ERJU SYSTEM PILLAR

T3-TopologyInterfaceSpecification

Topology Interface Specification

DISCLAIMER

This draft is to be intended as an Annex to the System Concept document and is issued as part of the planned deliverables of the first three months activity.

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Content

1 History of Changes

Nr.	Changes	Leader/Authors
01.00	First draft for internal revision	Marco Nanni
02.00	Integrate contributions of workgroup team. Alignment with Task2 TCCSSD1 model	Marco Nanni, Stefan Wegele, Herbert Knoedl, Simone Brezzi, Mirko Ghersi
02:01	Improved adherence to the SD1 model with the inclusion of Track Geometry. Aligned existing classes to comply with. Added a set of requirement for every object which qualify the object and give its need in terms of statements. Removed some elements which have no more reason after the revision	Marco Nanni, Stefan Wegele
02.02	Document improvement according to received comments from Mirror Group et. al.	Marco Nanni

2 Reference

· [Ref 1] – TCCS SD1 – Data Model_10_INFRA v. 1.1

· [Ref 2] – TCCS SD1 – Data Model_11_ATO v. 0.3

· [Ref 3] – TCCS SD1 – Data Model_11_ENG v. 0.3

· [Ref 4] – TCCS SD1 – Data Model_11_TP v. 0.2

· [Ref 5] – TCCS SD1 – Data Model_11_Operational Plan rev. 121838

· [Ref 6] – Communications Interface between TMS and CCS, “TMS <> CCS v. 1.3

· [Ref 7] – TCCS SD1 – Data Model_01_Introduction rev. 81500

· [Ref 8] – RNE – CG1 – Feasibility study CRD-RINF

· [Ref 9] – RNE – RINF and CRD harmonization

· [Ref 10] – X2Rail-4 - Deliverable D9.1 Amendment to the SRS of the Integration Layer

· [Ref 11] – System Architecture Description v0.04

3 Abbreviations

ATO Automatic Train Operation **[** Content to be approved, SPT3TMS-12973 **]**

CMS Capacity Management system **[** Content to be approved, SPT3TMS-12984 **]**

CRD Central Reference Data **[** Content to be approved, SPT3TMS-12990 **]**

ERA European Railway Agency **[** Content to be approved, SPT3TMS-12991 **]**

ETCS European Train Control System **[** Content to be approved, SPT3TMS-13797 **]**

GUID Globally Unique IDentifier **[** Content to be approved, SPT3TMS-13214 **]**

IM Infrastructure Manager **[** Content to be approved, SPT3TMS-13000 **]**

OSF Open Software Foundation **[** Content to be approved, SPT3TMS-13213 **]**

RCA Reference CCS Architecture **[** Content to be approved, SPT3TMS-13208 **]**

RIM Rail Infrastructure Manager **[** Content to be approved, SPT3TMS-12957 **]**

RINF Register of INFrastructure **[** Content to be approved, SPT3TMS-13207 **]**

RU Railway Undertaking **[** Content to be approved, SPT3TMS-13210 **]**

SD SubDomain **[** Content to be approved, SPT3TMS-13209 **]**

SSP Static Speed Profile **[** Content to be approved, SPT3TMS-13215 **]**

TAF/TAP Telematics Applications for Freight/Passenger Services **[** Content to be approved, SPT3TMS-13004 **]**

TCCS Transversal Command and System **[** Content to be approved, SPT3TMS-13219 **]**

TCS Train Control & Supervision **[** Content to be approved, SPT3TMS-12962 **]**

TE Track Edge **[** Content to be approved, SPT3TMS-13218 **]**

TES Track Edge Section **[** Content to be approved, SPT3TMS-13217 **]**

TMS Traffic Management System **[** Content to be approved, SPT3TMS-12967 **]**

TSI Technical Specifications for Interoperability **[** Content to be approved, SPT3TMS-13010 **]**

UUID Universally Unique IDentifier **[** Content to be approved, SPT3TMS-13216 **]**

4 Disclaimer

This document heavily relates to [Ref 1] and [Ref 2], and links should be traced towards these documents. As actually there are no permissions to trace these links, as these documents belong to another Domain, different from CMS/TMS, this specification shall be issued for approval without these links.
The permission to trace links to other Domains shall be requested later. Once approved, this specification shall be reopened and once achieved the right level of permission, the links shall be traced. **[** Content to be approved, SPT3TMS-13766 **]**

5 Introduction

5.1 Purpose

The overall Common Business Objectives which are at the basis of the System Pillars initiative and that drive the activity of the several working teams imply the design of a very detailed topological model which is general enough and exhaustive to satisfy the requirements of all systems depicted by the CCS and CMS/TMS architecture. **[** Content to be approved, SPT3TMS-11528 **]**

All subsystems which together draw the architecture of the layered railway system under definition must rely on the same topological model, which must prove to be complete and suitable to support every subsystem in:
· performing the apportioned features
· relying on a set of harmonized concepts, object and relations among objects which are the same for all subsystems, which use them for their functionalities
· implementing its interfaces with neighboring subsystems exchanging therefore consistent infrastructural data **[** Content to be approved, SPT3TMS-11527 **]**

The following chapters draw a topological infrastructure proposal that CMS and TMS subsystems need to perform their apportioned functionalities properly and with the required level of precision. **[** Content to be approved, SPT3TMS-11526 **]**

This topological infrastructure specification aims to draw a consistent and complete set of data which ensures that the development of the TMS and CMS functions is fully supported, as well as the data structures exchanged by the interface between TMS and CCS have the same meaning and represent the same entities for the two peer systems. **[** Content to be approved, SPT3TMS-11525 **]**

To accomplish this task, it has been chosen to start from the existing model elaborated by SD1 and derive a list of structures whose contained parameters describe the needs for CMS/TMS to perform their functions. Implicitly, these structures represent requirements themselves. However, to provide a clearer specification, a set of requirements is also provided prior to any structure description, showing the reason why they are given. **[** Content to be approved, SPT3TMS-11532 **]**

This specification does not to be intended as the definition of an alternative model, whose master remains Transversal task 2, Subdomain 1 only. Therefore, this document shall be provided and discussed with Transversal task 2, Sub Domain 1, which is in charge of the definition of the whole topological model for all final users of the CMS/TMS and CCS systems. **[** Content to be approved, SPT3TMS-11531 **]**

It is expected that this broad design phase is accomplished by all subsystems and shall be shared with the Transversal task 2, Subdomain 1, which will collect all needs and will act as a master for the finalization, distribution and maintenance of the overall topological model. **[** Content to be approved, SPT3TMS-11530 **]**

As an example, it can be noted that the Traffic Control and Supervision System shall comply with the exchanged data structures. It will require an adequate topological model based on the artifacts defined by the same specifications here considered and improved to be suitable to perform its apportioned features but will be consistent at the interface. The same is expected to be done by any other subsystem defined by all SP tasks. **[** Content to be approved, SPT3TMS-11529 **]**

For the scope of CMS/TMS, the alignment between the TCCS model and the ERA Ontology is required.

5.2 Preliminary analysis of the Transversal Data Model

The specification of CMS/TMS topological needs is based on the result of the specification activity carried out by the transversal Task 2 TCCS Sub Domain 1, whose goal is to define a topological model suitable to be used by all its “client” subsystems defined according to the Railway System architecture defined inside System Pillars. [Content to be approved, SPT3TMS-11535]

The preliminary analysis done on the four documents which build the data model defined by Task 2 TCCS Sub Domain 1, [Ref 1], [Ref 2], [Ref 3] and [Ref 4], led to the following conclusion: [Content to be approved, SPT3TMS-11534]

Data model “Infrastructure” ([Ref 1]): this is the most relevant document for CMS/TMS purposes: it defines the overall proposed topology, and the concepts described there are prominent and must be defined for CMS/TMS as well. Then this model will be deeply considered and modified/extended to match all CMS/TMS needs. [Content to be approved, SPT3TMS-11533]

Data model “ATO” ([Ref 2]): this model focuses on ATO relevant structures and models, which are tightly related to ETCS system relevant topological entities. The level of precision is specifically oriented to ATO functional implementation, but also CMS/TMS need this information to elaborate a feasible Production plan. On the other hand, some other objects are not controlled by CMS/TMS system and are just needed for ATO purposes. Then this model will be considered for all structures relevant for CMS/TMS purposes, disregarding the others. [Content to be approved, SPT3TMS-11539]

Data model “ETCS Engineering” ([Ref 3]): this model focuses on the structures required for the engineering of interlocking and ETCS. Some of the objects already defined into [Ref 1] have been also described here with a different approach, functionally oriented. [Content to be approved, SPT3TMS-11538]

However, TMS doesn’t operate directly on interlocking and ETCS; the objects here defined and in part available also in [Ref 1] have been analysed; they are considered as points, without a spatial dimension, which are located on objects which will be modelled, but they seem not to be associated to any of the functions apportioned to CMS/TMS. Therefore, they don’t have to be considered in this specification and by CMS/TMS. [Content to be approved, SPT3TMS-11537]

In case further considerations arise, adding elements which suggest their consideration, a revision of the specification shall be accomplished taking them into account. [Content to be approved, SPT3TMS-11536]

Data model “Train Protection” ([Ref 4]): this model focuses on the structures required for train protection and interferences among trains gauges. Two structures are defined, “Drive Protection Section” (and a group of them) and “Allocation Section”, both relevant for a safe implementation of train movements, but not relevant for CMS/TMS goals. Therefore, they don’t have to be considered in this specification and by CMS/TMS. [Content to be approved, SPT3TMS-11542]

In case further considerations arise, adding elements which suggest their consideration, a revision of the specification shall be accomplished taking them into account. [Content to be approved, SPT3TMS-11541]

Data model “Operational Plan” ([Ref 5]): this model focuses on the interface which must be implemented between TMS and TCS and provides a formal definition of the structures which contain data to be exchanged. Then, the document is oriented to define a functional model, extensively recalling and re-elaborating the structures defined in the SCI-OP specification delivered in the frame of RCA initiative (Ref 6]), rather than approaching topological related topics. [Content to be approved, SPT3TMS-11540]

The revision of this interface specification and its adaptation to the context of SP activities is an on-going activity according to the 2024 Task 3 Remit document and shall be accomplished according to the 2024 planning. Then, the analysis and verification of the defined functional data elements is not in scope of this specification. [Content to be approved, SPT3TMS-11555]

On the other hand, [Ref 5] was considered to review possible infrastructural or ATO-related concepts and verify whether new concepts must be added to the CMS/TMS infrastructure specification, or there are definitions diverging with the proposed model. The preliminary analysis showed that all the referred infrastructural classes in [Ref 5] have been already defined in [Ref 1] and shall be taken into account /

extended in the present document. Then, no additional contribution to the present document is foreseen from [Ref 5]. **[** Content to be approved, SPT3TMS-11554 **]**

5.3 Scope and exclusions

This document deals with the overall topology structure for CMS/TMS with the same level of detail given by [Ref 1], [Ref 2] and [Ref 3], provided by the TCSS SD1 team. Even if the best modelling of the topology for CMS/TMS functions should be probably different (CMS/TMS features need a level of abstraction greater than that provided by the “technical” topology), nevertheless it is necessary to have a consistent interface with the topological model suitable for all subsystems, which everyone will then process with its own tools to achieve the representation which better suits with their goals. **[** Content to be approved, SPT3TMS-11552 **]**

If deemed necessary, the CMS/TMS subsystem shall apply a specific set of tools to the topological model here defined, which elaborates and transforms this model into another one with the suitable level of abstraction. Anyway, the topological data used for the implementation of the interfaces with the external systems shall always be agreed with the peers and when inconsistencies are identified, a clarification process which leads to an agreement shall be implemented and pursued. **[** Content to be approved, SPT3TMS-11551 **]**

