RCA

Reference CCS Architecture

An initiative of the ERTMS users group and the EULYNX consortium

RCA Terms and Abstract Concepts

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1 Introduction

This document defines the Abstract Concepts and the Terms of the System RCA.

- None -

2 Definitions

2.1 Definition of Terms

Terms are defined as expressions that do not have relationships between each other and provide a unique meaning within RCA.

2.2 Definition of Abstract Concepts

Abstract concepts are defined as expressions that have relationships between each other and provide a unique meaning within RCA. These expressions are used to explain domain specific concepts and their relations.

2.3 Definition of Abstract Concepts Draft

Abstract Concepts Draft are defined similar to Abstract Concepts, but with the only difference that these concepts are in draft status, i.e. not yet approved with all stakeholders. However it is deemed worthwhile publishing them to share on-going work.

- None -

3 Terms

- Advanced Protection System (APS)

  A group of subsystems in the RCA interface architecture responsible for safe track usage and for control and supervision of the railway production.

  APS assures as a gatekeeper, that the requests of Plan Execution (PE) create a safe traffic flow and then executes them.

  It includes the subsystems Safety Logic (SL), Safety Manager (SM), Object Aggregation (OA), Movement Authority Transactor (MT), Mobile Object Transactor (MOT) and Fixed Object Transactor (FOT)
- Automatic Train Operation (ATO)

  Automatic Train Operation (ATO) is an operational enhancement used to help automate operations of trains.
- Digital Map (DM/MAP)

  Digital Map (DM/MAP) is a set of functionalities providing track and trackside infrastructure information in the form of structured Map Data. The initial scope of Digital Map ensures the quality criteria of Map Data along with Map management functionalities like Map versioning and download of Map Data for On-Board consuming systems. The extended scope of Digital Map will additionally cover the functionalities associated with the life cycle of the Map Data such as generation, validation, compiling of Map Data along with provisioning of Map Data to the trackside consuming systems.
- Driver Machine Interface (DMI)

  The interface to enable direct communication between the ERTMS/ETCS on-board equipment and the driver.
- Field Element

  Field Element is a railway fixed equipment on/or adjacent to track, e.g. Light Signal, Point, Level Crossing.
- Grade of Automation (GoA)

  Grade of Automation (GoA) refers to the automation level of train operation, in which a train can be operated, resulting from sharing responsibility for given basic functions of train operation between operations staff and system.
- Interlocking (IXL)

  In railway signalling, an interlocking is a system composed by a set of signal apparatus that prevents trains from conflicting movements through only allowing trains to receive authority to proceed, when routes have been set, locked and detected in safe combinations.
- Open CCS Onboard Reference Architecture (OCORA)

  European initiative to define the Control-Command and Signalling (CCS) on-board architecture.

- None -

- Railway Undertaking (RU)

  Any public or private undertaking licensed according to EU directive 2012/34/EU, the principal business of which is to provide services for the transport of goods and/or passengers by rail with a requirement that the undertaking ensure traction; this also includes undertakings which provide traction only.
- Reference CCS Architecture (RCA)

  Reference CCS architecture is an initiative by the members of ERTMS Uers Group (EUG) and EULYNX to define a harmonised architecture for the future railway Control-Command and Signalling (CCS), with the main goal to substantially in-crease the performance ratio of CCS in comparison with today's implementations.
- Shift2Rail

  Shift2Rail is a European initiative which fosters the introduction of better trains to the market (quieter, more comfortable, more dependable, etc.), which operate on an innovative rail network infrastructure reliably from the first day of service introduction, at a lower Life Cycle Cost, with more capacity to cope with growing passenger and freight mobility demand.
- Traffic Management System (TMS)

  Traffic Management System (TMS) is part of the Planning System and provides permanent control across the network, automatically plans the movement of trains and logs train movements as well as detects and solves potential operational conflicts.
- Train Integrity Monitoring System (TIMS)

  System to monitor and confirm train integrity.

4 Abstract Concepts

Abstract concepts are defined as expressions that have relationships between each other and provide a unique meaning within RCA. These expressions are used to explain domain specific concepts and their relations.

4.1 Map related concepts

The Map domain provides abstract concepts that will be used to provide reliable and validated topology and topography data in the form of Map Data.

