

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-BAL	**Balise**						
T3-BAL-1		id	Unique generated ID	String	UUID	1	
T3-BAL-2		version	Reference to the version information	*Version*	-	1	
T3-BAL-3		name	Name of the balise	String	alphanu-meric	1	
T3-BAL-4		appliesToTrackEdgePoint	Reference to the Track Edge Point on which this balise is located.	*TrackEdgePoint*		1	
T3-BAL-5		positionInGroup	Position of the balise in the corresponding balise group (N_PIG, Section 7.5.1.81 in [7]).	Integer	1..8	1	
T3-BAL-6		baliseTelegram	Content of the balise telegram in case this balise represents a virtual balise (in the long format of length defined by Section 4.3.1.2 in [9]).	Binary	1023 Bit	0..1	

[4] The requirement of balise is uncertain from APS point of view. Clear requirements or rejections are missing at the moment.

8.9.3 Basis / rules and regulations

The balises shall be represented using a TEP on the topology and it is not associated with a direction. The positionInGroup describes the relative position of the balise in a balise group.

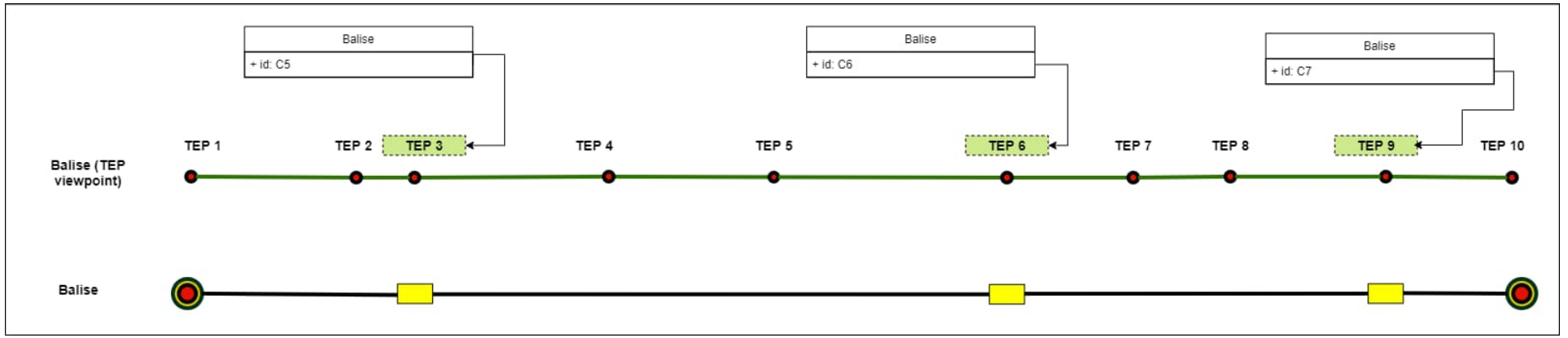


Figure 61: Balise

8.10 Balise Group

One or more balises to which the same reference position is assigned in the track.

8.10.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X[5]	X	X	X	-	-	X

8.10.2 Definition

Table 39: Definition Balise Group

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-BALG	**BaliseGroup**						
T3-BALG-1		id	Unique generated ID	String	UUID	1	
T3-BALG-2		name	Name of the balise group, proposal: {countryIdentifier}_{baliseGroupIdentifier}	String	alphanu-meric	1	
T3-BALG-3		version	Reference to the version information	*Version*	-	1	
T3-BALG-4		countryIdentifier	Country or region identifier (NID_C, Section 7.5.1.86 in [7])	Integer	0 - 1023	1	
T3-BALG-5		baliseGroupIdentifier	Identity number of the balise group. (NID_BG, Section 7.5.1.85 in [7])	Integer	0 - 16382	1	
T3-BALG-6		consistsOfBalise	Balises in this balise group	*Balise*	-	1..8	
T3-BALG-7		locationAccuracy	Defines the absolute value of the accuracy of the Balise location (Q_LOCACC, Section 7.5.1.115 in [7]).	Integer	0 – 63	1	

[5] The requirement of balise is uncertain from APS point of view. Clear requirements or rejections are missing at the moment.

8.10.3 Basis / rules and regulations

The balise groups do not have any topological relations but have a relation towards the different balises that are part of the current balise group. The topological references can be derived from the individual balises, if needed.

Every balise group has its own coordinate system. The orientation of the coordinate system of a balise group (i.e., nominal or reverse direction) is identified as balise group orientation. The origin of the coordinate system for each balise group is given by the balise number 1 (called location reference) in the balise group. The nominal direction of each balise group is defined by increasing internal balise numbers.

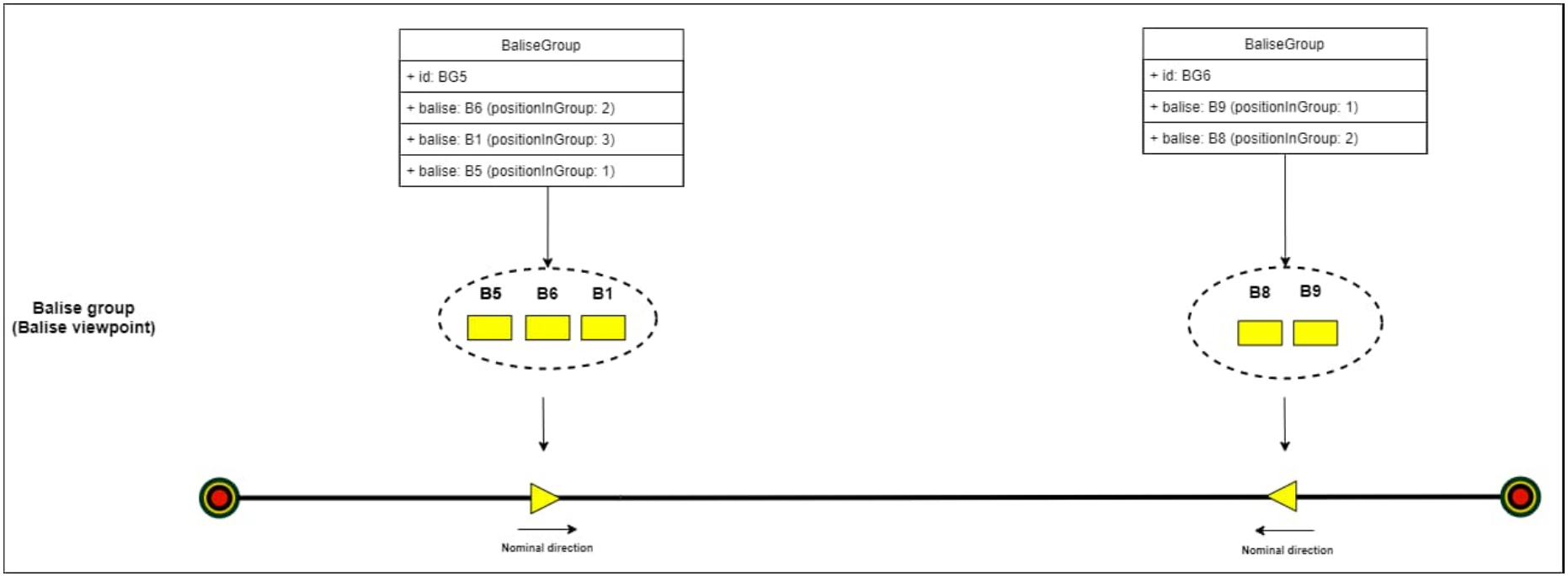


Figure 62: Balise groups

8.11 Timing Point

As defined in ATO over ERTMS glossary, ‘Timing Points have a location and stopping accuracy defined in the Segment Profile for which a type (Stopping or Passing Point) and specific time is identified in the Journey Profile. This time may be an arrival time, a departure time, or in the case of a train not scheduled to stop at that location, the passing time.’ [10]

8.11.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	X	X	-	-	-	-

8.11.2 Definition

Table 40: Definition Timing Point

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-TP	**TimingPoint**						
T3-TP-1		id	Unique generated ID	String	UUID	1	
T3-TP-2		name	Name of the timing point	String	alphanumeric	1	
T3-TP-3		version	Reference to the version information	*Version*	-	1	
T3-TP-4		timingPointIdentifier	Name of the timing point in the format: {countryIdentifier}_{timingPointIdentifier}	String	alphanumeric	1	
T3-TP-5		appliesToTrackEdgePoint	Reference to Track Edge Point at which this Timing Point is located.	*Directed-TrackEdgePoint*	-	1	
T3-TP-6		stopLocationTolerance	ENUM value indicating the required stopping tolerance to use when the TP is a Stopping Point.	*ENUM*	- 10cm - 20cm - 30cm - 40cm - 50cm - 1m - 1,5m - 2m - 2,5m - 3m - 5m - 7,5m - 10m - 15m - 20m	1	

					- 25m - 30m - 50m - 75m - 100m		
T3-TP-7		stoppingPointReachDistance	ENUM value indicating the distance from a Stopping Point to consider it as reached.	*ENUM*	- 10cm - 20cm - 30cm - 40cm - 50cm - 1m - 1,5m - 2m - 2,5m - 3m - 5m - 7,5m - 10m - 15m - 20m - 25m - 30m - 50m - 75m - 100m	1	
T3-TP-8		doorOpeningSide	ENUM value indicating on which side the passenger exchange doors have to be opened.	*ENUM*	- None - Right - Left - Both	1	
T3-TP-9		refersToSignal	Reference to trackside Signal at which the timing point is located	*Signal*	-	1	

8.11.3 Basic / rules and regulations

The timing points shall be represented using a DTEP on the topology.

8.11.4 Engineering rules

Timing points are engineered (keeping in mind ETCS L2 with marker boards) at,

1. Main signals
    a. Entry and Exit signals
    b. Block signals at which routes start or end
    c. Protection signals
2. ETCS location marker
3. ETCS stop marker boards at which routes start or end
4. Shunting signals
5. Stop posts
    a. based on train lengths (200m, 300m, …)
    b. based on stop location (H, 1, 2, 3, …)

In regards with RCA business goal T6 i.e. Movement Permission can start and end anywhere [12], timing points can be engineered at any required point along the track. This engineering shall lead to creation of static timing points and not dynamic timing points. Additional engineering rules regarding distance between the timing points, number of timing points, etc. are to be aligned with respective clusters.

Note: The rationale behind engineering timing points at shunting and protection signals is for optimisation purposes. Such timing points shall be always considered as ‘passing point’.

The illustration below shows the engineering of timing points along the ETCS stop marker boards.

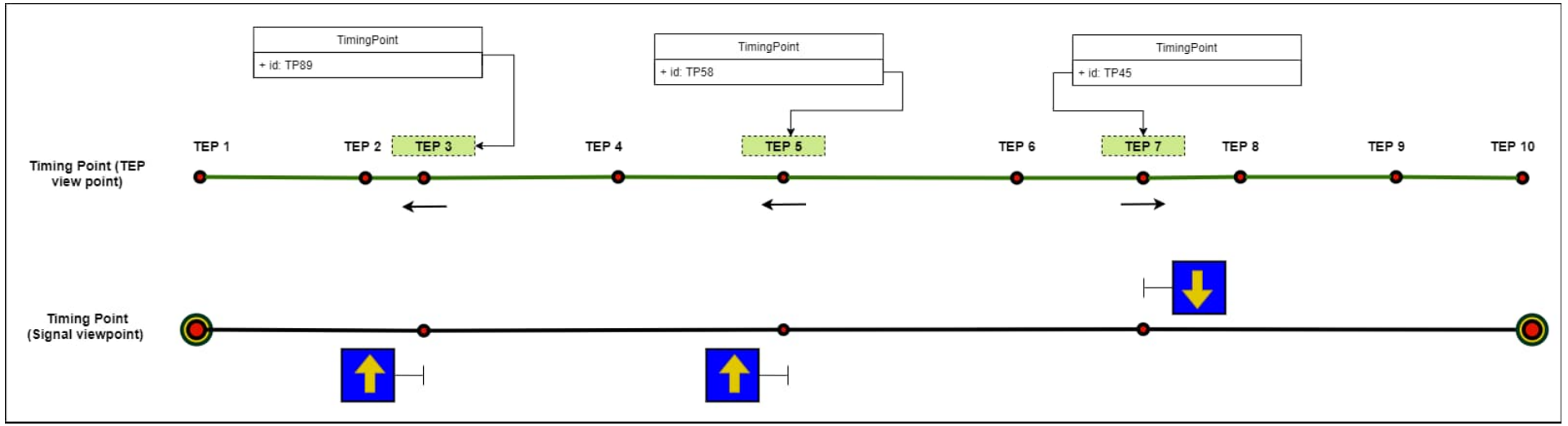


Figure 63: Timing Point

8.11.5 Dependencies

Timing points always have a reference to the signal at which they are located.

8.12 Segment Profile

As defined in ATO over ERTMS glossary, ‘Segment profiles are a set of static infrastructure data required by the ATO on-board to compute the Operational Speed Profile.’ [10]

Note:

1. This document only provides segment profile data along with references on the topology i.e. id, start and end locations, name, area, etc. and not the SS126 conform content of segment profiles. It is assumed that transformation to SS126 conform content shall be done on the consumer end.
2. In case, this method of definition / transformation of segment profiles and are not feasible for the consuming systems from operational, performance, or any other relevant point of views, then the definition of segment profiles corresponding to SS126 format shall be amended in this object catalogue.

8.12.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	-	X	-	-	-	-

8.12.2 Definition

Table 41: Definition Segment Profile

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-SMP	**SegmentProfile**						
T3-SMP-1		id	Unique generated ID	String	UUID	1	
T3-SMP-2		name	Name of the segment profile	String	alphanumeric	1	
T3-SMP-3		version	Reference to the version information	*Version*	-	1	
T3-SMP-4		segmentProfileIdentifier	Identifier for segment profile	String	alphanumeric	1	
T3-SMP-5		countryIdentifier	Country or region identifier (NID_C, Section 7.5.1.86 in [7])	Integer	0 - 1023	1	
T3-SMP-6		appliesToTrackEdgeSection	Directed Track Edge Sections which applies to the defined segment profile.	*DirectedTrackEdgeSection*	-	1	

T3-SMP-7		distanceToEoAOffset	Distance to stop the train before an EoA.	Double	0.001 [6] - 999999.999	1	m
T3-SMP-8		utcTimeOffset	Offset to add to the UTC time in order to calculate the local time.	Time	-14:00 – +14:00	1	minutes
T3-SMP-9		isWithinAreaOfControl	Reference to the Area of Control to which the segment profile belongs.	*AreaOfControl*	-	1	
T3-SMP-10		adjacentAtoTsCountryIdentifier	Country or region identifier (NID_C, Section 7.5.1.86 in [7])	Integer	0 - 1023	0..1	
T3-SMP-11		adjacentAtoTsIdentifier	Identity of the adjacent ATO-TS	String	alphanumeric	0..1	
T3-SMP-12		adjacentSegmentProfileIdentifier	Identifier for segment profile	String	alphanumeric	0..1	
T3-SMP-13		adjacentSegmentProfileCountryIdentifier	Country or region identifier (NID_C, Section 7.5.1.86 in [7])	Integer	0 - 1023	0..1	
T3-SMP-14		hasSpeedProfile	Reference to speed profiles that are part of this segment profile	*SpeedProfile*	-	0..*	
T3-SMP-15		hasGradientSegment	Reference to gradient segment that are part of this segment profile	*GradientSegment*	-	0..*	
T3-SMP-16		hasCurveSegment	Reference to curve segment that are part of this segment profile	*CurveSegment*	-	0..*	
T3-SMP-17		hasTimingPoint	Reference to timing point that are part of this segment profile	*TimingPoint*	-	0..*	

[6] The range is set to start from 0.001 to explicitly avoid ‘distanceToEoAOffset’ to be defined with 0 length.

T3-SMP-18		hasPlatform	Reference to platform that are part of this segment profile	*Platform*	-	0..*	
T3-SMP-19		hasBaliseGroup	Reference to balise group that are part of this segment profile	*BaliseGroup*	-	0..*	
T3-SMP-20		hasBalise	Reference to balise that are part of this segment profile	*Balise*	-	0..*	
T3-SMP-21		hasPermittedBraking-Distance	Reference to permitted braking distance that are part of this segment profile	*PermittedBrak-ingDistance*	-	0..*	
T3-SMP-22		hasCurrentLimitaion	Reference to current limitation that are part of this segment profile	*CurrentLimitation*	-	0..*	
T3-SMP-23		hasTractionSystem	Reference to traction system that are part of this segment profile	*TractionSystem*	-	0..*	
T3-SMP-24		hasTrackCondition	Reference to track condition that are part of this segment profile	*TrackCondition*	-	0..*	
T3-SMP-25		hasLevelCrossing	Reference to level crossing that are part of this segment profile	*LevelCrossing*	-	0..*	
T3-SMP-26		hasTunnel	Reference to tunnel that are part of this segment profile	*Tunnel*	-	0..*	
T3-SMP-26		adjacentAtoTsCon-tactInfoDirection	Reference to tunnel that are part of this segment profile. (Section 7.3.9.2 [13]).	ENUM	-No Contact info follows -ATO-TS con-tact info for nominal direc-tion follows -ATO-TS con-tact info for reverse direc-tion follows	0..1	

8.12.3 Basic / rules and regulations

The segment profiles are directed and shall be represented using a Directed Track Edge Section on the topology. If a segment profile is applicable to both directions, the direction of the Track Edge Section has to be set to “Both.

Note: Currently, the object catalogue allows the definition of unidirectional and bidirectional segment profiles. The direction of segment profile is restricted to either one of the types and is to be discussed and defined based on the consuming system needs and architecture decisions.

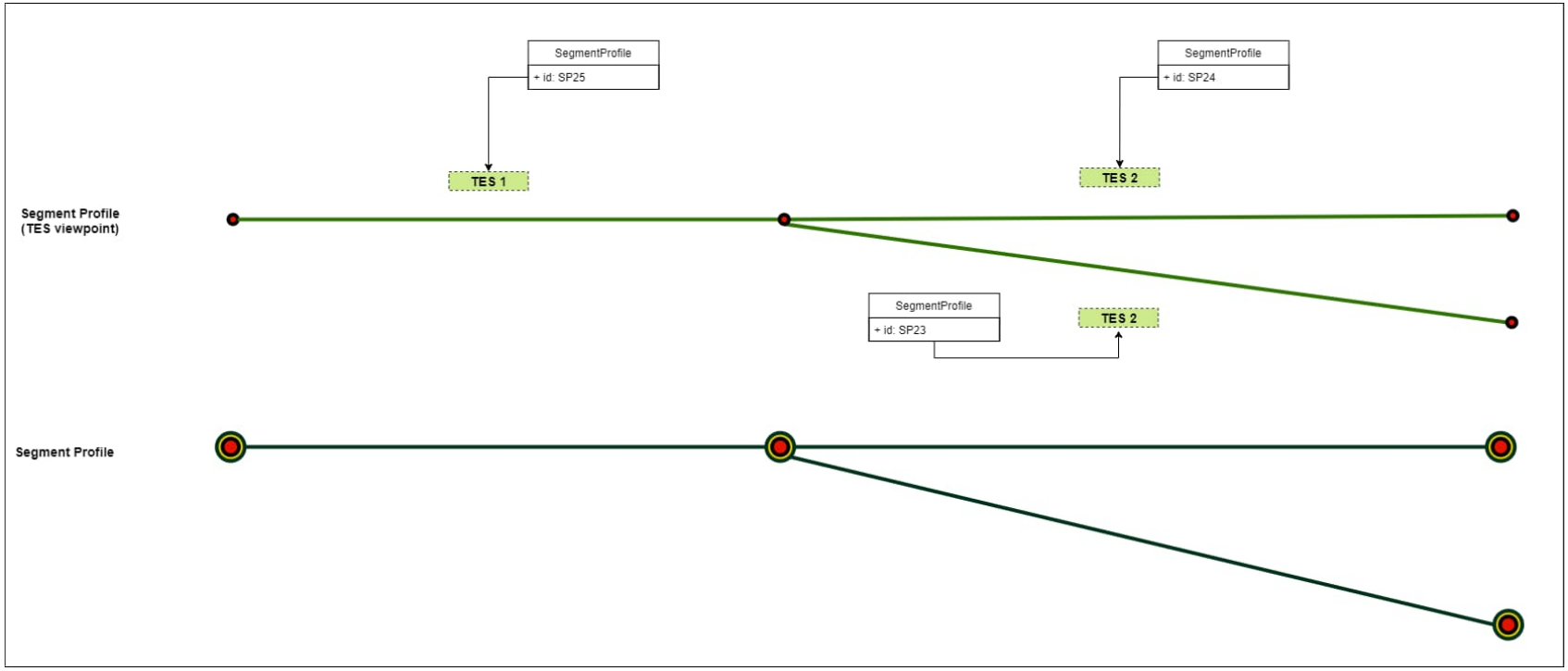


Figure 64: Segment profiles

8.12.4 Engineering rules

1. A Segment profile shall not be longer 167772.15 meters. *Note*: This is a requirement from ATO over ETCS Subset 126.
2. A Segment profile shall always be engineered between two Track Nodes.