The model designed inside this document shall be consistent and complete from CMS/TMS viewpoint. **[** Content to be approved, SPT3TMS-11562 **]**

The document focuses on topological needs for the CMS/TMS subsystem and doesn’t approach any other specific need of any other railway subsystem dealt within System Pillars. It is assumed that the specific needs of these other subsystems shall be elaborated by the respective teams and shall be submitted as part of System Pillars deliverables. **[** Content to be approved, SPT3TMS-11560 **]**

The publication of the topological model to all consumers is not in scope of this document. The distribution of the model its coming into service must be synchronized among the final users so as to be consistent when they exchange topology-based information. The distribution process, the protocol used and other details are not in scope of the document and shall be specified by other tasks. **[** Content to be approved, SPT3TMS-11558 **]**

5.4 Assumptions

The data model defined by [Ref 1], [Ref 2] and [Ref 3] is considered and its degree of completeness with respect the features which must be apportioned to CMS/TMS is evaluated. In case this model envisages structures which are deemed not necessary for CMS/TMS purposes, or if the level of detail of some modelled objects is too detailed, this shall not be a drawback for CMS/TMS which simply will not use them. **[** Content to be approved, SPT3TMS-11556 **]**

On the other hand, if some constructs/new structures or additional characteristics of existing structures are considered mandatory for CMS/TMS to perform their features with the right level of precision, which are not foreseen by the input model, their definition shall be proposed and their need shall be pinpointed, for further discussion and clarification. **[** Content to be approved, SPT3TMS-11568 **]**

The topological model here designed aims to suit for TMS as well as for CMS. These components of the CMS/TMS subsystem, for their complexity and the different tasks performed are to be considered disjointed and connected by a specific interface to be designed. However, even if they implement different business logic and different operational processes in different time spaces, both rely on the same topological model and data exchanges are tightly coupled with it. **[** Content to be approved, SPT3TMS-11566 **]**

The CMS/TMS data model shall align with the ontology that the European Railway Agency describe the concepts and relationships related to the European railway infrastructure and the vehicles authorized to operate over it. This includes operational points, section of lines, line properties, and (TAF/TAP TSI) Primary Locations that are needed for the exchange of TAF/TAP TSI messages in the scope of CMS/TMS. **[**SPT3TMS-13734 **]**

5.5 Constraints

The topological model defined by [Ref 1], [Ref 2], [Ref 3] and [Ref 4] is considered as a reference, but this is not considered as a constraint in case additional constructs or improvements of existing ones are deemed necessary for CMS/TMS needs. **[** Content to be approved, SPT3TMS-11572 **]**

No constraints about hardware compatibility are applicable, as this specification is independent from any hardware environment. **[** Content to be approved, SPT3TMS-11577 **]**

No constraints about software compatibility are applicable because the specification is language independent. Anyway, the data model shall need to be mapped into specific schemata suitable to be parsed by machines and therefore it shall be possible to describe it into a formal language (which must not be selected now). **[** Content to be approved, SPT3TMS-11576 **]**

6 Infrastructural model

This section describes the data structures which the CMS/TMS subsystems consider mandatory to define and organize a topological model suitable to perform their apportioned functions. **[** Content to be approved, SPT3TMS-11575 **]**

To keep a higher level of readability, the specification is done doesn't adopt an xml schema (xsd) or Json formal description. Instead, types and structures are organized in tables, where the elements are listed, along with a short description which defines their rationale and a suggested type. **[** Content to be approved, SPT3TMS-11573 **]**

This will make the next phase review easier, integrating the description and facilitating changes of elements and types. A UML description shall be added later. **[** Content to be approved, SPT3TMS-11583 **]**

6.1 Generalities

Identifying the boundaries of a linear object with capital letters "A" and "B" is generic but also other representations have been commonly used. In other contexts, the boundaries of a linear object are identified by using the words "Left" and "Right". From now on, "A" and "B" shall be used to identify object boundaries for linear objects. If useful, it can be assumed that "A" corresponds to "Left" and "B" to "Right". **[** Content to be approved, SPT3TMS-11582 **]**

When defining the topological data model, care is given to be sure to define a complete model, defining also structures that might be deemed to be not useful later. It has been considered better to make an additional effort and define more structures now, to be challenged by team analysis, rather than define a minimal model which might need to be extended later. Anyway, a guideline was followed that the more precise the model is, the better. **[** Content to be approved, SPT3TMS-11580 **]**

6.2 Topology views

A topological model can be designed with different levels of granularity, according to the purposes it is designed for. **[** Content to be approved, SPT3TMS-11578 **]**

Currently, in railway environment three views are commonly referred to, with a different level of detail:
· Macro Topology
· Meso Topology
· Micro Topology **[** Content to be approved, SPT3TMS-11588 **]**

The purpose of every view is to support an application/process, along with other input data, for building a full model of the railway area to be controlled, according to the application goals. According to the application goals, the model which better fits with the application goals shall be selected. **[** Content to be approved, SPT3TMS-11522 **]**

The following picture shows how the same fragment of a railway line can be modelled with three different levels of detail: **[** Content to be approved, SPT3TMS-11672 **]**

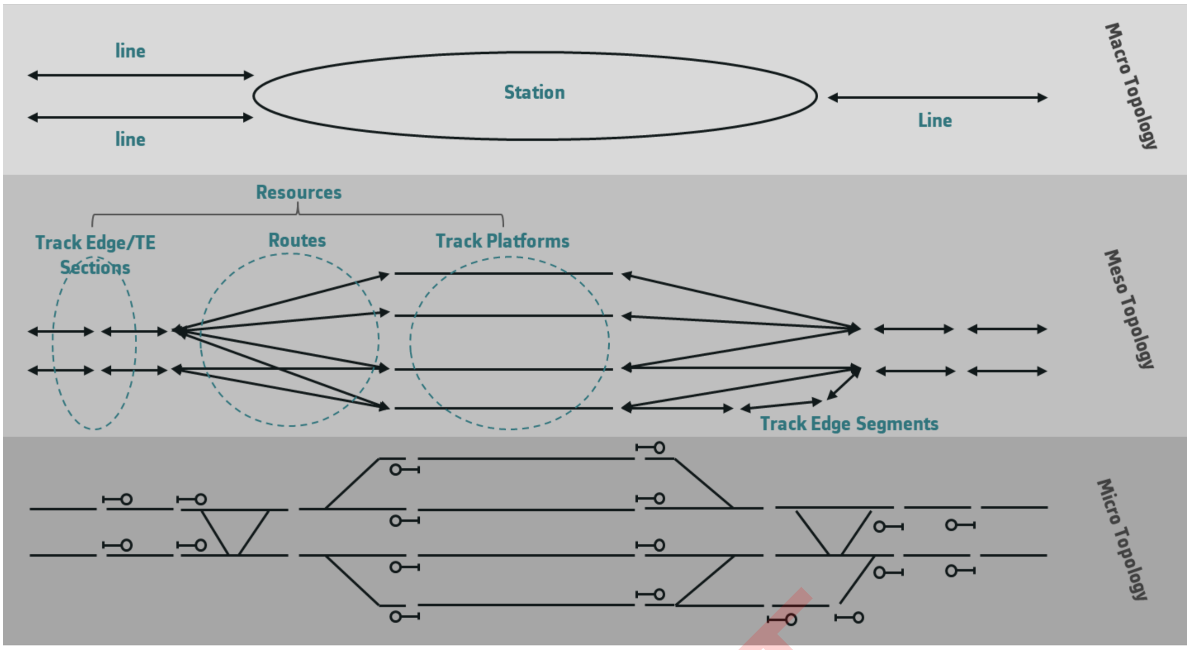


Figure 1 – Different topological models

CMS and TMS are systems that should aim to elaborate a precise train forecast (to provide an optimized, conflict-free capacity and production plan), to feed in the best precise way the ATO system, to detect and solve all conflicts which may arise following a divergence or in general any plan change, and provide other complex and cutting-.edge features (see [Ref 11]: to accomplish these functions the necessary level of topology must be detailed and the micro-topology shall be adopted. [Content to be approved, SPT3TMS-11521]

6.3 Basic types

The topological model relies on a set of elementary types, on top of which the more complex structured types are built.

6.3.1 Universal Unique Identifier (UUID)

Every topological element must be uniquely identified, to be referred unambiguously. Several criteria can be applied to achieve this result, but using a Universally Unique Identifier (UUID, promoted by Open Software Foundation, OSF, and defined by RFC4122) seems a good choice as it is universally widespread and widely used in any software development to uniquely identify system resources. [Content to be approved, SPT3TMS-11312]

This is a suggestion only, used here to keep consistency among the several classes described later. Every other identifier, which is unambiguous and generally applicable to the widest possible context, is suitable to be applied, and shall be proposed by the Task 2 TCCS SD1, which shall finally publish the document. [Content to be approved, SPT3TMS-11311]

Every topological object shall be identified unambiguously, to enable CMS/TMS functions and configuration tools to identify and use it. [SPT3TMS-11314]

The global identifier of a topological objects shall be used as a reference in all cases where it is exchanged with other systems different from CMS and TMS. [SPT3TMS-11313]

The global identifier of a topological objects shall be used in data exchange among TMS and CMS functions when it is deemed suitable. [SPT3TMS-11310]

The following table collects all the elements which a global object identifier should have to comply with previous requirements. [SPT3TMS-11295]

UniversalObjectIdentifier		
Description of a Universal Object Identifier.		
Element	**Description**	**Type**
UUID	Unique and unambiguous identifier which is used to refer an object	String

[SPT3TMS-11680]

Table 1 – Universal Object ID type

6.3.2 Object Identifier (ID)

In addition to the UUID, to address in a simple way an object where possible, it is defined an additional identifier which must be unique for all the objects of the same type for a given topology.
This Identifier must be considered local and not universally recognized. It is foreseen to be project specific and to be used if it is deemed useful, otherwise it can be null. [Content to be approved, SPT3TMS-11309]

In addition to the UUID, to address in a simple way an object where possible, it is defined an additional identifier which must be unique for all the objects of the same type for a given topology. [Content to be approved, SPT3TMS-11293]

This Identifier must be considered local and not universally recognized. It is foreseen to be project specific and to be used if it is deemed useful, otherwise it can be null. [Content to be approved, SPT3TMS-11299]

Every topological object shall have an optional identifier, which is given for custom usage. [SPT3TMS-11283]

This optional identifier is not mandatory for the model, and might be added once the model is received, as part of the post-processing phase. However, it could be useful to envisage this feature inside the model, to minimize the need of model customizations later. [SPT3TMS-11282]

Objects of different types may have the same id (e.g., a track edge and a point). [Content to be approved, SPT3TMS-11316]

The following table collects all the elements which an optional identifier should have to comply with previous requirement. [Content to be approved, SPT3TMS-11710]

ObjectIdentifier		
Description of an Object Identifier.		
Element	**Description**	**Type**
ID	Unique identifier of a generic element among all objects of the same type	Integer

[SPT3TMS-11679]

Table 2 – ID type

6.3.3 Primary Location Code (PLC)

The Primary Location Code is the TAF/TAP identifier which shall be the basis for future European data exchange, and its use will be extended from Operational Points to also section of lines. [Content to be approved, SPT3TMS-12657]

The Primary Location Code shall define a location suitable to define a path for a train in TAF/TAP TSI framework/messages. [SPT3TMS-12656]

This location identifies a rail point inside the rail network where train may start, ends, stop, or run through or change line. **[**SPT3TMS-12659 **]**

A Primary Location Code shall be unique all over Europe. **[**SPT3TMS-12658 **]**

A PLC shall be identified by single and unique Primary Location Code defined by a European entity **[**SPT3TMS-12652 **]**