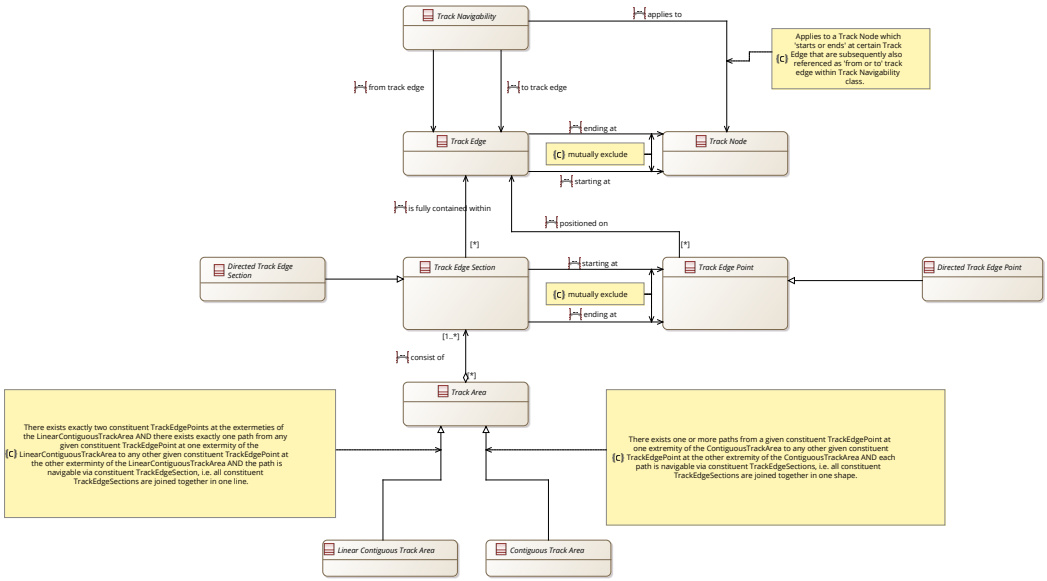


Figure 1: [O.CDB][AMOD-025] Base topology [Abstract concepts]

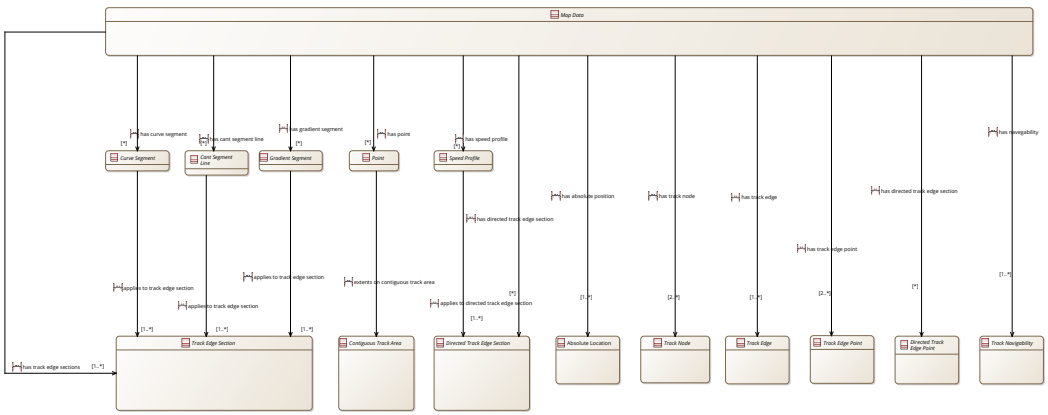


Figure 2: [O.CDB][AMOD-025] Content of map [Abstract concepts]