   Rational: If the distance between two Track Nodes of type ‘Point’ is larger than 167772.15 meters, then an intermediate Track Edge Point shall be introduced to divide the segment profiles into two.
3. A Segment profile shall be defined within limits of an Area of Control and shall not be defined over the border of an Area of Control.

8.12.5 Dependencies

Segment profiles are usually assigned to one Area of Control.

8.13 Landmark

Defines a prominent landmark alongside the track for localisation purposes.

8.13.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	-	-	-	X	X	X

8.13.2 Definition

Table 42: Definition Landmark

ID	Object	Attribute	Description	Type	Range	Cardinal-ity	Unit
T3-LM	**Landmark**						
T3-LM-1		id	Unique generated ID	String	UUID	1	
T3-LM-2		name	Name of the landmark	String	alphanumeric	1	
T3-LM-3		version	Reference to the version information	*Version*	-	1	
T3-LM-4		appliesToTrackEdge-Point	Reference to Track Edge Point on which this landmark is located.	*TrackEdgePoint*	-	1	
T3-LM-5		type	ENUM providing types of Landmark	*ENUM*	- Catenary Post - Building - Sign Post - Signal Post - Radio Post - Mileage Stone	1	

					- Hectometre Sign - Other Post[7]		
T3-LM-6		label	Additional label(s) on the Landmark (e.g. to indicate the line kilometre).	String	alphanumeric	0..*	

8.13.3 Basis / rules and regulations

The landmarks shall be represented using a TEP on the topology. The TEP used to reference a landmark shall also have a lateral offset, in addition to the linear offset.

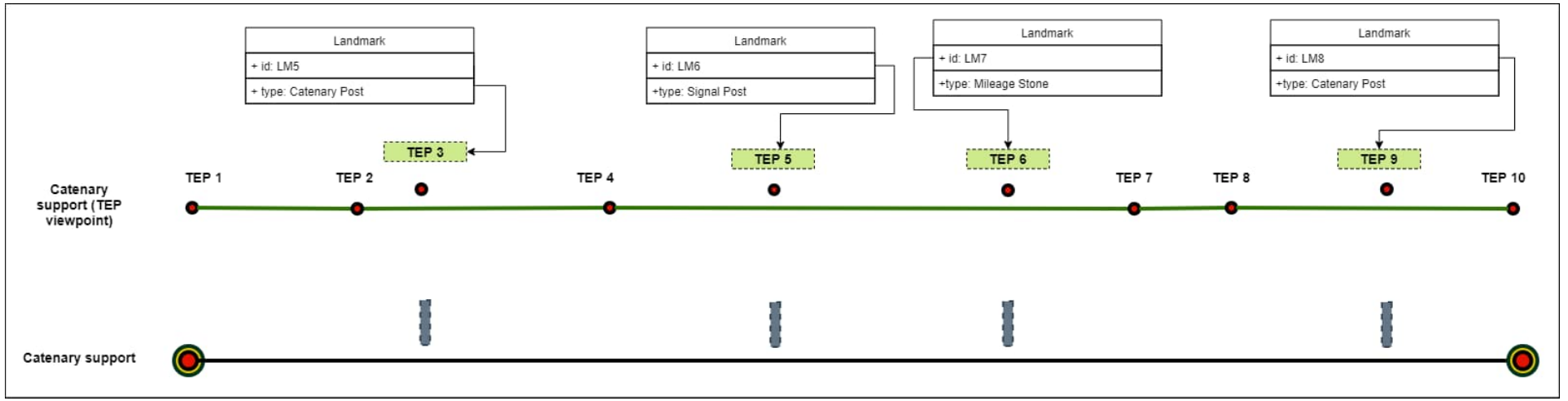


Figure 65: Landmark

[7] Includes all other kinds of posts which are not yet covered in the list.

8.14 Signals

The signals can be specialised into different types depending on their appearance. The following taxonomy below shows different kinds of signals.

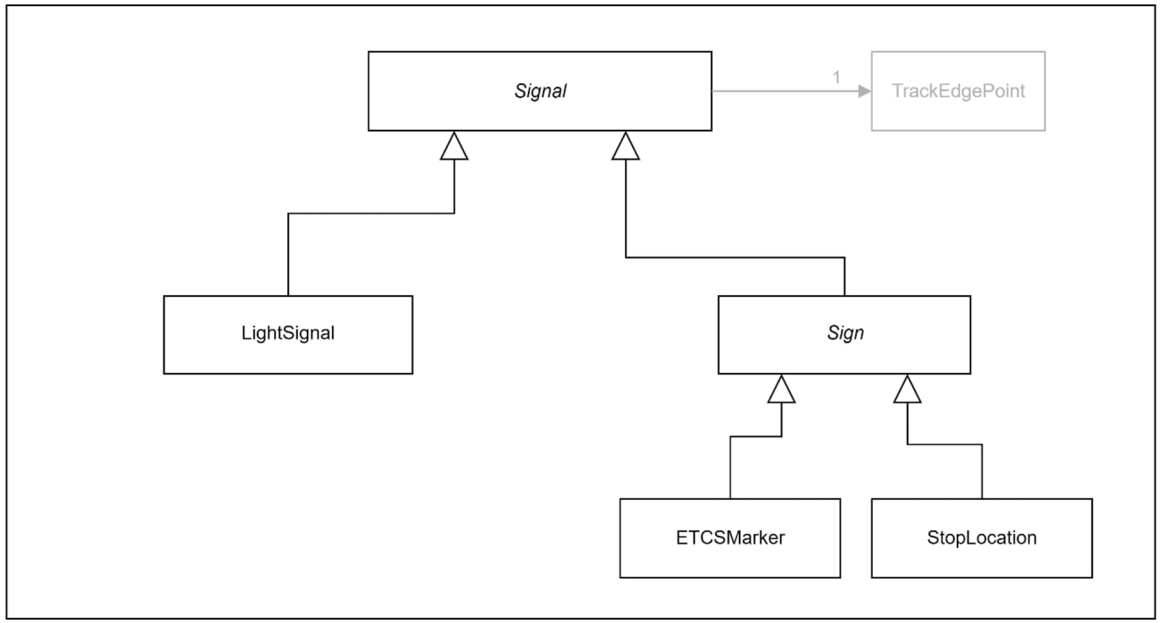


Figure 66: Taxonomy for Signals

Purpose of defining signals in this document are as follows:

1. To enable creation of Timing Points for ATO, which are related to signals;
2. To specify the transition signals in transition areas to the legacy world, e.g. signals at system borders or shunting yards;
3. To enable creation of movement permission target markers.

Only the signals relevant to realise these purposes would be specified in MAP.

8.14.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	-[8]	X	-	-	-

[8] ATO is not considered a direct consumer of signals, rather only an indirect consumer through Timing Points.

8.14.2 Signal

Base definition of a signal with properties, which are applicable to all signal types. Specific signals are defined as an extension to this base object.

A signal is either a:

- Light Signal or
- Sign

8.14.2.1 Definition

Table 43: Definition Signal

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-S	***Signal***						
T3-S-1		id	Unique generated ID	String	UUID	1	
T3-S-2		name	Name of the signal	String	alphanumeric	1	
T3-S-3		version	Reference to the version information	*Version*	-	1	
T3-S-4		appliesToTrackEdge-Point	Reference to the Directed Track Edge Point to which the signal is assigned to.	*Directed-TrackEdgePoint*	-	1..*	

Note: The Signal is an *abstract object*, which cannot be used standalone. Only the derived objects must be used to define a specific type of signal.

8.14.2.2 Basis / rules and regulations

The signals shall be represented using a DTEP on the topology. The DTEP used to reference a signal shall also have a lateral offset, in addition to the linear offset.

8.14.3 Light signal

Definition of a light signal, which is a railway signal that indicates whether and how the adjacent track section may be used or not.

8.14.3.2 Definition

Table 44: Definition Light Signal

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-LS	***Signal :: LightSignal***						
T3-LS1		type	Type of the light signal	ENUM	- Main signal[9] - Shunting signal	1	

[9] A main signal can be split into different types, e.g. entry-, exit, block or protection signal

8.14.3.3 Basis / rules and regulations

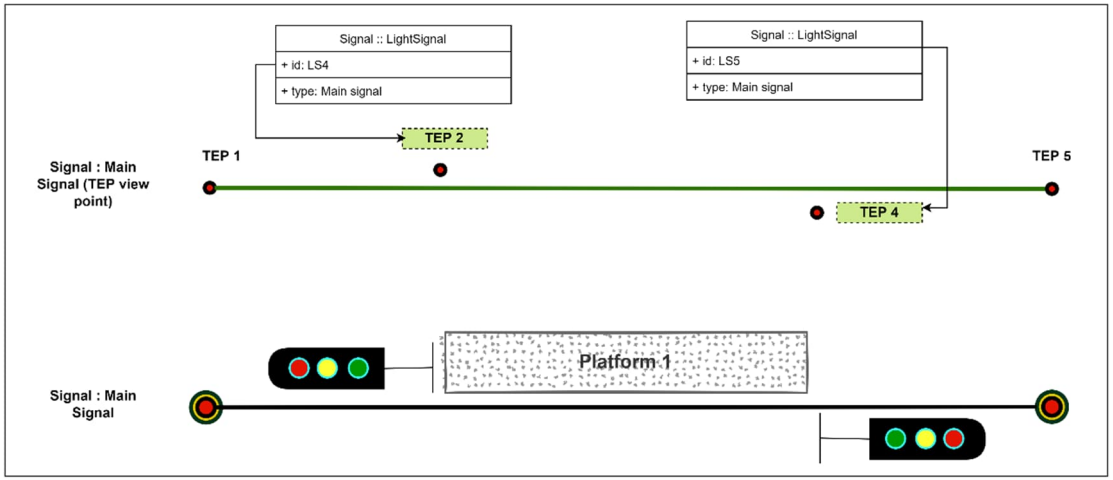


Figure 67: Main Signal as Light Signal

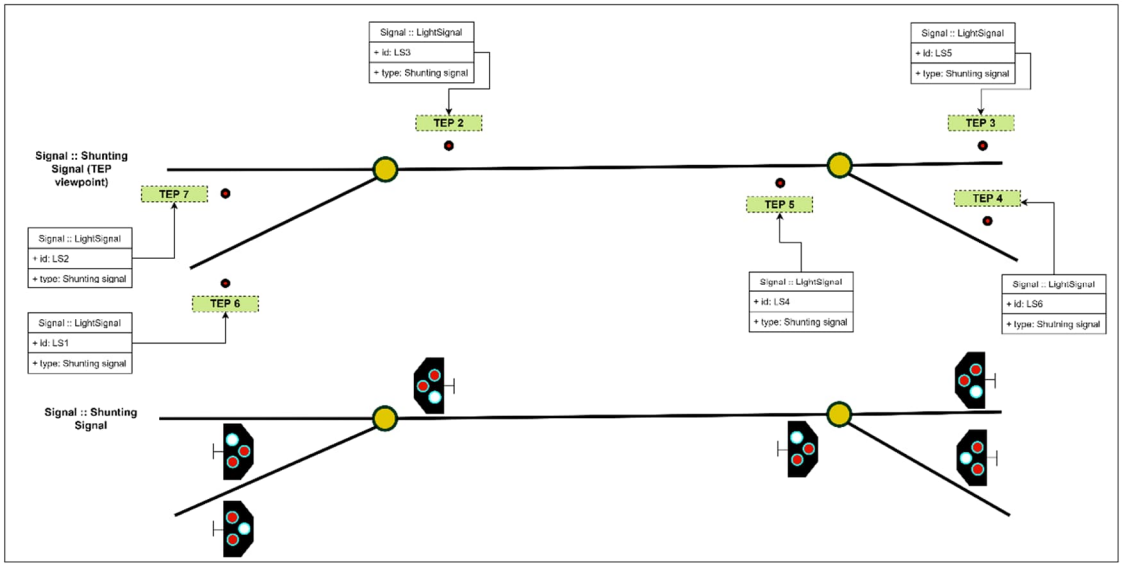


Figure 68: Shunting Signal as Light Signal

8.14.4 ETCS Marker

Definition of an ETCS marker board.

8.14.4.1 Definition

Table 45: Definition ETCS Marker

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-ET	***Signal :: Sign* :: ETCSMarker**						
T3-ET1		function	Function of the ETCS marker.	ENUM	- ETCS Stop Marker - ETCS Location Marker	1	

8.14.4.2 Basis / rules and regulations

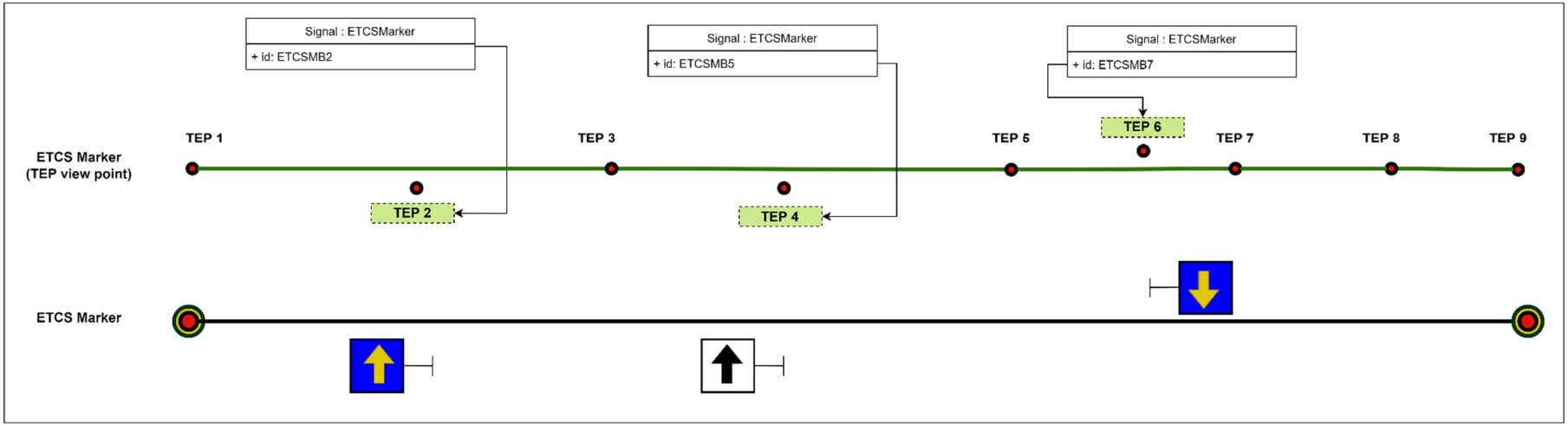


Figure 69: ETCS Marker

8.14.5 Stop Location

Definition of a stop location sign to indicate the stopping location of the train front to stop according to schedule.

8.14.5.1 Definition

Table 46: Definition Stop Location

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-STP	***Signal* :: Sign :: StopLocation**						
T3-STP-1		function	Type of the stop location.	ENUM	- Generic stop location (valid for all type of trains) - Stop location based on train length (200m, 300m, …) - Stop location based on the number of wagons (1, 2, 3, …) - Stop location based on number of axles - Stop location based on the configuration of train units (short train, half train, full train)	1	
T3-STP-2		value	Specific value (e.g., train length, axle count, stop location, wagon count) to define the stopping place according to various train characteristics.	String	alphanumeric	0..1	

8.14.5.2 Basis / rules and regulations

Multiple stopping locations can be placed on a platform, if different stopping locations are identified depending on train characteristics.

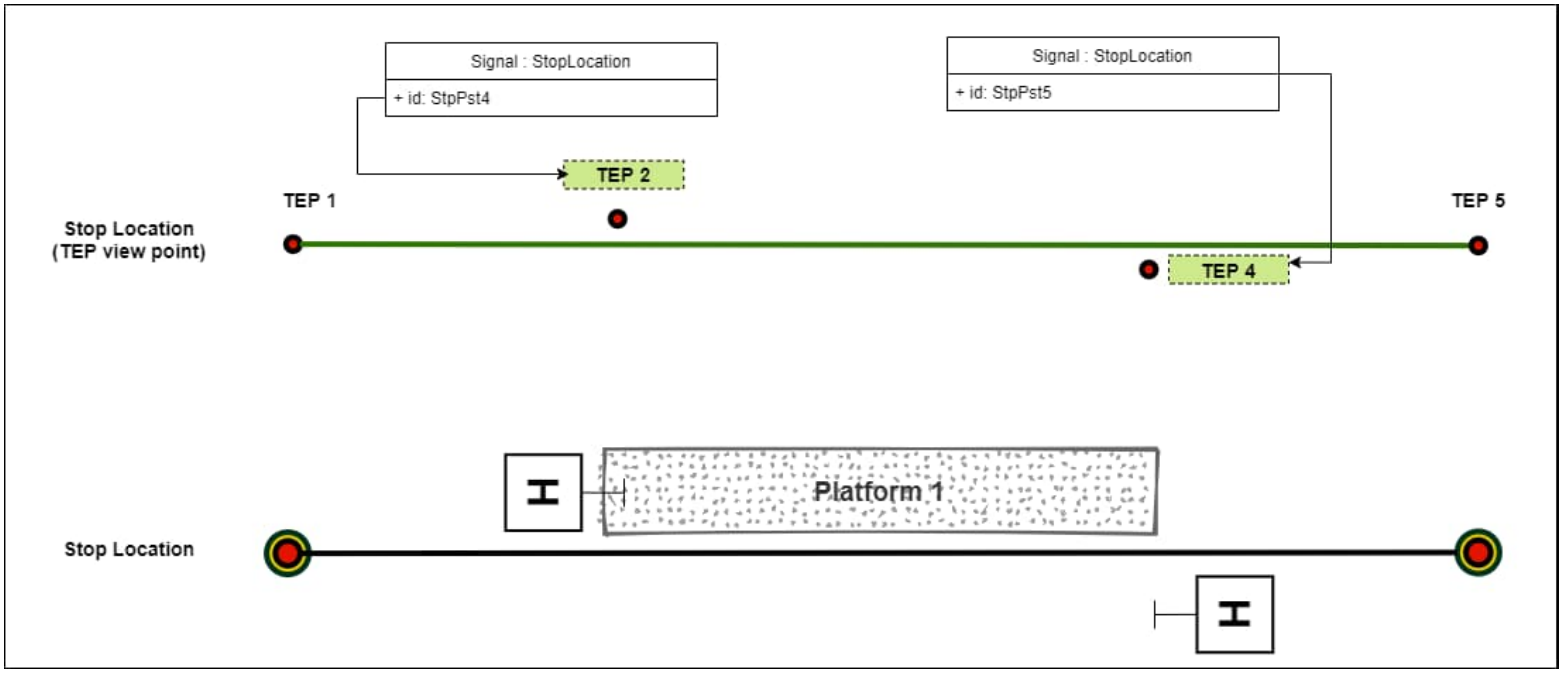


Figure 70: Stop Location

8.15 Platform Edge

Defines a section of a platform edge at which a train stops for the passenger to board or alight.