Every Operational Point shall be identified also by a PLC. **[**SPT3TMS-12651 **]**

This additional identifier is added to make the topology compliant to the way remarkable points are being identified in RINF. **[**SPT3TMS-12654 **]**

The following table collects all the elements which define a Primary Location Code: **[** Content to be approved, SPT3TMS-12653 **]**

PLC		
Description of a Primary Location Code		
Element	**Description**	**Type**
PLC	Unique identifier of any Operational Point of a topology	String

[SPT3TMS-12655 **]**

Table 3 – PLC type

6.3.4 Kilometric Point (KP)

Some objects are placed at a specific location of the track layout (when they can be assimilated to a point) or at two specific locations (when they can be represented as segments). For these objects, in both cases a location can be defined by a duple (km, m) which is valid along that track only. This parameter is to be used for navigation purposes only, to find/calculate a kilometric point for any object on the infrastructure. **[** Content to be approved, SPT3TMS-11294 **]**

The position of every remarkable point of the line shall be uniquely identified with respect to an origin. **[**SPT3TMS-11297 **]**

This position can be used in several places, as in graphical synoptics to visually show where an object is centred. **[**SPT3TMS-11296 **]**

The position identifier of every remarkable point of the line shall be expressed in a way which is easily recognized by a railway operator or user. **[**SPT3TMS-11302 **]**

A position identified by a GPS coordinate is suitable to be used by system, even external to railway, as a car navigator system, but it is not a user-friendly indication for a Signaller or a Dispatcher, who is used to have a direct reference to the schematic plan. A position described in terms of kilometric offset with respect to a non-ambiguous origin of a piece of line inside a track layout is deemed to fit with railway user viewpoint. **[**SPT3TMS-11306 **]**

Whichever is the choice operated inside the model, the possible conversion in a different representation which might be performed at post-processing phase shall be simple and easy to achieve. **[** Content to be approved, SPT3TMS-11305 **]**

The following table collects all the elements which a position identifier should have to comply with previous requirements. **[** Content to be approved, SPT3TMS-11711 **]**

KilometricPoint
Location of a topological point inside a track layout.

Element	Description	Type
KP	Unique identifier of a location onto a track layout	String with the following format: (kkk,mmm), where the first three digits represent a kilometre and the second three digits represent the offset in meters with respect the beginning of the km. The specific regular expression can be expressed as: specific regular expression: [0-9]+,*[0-9]{3}

[SPT3TMS-11682 **]**

Table 4 - Kilometric Point type

6.3.5 UsageDirection

This type is an enumerated which qualifies a direction with respect a Track Edge or a Track Edge Section. **[** Content to be approved, SPT3TMS-11304 **]**

It shall be possible to run across a topological line element in one or both directions. **[**SPT3TMS-11303 **]**

It shall be possible to distinguish the running direction inside a topological line element. **[**SPT3TMS-11308 **]**

According to the specific piece of line and its characteristics, or even according to some dynamic constraints, travelling direction can be different or limited. **[**SPT3TMS-11307 **]**

The following table collects all the elements which can qualify the direction along which a track element can be run across: **[** Content to be approved, SPT3TMS-11718 **]**

UsageDirection		
Type of Direction which is possible for a Track Edge or TrackEdge Section		
Element	**Description**	**Type**
UsageDirection	It is an enumerated value which defines a direction inside a linear object	Enumerated value which can assume the following values: (“both”, “endToStart”, “startToEnd”)

[SPT3TMS-11681 **]**

Table 5 – Topological Area type

Here, according to [Ref 1], it is meant that: **[** Content to be approved, SPT3TMS-11315 **]**

· both: applies for 'both' travel directions corresponding to Track Edge/TrackEdge Section **[**SPT3TMS-11322 **]**

· endToStart: applies for travel direction “end to start” corresponding to Track Edge/TrackEdge Section **[**SPT3TMS-11321 **]**

· startToEnd: applies for travel direction “start to end” corresponding to Track Edge/TrackEdge Section **[**SPT3TMS-11324 **]**

6.3.6 Stop Location

A Stop Location identifies a location where a train can stop according to its characteristics, as size, length, maximum number of axles admitted for a train to stop, etc. **[** Content to be approved, SPT3TMS-11323 **]**

Every location where a train can stop (also referred to as “Stop Location”) shall be uniquely identified in a station or along a line. **[**SPT3TMS-11318 **]**

Every location where a train can stop (also referred to as “Stop Location”) shall be referenced with an understandable name. **[**SPT3TMS-11317 **]**

The position and the reference for the stop location expressed in user-friendly can be used in graphical representations where they need to appear. **[**SPT3TMS-11320 **]**

Every stop location shall be qualified by a set of parameters which enable CMS/TMS algorithms to check whether a train can stop according to its characteristics. **[**SPT3TMS-11319 **]**

As not all trains have the same characteristics, a stop location can be suitable for a train to stop while cannot for another one. **[**SPT3TMS-11325 **]**

A stop location shall specify the maximum length of a train that can stop there. **[**SPT3TMS-11329 **]**

A stop location shall specify the maximum number of train axles which a train can have to stop there. **[**SPT3TMS-11328 **]**

A stop location shall specify the maximum number of wagons which a train can have to stop there. **[**SPT3TMS-11327 **]**

A stop location shall specify a qualitative size which a train can have to stop there. **[**SPT3TMS-11326 **]**

These parameters can be configured for example by conflict solution algorithms according to specific objective functions. **[**SPT3TMS-11333 **]**

The following table collects all the elements which can qualify a Stop Location: **[** Content to be approved, SPT3TMS-11717 **]**

StopLocation		
Description of a Stop Location type		
Element	**Description**	**Type**
ID	Identifies uniquely the Stop Location among all other Stop Locations of the topological model.	ID
Uuid	Identifies uniquely the Stop Location inside the overall topological model	UUID
Name	A string which defines a meaningful, user-friendly name for the Stop Location. If no name is given, it can be an empty string.	string
TrackEdgePointUUID	Identifies uniquely the TrackEdgePoint which is elected to be a Stop location	UUID
stopTrainLimit	This field gives the characteristics which a train must have to stop at this location.	StopTrainLimit

[SPT3TMS-11674 **]**

Table 6 – Stop Location

where StopTrainLimit type is defined as: **[** Content to be approved, SPT3TMS-11716 **]**

StopTrainLimit		
Description of a Stop Location type		
Element	**Description**	**Type**
maxTrainLength	Maximum admitted length for a train to stop	Unsigned integer (in m)
maxTrainAxles	Maximum number of axles admitted for a train to stop	Unsigned integer

maxWagonNumber	Maximum number of wagons admitted for a train to stop	Unsigned integer
stopTrainLimitSize	Gives a qualitative view of the train which can stop	StopTrainLimitSize

[SPT3TMS-11673]

Table 7 – StopTrainLimit type

And StopTrainLimitSize is defined as: [Content to be approved, SPT3TMS-11715]

StopTrainLimitSize		
Description of a StopTrainLimitSize type		
Element	**Description**	**Type**
StopTrainLimitSize	It is an enumerated value which defines a rough train size	Enumerated value which can assume the following values: (“fullTrain”, “halfTrain”, “shortTrain”)

[SPT3TMS-11677]

Table 8 – StopTrainLimitSize type

6.3.7 Topology Object

A topology object is a generic class which collects a set of properties which are common to all infrastructure objects. All topological objects are derived from this class. [Content to be approved, SPT3TMS-11332]

Every topological object shall be uniquely identified inside the configured railway area. [SPT3TMS-11331]

Every topological object shall have a user-friendly name, to be referred to in graphical views and wherever else is useful by a human being. [SPT3TMS-11335]

It should be possible to refer a specific object by both the functions of every system and when exchanging topological information in messages among different systems. [SPT3TMS-11334]

These attributes are meant to be common to every object. Here, they have been grouped into a class to be inherited by more specific classes, but this must be intended merely as a description, not a solution. [SPT3TMS-11341]

Some custom fields are proposed to be associated to every object as a placeholder for additional specific descriptions, even if not directly used by any system function. These characteristics can of course be added as a specialization of the model, by a specific user, but defining them as part of the model would improve the common parts minimizing variants. [SPT3TMS-11340]

The following table collects all the elements which can qualify a Topology Object: [Content to be approved, SPT3TMS-11723]

TopologyObject		
Description of Topology Object class		
Element	**Description**	**Type**
iD	Identifies uniquely the object among all objects of the same type	ID
uuid	Identifies uniquely the object inside the full topological model	UUID
Name	A string which defines a meaningful name for the object	string

CustomFieldID	Free field proposed as placeholder for a specific ID if needed	String (optional)
CustomFieldDescr	Free field proposed as placeholder for a specific object description if needed	String (optional)

[SPT3TMS-11675 **]**

Table 9 – Topology Object class

6.3.8 Track Entity

A Track Entity represents a generic class which defines a set of properties common to all other classes modelling the topology. All these classes are derived from Track Entity. **[** Content to be approved, SPT3TMS-11343 **]**

Every topological object shall be linked to all the regions where the controlled area is split and which it belongs to. **[**SPT3TMS-11342 **]**

When configuration tools process an object to instantiate the model, it should be possible to walk through the links between the object and the entities which contain it. This may or may not be necessary according to the configuration tool used, but it is a possibility which should be taken into account. **[**SPT3TMS-11337 **]**

Here, a derived class is used to collect other parameters which a further review might add, but it is recognized that this class might be removed. Again, this is a way to represent needs, and nod to define a model, so the class nesting is kept without any constraint exported to the model designer. **[**SPT3TMS-11336 **]**

The following table collects all the elements which can qualify a Track Entity: **[** Content to be approved, SPT3TMS-11722 **]**

Track Entity (Derived from the base class TopologyObject)		
Description of Track Entity class		
Element	**Description**	**Type**
RegionUUIDList	List of the UUIDs of the Topological Region objects to which the Track Entity belongs	UUID []

[SPT3TMS-11683 **]**

Table 10 – Track Entity class

6.3.9 Operational Point Type

This type is foreseen to group several objects belonging to an area which can be used as a single entity by CMS/TMS functions. **[** Content to be approved, SPT3TMS-11339 **]**

An Operational Point type characterizes an Operational Point, which is an element used when it is necessary a high-level abstraction of the topology. **[** Content to be approved, SPT3TMS-11338 **]**

It shall be possible to group a set of neighbouring topological objects together, to define the content of a railway region. **[**SPT3TMS-11345 **]**

It shall be possible to classify different types of railway areas, characterized by a different set of objects or attributes. **[**SPT3TMS-11349 **]**

This type supports the possibility to define a set of objects related together from the viewpoint of a set of functions operating on a specific area. **[**SPT3TMS-11348 **]**

Every Operational Point shall be qualified regarding to its set of characteristics. **[**SPT3TMS-11347 **]**

According to [Ref. 1]. **[**SPT3TMS-11346 **]**

The following table collects all the elements which can qualify an Operational Point: [Content to be approved, SPT3TMS-11721]

OPType		
Description of Operational Point type		
Element	**Description**	**Type**
OPType	Indicates the type of Operational Point	Enumerated value which can assume the following values: (“station”, "small station, "passenger terminal", "passenger stop", "freight terminal", “depot”, "train technical services", "junction", "point", “shunting yard“, "technical change", “siding”, “private siding“, “border point“, "domestic border point") according to Eulinx/RCA Digital map object catalogue

[SPT3TMS-11678]

Table 11 – OPType type

This definition is in line with the same given in [Ref 1], but not [Content to be approved, SPT3TMS-11353]

all types are of interest for CMS/TMS and therefore is reported here to highlight differences. In a later version can be removed and the full definition of the original type in [Ref 1] can be kept. [Content to be approved, SPT3TMS-12575]