- None -

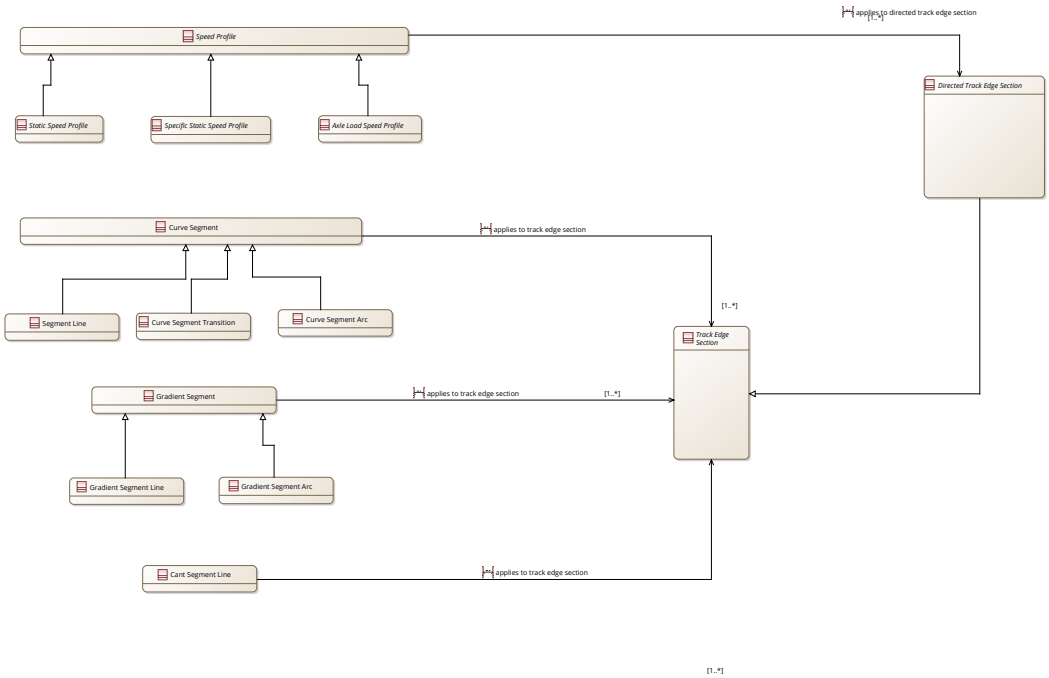


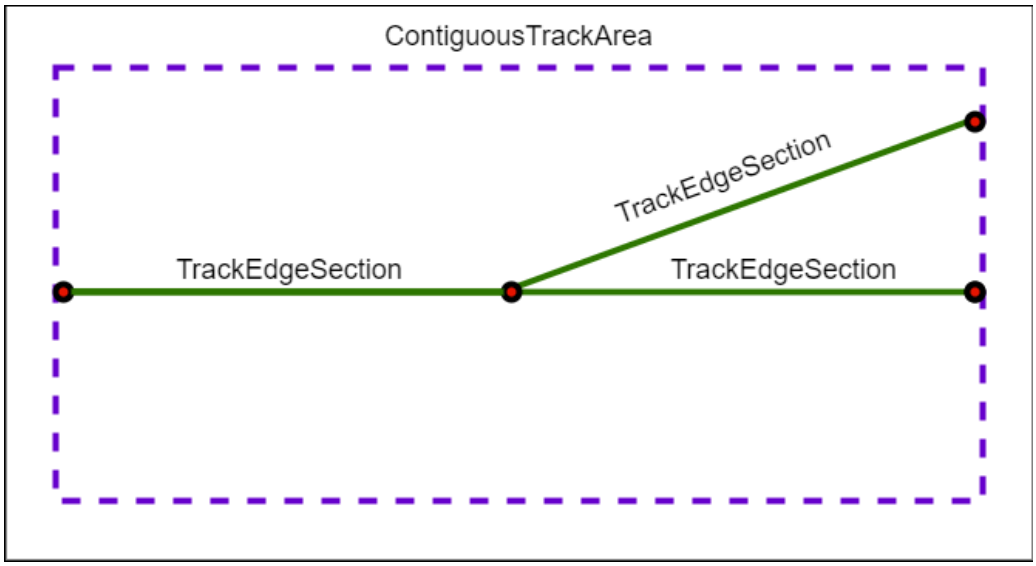
Figure 3: [O.CDB][AMOD-025] Taxonomy for map objects [Abstract concepts]

4.1.1 Description of Map related concepts

⌘ Contiguous Track Area

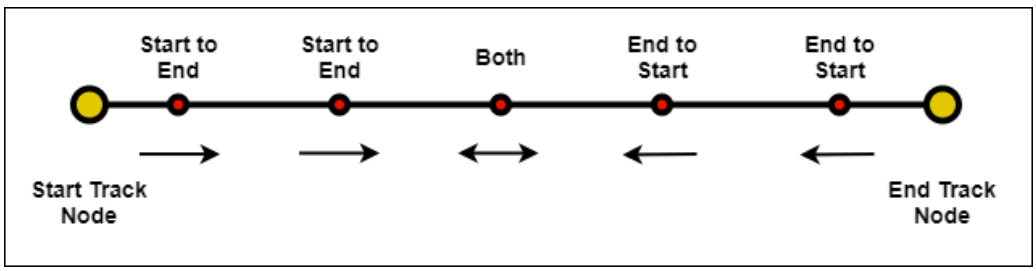
The Contiguous Track Area is a specialised class of Track Area to group a number of Track Edge Sections, which are topologically connected to each other such that they form one or more paths.