8.15.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	-	X	-	X	X	X

8.15.2 Definition

Table 47: Definition Platform Edge

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-PFE	**PlatformEdge**						
T3-PFE-1		id	Unique generated ID	String	UUID	1	
T3-PFE-2		name	Name of the platform edge	String	alphanumeric	1	
T3-PFE-3		version	Reference to the version information	*Version*	-	1	
T3-PFE-4		appliesToLinear-ContiguousTrackA-rea	Reference to the LCTA, which defines the extent of this platform edge. The LCTA should contain references to Track Edge Sections. The effective direction of the LCTA can be derived from the start and end TEPs of the LCTA.	*LinearContiguous TrackArea*	-	1	
T3-PFE-5		situatedSide	Indicates the side, on which passengers board and alight (in relation to the start to end direction of the LCTA).	ENUM	- Right - Left	1	

T3-PFE-6		length	Maximum usable platform length in meter (with 3 decimal places)	Double	0.001 [10] – 999.999	1	m
T3-PFE-7		hasStopLocation	Reference to the stop locations for the platform edge	*StopLocation*	-	1..*	
T3-PFE-8		hasAccessVia-Tracks	If the platform edge is only accessible for passengers by crossing tracks, the attribute contains the reference to the Track Area defining the TES of the tracks to be crossed.	*TrackArea*	-	0..1	

[10] The range is set to start from 0.001 to explicitly avoid platforms to be defined with 0 length.

8.15.3 Basis / rules and regulations

The platform edge is always facing a track edge, i.e. one platform has to be represented as two platform edges if it has tracks on both sides.

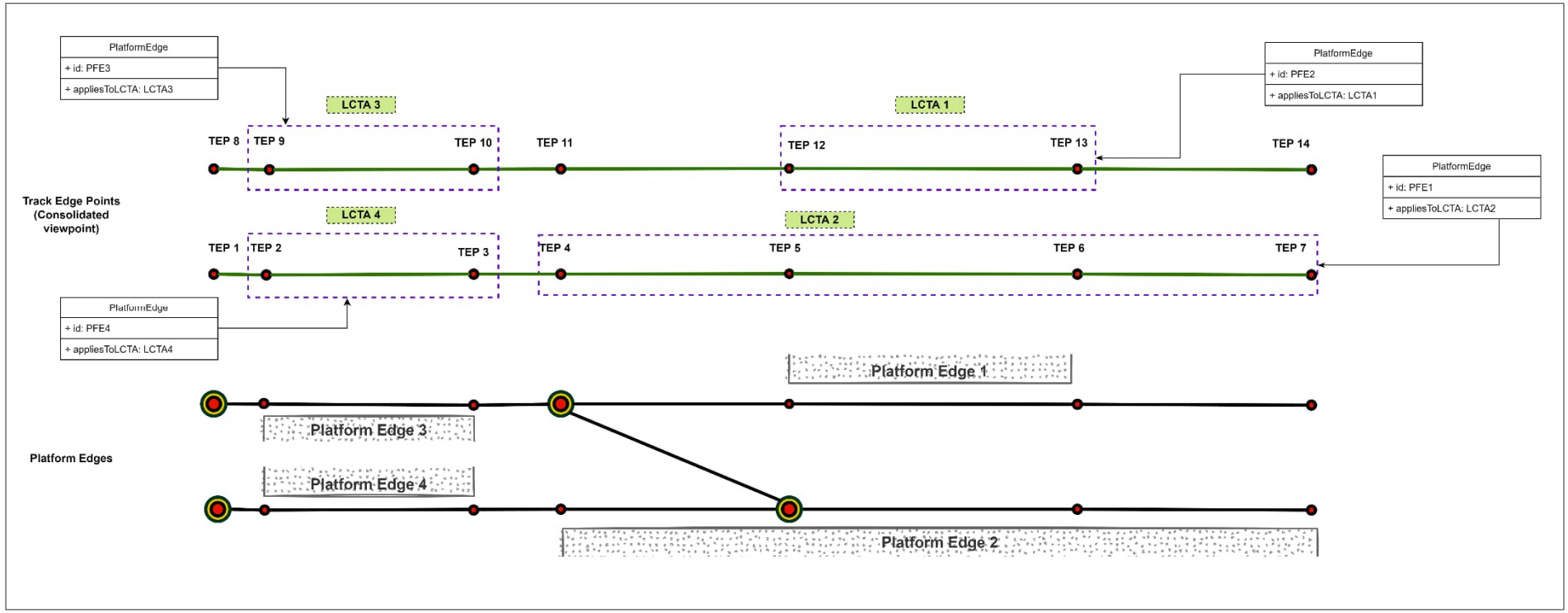


Figure 71: Platform Edge

8.15.4 Engineering rules

If the platform is only accessible by crossing one or more tracks, the following steps have to be executed:

- Define a TES for those locations, where the tracks will be crossed
- Add all those TES into one Track Area
- Add the reference to this Track Area to the Platform Edge

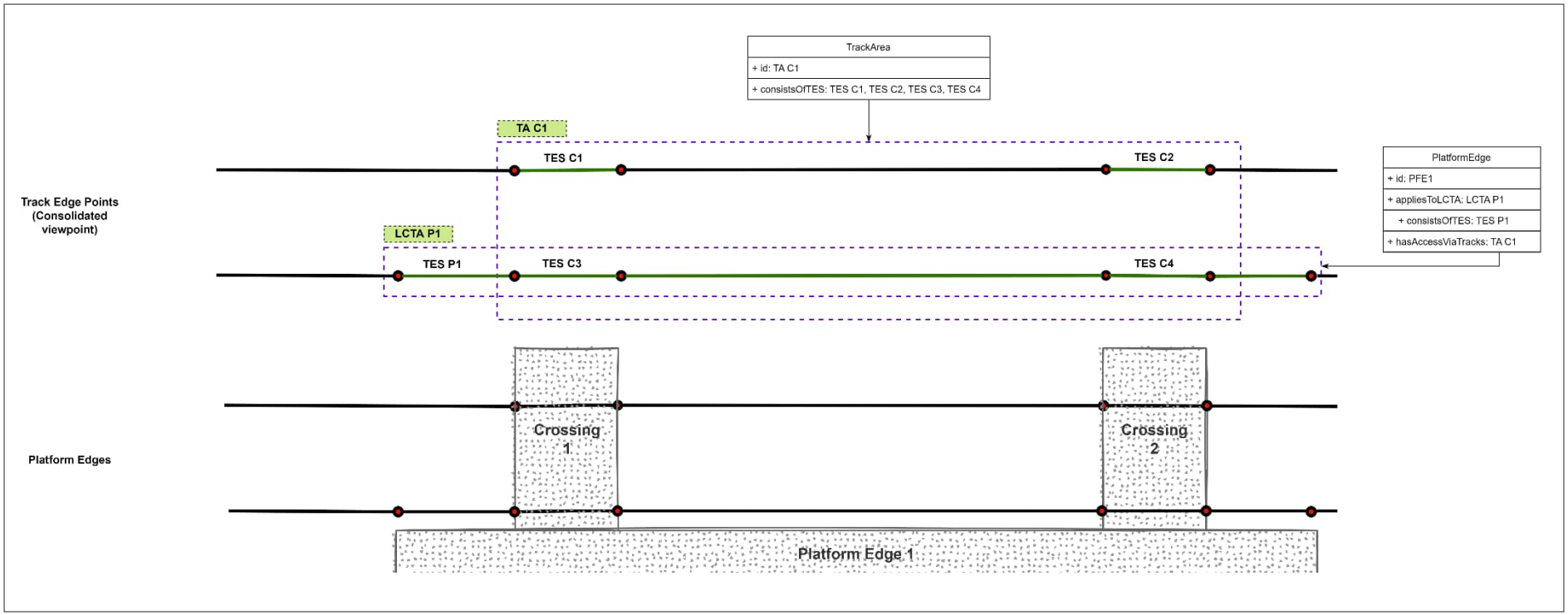


Figure 72: Platform Edge with track access

8.15.5 Dependencies

After the platform edge has been defined, all stop locations (see chapter 8.14.5) that are valid for the platform edge in each direction have to be added as a reference.

8.16 Tunnel

The object tunnel provides a physical representation of the tunnel infrastructure.

A tunnel consists of the following sub-elements:

- Tunnel Tube
- Tunnel Portal

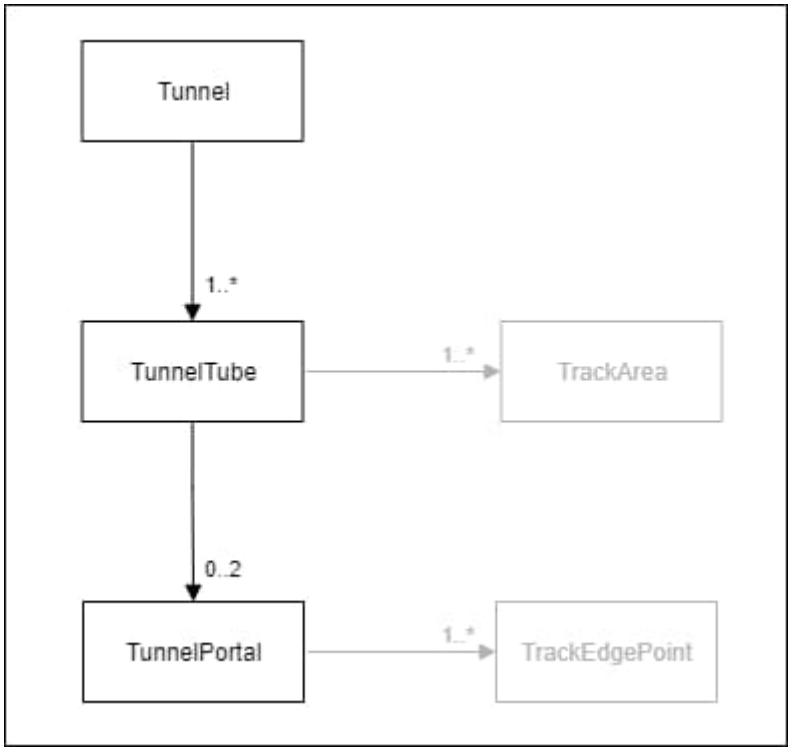


Figure 73: Taxonomy for Tunnels

8.16.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	-	X	X	X	X	X

8.16.2 Tunnel Portal

Defines the entry and exit points of a tunnel. Depending on the construction type, a portal can span over one or multiple tracks.

8.16.2.1 Definition

Table 48: Definition Tunnel Portal

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-TUP	**TunnelPortal**						
T3-TUP-1		id	Unique generated ID	String	UUID	1	
T3-TUP-2		name	Name of the tunnel portal	String	alphanumeric	1	
T3-TUP-3		version	Reference to the version information	*Version*	-	1	
T3-TUP-4		appliesToTrackEdge-Point	Offset and direction on the referenced edge. A position is defined for each track that is spanned by the portal.	*TrackEdgePoint*	-	1..*	

8.16.2.2 Basis / rules and regulations

A tunnel portal shall be engineered with the Track Edge Point on the Track Edge over which it spans.

8.16.2.3 Engineering rules

One Track Edge Point is specified per spanned Track Edge. For tunnels with multiple tubes, separate entry and exit portals are to be defined per tube.

8.16.2.4 Dependencies

The project engineering of a tunnel consists of three elements:

- Tunnel portal
- Tunnel tube
- Tunnel

For the complete engineering of a tunnel, all three objects must be planned and defined.

8.16.3 Tunnel Tube

Defines the tunnel tube, through which one or multiple tracks are leading.

8.16.3.1 Definition

Table 49: Definition Tunnel Tube

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-TUT	**TunnelTube**						
T3-TUT-1		id	Unique generated ID	String	UUID	1	
T3-TUT-2		name	Name of the tunnel tube	String	alphanumeric	1	
T3-TUT-3		version	Reference to the version information	*Version*	-	1	
T3-TUT-4		appliesToTrackArea	Reference to the Track Edge Sections, which are located inside the tunnel tube. A separate Track Edge Section is defined for each track in the tunnel tube.	*TrackArea*	-	1..*	
T3-TUT-5		hasStartTunnelPortal	Reference to the start tunnel portal delimiting the tunnel tube.	*TunnelPortal*	-	0..1	
T3-TUT-6		hasEndTunnelPortal	Reference to the end tunnel portal delimiting the tunnel tube.	*TunnelPortal*	-	0..1	
T3-TUT-7		length	Real length of the tube (not track) in meters (with 3 decimal places).	Double	0.001 [11] – 999999.999	1	m

8.16.3.2 Basis / rules and regulations

A tunnel tube is engineered via a Track Area which groups the Track Edge Sections that are inside the tunnel tube.

[11] The range is set to start from 0.001 to explicitly avoid tunnels to be defined with 0 length.

8.16.3.3 Engineering rules

A tunnel tube is bounded either by tunnel portals or by a new tunnel tube (e.g. when a track branches off within a tunnel tube and is led through a new tunnel tube). In case of a branch, the boundary of the tunnel tube is the position of the node (point tip).

The start tunnel portal shall be the one which is located at the lower line kilometre, the end tunnel portal the one located at the higher line kilometre.

8.16.3.4 Dependencies

The project engineering of a tunnel consists of three elements:

- Tunnel portal
- Tunnel tube
- Tunnel

For the complete engineering of a tunnel, all three objects must be planned and defined.

8.16.4 Tunnel

Defines the entire tunnel system, grouping the corresponding tunnel portals, tunnel tubes, and all related properties of the tunnel.

8.16.4.1 Definition

Table 50: Definition Tunnel

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-TU	**Tunnel**						
T3-TU-1		id	Unique generated ID	String	UUID	1	
T3-TU-2		name	Name of the tunnel	String	alphanumeric	1	
T3-TU-3		version	Reference to the version information	*Version*	-	1	
T3-TU-4		consistsOfTunnelTube	Reference to tunnel tubes which are part of the tunnel.	*TunnelTube*	-	1..*	
T3-TU-5		tunnelType	ENUM indicating the type of tunnel	*ENUM*	- Single Track Tunnel - Double Track Tunnel - Wide-cross Section Tunnel	1	

8.16.4.2 Basis / rules and regulations

A tunnel groups the associated tunnel portals and tubes into a coherent tunnel structure.

8.16.4.3 Dependencies

The project engineering of a tunnel consists of three elements:

- Tunnel portal
- Tunnel tube
- Tunnel

For the complete engineering of a tunnel, all three objects must be planned and defined.