6.3.10 Track Edge Section

The Track Edge Section is a type which is used to identify a subset of a Track Edge which is dynamically characterized by a specific set of constraints that may last for a period. Then, it can be seen as a portion of Track Edge, characterized by an offset from the start of the containing Track Edge and a length. Its main purpose is to represent some dynamically variable conditions, as portions of Track Edges where a of Low Adhesion condition exists (Low Adhesion Area) or which are characterized by a temporary speed restriction. These conditions are set up and removed dynamically without any change of the topological infrastructural model. [SPT3TMS-11352]

A track edge section is an “atomic” piece of line and cannot be split into any further “sub-track” element. [Content to be approved, SPT3TMS-11351]

A constraint which dynamically applies to a piece of line shall be precisely located in space. [SPT3TMS-11350]

A constraint which is set on a portion of infrastructure shall be associated to a Track Edge. [SPT3TMS-11355]

This means that its beginning and end must be uniquely identified. A constraint cannot be a topological object as it may exist or not and its location is not fixed; however, it is defined on a topological object and therefore must be precisely located inside. This is necessary for CMS/TMS algorithms to apply and handle specific restrictions to the train movement forecast when constraints are present on the line. [SPT3TMS-11354]

The following table collects all the elements which can qualify a Track Edge Section: [Content to be approved, SPT3TMS-11720]

TrackEdgeSection (Primitive class)		
Definition of TrackEdgeSection structure		
Element	**Description**	**Type**
Length	Defines the length of the Track Edge Section	Unsigned integer (in meters)
SkipFromStart	Incremental offset (in meters) from the start of the containing Track Edge	Unsigned integer
TrackEdgeUuid	Track Edge which the Track Edge Section belongs to	UUID

[SPT3TMS-11676 **]**

Table 12 – TrackEdgeSection class

A TrackEdgeSection depends on the containing TrackEdge. Its position is uniquely determined by the two parameters *SkipFromStart* and *Length*; the decremental offset (in meters) from the end of the containing Track Edge can be derived from these two parameters and the length of the containing TrackEdge. **[**SPT3TMS-11344 **]**

6.3.11 Timing Point

The Timing Point is a type which is used to identify a relevant position on the track, necessary for TMS functions to re-evaluate the production plan, comparing the planned time at which the train is envisaged to cross it with the real time when this crossing occurs. **[** Content to be approved, SPT3TMS-12635 **]**

A timing point shall be precisely located in space. **[**SPT3TMS-12639 **]**

A timing point shall be associated to a Track Edge. **[**SPT3TMS-12638 **]**

The following table collects all the elements which can qualify a Timing Point: **[** Content to be approved, SPT3TMS-12636 **]**

Timing Point (Primitive class)		
Definition of TimingPoint structure		
Element	**Description**	**Type**
TimingPointUuid	Timing Point Identifier	UUID
TrackEdgeUuid	Track Edge which the Track Edge Section belongs to	UUID
SkipFromStart	Incremental offset (in meters) from the start of the containing Track Edge.	Unsigned integer

[SPT3TMS-12637 **]**

Table 13 – Timing Point class

Now, other qualifiers, as etcsMarker, or stopLocation, or other, seem not relevant for TMS/CMS purposes. **[** Content to be approved, SPT3TMS-12640 **]**

6.3.12 Directed Track Edge Section

A Directed Track Edge Section class is a specialization of the Track Edge Sectionclass, which adds to the latter a direction. [Content to be approved, SPT3TMS-12646]

A Track Edge Section shall be qualified by a direction when it is necessary. [SPT3TMS-12644]

This attribute is necessary when a path must be run across towards a direction. [SPT3TMS-12649]

The following table collects all the elements which can qualify a Directed Track Edge Section: [Content to be approved, SPT3TMS-12647]

DirectedTrackEdgeSection (Derived from the base class TrackEdgeSection)		
Definition of DirectedTrackEdgePoint structure		
Element	**Description**	**Type**
direction	Identifies uniquely the direction of the Track Edge Section	UsageDirection

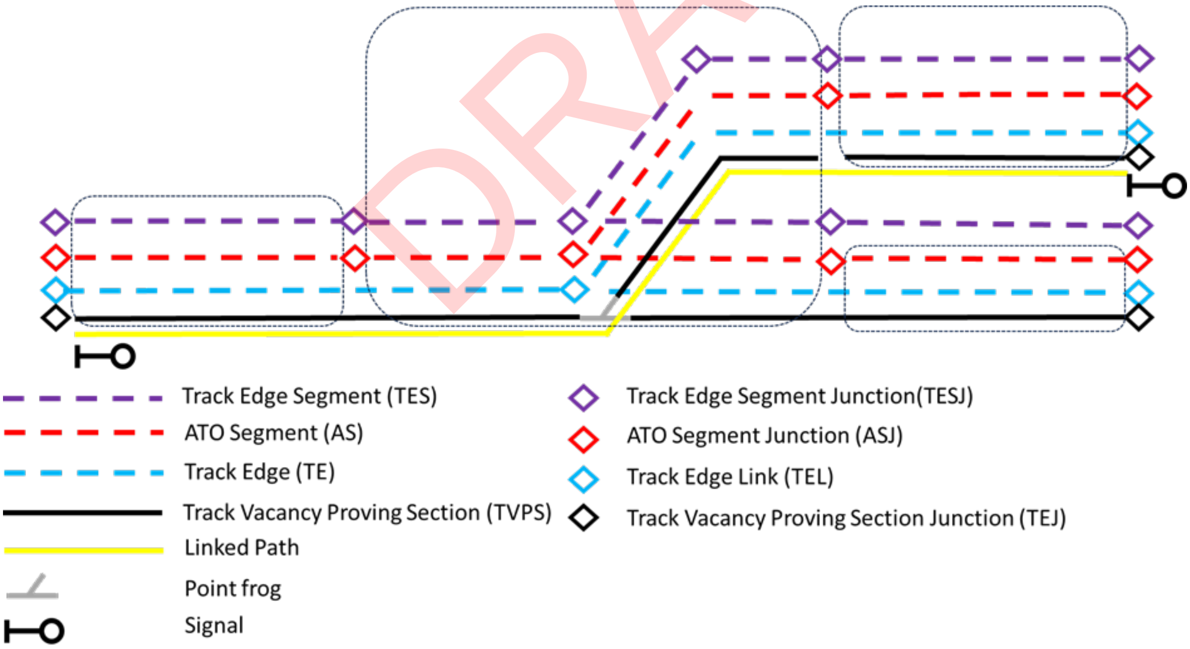
[SPT3TMS-12645]

Table 14 – DirectedTrackEdge Section class

6.4 Composite types

On top of the previous elementary types, this paragraph and its sub-paragraph lists the complex types which build the overall CMS/TMS topological model. [Content to be approved, SPT3TMS-11359]

The following picture summarizes the basic concepts on which the topological model relies, according to what drawn in [Ref 1] and adding other artifacts related to the track layout which are necessary for CMS/ TMS subsystems. [Content to be approved, SPT3TMS-11358]



[SPT3TMS-11689]

Figure 2 - Basic concepts of the topological model

The goal is to achieve the maximum flexibility, to define a model able to envisage all singularities or specific configurations which may occur in specific parts of the line (complex stations, particularities at the boundary of the controlled area, etc. [Content to be approved, SPT3TMS-11361]

6.4.1 Track Edge Segment

The Track Edge Segment is the constituent element of the geometry associated to every Track Edge. [Content to be approved, SPT3TMS-11360]

According to [Ref 1], the most generic model associates a Track Edge Geometry to a Track Edge. However, for the purpose of the present specification this is considered not necessary, as it is enough to adopt a simpler model which uses the concept of a Track Edge Sampled Geometry. [SPT3TMS-11357]

Therefore, we consider a Track Edge characterized by a specific Track Edge Sampled Geometry, whose definition is obtained by a list of one or more contiguous segments. A segment begins where the preceding one ends. This is in accordance with what described in [Ref 1]. The properties defined in [Ref 1] for a track edge segment still apply. [SPT3TMS-11356]

A Track Edge Segment is a portion of Track Edge characterized by the same set of geometric and functional parameters, which shall be used by CMS/TMS algorithms to perform the necessary calculations for determining a precise trip for every train, i.e. the overall capacity/production plan. [Content to be approved, SPT3TMS-11366]

A Track Edge Segment is identified inside by an initial and final position inside its containing Track Edge, which correspond to the sampled points in which the Track Edge is split. Any Track Edge is then modelled as a polygonal, whose elements are defined by the same set of parameters. [Content to be approved, SPT3TMS-11368]

It is recognized that the utmost general model a Track Edge Segment is characterized by several parameters, but not all of them are interesting to perform the functions apportioned to CMS/TMS. Therefore, hereafter, only those parameters necessary to perform CSM/TMS features are indicated into the proposed segment structure. [SPT3TMS-11367]

An uninterrupted stretch of a railway track which is characterized by a homogeneous set of characteristics shall be precisely located in space. [SPT3TMS-11363]

This is necessary for CMS/TMS algorithms to apply motion law and other rules using a valid set of parameters along the segment length. [SPT3TMS-11362]

When along an uninterrupted stretch of a railway track some characteristics change, either related to the infrastructure or any other functional parameter, the new segment shall be distinguished from the previous one and fully located in space. [SPT3TMS-11365]

This concept maps whichever railway line into a set of segments (sections), linked together from the beginning to the end of the same track edge, each of them with the same set of characteristics, so the CMS/TMS algorithms can be applied to each of them separately. [SPT3TMS-11364]

Every segment shall be associated to its containing Track Edge identifier. [SPT3TMS-11369]

The beginning of every segment shall be precisely located inside the containing track edge. [SPT3TMS-11373]

Every segment shall be characterized by its length. [SPT3TMS-11372]

These requirements aim to precisely locate a segment inside the track layout and the controlled area. [SPT3TMS-11375]

Every segment shall be qualified by a maximum speed to which it can be run across from its start point to its end point. [SPT3TMS-11371]

Every segment shall be qualified by a maximum speed to which it can be run across from its end point to its start point. [SPT3TMS-11370]

Maximum speed may be different according to the direction a segment is run across. These parameters are necessary to evaluate the train movement forecast and other functions. [SPT3TMS-11374]

Every segment shall be qualified by a gradient in the direction from its start point to its end point. **[**SPT3TMS-11377 **]**

Every segment shall be qualified by a gradient in the direction from its end point to its start point. **[**SPT3TMS-11376 **]**

Gradient may be different according to the direction a segment is run across. These parameters are necessary to evaluate the train movement forecast and other functions. The Gradients associated to the segment refer to the slope parameter given in [Ref 1]. Here, the possibility is foreseen to have two different gradient values according to the travelling direction of the segment. **[**SPT3TMS-11379 **]**

Every segment shall be qualified by a parameter which indicates the associated cant. **[**SPT3TMS-11378 **]**

Every segment shall be qualified by a parameter which indicates the associated radius. **[**SPT3TMS-11380 **]**

Even cant and radius can be used by algorithms to evaluate the train movement forecast. **[**SPT3TMS-11386 **]**

A segment shall be associated to an ATO segment. **[**SPT3TMS-11384 **]**

This reference shall be used to retrieve ATO Segment characteristics. **[**SPT3TMS-11381 **]**

A track edge segment shall contain only one ATO segment. **[**SPT3TMS-11383 **]**

This assumption doesn't set any real constraint but is given for simplicity. **[**SPT3TMS-11382 **]**

The following table collects all the elements which can qualify a Track Edge Segment: **[** Content to be approved, SPT3TMS-11724 **]**