Example of an Contiguous Track Area that consists of three Track Edge Sections:



⌘ Directed Track Edge Point

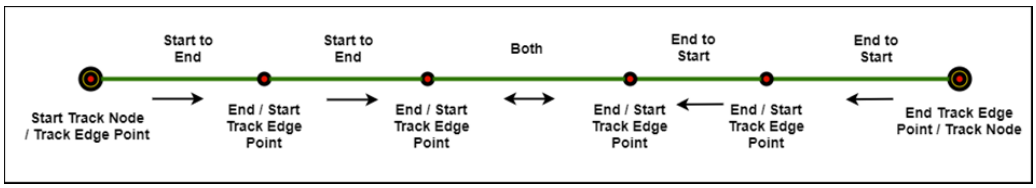
The Directed Track Edge Point is used to describe a directed spot object with an effective direction. The effective direction is specified in relation to the direction of the underlying Track Edge.



⌘ Directed Track Edge Section

The Directed Track Edge Section is used to describe a directed linear object with an effective direction. The effective direction is specified in relation to the direction of the underlying Track Edge.

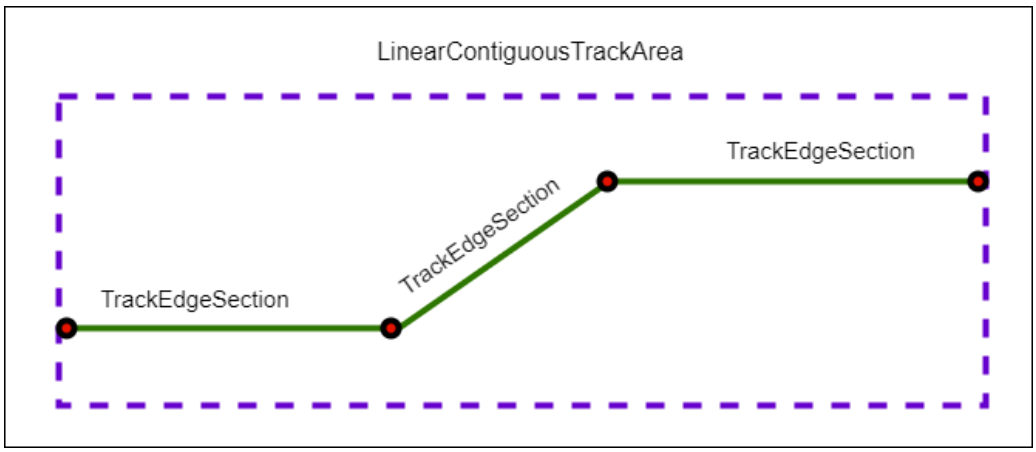
Directed Track Edge Sections shall be used to provide references to elements representing track properties like Speed Profiles: Static Speed Profile, Specific Static Speed Profile, and Axle Load Speed Profile.



⌘ Linear Contiguous Track Area

The Linear Contiguous Track Area is a specialized class of Track Area to group an ordered and directional number of topologically connected Track Edge Sections such that they form exactly one path. The sequence of sections needs to be unambiguously navigable along the track network. Meaning that, each end of a Track Edge Section coincides with the start / end of the immediately succeeding section in the sequence.