8.16.5 Example

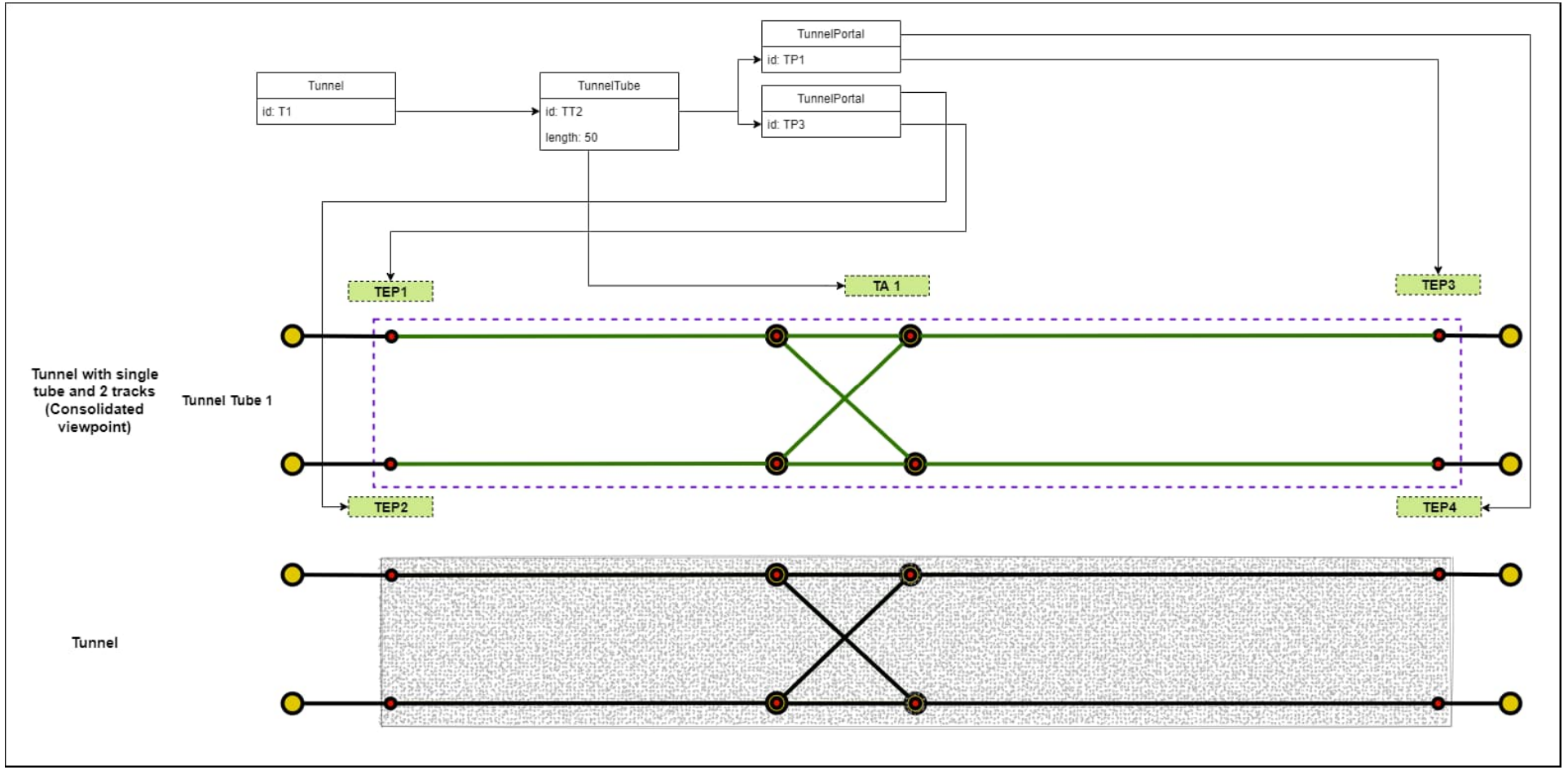


Figure 74: Tunnel with single tube

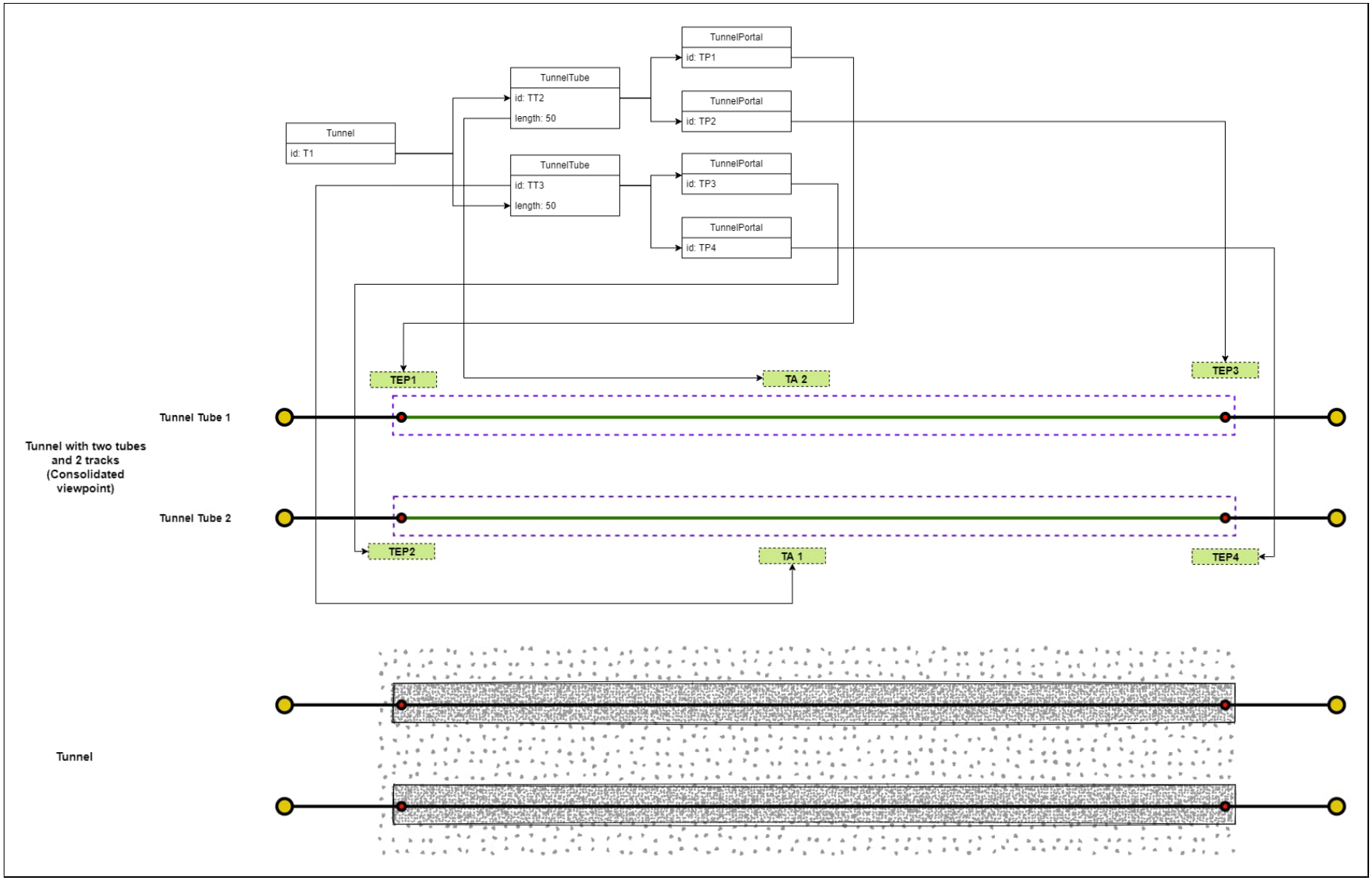


Figure 75: Tunnel with two tubes

8.17 Point, Crossing, and Derailer

Point, crossing and derailer are track assets / field elements. They contain moveable components, and they are equipped with electrical point machines in order to set / change the status of the field element. The following taxonomy below shows the different kinds of track assets.

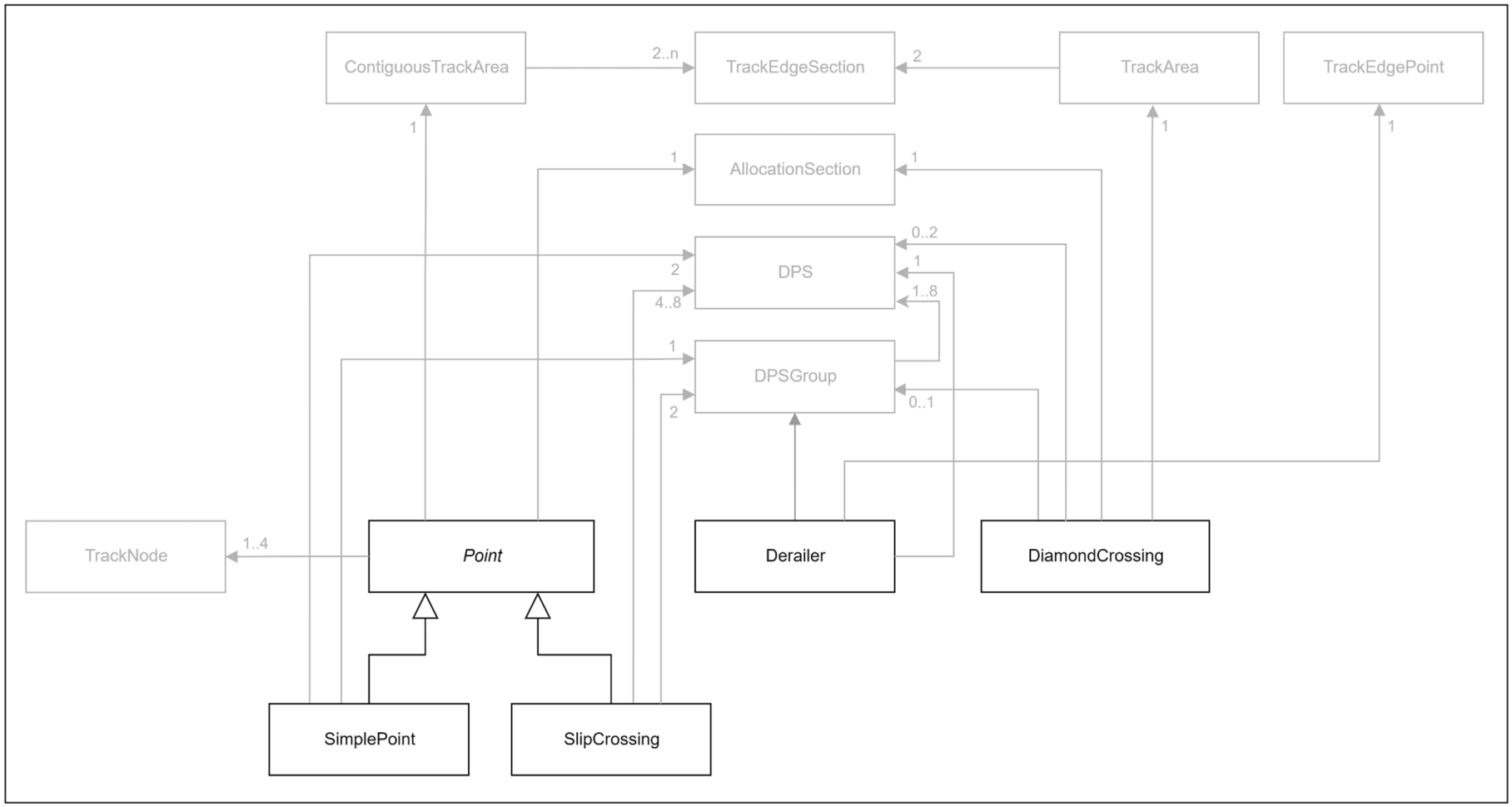


Figure 76: Taxonomy for Point, Crossing and Derailer

8.17.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	-	X	-	-	-

8.17.2 Point

Base definition of the physical track asset / field element point with properties which are applicable to all the derived objects according to the taxonomy shown in the figure above.

8.17.2.1 Definition

Table 51: Definition Point

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-PO	***Point***						
T3-PO-1		id	Unique generated ID	String	UUID	1	
T3-PO-2		name	Name of the point	String	alphanu-meric	1	
T3-PO-3		version	Reference to the version infor-mation	*Version*	-	1	
T3-PO-4		applie-sToTrackNode	The Track Node that repre-sents the point in the node-edge-model.	*TrackNode*	-	1..4 [12]	
T3-PO-5		appliesToTrackA-rea	Reference to the Contiguous Track Area, on which the point	*ContiguousTrackArea*	-	1	

[12] Only 1, 2 or 4 are valid values

			is located (the extension of the point on the Track Edges)				
T3-PO-6		appliesToAlloca-tionSection	Reference to the Allocation Section, which is assigned to the point.	*AllocationSection*	-	1	
T3-PO-7		reversalTime	The time in seconds (with 1 decimal place) to switch the point from one position to the other (e.g. from right to left).	Double	0.0 – 20.0	1	seconds

Note: The Point is an *abstract object*, which cannot be used standalone. Only the derived objects must be used to define a specific type of point.

8.17.2.2 Basis / rules and regulations

Points are controlled field elements which represent a branching point in the track network wherein exists a possibility to continue either on the right or on the left branch, depending on the state of the field element:

- Simple points (with and without moveable frogs)
    - Reference to one Track Node
- Single- and double-slip crossings
    - Reference to two (single-slip) or four (double-slip) Track Nodes

8.17.2.3 Spatial extension of a point

Since the representation of points as Track Nodes describes only the start location of the point without its spatial extension, the parts of the point (between the start and the end location of the point) are also needed to be located on the Track Edges. Therefore, a Contiguous Track Area with Track Edge Sections is used to describe the extent of the point along the Track Edges.

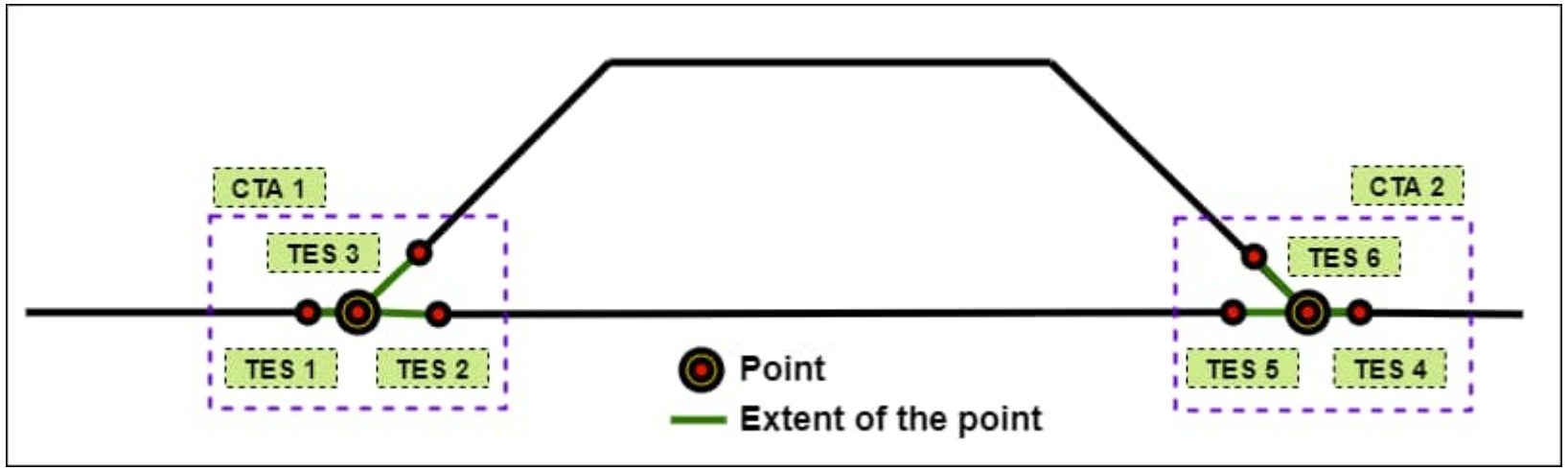


Figure 77: Spatial extension of a point

8.17.2.4 Dependencies

Each point is mapped to their corresponding Allocation Section (see chapter 8.6).

8.17.3 Simple Point

A simple point with one or more point machines and with or without a movable frog.

8.17.3.1 Definition

Table 52: Definition Simple Point

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-SPO	***Point* :: SimplePoint**						
T3-SPO-1		appliesToDpsGroup	Drive protection section group which is assigned to this point (group contains two DPS).	*DriveProtection-SectionGroup*	-	1	
T3-SPO-2		appliesToDpsRight	Drive protection section which is assigned to the right route of this point.	*DriveProtection-Section*	-	1	
T3-SPO-3		appliesToDpsLeft	Drive protection section which is assigned to the left route of this point.	*DriveProtection-Section*	-	1	
T3-SPO-4		speedRightRoute	Maximum allowed speed on the right route (empty value if the right route doesn't limit the speed compared to the line speed).	Integer	0 – 600	0..1	km/h
T3-SPO-5		speedLeftRoute	Maximum allowed speed on the left route (empty value if the left route doesn't limit the speed compared to the line speed).	Integer	0 – 600	0..1	km/h
T3-SPO-6		hasTrailDetection	Indicates, whether the point is equipped with a trail detection or not.	boolean	true, false	1	

8.17.3.2 Basis / rules and regulations

In a simple point, a branch track branches off from a main track. A simple point offers two driving possibilities i.e. one along main train and one along the branch track. The direction switch can be set using the point machines.
Depending on the allowed speed for the branch track, the simple point might have moveable frogs. In this case, the point also consists of multiple point machines in order to move the tongues and the frog of the point.

8.17.3.3 Dependencies

To establish the connection between the simple point and Drive Protection Sections, the associated DPS-Group together with their two DPSs must be assigned to the point (see chapter 8.7 and 8.8).

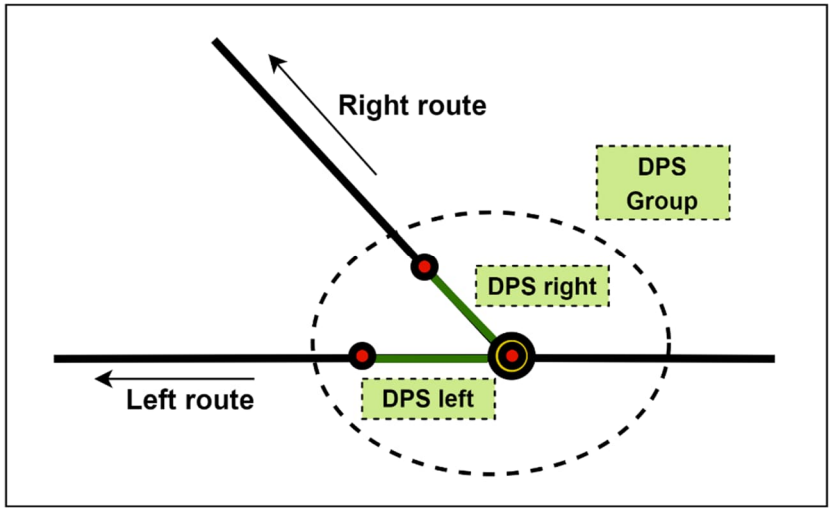


Figure 78: DPS allocation for a simple point

8.17.4 Slip Crossing

A single or double crossing between two tracks without grade of separation and with possibility to switch between straight passing track and turning track.

8.17.4.1 Definition

Table 53: Definition Slip Crossing

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-SCR	***Point ::*** **SlipCrossing**						
T3-SCR-1		type	Slip crossing type	ENUM	- Single Slip - Double Slip	1	
T3-SCR-2		appliesToD-psGroupA	Drive protection section group which is assigned to the left part of the slip cross-ing (group contains either two (single slip crossing) or four (double slip crossing) DPS).	*DriveProtection-SectionGroup*	-	1	
T3-SCR-3		appliesToDpsRightA	Drive protection section(s) which is/are assigned to the right route of this slip crossing from group A (1 for single, 2 for double slip crossings).	*DriveProtection-Section*	-	1..2	
T3-SCR-4		appliesToDpsLeftA	Drive protection section(s) which is/are assigned to the left route of this slip crossing from group A (1 for single, 2 for double slip crossings).	*DriveProtection-Section*	-	1..2	
T3-SCR-5		appliesToD-psGroupB	Drive protection section group which is assigned to the right part of the slip crossing (group contains either two (sin-gle slip crossing) or four (double slip crossing) DPS).	*DriveProtection-SectionGroup*	-	1	

T3-SCR-6		appliesToDpsRightB	Drive protection sections which is/are assigned to the right route of this slip crossing from group B (1 for single, 2 for double slip crossings).	*DriveProtectionSection*	-	1..2	
T3-SCR-7		appliesToDpsLeftB	Drive protection sections which is/are assigned to the left route of this slip crossing from group B (1 for single, 2 for double slip crossings).	*DriveProtectionSection*	-	1..2	
T3-SCR-8		speedBranchRoute	Maximum allowed speed on the branching route(s).	Integer	0 – 600	1	km/h

8.17.4.2 Basis / rules and regulations

A single crossing slip is a crossing that has been supplemented by points in such a way that the transition from one track to the other is possible at least in one direction of travel. A double slip crossing allows crossovers in both directions.

8.17.4.3 Engineering rules

The DPS-Group A and their corresponding DPS right A and DPS left A are assigned to the side of the slip crossing that is located towards the lower line kilometre.
The DPS-Group B and their corresponding DPS right B and DPS left B are assigned to the side of the slip crossing that is located towards the higher line kilometre.

8.17.4.4 Dependencies

To establish the connection between the slip crossing and Drive Protection Sections, the associated DPS-Groups together with their DPSs must be assigned to the slip crossing (see chapter 8.7 and 8.8).

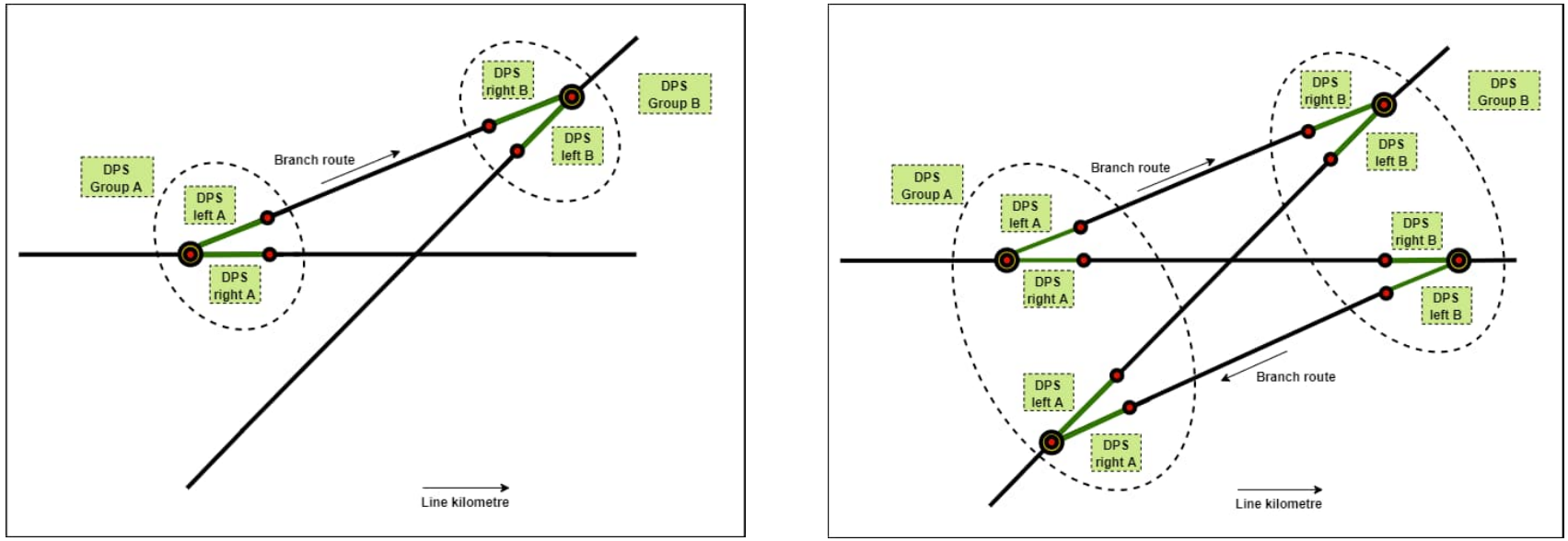


Figure 79: DPS allocation for a single and double slip crossing

8.17.5 Derailer

A safety device attached to a rail, which when operated can cause a derailment of a train that is making an unauthorised movement.