TrackEdgeSegment (Primitive class)		
Definition of TrackEdgeSegment structure		
Element	**Description**	**Type**
TrackEdgeUuid	Track Edge which the Track Edge Segment belongs to	UUID
Length	Defines the length of the Track Edge Section	Unsigned integer (in meters)
SkipFromStart	Incremental offset (in meters) from the start of the containing Track Edge; this is the starting sampled point of this segment	Unsigned integer
SpeedA2B	Max permitted train speed in the direction “A” to “B”	Unsigned integer (in m/s)
SpeedB2A	Max permitted train speed in the direction “B” to “A”	Unsigned integer (in m/s)
GradientA2B	Gradient in the direction “A” to “B” on this Track Edge Segment	Unsigned integer (in mm)
GradientB2A	Gradient in the direction “B” to “A” on this Track Edge Segment	Unsigned integer (in mm)
Cant	Cant value associated to the Segment	Integer (in mm)
Radius	Radius of the track at the beginning of the segment	Integer (in mm)
ATOSegmentUUID	UUID of the ATO Segments associated to the Track Edge Segment	UUID

[SPT3TMS-11688 **]**

Table 15 – TrackEdgeSegment class

The position of a segment is uniquely determined by the two parameters *SkipFromStart*and *Length*; the decremental offset (in meters) from the end of the containing Track Edge can be derived from these two parameters and the length of the containing TrackEdge. **[**SPT3TMS-11385 **]**

6.4.2 Sampled Track Edge Geometry

The Sampled Track Edge Geometry unambiguously characterizes a Track Edge, in terms of segments obtained by sampling the Track Edge. **[** Content to be approved, SPT3TMS-11410 **]**

A Sampled Track Edge Geometry shall be associated to a Track Edge. **[**SPT3TMS-11409 **]**

The Sampled Track Edge Geometry associated to a Track Edge shall uniquely identify all the elementary segments in which it is subdivided. **[**SPT3TMS-11412 **]**

This structure is necessary for the sectional runtime calculation algorithm to evaluate the time needed for any train to run across a piece of line and thus build the train trip plan. **[**SPT3TMS-11411 **]**

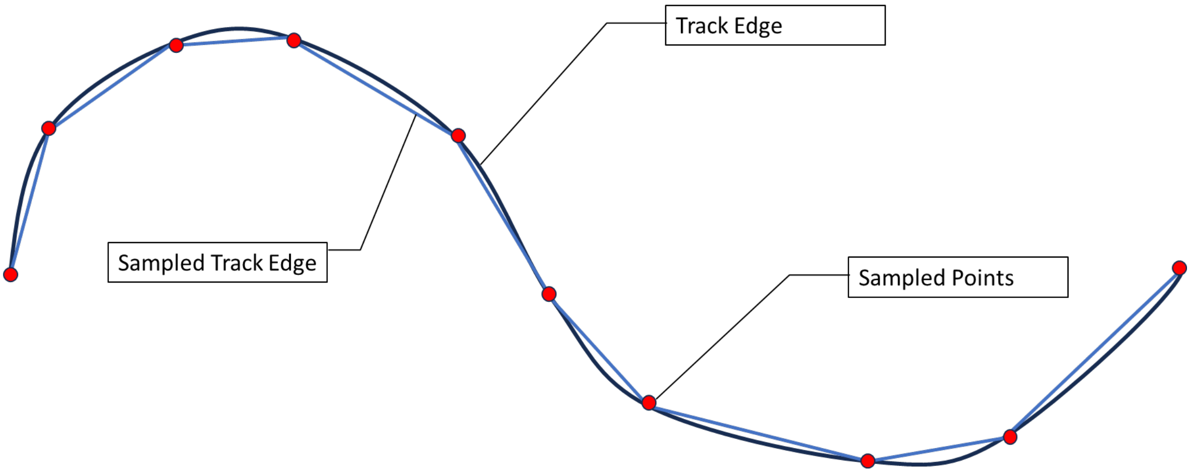
The following table collects all the elements which can qualify a Sampled Track Edge Geometry: **[** Content to be approved, SPT3TMS-11692 **]**

SampledTrackEdgeGeometry (Derived from the base class TrackEntity)		
Definition of SampledTrackEdgeGeometry structure		
Element	**Description**	**Type**
TrackEdgeUuid	Track Edge which the Track Edge Segment belongs to	UUID
trackEdgeSegments	List of all Track Edge Segments which make up the Track Edge	TrackEdgeSegment []

[SPT3TMS-11690 **]**

Table 16 – SampledTrackEdgeGeometry class

There shall be a 1:1 association between a Sampled Track Edge Geometry and a Track Edge. **[**SPT3TMS-11406 **]**



[SPT3TMS-13838 **]**

Figure 3 - Sampled Track Edge Geometry

6.4.3 Track Edge Point

A Track Edge Point identifies a topological element which describes an object without neither a spatial extension nor a direction, located inside or alongside a Track Edge Section, with its attributes. [Content to be approved, SPT3TMS-11405]

Every Track Edge Point shall be always referred to a Track Edge. [SPT3TMS-11408]

Every Track Edge Point shall be associated to the Track Edge which contains it. [SPT3TMS-11407]

Every Track Edge Point shall be precisely located inside the Track Edge which contains it. [SPT3TMS-11414]

A Track Edge Point which refers to a remarkable location outside a Track Edge shall nevertheless be associated to its nearest Track Edge. [SPT3TMS-11419]

It is necessary to precisely locate a Track Edge Point in a specific position to qualify stop locations and handle specific functions as stopping trains on platforms where more trains can be hosted at a time (e.g. for joining and splitting, or else), or evaluate a train path run. [SPT3TMS-11418]

Regardless of other position coordinates, every Track Edge Point shall be identified also in terms of absolute position along the track layout. [SPT3TMS-11417]

The Track Edge Point absolute position along the track layout shall consider the possibility of kilometric “jumps”. [SPT3TMS-11416]

An indication of the kilometric point of a location, directly related to the positioning system adopted in track layout drawings, is immediately understandable by an operator and can be used to identify objects in graphical representations. [SPT3TMS-11424]

Discontinuities in mileage progression along a line are possible and in addition to the concept of offset with respect an initial point should be considered. [Content to be approved, SPT3TMS-11423]

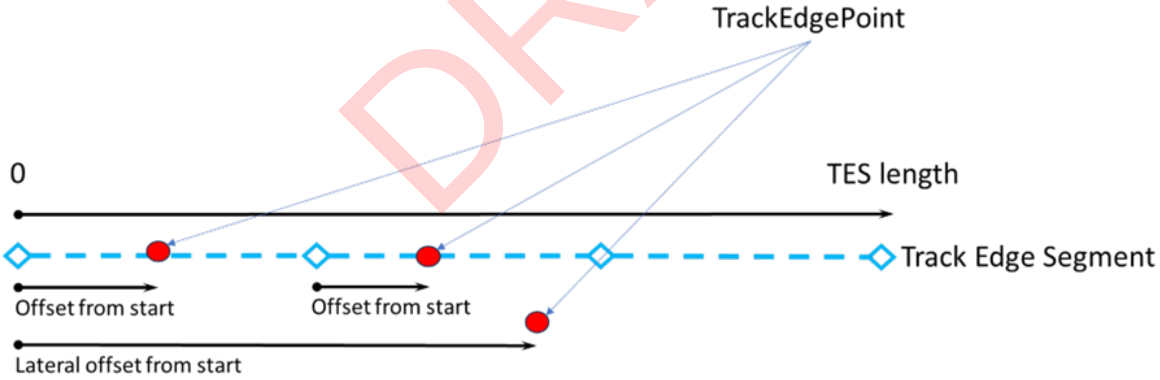


Figure 4 – Track Edge Point

The Track Edge Point class is used to identify any remarkable point inside the Topological Area. A Track Edge Point always belongs to a Track Edge Segment, so in turn it can be associated also to the containing Track Edge. The exact location is identified as offset from the beginning of the related Track Edge Section, so it is possible to refer it also to the beginning of the related Track Edge. [SPT3TMS-11422]

The following table collects all the elements which can qualify a Track Edge Point: [Content to be approved, SPT3TMS-11691]

TrackEdgePoint (Derived from the base class TrackEntity)		
Definition of TrackEdgePoint structure		
Element	**Description**	**Type**
TrackEdgeUuid	Track Edge which the Track Edge Point belongs to	UUID
OffsetFromStart	Incremental offset (in meters) from the start of the containing Track Edge	Unsigned integer
LateralOffsetFromStart	Incremental offset (in meters) from the start of the containing Track Edge.	Unsigned integer
Kp_A	Identifies the position of the TrackEdgePoint onto the track layout. It is usually the same than Kp_B, unless there’s a change in the track layout, which introduces a different identification for the location. Two identifications of the position of the TrackEdgePoint are introduced to keep flexibility and manage this case	KP
Kp_B	Identifies the position of the TrackEdgePoint onto the track layout. It is usually the same than Kp_A, unless there’s a change in the track layout, which introduces a different identification for the location. Two identifications of the position of the TrackEdgePoint are introduced to keep flexibility and manage this case	KP

[SPT3TMS-11685 **]**

Table 17 – TrackEdgePoint class

6.4.4 Directed Track Edge Point

A Directed Track Edge Point class is a specialization of the TrackEdgePoint class, which adds to the latter a direction. **[**Content to be approved, SPT3TMS-11421 **]**

A Track Edge Point which needs to be associated with a running direction shall be qualified with a direction. **[**SPT3TMS-11426 **]**

A Track Edge Point can be specialized. **[**SPT3TMS-11425 **]**

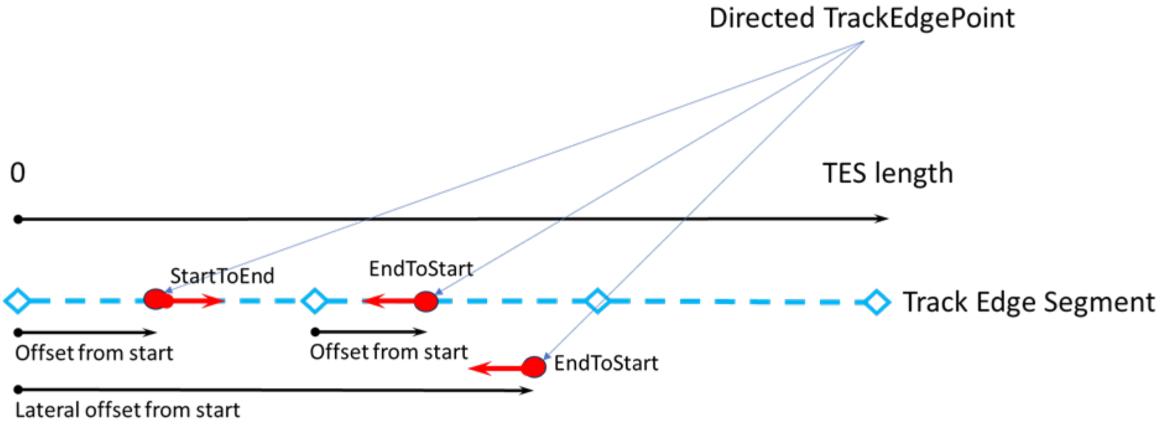


Figure 5 – Directed Track Edge Point

The following table collects all the elements which can qualify a Directed Track Edge Point: [Content to be approved, SPT3TMS-11700]

DirectedTrackEdgePoint (Derived from the base class TrackEdgePoint)		
Definition of DirectedTrackEdgePoint structure		
Element	**Description**	**Type**
direction	Identifies uniquely the direction of the Track Edge Point.	UsageDirection

[SPT3TMS-11684]

Table 18 – DirectedTrackEdgePoint class

6.4.5 Track Edge

The Track Edge represents a topological object which is made by a set of Track Edge Segments, described by a Track Edge Geometry associated to this Track Edge. A Track Edge is a linear portion of the track that defines a stretch of a railway track without divergence or convergence, as stated in [Ref 1]. [Content to be approved, SPT3TMS-11427]