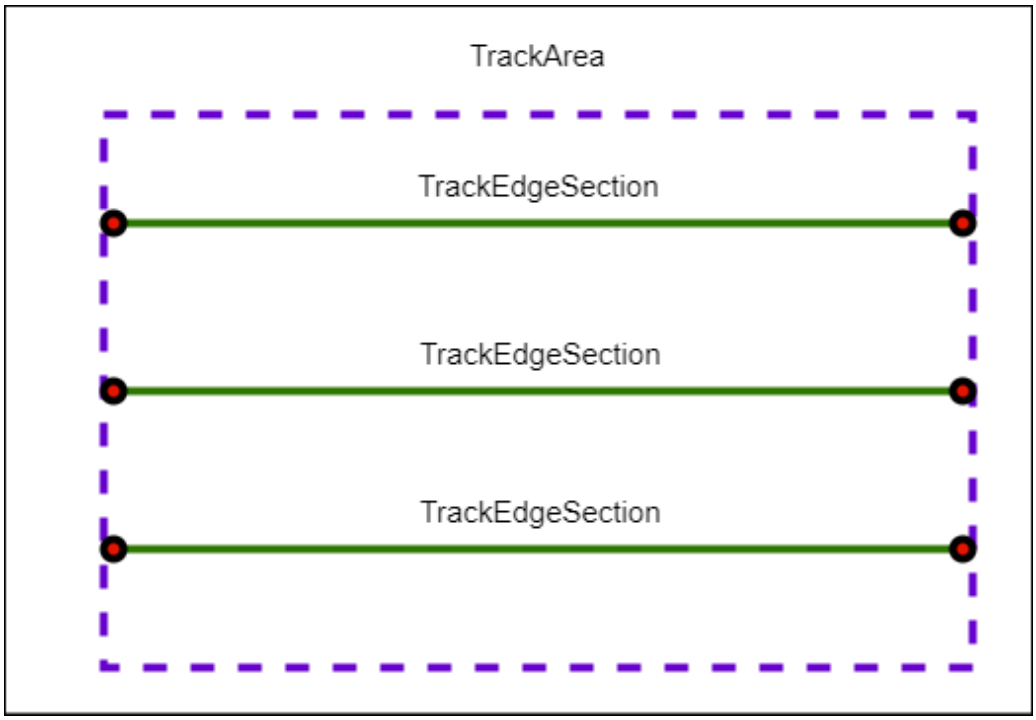
Example of a Linear Contiguous Track Area that consists of three Track Edge Sections:



⌘ Track Area

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

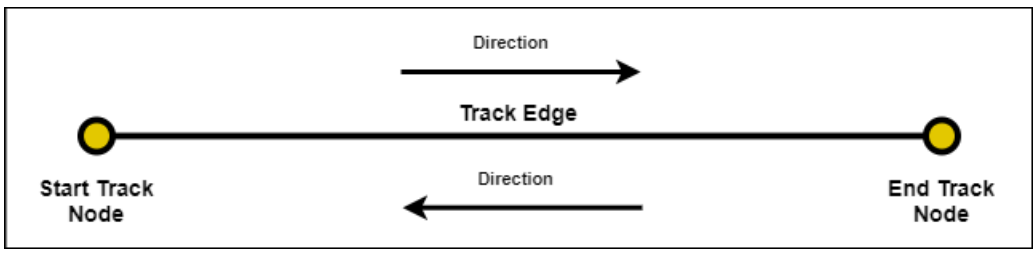
Example of a Track Area that consists of three Track Edge Sections:



⌘ Track Edge

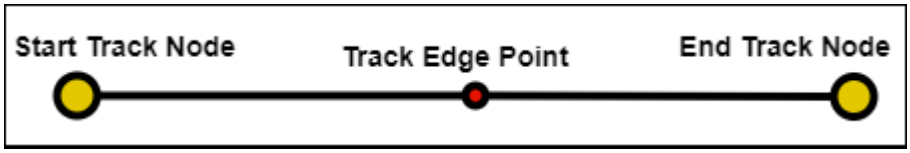
A Track Edge is a linear object that connects exactly two Track Nodes. One of these Track Nodes is defined as a Start Track Node, the other is defined as an End Track Node. The Track Edges have a direction and a length.

Track Edges are directed to indicate possible usage directions i.e. Start to end or End to start. The Track Edge direction doesn't specify the drivability of a Track Edge. Each route path between two adjacent Track Nodes is represented by a Track Edge.



⌘ Track Edge Point

A Track Edge Point is used to describe non-directed spot objects (without spatial expansion) and to locate them on (or alongside) a Track Edge. Track Edge Points shall be used to provide references to elements representing track assets like Balises, etc.



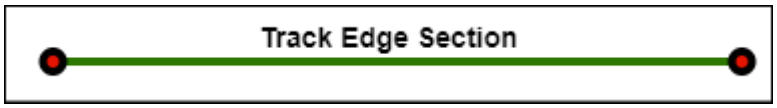
⌘ Track Edge Section

A Track Edge Section is used to describe non-directed linear objects (with a linear extension) and to place them on (or at the side of) a Track Edge.