8.17.5.1 Definition

Table 54: Definition Derailer

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-DER	**Derailer**						
T3-DER-1		id	Unique generated ID	String	UUID	1	
T3-DER-2		name	Name of the derailer	String	alphanumeric	1	
T3-DER-3		version	Reference to the version information	*Version*	-	1	
T3-DER-4		appliesToTrackEdge-Point	The Track Edge Point that represents the derailer in the node-edge-model.	*TrackEdgePoint*	-	1	
T3-DER-5		appliesToDpsGroup	Drive protection section group which is assigned to this derailer (group contains one DPS)	*DriveProtection-SectionGroup*	-	1	
T3-DER-6		appliesToDps	Drive protection section which is assigned to the derailer.	*DriveProtection-Section*	-	1	
T3-DER-7		reversalTime	The time in seconds (with 1 decimal place) to switch the derailer from one position to the other.	Double	0.0 – 20.0	1	seconds

8.17.5.2 Basis / rules and regulations

A derailer prevents rail vehicles from driving on the track beyond the point secured by the derailer. Derailers are intended to prevent accidents caused by cold movements, for example rolling of parked rail vehicles which were not secured against unintentional movements.

8.17.5.3 Dependencies

To establish the connection between the derailer and Drive Protection Sections, the associated DPS-Group together with its DPS must be assigned to the derailer crossing (see chapter 8.7 and 8.8).

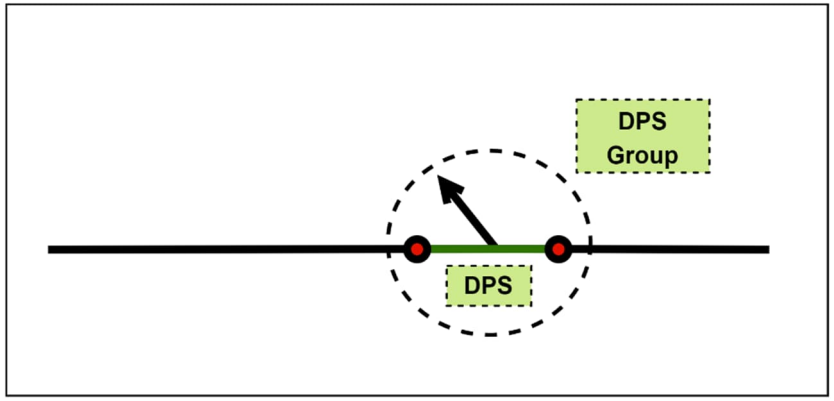


Figure 80: DPS allocation for a derailer

8.17.6 Diamond Crossing

A track crossing between two tracks without grade of separation and without possibility to switch between straight passing track and turning track.

8.17.6.1 Definition

Table 55: Definition Diamond Crossing

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-DCR	**DiamondCrossing**						
T3-DCR-1		id	Unique generated ID	String	UUID	1	
T3-DCR-2		name	Name of the diamond crossing	String	alphanumeric	1	
T3-DCR-3		version	Reference to the version information	*Version*	-	1	
T3-DCR-4		appliesToTrackArea	Reference to the Track Area, on which the diamond crossing is located (the extension of the diamond crossing on the Track Edges).	*TrackArea*	-	1	
T3-DCR-5		appliesToAllocation-Section	Reference to the Allocation Section, which is assigned to the diamond crossing.	*AllocationSection*	-	1	
T3-DCR-6		appliesToDpsGroup	Drive protection section group which is assigned to a switched diamond crossing (group contains 4 DPS).	*DriveProtection-SectionGroup*	-	0..1	
T3-DCR-7		appliesToDpsRight	Drive protection sections which are assigned to the right route of a switched diamond crossing.	*DriveProtection-Section*	-	0..2	
T3-DCR-8		appliesToDpsLeft	Drive protection sections which are assigned to the left route of a switched diamond crossing.	*DriveProtection-Section*	-	0..2	
T3-DCR-9		reversalTime	The time in seconds (with 1 decimal place) to switch the diamond crossing from one position to the other.	Double	0.0 – 20.0	0..1	seconds

8.17.6.2 Basis / rules and regulations

A diamond crossing is the overlapping of two tracks at the same level without the possibility of changing tracks. There are two possible types of a diamond crossing, one with movable tongues (switched diamond crossing) and one without movable parts (non-switched diamond crossing).

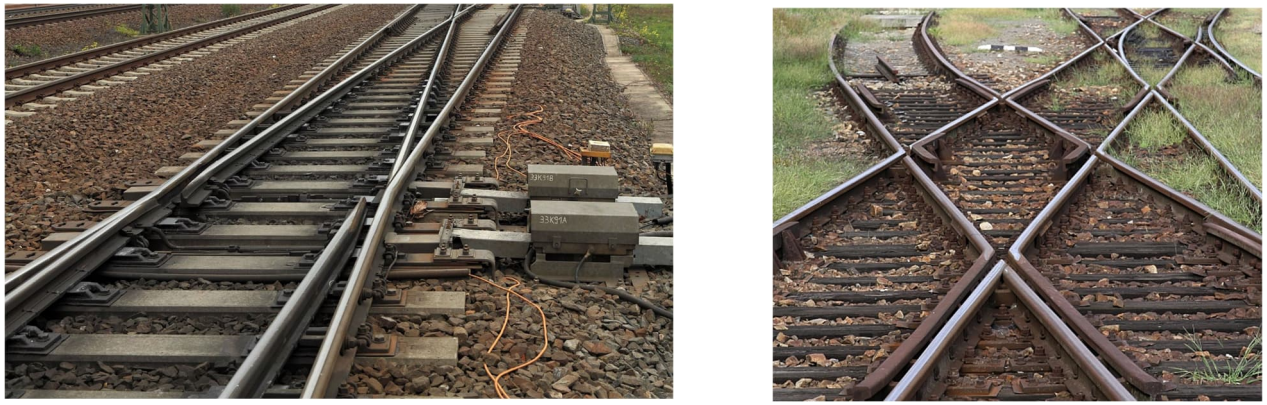


Figure 81: Switched and non-switched diamond crossing

8.17.6.3 Engineering rules

The Track Area that defines the extension of the Diamond Crossing shall contain two Track Edge Sections for the two crossing Track Edges.

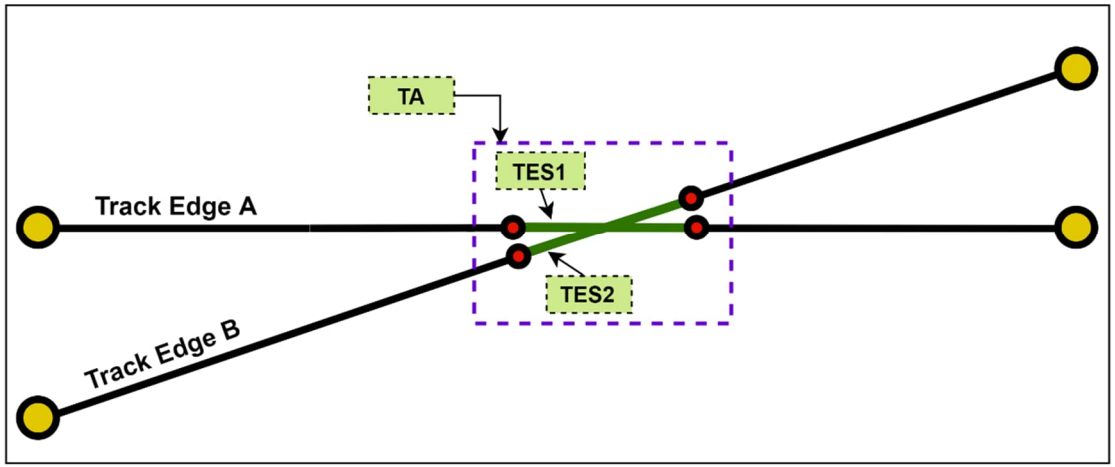


Figure 82: Extension of a Diamond Crossing

A switched Diamond Crossing has a reference to one Drive Protection Section Group whereas the non-switched Diamond Crossing. The direction of the routes (right or left) is seen in the direction of the tracks that are leading away from the diamond crossing looking from the crossing point of the tracks (see chapter 0 for the assignment of the different Drive Protection Sections to the DPS-Group).

A non-switched Diamond Crossing has no reference to Drive Protection Sections and to a Drive Protected Section Group as it does not contain any movable parts.

8.17.6.4 Dependencies

To establish the connection between the switched diamond crossing and its Drive Protection Sections, the associated DPS-Group together with their DPSs must be assigned to the diamond crossing (see chapter 8.7 and 8.8).

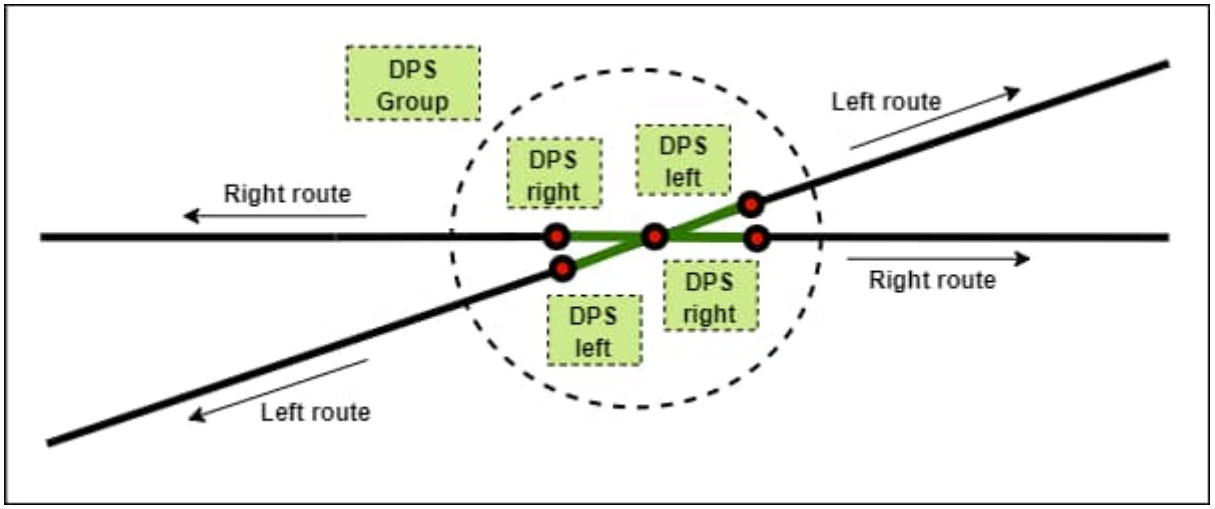


Figure 83: DPS allocation for a switched diamond crossing

8.18 Level Crossing

Installation to technically protect a level crossing with barriers, lights or a combination of both.

8.18.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	-	-	-

8.18.2 Definition

Table 56: Definition Level Crossing

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-LX	**LevelCrossing**						
T3-LX-1		id	Unique generated ID	String	UUID	1	
T3-LX-2		name	Name of the level crossing	String	alphanumeric	1	
T3-LX-3		version	Reference to the version information	*Version*	-	1	
T3-LX-4		appliesToTrackArea	Reference to the Track Area, on which the level crossing is located (the extension of the level crossing on the Track Edges)	*TrackArea*	-	1	
T3-LX-5		appliesToDpsGroup	Drive protection section group which is assigned to this level crossing (group contains as many DPS as tracks are protected).	*DriveProtectionSectionGroup*	-	1	

8.18.3 Basis / rules and regulations

A level crossing is an intersection where a railway line crosses a road or path at the same level. Only technically controlled level crossings that are secured by barriers and/or light signals and which are not operated manually are relevant for the object catalogue.

A level crossing is represented using a Track Area on the topology.

8.18.4 Dependencies

To establish the connection between the level crossing and Drive Protection Sections, the associated DPS-Group must be assigned to the level crossing (see chapter 8.7). The Tack Area for a level crossing contains the Track Edge Sections that refer to the level crossing, one for each track. The length of each TES shall be at least equal to the width of the road and/or path that crosses the track.

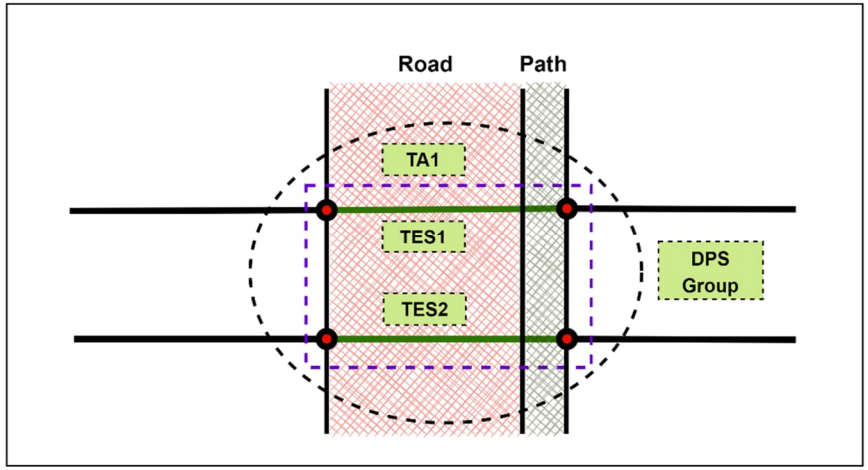


Figure 84: DPS and TA allocation for a level crossing

8.19 Track Condition

The Track Condition is used to represent the condition of a section of a track.

8.19.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	-	-	-

8.19.2 Definition

Table 57: Definition Track Condition

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-TRC	**TrackCondition**						
T3-TRC-1		id	Unique generated ID	String	UUID	1	
T3-TRC-2		name	Name of the track condition	String	alphanumeric	1	
T3-TRC-3		version	Reference to the version information	*Version*	-	1	
T3-TRC-4		condition	Type of the track condition	ENUM	- Powerless section, lower pantograph - Powerless section, switch off main power switch - Air tightness - Sound horn - Non stopping area - Tunnel stopping area - Big metal masses, ignore onboard integrity check alarms of balise transmission - Radio hole, stop supervision of the loss of safe radio connection - Switch off regenerative brake	1	

					- Switch off eddy current brake for service brake - Switch off eddy current brake for emergency brake - Switch off magnetic shoe brake		
T3-TRC-5		applie-sToTrackEdge-Section	Track Edge Sections which apply to the defined track condition.	*TrackEdge-Section*	-	1..*	

8.19.3 Basis / rules and regulations

The Track Condition is always defined without a direction for the containing Track Edge Sections, as they are supposed to be direction independent.

The cardinality 1..* for the referenced Track Edge Sections is not to be confused with instantiation of TA(s). In case of Track Conditions, this cardinality allows us to use the same object instantiation for several Track Edge Sections that exist on the network with same conditions.

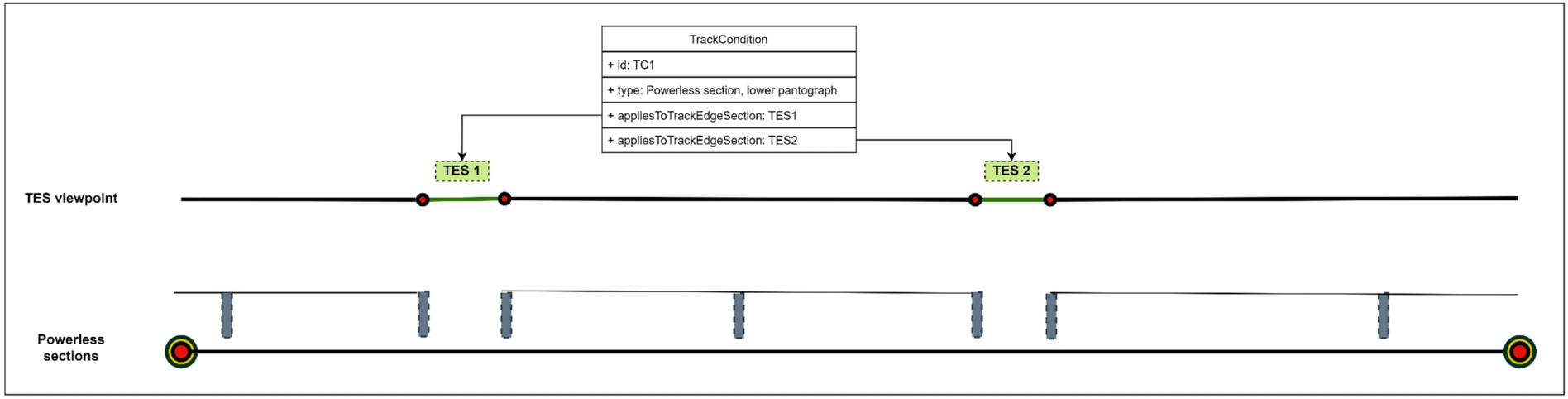


Figure 85: Track Condition Example

8.19.4 Engineering rules

The different Track Conditions shall only be defined for those Track Edge Sections, where they apply. For those Track Edge Sections, where the default value of the corresponding condition is valid, no Track Condition needs to be defined. The following initial values are defined:

- Powerless section, lower pantograph: no powerless section, i.e. pantograph not to be lowered
- Powerless section, switch off main power switch: no powerless section, i.e. main power switch not to be switched off
- Air tightness: no request for air tightness
- Sound horn: no request for sound horn
- Non stopping area: stopping permitted
- Tunnel stopping area: no tunnel stopping area
- Big metal masses: alarms not ignored
- Radio hole: loss of safe radio connection supervised
- Switch off regenerative brake: regenerative brake on
- Switch off eddy current brake for service brake: eddy current brake on for service brake
- Switch off eddy current brake for emergency brake: eddy current brake on for emergency brake
- Switch off magnetic shoe brake: magnetic shoe brake on

8.20 Traction System

Indication of the traction system (nominal voltage and frequency).

8.20.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	-	-	-

8.20.2 Definition

Table 58: Definition Traction System

ID	Object	Attribute	Description	Type	Range	Cardinal-ity	Unit
T3-TRS	**TractionSys-tem**						
T3-TRS-1		id	Unique generated ID	String	UUID	1	
T3-TRS-2		name	Name of the traction system	String	alphanumeric	1	
T3-TRS-3		version	Reference to the version in-formation	*Version*	-	1	
T3-TRS-4		voltageCategory	Type of the traction system on the track	ENUM	- Line not fitted with any traction system - DC 600V - DC 650V - DC 750V - DC 850V - DC 1.5kV - DC 3kV - AC 15kV 16.7Hz - AC 25kV 50Hz - other	1	

T3-TRS-5		applie-sToTrackEdgeSec-tion	Track Edge Sections which apply to the defined traction system.	*TrackEdgeSec-tion*	-	1..*	
T3-TRS-6		countryIdentifier	Country or region identifier (NID_CTRACTION, Section 7.5.1.86.1 in [7])	Integer	0 - 1023	1	

8.20.3 Basis / rules and regulations

The Traction System is always defined without a direction for the containing Track Edge Sections, as it is supposed to be direction independent.