Every Track Edge shall be associated to a SampledTrackEdgeGeometry which describes precisely its characteristics as a set of homogeneous segments. [SPT3TMS-11431]

Every Track Edge shall have a length. [SPT3TMS-11430]

A Track Edge shall have a reference to every track edge which is connected to at its start. [SPT3TMS-11429]

A Track Edge shall have a reference to every track edge which is connected to at its end. [SPT3TMS-11428]

A Track Edge shall have a reference to all the Stop Locations which are defined inside. [SPT3TMS-11435]

A Track Edge shall have a reference to all the Topology Objects which it contains. [SPT3TMS-11434]

A Track Edge shall have a reference to the Track Edge Links which connect it to neighbouring Track Edges. [SPT3TMS-11433]

These attributes are deemed necessary to enable CMS and TMS functions to run across every Track Edge along every possible path of the Track Layout of the controlled area. [SPT3TMS-11432]

The Track Edge inherits from Track Entity. [Content to be approved, SPT3TMS-11436]

The following table collects all the elements which can qualify a Track Edge: [Content to be approved, SPT3TMS-11698]

TrackEdge (Derived from the base class TrackEntity)		
Definition of TrackEdge structure		
Element	**Description**	**Type**
Length	Defines the length of the Track Edge	Unsigned integer (in meters)
TrackEdgeLinkA_UUID	UUIDs of the TrackEdgeLink object connected at the “A” side of the Track Edge	UUID
TrackEdgeLinkB_UUID	UUIDs of the TrackEdgeLink object connected at the “B” side of the Track Edge	UUID
TrackEdgeGeometry	Sampled Geometry associated to this TrackEdge	SampledTrackEdgeGeometry
TrackEdgeA_UUIDList	List of the UUIDs of the Track Edges connected at the “A” side of this Track Edge	UUID []
TrackEdgeB_UUIDList	List of the UUIDs of the Track Edges connected at the “B” side of this Track Edge	UUID []
StopLocationsUUIDList	List of Global Identifiers of the StopLocations associated to this Track Edge	UUID []
TopologyObjUUIDList	List of Global Identifiers of the Topology objects associated to this Track Edge	UUID []

[SPT3TMS-11687]

Table 19 – TrackEdge class

6.4.6 Directed Track Edge

A Directed Track Edge class is a specialization of the TrackEdge class, which adds to the latter a direction. [Content to be approved, SPT3TMS-11415]

A Track Edge shall be qualified by a direction when it is necessary. [SPT3TMS-11413]

This attribute is necessary when a path must be run across towards a direction. [SPT3TMS-11420]

The following table collects all the elements which can qualify a Directed Track Edge: [Content to be approved, SPT3TMS-11696]

DirectedTrackEdge (Derived from the base class TrackEdge)		
Definition of DirectedTrackEdgePoint structure		
Element	**Description**	**Type**
direction	Identifies uniquely the direction of the Track Edge.	UsageDirection

[SPT3TMS-11686]

Table 20 – DirectedTrackEdge class

6.4.7 Track Vacancy Proving Section

The Track Vacancy Proving Section identifies a section along the track for which the occupancy by a movable object can be technically detected, as indicated into [Ref 1]. Here the class is defined indicating only those elements which are of interest for CMS/TMS subsystems. [Content to be approved, SPT3TMS-11439]

The trainDetector element, present in the general model, is here considered not necessary as train detection is performed by the Traffic Control and Supervision System, which will provide TMS the train position along the track. [Content to be approved, SPT3TMS-11438]

The Track Vacancy Proving Section inherits from Track Entity. [Content to be approved, SPT3TMS-11441]

A Track Vacancy Proving Section shall have a reference to all the Track Edges which it is made of. [SPT3TMS-11440]

These attributes are deemed necessary to enable CMS and TMS functions to run across every Track Vacancy Proving Section along every possible path of the Track Layout of the controlled area. Even if TVPS might be avoided and algorithms might focus directly on the contained TrackEdges, it is considered useful to define this object in those cases where the contained Track Edges must be considered as a whole. [SPT3TMS-11437]

The following table collects all the elements which can qualify a Track Vacancy Proving Section: [Content to be approved, SPT3TMS-11694]

TVPSection (Derived from the base class TrackEntity)		
Definition of TVPSection structure		
Element	**Description**	**Type**
TrackEdgeUUIDList	List of the UUIDs of the Track Edges objects included in the TVPSection	UUID []

[SPT3TMS-11693]

Table 21 – TVPSection class

6.4.8 Track Edge Link

A Track Edge Link defines a class which describes the connection between two adjacent Track Edges. This class is derived from Track Entity. [Content to be approved, SPT3TMS-11447]

A Track Edge Link shall connect two Track Edges only. [SPT3TMS-11446]

When more than two Track Edges converge to the same location, more Track Edge Links shall be defined. [SPT3TMS-11449]

This is to have a clear and simple way to run across the list of track edges which model a piece of line. **[**SPT3TMS-11454 **]**

A Track Edge Link shall have a reference to the track edge which is connected to at its start. **[**SPT3TMS-11448 **]**

A Track Edge Link shall have a reference to the track edge which is connected to at its end. **[**SPT3TMS-11443 **]**

For both the Track Edges it connects, the Track Edge Link shall indicate whether it connects to the start of the Track Edge or not. **[**SPT3TMS-11442 **]**

Regardless of other position coordinates, every Track Edge Link shall be identified also in terms of absolute position along the track layout. **[**SPT3TMS-11445 **]**

The Track Edge Link absolute position along the track layout shall consider the possibility of kilometric “jumps”. **[**SPT3TMS-11444 **]**

An indication of the kilometric point of a location, directly related to the positioning system adopted in track layout drawings, is immediately understandable by an operator and can be used to identify objects in graphical representations. Discontinuities in mileage progression along a line are possible and in addition to the concept of offset with respect an initial point should be considered. **[**SPT3TMS-11453 **]**

The Track Edge Link shall have an indication of the maximum speed at which it can be crossed. **[**SPT3TMS-11450 **]**

This information is necessary to properly evaluate the train run forecast. **[**SPT3TMS-11452 **]**

The following table collects all the elements which can qualify a Track Edge Link: **[** Content to be approved, SPT3TMS-11708 **]**

TrackEdgeLink (Derived from the base class TrackEntity)

Definition of TrackEdgeLink class

Element	Description	Type
Kp_A	Identifies the position of the TrackEdgeLink onto the track layout. It is usually the same than Kp_B, unless there’s a change in the track layout, which introduces a different identification for the location. Two identifications of the position of the TrackEdgeLinks are introduced to keep flexibility and manage this case	KP
Kp_B	Identifies the position of the TrackEdgeLink onto the track layout. It is usually the same than Kp_A, unless there’s a change in the track layout, which introduces a different identification for the location. Two identifications of the position of the TrackEdgeLinks are introduced to keep flexibility and manage this case	KP
TrackEdgeAUUID	Represents the UUID of the Track Edge “A”	UUID

TrackEdgeBUUID	Represents the UUID of the Track Edge “B”	UUID
StartOnA	Flag which is “True” if the TrackEdge Link connects to the start of TrackEdge A, “False” if it connects to the end.	Boolean
StartOnB	Flag which is “True” if the TrackEdge Link connects to the start of TrackEdge B, “False” if it connects to the end.	Boolean
MaxSpeed	Identifies the maximum speed at which the link can be crossed	Integer (in m/s)

[SPT3TMS-11701 **]**

Table 22 – TrackEdgeLink class

Note: This specification recalls and extends the TrackEdge Link defined in [Ref 1], adding elements which better connects the object defined by the class with other objects of the Schematic Plan. **[** Content to be approved, SPT3TMS-11451 **]**

6.4.9 LinkedPath

A LinkedPath, according to [Ref 1] defines a continuous path between two given reference points (a “start” and a “end”) through a set of connected track edges (each of them made by one or more track edge sections. Each track edge section. **[** Content to be approved, SPT3TMS-11455 **]**

A linked path can start from the beginning of a track edge and finish at the end of another track edge, but more generally it can start and end elsewhere inside track edges; the path length is evaluated considering for every initial and ending point its increment/decrement from start/end of track edge section it belongs to. **[**SPT3TMS-11461 **]**

Every Linked Path shall be uniquely identified inside the controlled area. **[**SPT3TMS-11460 **]**

Every Linked Path shall be optionally referrable with a user-friendly name or description. **[**SPT3TMS-11463 **]**

The possibility to identify a linked path in a readable way can be shared with external systems which have to display information, either for CMS/TMS users or outside CMS/TMS. **[**SPT3TMS-11456 **]**

The starting point of every Linked Path shall be expressed as offset from the start location of the containing Track edge. **[**SPT3TMS-11462 **]**

The ending point of every Linked Path shall be expressed as offset from the end location of the containing Track Edge. **[**SPT3TMS-11457 **]**

In a traditional railway system usually the linked path (which is expressed as a set of track circuits) is made by a set of complete Track Edges, but in system where an advanced ETCS is present a greater level of freedom supporting a more optimized traffic capacity, it might be that the first and last Track Edges may only partially belong to it. **[**SPT3TMS-11459 **]**

The following table collects all the elements which can qualify a Linked Path: **[** Content to be approved, SPT3TMS-11706 **]**

LinkedPath		
Definition of Linked Path class		
Element	**Description**	**Type**
ID	Identifies uniquely the Linked Path among all other Linked Paths of the topological model.	ID

Uuid	Identifies uniquely the Linked Path inside the overall topological model	UUID
Name	A descriptive string, or acronym which names the linked path	String
DirTrackEdgeUUIDList	List of UUIDs of DirectedTrackEdge which build the path	UUID []
SkipFromStart	Incremental offset (in meters) from the start of the first Track Edge Section of the path	Unsigned integer
SkipFromEnd	Decremental offset (in meters) from the end of the last Track Edge Section of the path	Unsigned integer

[SPT3TMS-11699 **]**

Table 23 –LinkedPath class

Note: This specification recalls and extends the TrackEdge Link defined in [Ref 1], adding elements which better connects the object defined by the class with other objects of the Schematic Plan. **[** Content to be approved, SPT3TMS-11458 **]**

6.4.10 Track Platform

A Track Platform defines a platform along a track with its attributes. This class is derived from Track Entity. [REQ] – Every Track Platform shall be uniquely identified inside the controlled area. **[** Content to be approved, SPT3TMS-11469 **]**

Every Track Platform shall be described by a user-friendly name or description. **[**SPT3TMS-11468 **]**

A Track Platform is referred to inside alphanumeric and graphical views and is a key element of a train trip descriptor. **[**SPT3TMS-11471 **]**

It shall be possible to associate a Track Platform to a Track Edge which the train runs and from which it is possible to get on or get off and perform other operations. **[**SPT3TMS-11470 **]**

It shall be possible to associate a Track Platform to a Track Edge on its left or on its right or on both sides. **[**SPT3TMS-11465 **]**

According to the train direction and other trains characteristics, it is important to know whether a train can use a platform for getting on and off, and then where this platform is located with respect to the train. Depending on the platform is on the right or the left of the track edge, or it is present or not, the train can stop or not. **[**SPT3TMS-11473 **]**

The start location of a Track Platform shall be expressed as offset with respect the start location of the associated Track Edge. **[**SPT3TMS-11464 **]**

The start location of a Track Platform shall be expressed as a kilometric position according to the track layout reference coordinates. **[**SPT3TMS-11467 **]**

The Track Platform shall be qualified by its length. **[**SPT3TMS-11466 **]**

The Track Platform shall be associated to all the Track Edges linked to it. **[**SPT3TMS-11481 **]**

It is reasonable to expect that usually a platform corresponds to a Track Edge only. To be more general, the case of more than a Track Edge is foreseen. **[**SPT3TMS-11479 **]**