Track Edge Sections shall be used to provide references to elements representing track properties (e.g. Curve) or track assets (e.g. Point).

1. Track Geometry
   - ⌘ Curve
   - ⌘ Gradients
   - ⌘ Cant

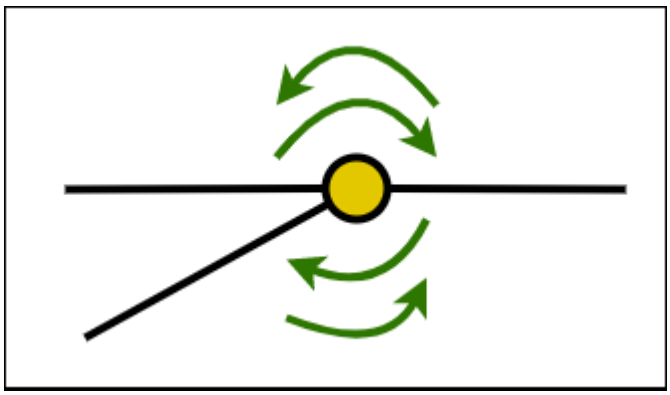
2. Drive Protection Sections



⌘ Track Navigability

Information on a Track Node, whether a Physical Train Unit is able to pass from one Track Edge to another over a Track Node (valid movement path). Track Navigability represents ordered pairs of navigable Track Edges, referenced by Track Edge attributes. The Track Navigability always refers to one direction only, meaning if navigation between two Track Edge A and B in both directions is possible, two navigabilities ("from Track Edge A to Track Edge B" and "from Track Edge B to Track Edge A") have to be defined.

Example: Simple Point (4 Track Navigabilities)



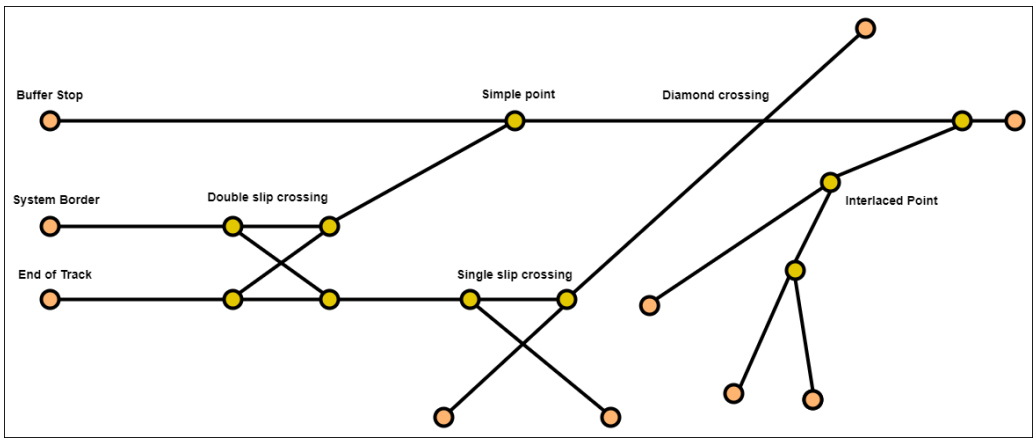
- None -

⌘ Track Node

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

- ⌘ Points – It is a location of the track network where trains coming from one direction and have more than one possible Track Edge to continue driving. Note: Even if one Track Edge begins while another passes through the point, the Track Node that represents the point splits the passing track into two Track Edges
- ⌘ End Of Track – The position on the track network where the physical track ends or a Buffer Stop is located.
- ⌘ System borders - The position defining a system border (i.e. between two infrastructure operators, between two areas of control or between a controlled and a non-controlled area. Note: Even if the physical track continues, on this location one track edge ends and another begins.

Examples showing Track Nodes and Track Edges for describing certain topologies:



- Map Data

  Map Data is provided to the consuming systems. During the operation, the Map Data is used to realize system specific functionalities, e.g. for support with on-board localisation, generating Movement Authorities or other specific use cases.

  The Map Data includes a build-up set of edges along with associated nodes (e.g. points, buffer stops), the relevant infrastructure characteristics (e.g. curve radius and gradients), and location information (e.g. specific reference points, balises). The Map Data remain unchanged during operation phase until the next provisioning of Map Data.