The cardinality 1..* for the referenced Track Edge Sections is not to be confused with instantiation of TA(s). In case of the Traction System, this cardinality allows us to use the same object instantiation for several Track Edge Sections that exist on the network with the same system.

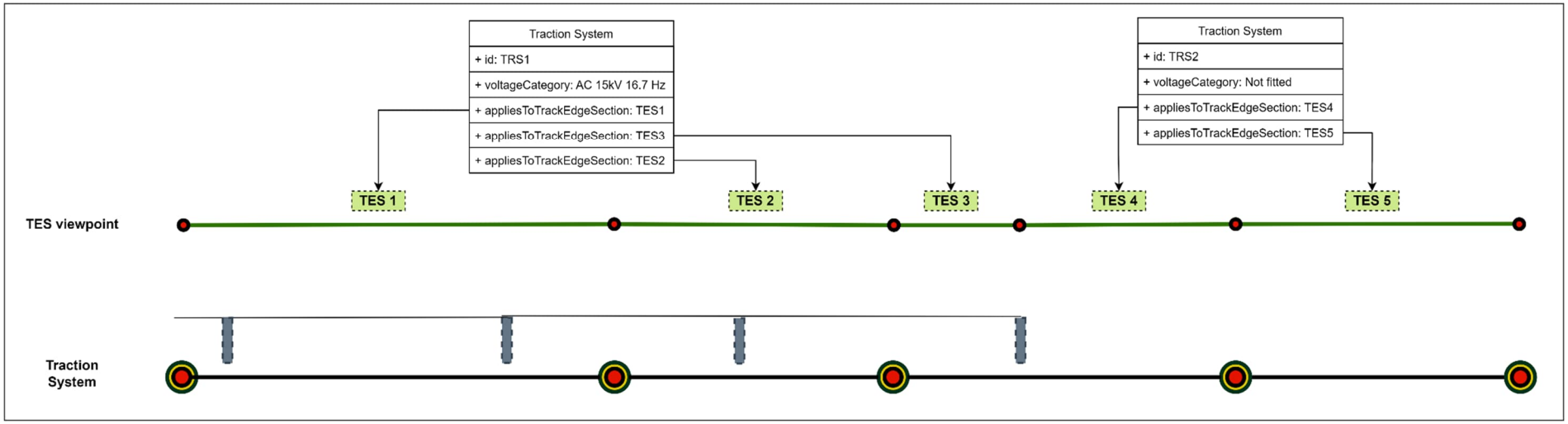


Figure 86: Traction System Example

8.20.4 Dependencies

For all Track Edge Sections, where the Traction System is not “Not electrified”, the maximum allowed train current has to be defined, see next chapter.

8.21 Current Limitation

Maximum allowed current taken by the complete train (composition of one or more units).

8.21.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	X	X	-	-	-

8.21.2 Definition

Table 59: Definition Current Limitation

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-CLI	**CurrentLimita-tion**						
T3-CLI-1		id	Unique generated ID	String	UUID	1	
T3-CLI-2		name	Name of the current limitation definition	String	alphanumeric	1	
T3-CLI-3		version	Reference to the version information	*Version*	-	1	
T3-CLI-4		maximumCurrent	The maximum allowed train current given in amperes	Integer	0 – 15000	1	A
T3-CLI-5		appliesToTrackEdge-Section	Track Edge Sections which apply to the defined current limitation	*TrackEdgeSection*	-	1..*	

8.21.3 Basis / rules and regulations

The Current Limitation is always defined without a direction for the containing Track Edge Sections, as it is supposed to be direction independent.

The cardinality 1..* for the referenced Track Edge Sections is not to be confused with instantiation of TA(s). In case of the Current Limitation, this cardinality allows us to use the same object instantiation for several Track Edge Sections that exist on the network with the same limit.

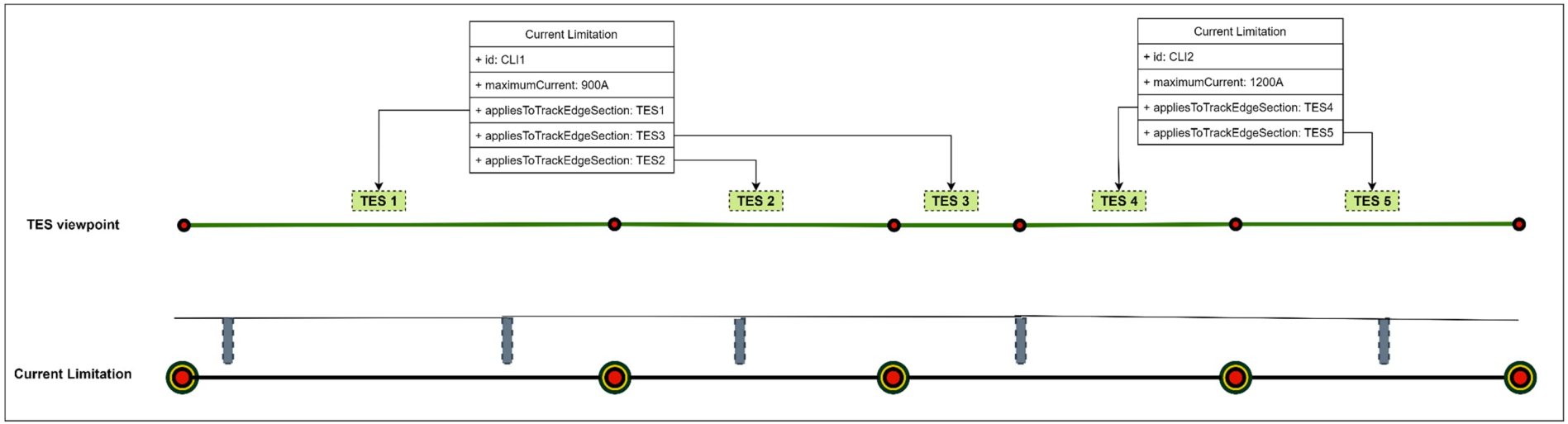


Figure 87: Current Limitation Example

8.21.4 Dependencies

For all Track Edge Sections, where a Current Limitation is defined, the corresponding Energy Supply System has also to be defined, see previous chapter.

8.22 Permitted Braking Distance

Maximum permitted braking distance for the train to come to a halt when using Automatic Train Operation.

8.22.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	-	X	-	-	-	-

8.22.2 Definition

Table 60: Definition Permitted Braking Distance

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-PBD	**PermittedBrakingDistance**						
T3-PBD-1		id	Unique generated ID	String	UUID	1	
T3-PBD-2		name	Name of the maximum train current definition	String	alphanumeric	1	
T3-PBD-3		version	Reference to the version information	*Version*	-	1	
T3-PBD-4		permittedBrakingDistance	Permitted Braking Distance value.	Double	0.001 [13] - 999999.999	1	
T3-PBD-5		appliesToTrackEdgeSection	Track Edge Sections which apply to the defined Permitted braking distance	*TrackEdgeSection*	-	1..*	

[13] The range is set to start from 0.001 to explicitly avoid ‘permittedBrakingDistance’ to be defined with 0 length.

T3-PBD-6		brakeType	ENUM indicating the brake to be used to achieve the permitted braking distance.	*ENUM*	- Service Brake - Emergency Brake	1	

8.22.3 Basis / rules and regulations

The Permitted Braking Distances are represented using Track Edge Sections.

The cardinality 1..* for the referenced Track Edge Sections is not to be confused with instantiation of TA(s). In case of the Permitted Braking Distance, this cardinality allows us to use the same object instantiation for several Track Edge Sections that exist on the network with the same value.

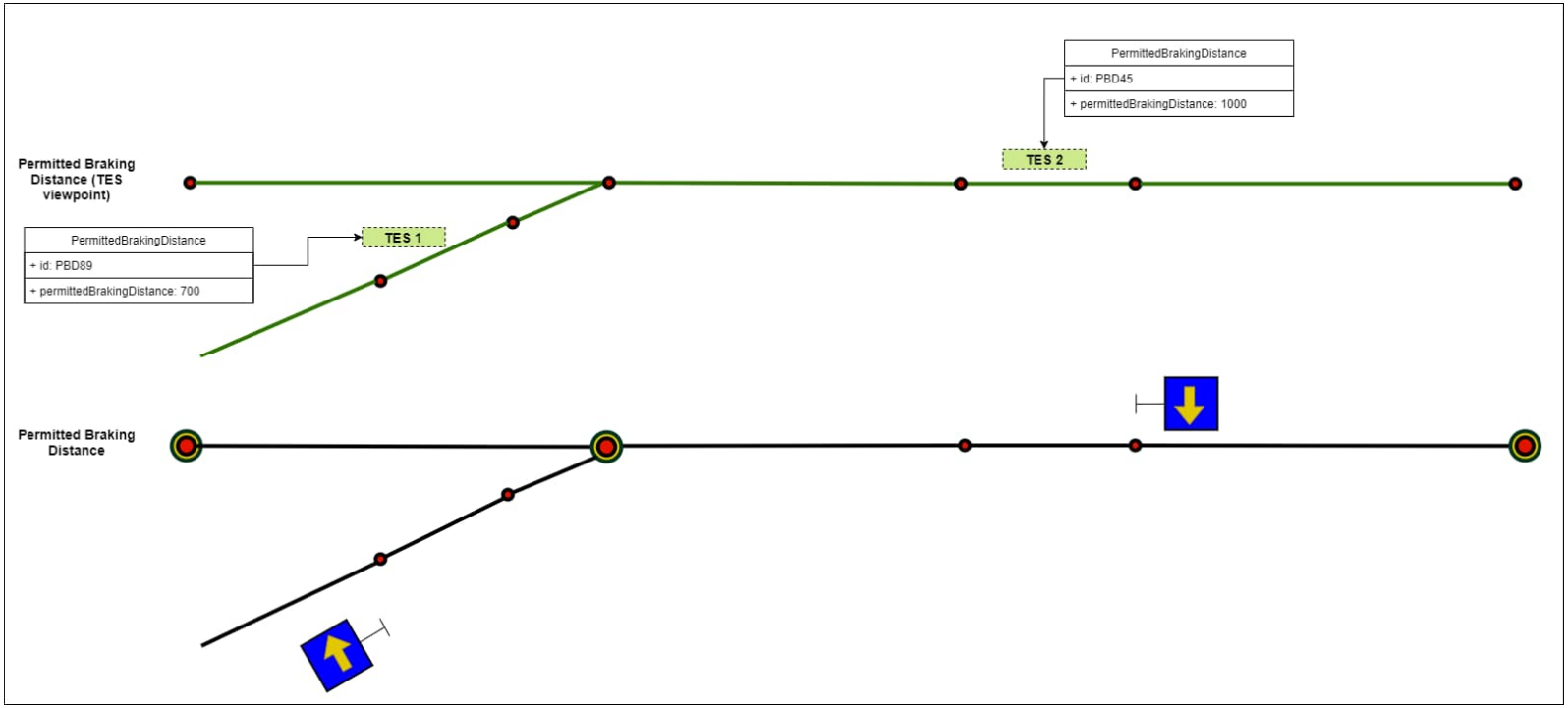


Figure 88: Permitted Braking Distance

8.22.4 Dependencies

The gradient of the track affects the braking distances. Hence a gradient value is specified along with the Permitted Braking Distance for the referenced Track Edge Section. The gradient information for the referenced Track Edge Section shall be retrieved from the specifications in chapter 8.3

8.23 Track Properties

Definition of different general track properties:

- Line Category
    - Category of the railway track, according to the European norm EN 15528. The category defines the maximum allowed axle load and the allowed load per unit length for a track or a track section at its weakest point. It represents the ability of the infrastructure to withstand the vertical loads imposed by vehicles on the track for regular service.
- Loading Gauge
    - The minimal area which needs to stay unobstructed by any trackside construction along the track, so all vehicles can move safely.

8.23.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	-	X	-	-	-

8.23.2 Definition

Table 61: Definition Line Category

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-TRP	**TrackProperties**						
T3-TRP-1		id	Unique generated ID	String	UUID	1	
T3-TRP-2		name	Name of the track properties	String	alphanumeric	1	
T3-TRP-3		version	Reference to the version information	*Version*	-	1	
T3-TRP-4		lineCategory	Line category classification.	ENUM	- A - Bx - Cx - Dx	1	

					- Ex - …[14]		
T3-TRP-5		loadingGauge	Loading gauge classification.	ENUM	- G1 - G2 - GA - GB - GC - …[15]	1	
T3-TRP-6		appliesToTrackEdge-Section	Track Edge Sections which apply to the defined track properties	*TrackEdgeSection*	-	1..*	

[14] The complete list of possible line categories can be found in EN 15528:2008 (Annex A) or in the RINF application guide [5], Number 1.1.1.1.2.4 (IPP_LoadCap), the list might be extended by national specific categories.

[15] The complete list of possible loading gauges can be found in EN15273-3 (2013): Annex C and Annex D or in the RINF application guide [5], Number 1.1.1.1.3.1.1 (ILL_Gauging), the list might be extended by national specific gauge categories.

8.23.3 Basis / rules and regulations

The Track Properties are always defined without a direction for the containing Track Edge Sections, as they are supposed to be direction independent.

The cardinality 1..* for the referenced Track Edge Sections is not to be confused with instantiation of TA(s). In case of the Track Properties, this cardinality allows us to use the same object instantiation for several Track Edge Sections that exist on the network with the same properties.

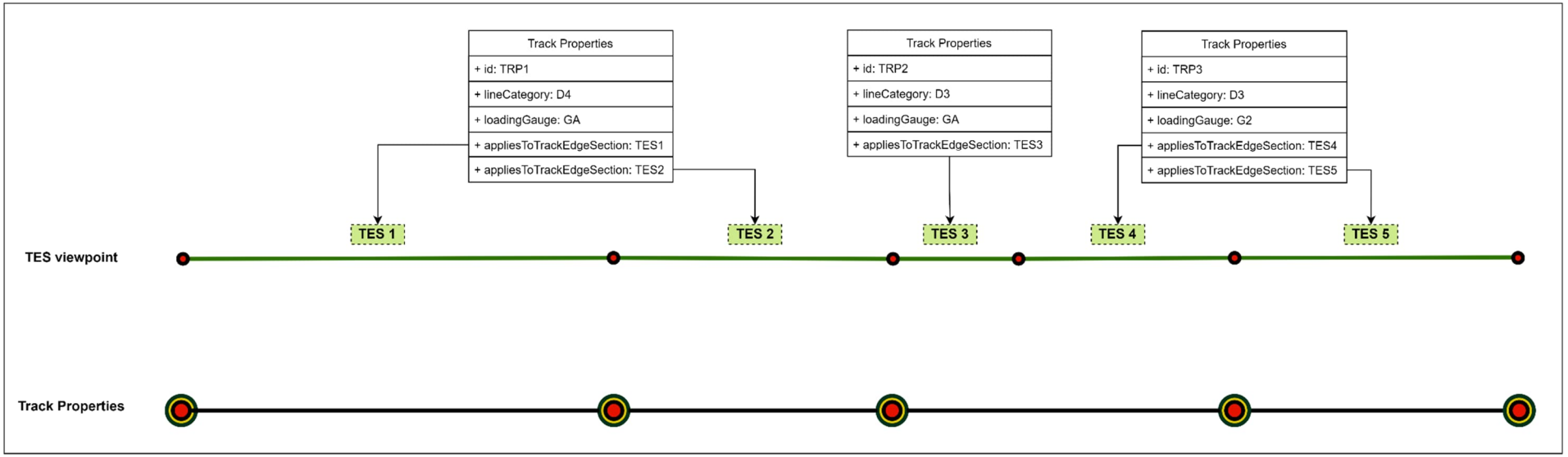


Figure 89: Track Properties Example

8.24 Trackside Train Detection Area

An area consisting of at least one section of a track, for which the occupancy by a movable object can be technically detected.

8.24.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
X	X	-	X	-	-	-

8.24.2 Definition

Table 62: Definition Train Detection Area

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-TTDA	**Trackside-TrainDetection-Area**						
T3-TTDA-1		id	Unique generated ID	String	UUID	1	
T3-TTDA-2		name	Name of the trackside train detection area	String	alphanumeric	1	
T3-TTDA-3		version	Reference to the version information	*Version*	-	1	
T3-TTDA-4		appliesToTrackArea	Reference to the Contiguous Track Area, which applies to the defined trackside train detection section(s).	*ContiguousTrack-Area*	-	1	

8.24.3 Basis / rules and regulations

A Trackside Train Detection Area is made of a Contiguous Track Area which contains one or more Track Edge Sections, a direction information is not relevant.

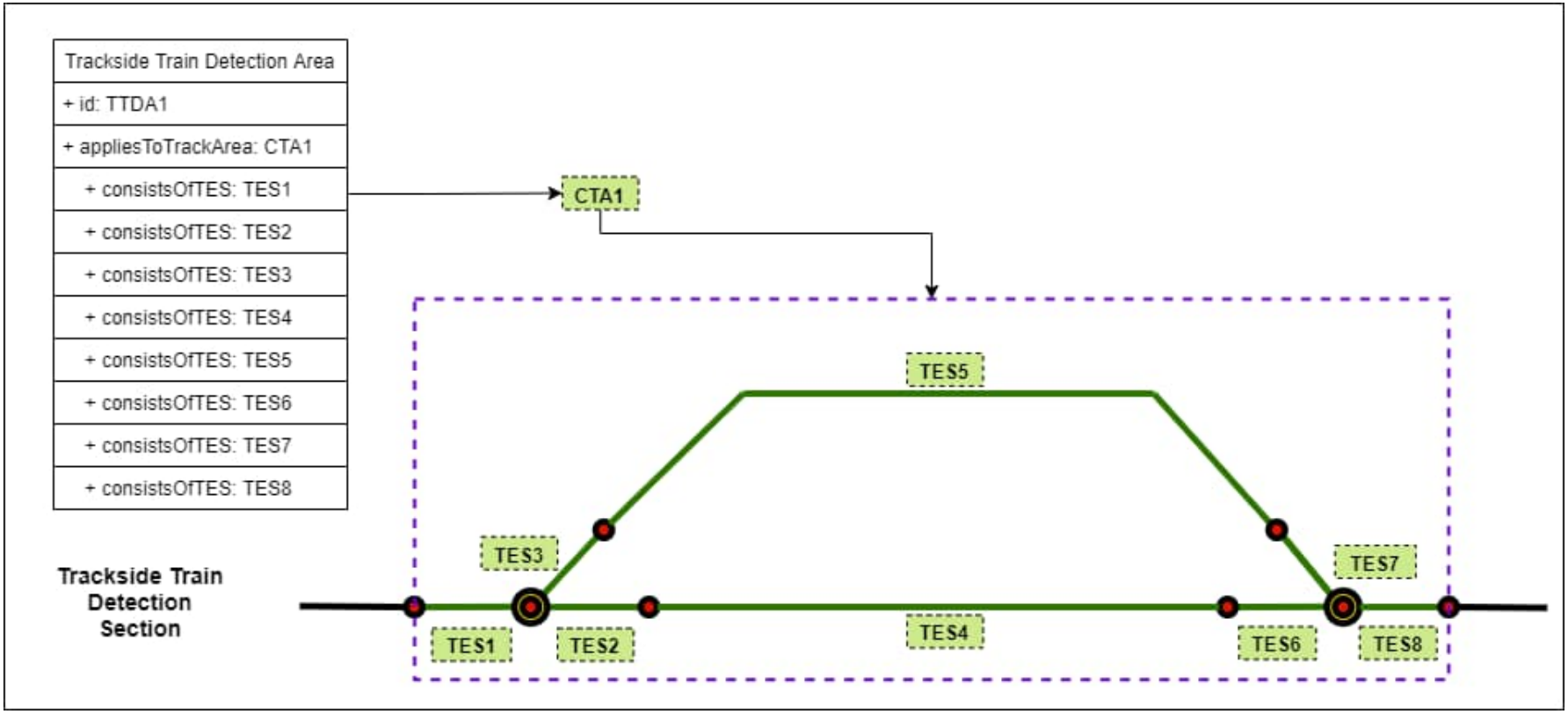


Figure 90: Trackside Train Detection Area

8.25 Movement Permission Target Marker

The Movement Permission Target Marker (MP Target Marker) is used to define a location where a Movement Permission can end.