The Track Edges linked to a Platform from the same side shall be grouped together. **[**SPT3TMS-11477 **]**

To simplify search and other operations. **[**SPT3TMS-11475 **]**

The Track Platform shall be associated to all the stop locations contained inside the associated Track Edges. **[**SPT3TMS-11489 **]**

This can be used to identify the train position along the platform. **[**SPT3TMS-11487 **]**

The following table collects all the elements which can qualify a Track Platform: [Content to be approved, SPT3TMS-11704]

TrackPlatform (Derived from the base class TrackEntity)		
Definition of TrackPlatform class		
Element	**Description**	**Type**
trackSide_A	Boolean which, when True, associates the platform to the TrackEdges on its left on the Schematic plan	Boolean
A_Pos	Start Location of the Platform expressed as offset from the beginning of the associated Track Edge if trackSide_A is True. Not meaningful if trackSide_A is False	Integer (in meters)
AP_Kp_Start	Start Location of the Platform if trackSide_A is True. Not meaningful if trackSide_A is False	KP
AP_Length	The Length of the platform	Integer (in meters)
AP_TrackEdgeUUIDList	List of UUIDs of TrackEdge related to the platform on its left if trackSide_A is True. Not meaningful if trackSide_A is False	UUID []
AP_stopLocationsUUIDList	List of UUIDs of Stop locations related to TrackEdges on platform left if trackSide_A is True. Not meaningful if trackSide_A is False.	UUID []
trackSide_B	Boolean which, when True, associates the platform to the TrackEdges on its right on the Schematic plan	Boolean
B_Pos	Start Location of the Platform expressed as offset from the beginning of the associated Track Edge if trackSide_B is True. Not meaningful if trackSide_B is False	Integer (in meters)
BP_Kp_Start	Start Location of the Platform if trackSide_B is True. Not meaningful if trackSide_B is False	KP
BP_Length	The Length of the platform	Integer (in meters)
BP_TrackEdgeUUIDList	List of UUIDs of TrackEdge related to the platform on its left if trackSide_B is True. Not meaningful if trackSide_B is False	UUID []
BP_stopLocationsUUIDList	List of UUIDs of Stop locations related to TrackEdges on platform left if trackSide_B is True. Not meaningful if trackSide_B is False.	UUID []

[SPT3TMS-11697]

Table 24 – TrackPlatform class

This structure fully characterizes a platform, not only in terms of position where it is located and length but also from an operational viewpoint, indicating the relevant points where a train can stop inside (named Stopping points). [Content to be approved, SPT3TMS-11485]

6.4.11 Operational Point

The Operational Point class keeps the same meaning of the corresponding object in [Ref 1], where the “platform” element is of TrackPlatform type as defined above. [Content to be approved, SPT3TMS-11483]

Every Operational Point shall be uniquely identified inside the controlled area. [SPT3TMS-11492]

Every Operational Point shall be described by a user-friendly name or description. [SPT3TMS-11491]

A more extensive interpretation of the Operational Point might be to consider it as a more specific Topological Area, defining a portion of the schematic plan where a specific characteristic need to be highlighted or managed. Therefore, examples of Operational Points in this broader view can be areas in a station managed by a specific catenary section, which can be powered/unpowered as a whole, so being at once available or not available for electrically powered trains, or a Radio Hole area, which can be subject to an unavailability of the Radio Communication System. An Operational Point can be also made of a set of track platforms and related paths, which can be considered as arrival/departure locations for a train. [SPT3TMS-11493]

This view is consistent also with the approach followed by RINF in ERA in defining the concept of Operational Point, which is related also to the concept of location in CRD, used by IM in defining a train path in TAF/TAP TSI. [SPT3TMS-11501]

Every Operational Point shall be qualified with its type. [SPT3TMS-11499]

Every Operational Point shall be described by a user-friendly name or description. [SPT3TMS-11498]

A descriptive name can be used in views.

Every Operational Point shall be associated to a maximum speed at which it can be crossed. [SPT3TMS-11497]

An overall maximum speed limit can be used in case the speed of a contained elementary object is not configured. This should not happen and this field should be removed when the configuration process reaches a quality which is good enough. [SPT3TMS-11504]

Every Operational Point shall have a reference to all the Topology Objects which it contains. [SPT3TMS-11506]

Every Operational Point shall have a reference to all the Track Platforms which it contains. [SPT3TMS-11505]

An Operational Point represents a high-level view of an area which CMS and TMS configuration functions browse to derive and organize all contained objects. All the these attributes are deemed necessary to enable CMS and TMS configuration functions to browse every Operational Point and connect the contained objects together. [SPT3TMS-11503]

The following table collects all the elements which can qualify an Operational Point: [Content to be approved, SPT3TMS-11702]

OperationalPoint		
Definition of OperationalPoint class		
Element	**Description**	**Type**
ID	Identifies uniquely the Operational Point among all other Operational Points of the topological model.	ID
Uuid		UUID

	Identifies uniquely the Operational Point inside the overall topological model	
Name	A descriptive string, or acronym which names the Operational Point	String
type	Defines the type of the Operational Point. See [Ref 1] for this type definition	OPType
MaxSpeed	Maximum speed allowed inside the Operational Point	Integer (in m/s)
TrackEdge_UUIDList	Represents the list of UUID of the TrackEdges belonging to this region, according to the schematic plan	UUID []
TrackEdgeLinksA_UUIDList	Represents the list of UUID of the TrackEdgeLinks located on the “A” edge of this region, according to the schematic plan	UUID []
TrackEdgeLinksB_UUIDList	Represents the list of UUID of the TrackEdgeLinks located on the “B” edge of this region, according to the schematic plan	UUID []
TopologyObjUUIDList	Represents the list of UUID of the Topology Objects belonging to this Operational Point	UUID []
platformsUUIDList	List of UUIDs of TrackPlatforms associated to this OperationalPoint	UUID []

[SPT3TMS-11695 **]**

Table 25 – OperationalPoint class

This structure fully characterizes a platform, not only in terms of position where it is located and length but also from an operational viewpoint, indicating the relevant points where a train can stop inside (named Stopping points). **[**Content to be approved, SPT3TMS-11507 **]**

6.4.12 ATO Segment Profile

The ATO Segment Profile class gets back the Segment Profile class defined in [Ref 2] and integrates it inside the topology model defined in this document. Inside this definition, only the parameters which are necessary to perform CMS/TMS features are indicated, so filtering the full definition of the class in [Ref 2] according to what is deemed useful for CMS/TMS; this doesn’t mean that the other parameters designed into [Ref 2] must be removed; instead, they are considered mandatory for other system purposes and shall keep their validity in the original context. **[**Content to be approved, SPT3TMS-11474 **]**

In a later revision of this specification, if it is agreed that all fields defined into the original specification are suitable also for CMS/TMS, this class will be removed sending back to [Ref 2] for its complete definition. **[**Content to be approved, SPT3TMS-11472 **]**

Every ATO Segment Profile shall be qualified with a length. **[**SPT3TMS-11482 **]**

Every ATO Segment Profile shall be qualified with an altitude. **[**SPT3TMS-11480 **]**

Every ATO Segment Profile shall be associated to a Static Speed Profile. **[**SPT3TMS-11478 **]**

WHEN the static Speed Profile changes along the ATO Segment, another speed profile shall be linked to the ATO Segment Profile. **[**SPT3TMS-11476 **]**

Every new static Speed Profile associated to an ATO Segment Profile shall be positioned at a specific offset inside it. **[**SPT3TMS-11490 **]**

Every ATO Segment Profile shall be associated to a gradient. **[**SPT3TMS-11488 **]**

WHEN the gradient changes along the ATO Segment, another gradient shall be linked to the ATO Segment Profile. **[**SPT3TMS-11486 **]**

Every new gradient associated to an ATO Segment Profile shall be positioned at a specific offset inside it. **[**SPT3TMS-11484 **]**

Every ATO Segment shall be associated to a list of timing points. **[**SPT3TMS-11496 **]**

Timing Points are used as reference points to elaborate a train movement forecast to be sent to ATO. They have to be agreed and shared with Train On-board. **[**SPT3TMS-11494 **]**

Every ATO Segment shall be associated to a list of Axle load speed profiles. **[**SPT3TMS-11495 **]**

Axle load speed profiles and all other parameters here specified are used by CMS/TMS Algorithms to evaluate a precise train trip forecast. **[**SPT3TMS-11502 **]**

The following table collects all the elements which can qualify an ATO Segment Profile: **[** Content to be approved, SPT3TMS-11714 **]**

ATOSegmentProfile		
Definition of ATOSegmentProfile structure		
Element	**Description**	**Type**
length	Defines the length of the ATOSegment	Integer (in m)
startAltitude	Defines the altitude at the beginning of the Segment	Integer (in cm)
staticSpeedProfileStart	ETCS area name to which the ATO Segment object belongs	StaticSpeedProfileStart
staticSpeedProfileChanges	Defines the several different Static Speed Profile changes which apply inside the same segment	StaticSpeedProfileChange []
gradientStart	Indicates the gradient at the beginning of the segment	GradientStart
gradientChanges	Indicates the gradient at the beginning of the segment	GradientChange []
timingPoints	Defines a list of timing points inside the segment.	TimingPoint []
axleLoadSpeedProfiles	List of axle load speed profiles applicable to the ATO Segment	AxleLoadSpeedProfiles []

[SPT3TMS-11709 **]**

Table 26 – ATOSegmentProfile class

6.4.13 ATO Segment

The ATO Segment class gives a complete characterization of an elementary portion of line as seen by a ETCS system, with all information necessary to implement ATO on the controlled area. **[** Content to be approved, SPT3TMS-11500 **]**

Every ATO Segment shall be uniquely identified inside the controlled area. **[**SPT3TMS-11513 **]**

Every ATO Segment shall be described by a user-friendly name or description. **[**SPT3TMS-11512 **]**

The possibility to identify an ATO Segment in a readable way can be used to identify it in graphical views. **[**SPT3TMS-11509 **]**

Every ATO Segment shall indicate whether the running direction is the same than the associated Track Edge. **[**SPT3TMS-11515 **]**

Every ATO Segment shall be configured with its profile. **[**SPT3TMS-11514 **]**

The following table collects all the elements which can qualify an ATO Segment: **[** Content to be approved, SPT3TMS-11713 **]**

ATOSegment

Definition of ATOSegment structure

Element	**Description**	**Type**
ID	Identifies uniquely the ATOSegment among all other ATOSegment of the topological model.	ID
Uuid	Identifies uniquely the ATOSegment inside the overall topological model	UUID
Name	A string which defines a meaningful, user-friendly name for the ATOSegment. If no name is given, it can be an empty string.	string
sameDir	Indicates whether the running direction is the same than the Track Edge Section associated with it ("True") or it is the opposite ("False")	Boolean
Profile	Describes the characteristics of the segment with all parameters necessary to elaborate a precise forecast for the train crossing it.	ATOSegmentProfile

[SPT3TMS-11707 **]**

Table 27 – ATOSegment class

The possibility to have an ATO segment made of more than a Track Edge Section is kept for flexibility but it should not be the normal case when modelling an area. **[** Content to be approved, SPT3TMS-11508 **]**

6.4.14 ATO Area

The ATO Area class describes a portion of the controlled area in terms of ATO segments. **[** Content to be approved, SPT3TMS-11511 **]**

Every ATO Area shall be uniquely identified inside the railway controlled area. **[**SPT3TMS-11510 **]**

Every ATO area shall be described by a user-friendly name or description. **[**SPT3TMS-11516 **]**

The possibility to identify an ATO Area in a readable way can be used to identify it in graphical views. **[**SPT3TMS-11518 **]**