8.25.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	X	-	X	-	-	-

8.25.2 Definition

Table 63: Definition Movement Permission Target Marker

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-MPT	**MpTargetMarker**						
T3-MPT-1		id	Unique generated ID	String	UUID	1	
T3-MPT-2		name	Name of the MP Target Marker	String	alphanumeric	1	
T3-MPT-3		version	Reference to the version information	*Version*	-	1	
T3-MPT-4		appliesToTrackEdge-Point	Reference to Track Edge Point at which this MP Target Marker is located.	*Directed-TrackEdgePoint*	-	1	
T3-MPT-5		markerType	Defines the type of the marker	ENUM	- ETCS Marker - Stopping Location - Balise - Other[16]	1	

[16] Placeholder to indicate any other type of MpTargetMarker

T3-MPT-6		riskBufferConfigura-tion	The configuration of the minimum risk buffer length which is applicable for this target marker	*RiskBufferCon-figuration*	-	0..*	

8.25.2.1 Risk Buffer Configuration

The risk buffer configuration defines the minimum length of the risk buffer, which is added as a kind of overlap to the end of a Movement Permission in relation to the speed of the trains.

Table 64: Definition Risk Buffer Configuration

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-RBC	**RiskBufferConfiguration**						
T3-RBC-1		startingFromSpeed	The speed from which the specified risk buffer length is valid	Integer	0 – 600	1	km/h
T3-RBC-2		minRiskBufferLength	The minimum length of the risk buffer	Integer	0 – 1000	1	m

Note: The length of the minimum risk buffer length varies depending on the location of the target marker (e.g. if it is located in a tunnel that exceeds a defined length or if it is located next to industrial facilities).

8.25.3 Basis / rules and regulations

The MP Target Marker shall be represented using a Directed Track Edge Point on the topology to be able to define a direction dependant marker.

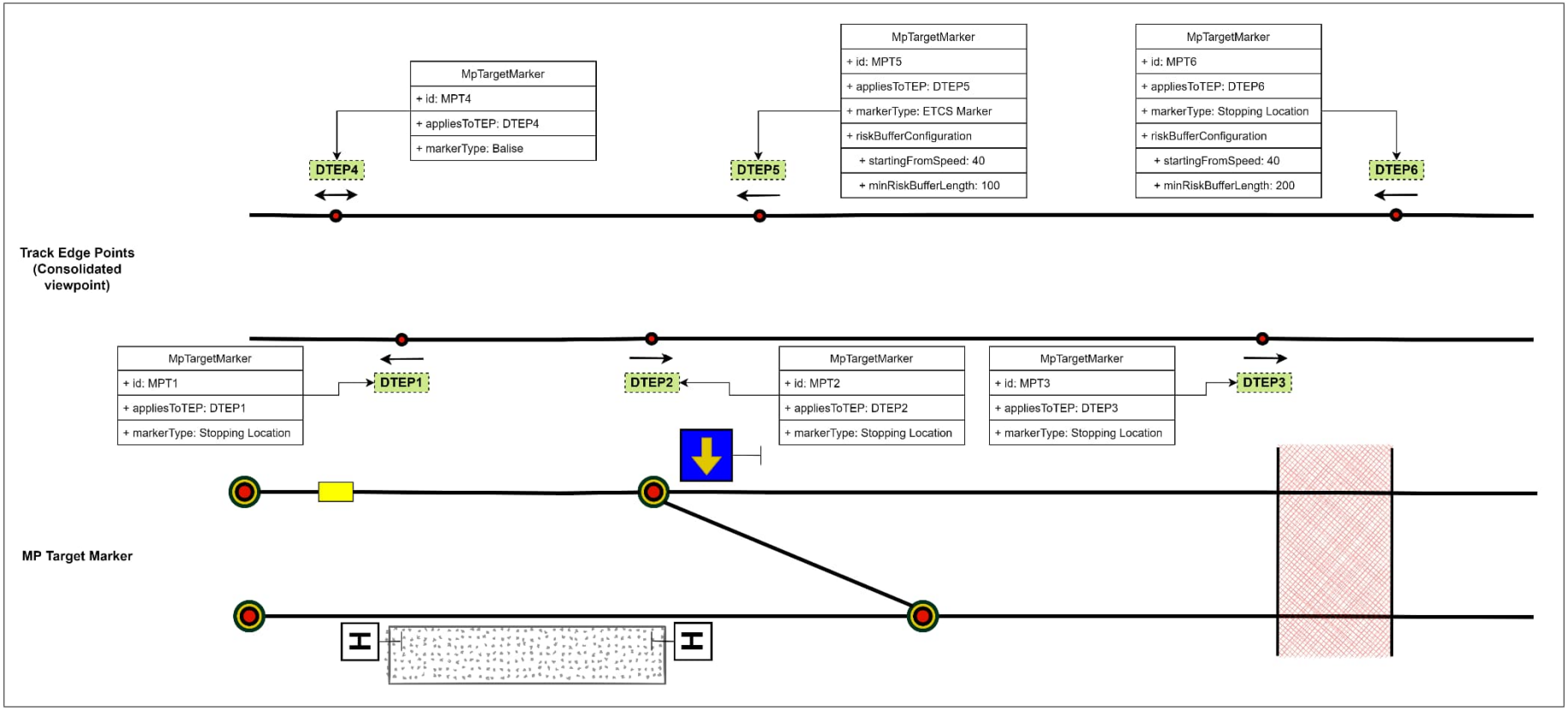


Figure 91: MpTargetMarker Examples

8.25.4 Dependencies

If the MP Target Marker is of type “ETCS Marker”, the corresponding ETCS marker board (see chapter 8.14.4) has also to be defined.

8.26 Zones

The area on and around track can be divided into several zones like track zone, near track zone, protection zone, etc… This chapter defines and describes the different zones[17] along with a taxonomy:

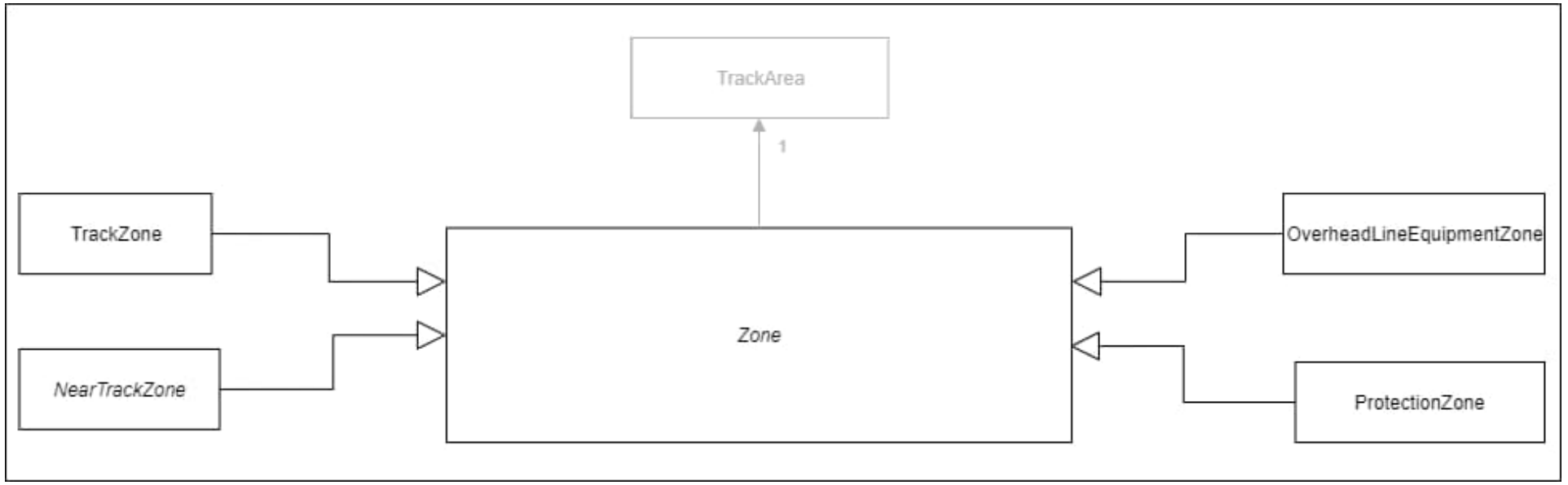


Figure 92: Taxonomy for Zones

8.26.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	-	-	-	X	X	-

[17] The definition of the zones is currently based only on the requirements coming from IPM/PER.

8.26.2 Zone

Zone defines a generic representation / specification of areas on and around the tracks.

8.26.2.1 Definition

Table 65: Definition of Zone

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-ZO	***Zone***						
T3-ZO-1		id	Unique generated ID	String	UUID	1	
T3-ZO-2		name	Name of the zone	String	alphanumeric	1	
T3-ZO-3		version	Reference to the version information	*Version*	-	1	
T3-ZO-4		appliesToTrackArea	Reference to the Track Area on or around the track. *Note*: This reference can either be Track Area or a Linear Contiguous Track Area.	*TrackArea*	-	1	
T3-ZO-5		length	Real length of zone in meters (with 3 decimal places).	Double	0.001 [18] - 999999.999	1	m
T3-ZO-6		width	Real width of zone in meters (with 3 decimal places).	Double	0.001 [18] - 999999.999	1	m
T3-ZO-7		height	Real height of zone in meters (with 3 decimal places).	Double	0.001 [18] - 999999.999	1	m

[18] The range is set to start from 0.001 to explicitly avoid length to be defined as 0.

8.26.2.2 Basic / rule and regulations

The Zones are represented using a Track Area on the topology. The referenced Track Area can be either a Linear Contiguous Track Area or a Track Area depending on the Zone. E.g. Overhead line equipment zone is represented using a Track Area and track zone is represented using a Linear Contiguous Track Area.

8.26.2.3 Example

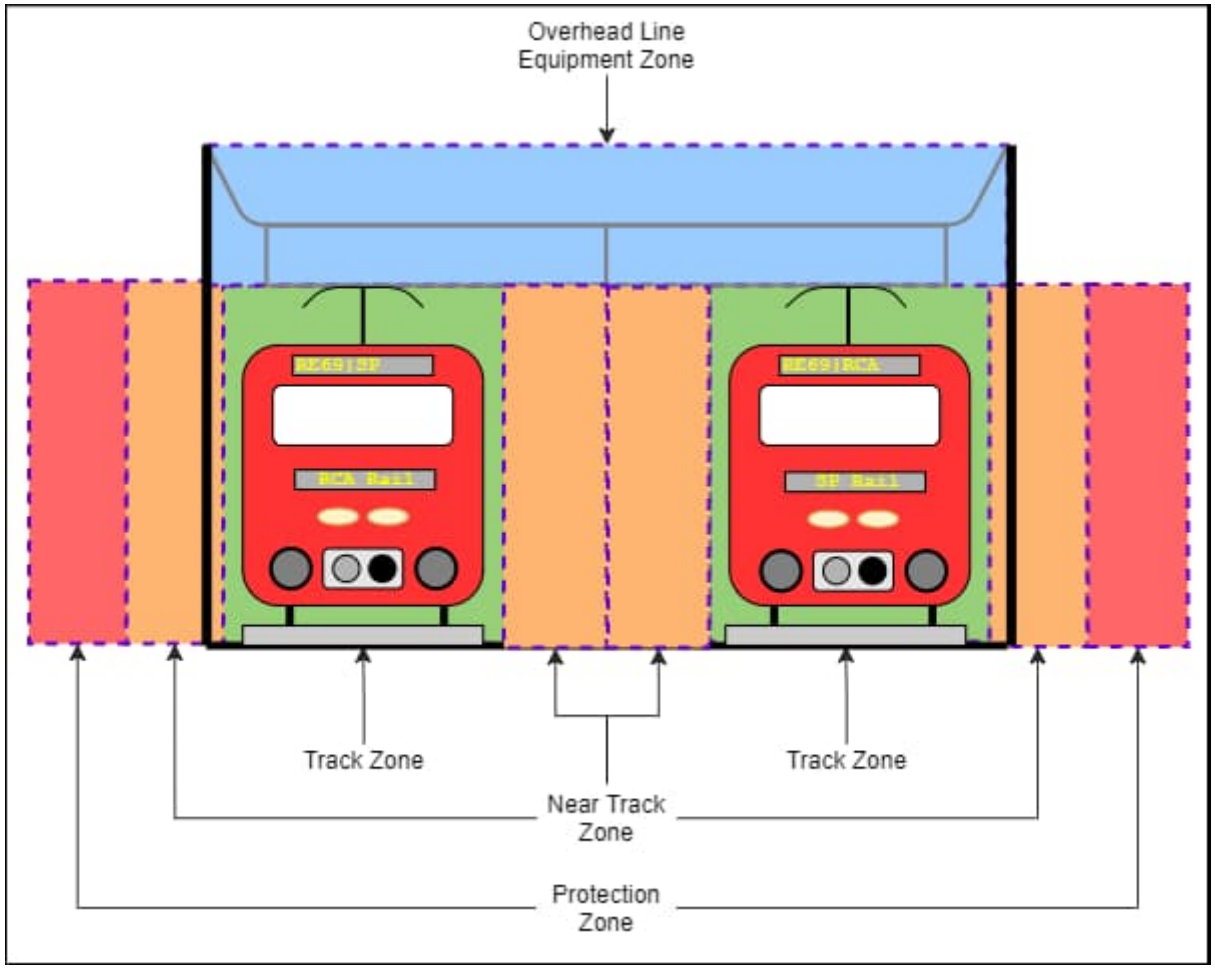


Figure 93: Example Zones

8.26.3 Track Zone

Track zone represents the area surrounding the tracks.

8.26.3.1 Definition

Table 66: Definition of Track Zone

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-TZ	***Zone* ::** **TrackZone**						

8.26.3.2 Basic / rule and regulations

The track zones are represented using a Linear Contiguous Track Area on the topology.

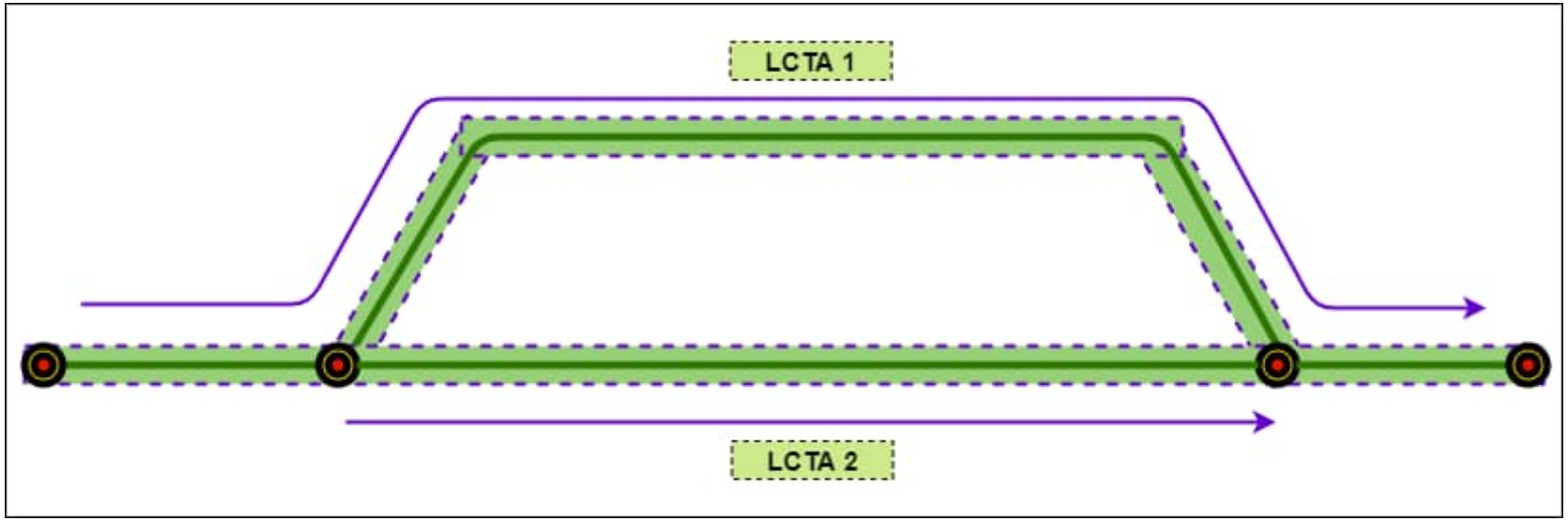


Figure 94: Track Zone

8.26.3.3 Engineering rules

The engineering of these zones is assumed to be infrastructure manager specific and will be specified in later iterations of this document.

8.26.4 Near Track Zone

Near track zone represents the area directly adjacent to the tracks.

Note:

1. During definition of track zones, it was noticed that track zones can be static and dynamic. For ease of definition and due to outstanding uncertainties in configuration of such zones, both the aspects have been combined into one class.
2. It is also as per our understanding that these static and dynamic zones can be defined using national values depending on Area of Control instead of defining a track edge specific configuration.

8.26.4.1 Definition

Table 67: Definition of Near Track Zone

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-NTZ	***Zone* ::** **NearTrackZone**						

8.26.4.2 Basic / rule and regulations

The near track zones are represented using a Linear Contiguous Track Area on the topology. The Track Edge Sections part of the LCTA shall have a corresponding lateral offset.

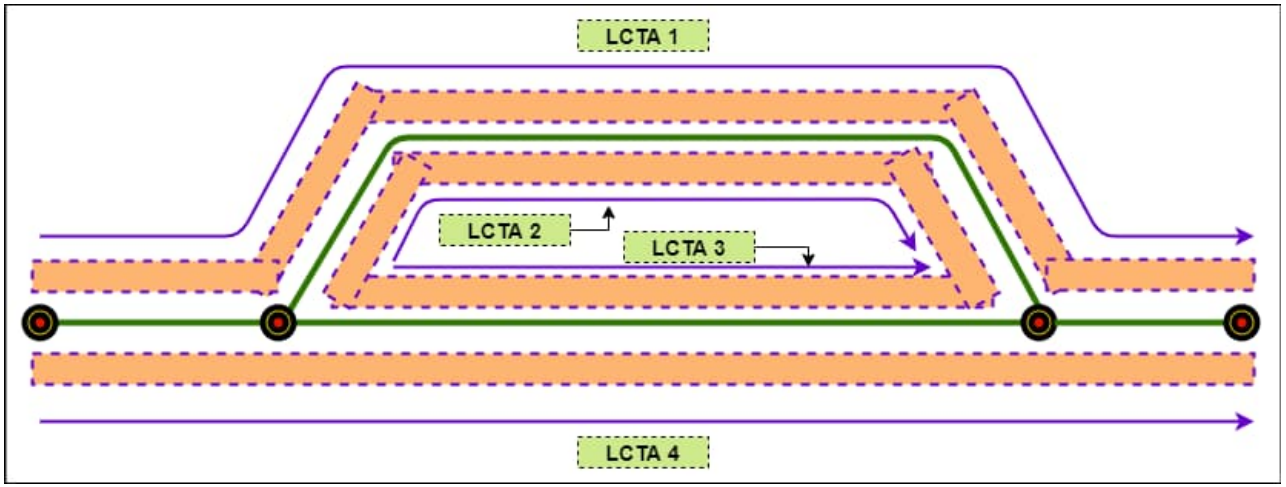


Figure 95: Near Track Zone

8.26.4.3 Engineering rules

The engineering of these zones is assumed to be infrastructure manager specific and will be specified in later iterations of this document.

8.26.5 Protection Zone

Protection zone represents the area adjacent to the tracks which permits the presence of authorised staff.

8.26.5.1 Definition

Table 68: Definition of Protection Zone

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-PZ	***Zone* ::** **ProtectionZone**						

8.26.5.2 Basic / rule and regulations

The protection zones are represented using a Linear Contiguous Track Area on the topology. The Track Edge Sections part of the LCTA shall have a corresponding lateral offset.

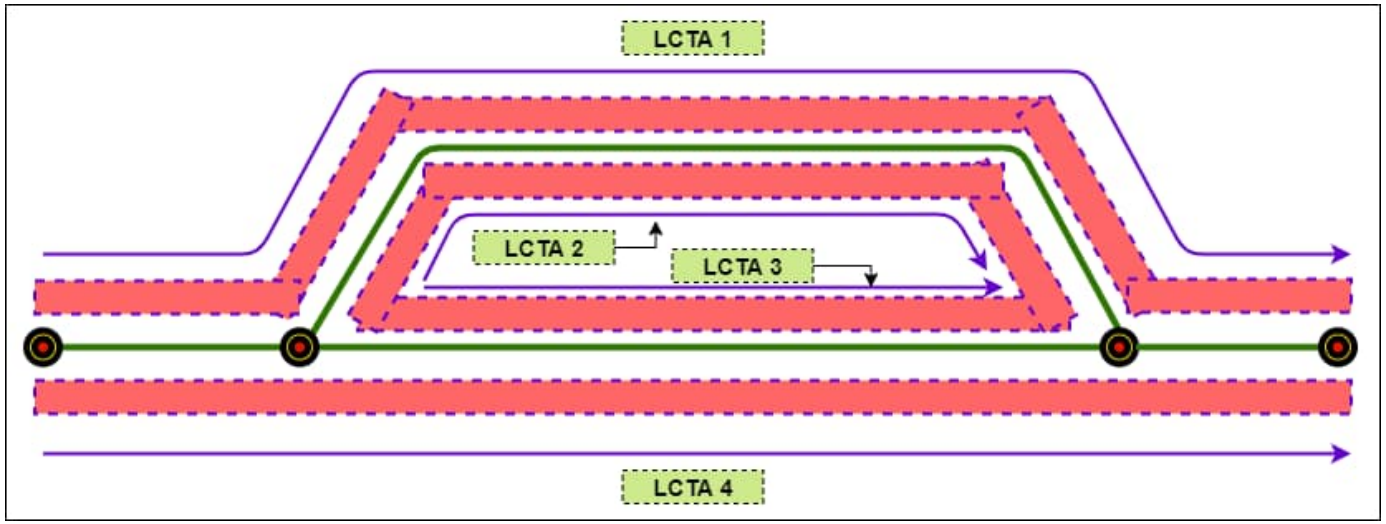


Figure 96: Protection Zone

8.26.5.3 Engineering rules

The engineering of these zones are assumed to be infrastructure manager specific and will be specified in later iterations of this document.

8.26.6 Overhead Line Equipment Zone

Overhead line equipment zone represents the area covering the overhead line equipment above the tracks.

8.26.6.1 Definition

Table 69: Definition of Overhead Line Equipment Zone

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-OLEZ	***Zone :*: OverheadLineEquip-mentZone**						
T3-OLEZ-1		verticalTrackA-reaOffset	Represents a constant vertical offset value throughout the Linear Contiguous Track Area in meters from the Track Edge (with 3 decimal places).	-	0.000 – 99.999	1	m

8.26.6.2 Basic / rule and regulations

The overhead line equipment zones are represented using a Track Area on the topology. The Track Edge Sections part of the LCTA shall have a corresponding vertical offset.

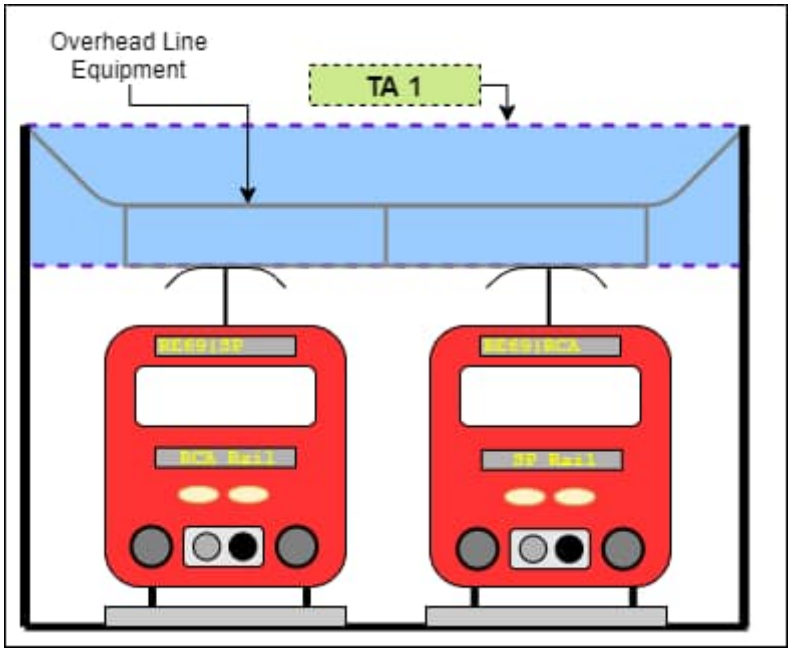


Figure 97: Overhead Line Equipment Zone

8.26.6.3 Engineering rules

The engineering of these zones is assumed to be infrastructure manager specific and will be specified in later iterations of this document.

8.27 Generic Spatial Objects

Defines generic spatial objects alongside the track i.e. Signal pole, Wall, Platform, etc. along with their geometric representations.

This chapter defines and describes the different generic objects along with a taxonomy:

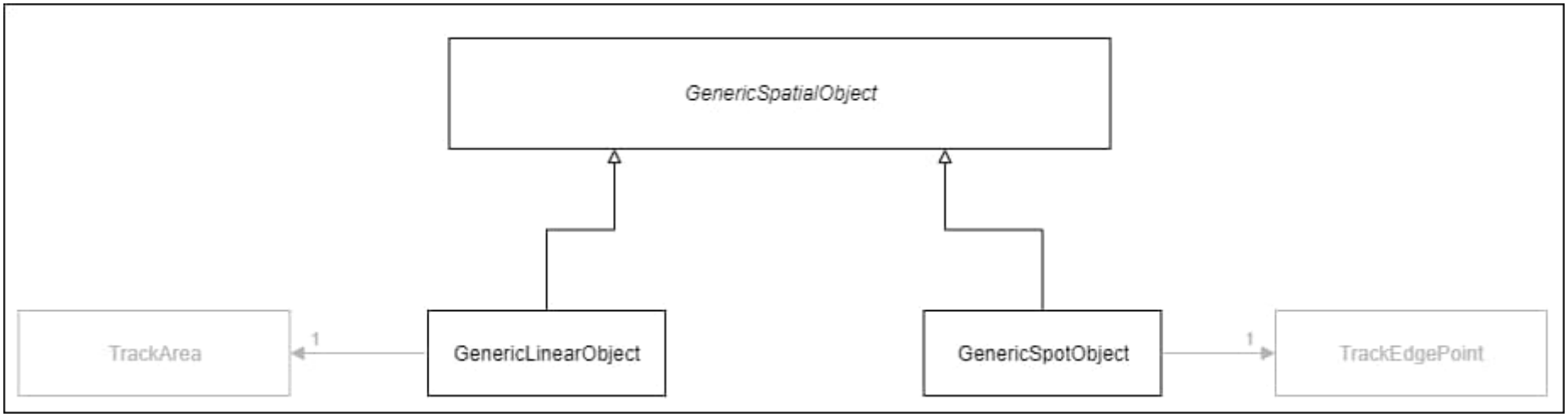


Figure 98: Taxonomy for Generic Spatial Objects

8.27.1 Consumer

APS	PAS	ATO	PE	IPM	PER	LOC
-	-	-	-	X	X	X

8.27.2 Generic Spatial Object

Defines a representation of generic spatial objects alongside the track.

8.27.2.1 Definition

Table 70: Definition Generic Spatial Object

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-GSO	**GenericSpatia-lObject**						
T3-GSO-1		id	Unique generated ID	String	UUID	1	
T3-GSO-2		name	Name of the generic spatial object	String	alphanumeric	1	
T3-GSO-3		version	Reference to the version information	*Version*	-	1	
T3-GSO-4		geometric-Construct	3D Geometric definition of the object	Polygon		1	

Note:

1. The geometric construct attribute currently enables this object catalogue to cover IPM/PER specific needs in terms of providing a finite 3D geometry for the objects. This aspect is still incomplete due to uncertainties regarding methods and processes to be used for definition a 3D object geometry in an object catalogue.
2. Type ‘polygon’ is a placeholder until a actual type of geometric construct is decided upon.

8.27.2.2 Basic / rule and regulations

The generic spatial objects are represented using a Track Area or a Track Edge Point on the topology depending on the type of trackside object i.e. generic linear generic spot.

8.27.2.3 Example

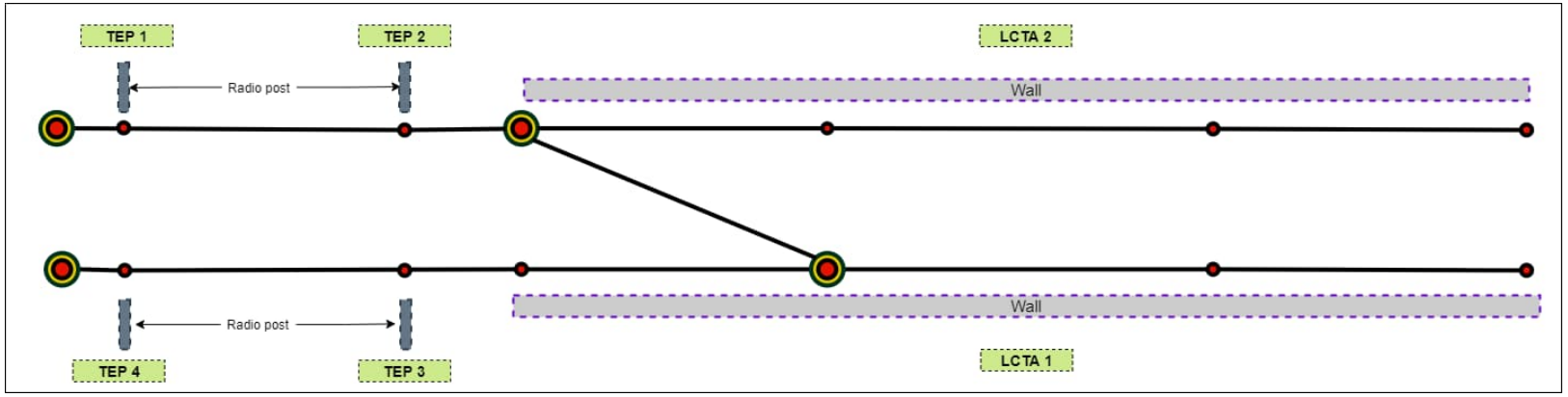


Figure 99: Generic Spatial objects

8.27.3 Generic Linear Object

Defines the generic linear objects alongside the track for localisation, perception, or incident prevention purposes.

8.27.3.1 Definition

Table 71: Definition Generic Linear Object

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-GLO	**GenericSpatialObject :: GenericLinearObject**						
T3-GLO-1		appliesToTrackArea	Reference to the Track Area on or around the track. *Note:* This reference can either be Track Area or a Linear Contiguous Track Area.	*TrackArea*	-	1	
T3-GLO-2		type	ENUM providing type of generic linear object	ENUM	Platform Wall Tunnel Handrail Cable Duct Bridge	1	

8.27.3.2 Basis / rules and regulations

The generic linear objects are represented using a Track Area on the topology. The referenced Track Area can be either a Linear Contiguous Track Area or a Track Area depending on the spatial trackside object. E.g. Tunnel is represented using a Track Area and platform is represented using a Linear Contiguous Track Area. The Track Edge Sections part of the LCTA shall have a corresponding lateral offset.

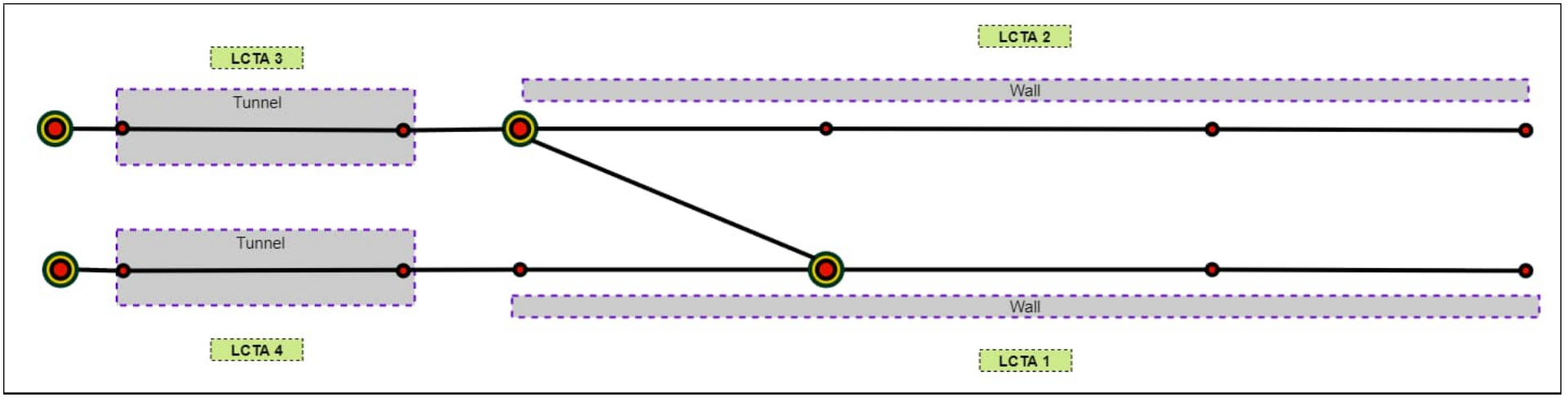


Figure 100: Generic linear object

8.27.3.3 Dependencies

The TA for Tunnel shall refer to the same TA as defined in chapter 8.16.4. No redundant TAs shall be created.

The LCTA for Platform shall refer to the same LCTA as defined in chapter 8.15. No redundant LCTAs shall be created.

8.27.4 Generic Spot Object

Defines the generic spot object alongside the track for localisation, perception, or incident prevention purposes.

8.27.4.1 Definition

Table 72: Definition Generic Spot Object

ID	Object	Attribute	Description	Type	Range	Cardinality	Unit
T3-GSPO	**GenericSpatialObject :: GenricSpotObject**						
T3-GSPO-1		applie-sToTrackEdgePoint	Reference to Track Edge Point on which this landmark is located.	*TrackEdge-Point*	-	1	
T3-GSPO-2		type	ENUM providing type of generic spot object	ENUM	Catenary Post Sign Post Signal Post Radio Post Mileage Stone Hectometre Sign Camera Post Communication Post End of Track Other Post[19]	1	

8.27.4.2 Basis / rules and regulations

The generic spot objects are represented using a Track Edge Point on the topology.

[19] Includes all other kinds of posts which are not yet covered in the list.

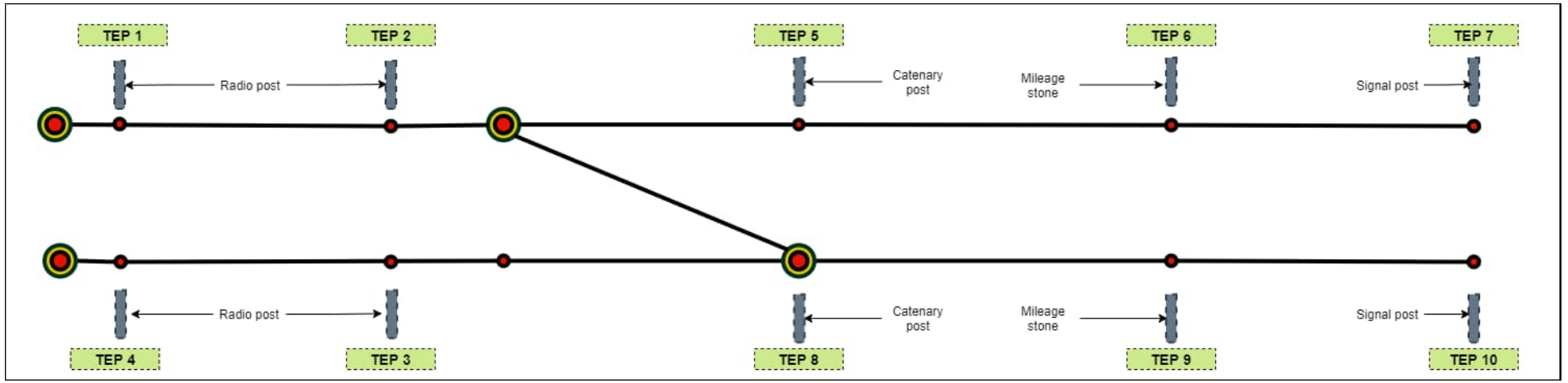


Figure 101: Generic spot object

8.27.4.3 Dependencies

The TEP references of all the generic spot objects shall refer to the references any previously existing TEP and redundancies shall be avoided.

9 Open Points

- Agree on the modelling proposal for dual gauge tracks (see chapter 6.1.5)
- Need for ‘direction’ attribute for LCTA or a Directed LCTA object, e.g. Shunting with MA use cases (see chapter 7.3.4)
- Need for a Fixed Usage Restriction Area to configure specific (safety) rules and definitions for a dedicated area (e.g. a shunting yard)
- Additional attributes for the Balise (type of Balise (fixed or transparent)) based on the requirements of LOC-OB (see chapter 8.9)
- Definition of list of elements defined as landmarks (see chapter 8.13)
- Alignment of concept of Train Detection Section (see chapter 8.24) with MOB concept from APS
- Alignment on modelling of zones as per advancements in discussions from PER/IPM cluster (see chapter 8.26)
- Definition of shape of Generic spatial objects (see chapter 8.27)
- Need for safety related aspects about tunnels (e.g. rescue points, prohibition of two trains heading towards each other, see chapter 8.16)
- Flank Protection: To be checked by APS that this is a configuration parameter and not something that can be calculated during runtime in APS (see chapter 8.7.4.2)
    - APS concept for flank protection is currently in development and will be published for review in August 2022
- Modelling of Magnetic field signatures for localisation application.
- Alignment of LX modelling with the concepts of LX position paper from APS (see chapter 8.18)
- Movement Permission Target Marker definition needs to be coordinated between APS and PE (see chapter 8.25)
- Does Map also contain Cell Data/Radio transition data for CS/PS/FRMCS operation?
- Alignment on a standardised option to manage Map data version? See scenarios defined in chapter 5.2.3
- Alignment on use of data types for attribute e.g. double, float, or integer.
- Clarification of meaning of ‘centre point’ for an Operational Point. See chapter 5.6