Every ATO Area shall be associated with the list of segments which belong to. **[**SPT3TMS-11519 **]**

The following table collects all the elements which can qualify an ATO area: **[** Content to be approved, SPT3TMS-11712 **]**

ATOArea		
Definition of ATOArea structure		
Element	**Description**	**Type**
ID	Identifies uniquely the ATOArea among all other ATOArea of the topological model.	ID
Uuid	Identifies uniquely the ATOArea inside the overall topological model	UUID
Name	A string which defines a meaningful, user-friendly name for the ATOArea. If no name is given, it can be an empty string.	string
ATOsegmentUUIDList	Gives the list of the ATO segments inside the ATO area	UUID []

[SPT3TMS-11705 **]**

Table 28 – ATOArea class

The classes:
· StaticSpeedProfileStart and SpecificStaticSpeedProfileStart (which is an element of StaticSpeedProfileStart),
· StaticSpeedProfileChange and SpecificStaticSpeedProfileChange (which is an element of StaticSpeedProfileChange)
· The enumerated type TrainEndApplicability

defined in [Ref 2], and the enumerated types:
· SpecificStaticSpeedProfileType
· OtherSpecificStaticSpeedProfileCategory
· CantDeficiencyCategory
defined in [Ref 1] are already suitable to be used for CMS/TMS and don't need to be modified, and therefore are not recalled here. Please, see [Ref 1] and [Ref 2] for the classes' definitions. **[**SPT3TMS-11517 **]**

The same applies to the following types:
· GradientStart type, defined in [Ref 2]
· GradientChange type, defined in [Ref 2]
· AxleLoadSpeedProfile type, defined in [Ref 2]
· SegmentSection type, defined in [Ref 2]
See sect. 6.7 for further considerations. **[**SPT3TMS-11520 **]**

6.4.15 Topology

The Topology class is the highest-level class of the model, which defines the overall railway network defined for a specific project, in terms of tracks, connections and other topological elements that allow a complete and precise description of the path of a train which travels from its origin to its destination. In addition to that, the topology class defines all the elements necessary to describe restrictions and warning areas, which are used to plan and support the execution of the production plan. **[** Content to be approved, SPT3TMS-11548 **]**

The design decision in [Ref 1], which groups Topology into “TopoArea(s)”, is confirmed to be suitable for CMS/TMS subsystem and therefore kept. **[** Content to be approved, SPT3TMS-11547 **]**

A Topology shall contain the list of all Track Edges which belong to. **[**SPT3TMS-11550 **]**

A Topology shall contain the list of all Track Vacancy Proving Sections which belong to. **[**SPT3TMS-11549 **]**

A Topology shall contain the list of all Track Edge Links which belong to. **[**SPT3TMS-11544 **]**

A Topology shall contain the list of all Regions which belong to. **[**SPT3TMS-11543 **]**

A Topology shall contain the list of all Operational Points which belong to. **[**SPT3TMS-11546 **]**

A Topology shall contain the list of all Track Platforms which belong to. **[**SPT3TMS-11545 **]**

A Topology shall contain the list of all ATO Areas which belong to. **[**SPT3TMS-11553 **]**

This is a way to collect into a structure all the elements of a topology. **[**SPT3TMS-11563 **]**

The following table collects all the elements which can qualify a Topology: **[** Content to be approved, SPT3TMS-11719 **]**

Topology		
Topology structure		
Element	**Description**	**Type**
TrackEdgeUUIDList	Represents the list of UUID of the TrackEdges belonging to the Topology	UUID []
TVPSectionUUIDList	Represents the list of UUID of the TVPSections belonging to the Topology	UUID []
TrackEdgeLinkUUIDList	Represents the list of UUID of the TrackEdgeLinks belonging to the Topology	UUID []
RegionUUIDList	Represents the list of UUID of the TopoARegionss belonging to the Topology	UUID []
OperationalPointsUUIDList	Represents the list of UUID of the Operational Points belonging to the Topology	UUID []
TrackPlatformUUIDList	Represents the list of UUID of the TrackPlatforms belonging to the Topology	UUID []

ATOAreaUUIDList	Represents the list of ATO Areas belonging to the Topology	UUID []

[SPT3TMS-11703 **]**

Table 29 – Topology class

7 Cross-check with Transversal Topological model

7.1 Generalities

Only a subset of the objects inside [Ref 1] have been considered part of the topological model designed for CMS/TMS purposes, as the specification focuses defining a model which supports CMS/TMS functions only. The goal is to provide the master of the data model with the specific needs of Task 3, which behaves as a “client”. It is assumed that other “clients”, as Train Control and Supervision system and Traffic Control and Supervision system at least, do the same job and provide a similar specification which is to be used by TCCS SD1 as input for the elaboration of the final and complete release of the model. **[** Content to be approved, SPT3TMS-11561 **]**

To achieve this goal, the specification doesn’t elaborate another model like what described in the referenced input documents. Topological information is here subpackaged in topology data structure main container called Topology (see sect. 5.4.15) while topological data are collected in TopoRegion structures that are kept by main container data structure called infrastructure. This is a different and simplified approach to describe additional needs with anyway refer to the same physical objects, due to a limited scope with respect the wider TCCS SD1 one; the goal remains to describe the same infrastructural model. **[** Content to be approved, SPT3TMS-11559 **]**

As an example, in this specification the topology data structure main container refers directly to ATO areas using a list of ATOAreaUUID while [Ref 1] doesn’t model ATO data, which are collected into [Ref 2]; this has not to be seen as a major difference between the two specifications, but a simplified way to highlight CMS/TMS needs related to ATO. **[** Content to be approved, SPT3TMS-11557 **]**

From a designing perspective, the approach followed in the present document largely does make use of inheritance (for example: TrackEdge is a TrackEntity and TrackEntity is a TopologyObject) while Task 2 SD1 model does not and relations between objects and entities are preferred to be implement by using encapsulation. The same considerations as above apply; with this specification the CMS/TMS domain intends to highlight what is necessary for its purposes, not how to model them. The TCCS SD1 shall model additional requests in a way which fits with its approach, being agreed that the model shall be transmitted to the users in a clear a non-ambiguous way. This is also the reason why the description of the entities is not performed in Json but in tables. **[** Content to be approved, SPT3TMS-11569 **]**

7.2 Static Speed Profile

In CMS/TMS model, the ATO Static Speed Profile is related to a ATO Segment Profile, which is considered a property of. On the other hand, in [Ref 1], the static speed profile contains a Track Edge as a parameter. **[** Content to be approved, SPT3TMS-11567 **]**

It is considered more general to associate a static Speed Profile to a Track Edge Segment, which is the portion of the Track Edge with homogeneous characteristics, envisaging that a Track Edge may have more Track Edge Segments with potentially different Static Speed Profiles. **[**SPT3TMS-11565 **]**

7.3 Track Edge and Track Edge Segment

The CMS/TMS complies with the concept of the Track Edge depicted in [Ref 1] and associates to this object a sampled description of the geometry, whose simplified description with respect the more general concept of track geometry describes a data model which is deemed suitable to deploy CMS/TMS apportioned functions. **[** Content to be approved, SPT3TMS-11564 **]**

The Track Edge Segment becomes the object with the finest granularity of the model. When evaluating the train forecast and paths, it is necessary to use the most elementary resources to achieve the best precision in representing the path. The Track Edge Segment contains a number of parameters sufficient to fully characterise the train run on it. **[** Content to be approved, SPT3TMS-11571 **]**

7.4 Track Edge Section

The CMS/TMS complies with the concept of the Track Edge Section depicted in [Ref 1] and considers this element suitable to identify dynamically defined areas where a constraint is set up or removed, without any change to the infrastructure model. Therefore, it is agreed to use this construct to identify Low Adhesion Areas, Temporary Speed Restrictions or similar. **[** Content to be approved, SPT3TMS-11570 **]**

7.5 Stop Location

This specification adopts the concept of Stop Location as defined in [Ref 1], but it simplifies it as it seems that the organization of nested types in [Ref 1] is somehow redundant. **[** Content to be approved, SPT3TMS-11574 **]**

7.6 TrackPlatform

This specification adopts the concept of Platform as defined in [Ref 1], but it doesn't keep a linked path as it seems not clear how to locate the former into the latter. **[** Content to be approved, SPT3TMS-11584 **]**

In addition to that, several parameters have been added to the platform because it is considered useful to locate the possible stopping locations (stopping points) inside the platform, in both directions (it may be the case that stopping locations for trains crossing the platform from A to B are different from those which can be defined if crossing the platform from B to A. **[**SPT3TMS-11579 **]**

7.7 Track Edge Speed Profile Limit

This class is defined in [Ref 1], but used only to characterize a functional area, and is not used as attribute for a Track Edge. Considering the high detail kept in defining ATO segment profile, which includes a detailed characterization of the speed profile, it is proposed not to consider this class and its subclasses defined in [Ref 1]. **[** Content to be approved, SPT3TMS-11581 **]**

7.8 ATO Segment Profile

The specification of the ATOSegmentProfile class given in [Ref 2] contains several parameters which are considered not relevant for CMS/TMS features: nidSP, version, nidC, eoaOffset, utcOffset, atotsContactInfoDir, atotsContactInfo, curveStart, curveChanges, voltageStart, voltageChanges, currentStart, currentChanges, baliseGroups, platformAreas, tunnels, UnprotectedLXs, permittedBrakingDistances, switchOffEddyCurrentBrakeServiceBrakes, switchOffEddyCurrentBrakeEmergencyBrakes, switchOffRegenerativeBrakes, switchOffMagneticShoeBrakes, dynamicBrakeForceInhibitions, limitedDynamicBrakeForces and related subtypes have not been considered here. In case they are considered to be relevant after a further analysis, the class shall be modified accordingly in a later version of the document. **[** Content to be approved, SPT3TMS-11589 **]**

The specification envisages a StaticSpeedProfileStart type, which contains a SpecificStaticSpeedProfileChange type; both define a speed element which is not clear how to use it and which of the two has priority. **[** Content to be approved, SPT3TMS-11587 **]**

The same ambiguity is detected for the StaticSpeedProfileChange type, which contains a SpecificStaticSpeedProfileChange type, and has the same meaning of the previous one for the next variations of speed profile which may occur inside the segment. **[** Content to be approved, SPT3TMS-11586 **]**

Nevertheless, these two parameters are kept because they are relevant to evaluate precisely the train forecast along the segment; clarifications about the speed shall occur later. **[** Content to be approved, SPT3TMS-11585 **]**

However, other two fields are defined into the class: specificStaticSpeedProfileStart and specificStaticSpeedProfileChange, whose type is the same than inside StaticSpeedProfileStart and StaticSpeedProfileChange respectively; it is not clear the added value that they bring to the class and the relationship with the previous fields. Therefore, in this release of the document they shall not be considered in the class definition. **[** Content to be approved, SPT3TMS-11590 **]**

7.9 Operational Points

The concept of Operational Point has been considered here broader with respect to the definition of [Ref 1]. This concept defines a topological element which has a greater level of abstraction than the other objects, but it is deemed relevant for this document, also because it recalls a concept defined also elsewhere, in previous feasibility studies or specifications dealing with the definition of a topological model (see [Ref 8] and [Ref 9]. **[** Content to be approved, SPT3TMS-11524 **]**

7.10 Field Objects

Field Objects as Level Crossing and ETCS Marker boards, and characteristics of the line as Tunnels, Bridges, Underpasses, Buffer stops have not been considered in the model. The rationale behind this is that TMS neither controls nor directly monitors these objects but gets indications about the train trip in terms of position along the line. Then, every information necessary for CMS and TMS functions is derived by indications received by TCS according to [Ref. 6]; in case it is deemed necessary to model some or all of them at a late **[**SPT3TMS-11523 **]**