  The so-called Map Data is based on the existing Topology Domain from RCA Terms and Abstract concepts [RCA.Doc.14] along with some additional information regarding Track Geometry and Location information.

  Note: While the configuration of the RCA systems shall mainly consist of Map Data it is complemented by additional system specific parameter data. Unless explicitly included in the respective context, the parameter data is not part of the Map Data. However, the following dependencies should be considered:
  - *the parameter data is based on the same Engineering Data as Map Data,*
  - *the parameter data will be provided in the same way as Map Data and*
  - *a consistent system configuration requires at least partial alignment between Map Data and system parameters.*

- Curve Segment Transition

  The Curve Segment Transition defines the transitions from the straight to the curved (circle) sections.

- Gradient Segment Line

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

- Curve Segment Arc

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

- Gradient Segment Arc

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

- Cant Segment Line

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

- Curve Segment

  Base definition of a curve. The specific elements of a curve are defined as an extension to this base object.

- Segment Line

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

- Gradient Segment

  Base definition of a gradient. The specific elements of a gradient are defined as an extension to this base object.

- Speed Profile

  Base definition of a speed profile. Specific speed profiles are defined as an extension to this base object.

- Static Speed Profile

  The Static Speed Profile (SSP) is a description of the fixed speed restrictions of a given piece of track. The speed restrictions can be related to e.g. maximum line speed, curves, points, tunnel profiles, bridges (As defined in Subset 026-3.11.3.1.1).

- Specific Static Speed Profile

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

- Axle Load Speed Profile

  Defines speed profile based on axle load categories.

- Point

  A Point is an item of movable infrastructure with two possible drivable paths. A point enables navigability between one Track Edge and only one of two possible Track Edges.

4.2 Mission related concepts

The Mission domain provides abstract concepts that will be used to plan the movement of rolling stock from an origin to a destination.

- None -

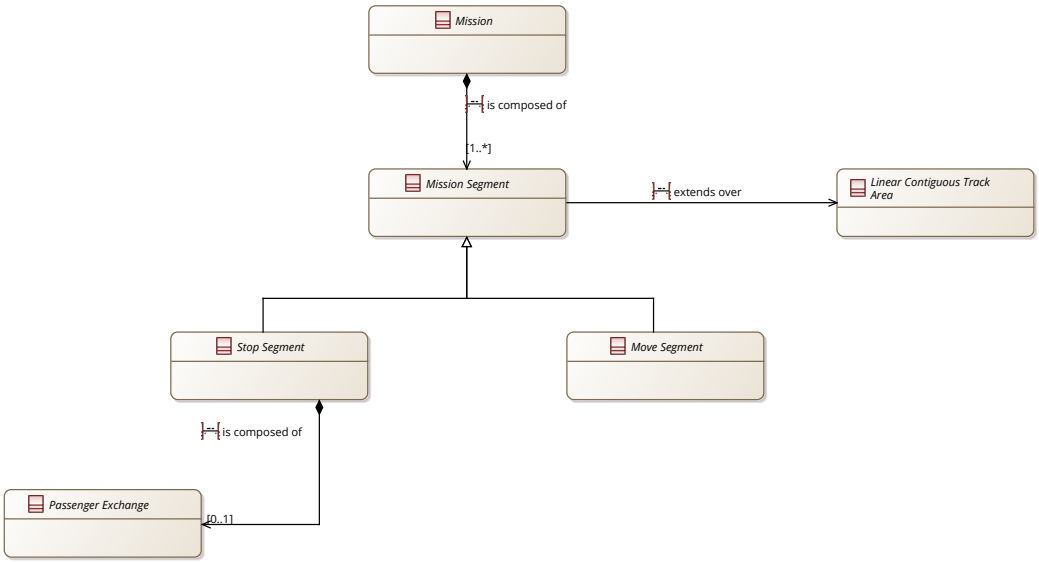


Figure 4: [O.CDB][AMOD-025] Mission [Abstract concepts]

4.2.1 Description of Mission related concepts

⌘ Mission

A movement of rolling stock from an origin to a destination. It is described by a continuous sequence of Mission Segments from origin to destination, without gaps and branches and is operated on each Mission Segment by exactly one Train Unit, with possibly different Train Units on individual Mission Segments.

⌘ Mission Segment

A part of a Mission that is either a Move Segment or a Stop Segment.

⌘ Move Segment

A part of a Mission that represents the movement of a Train Unit from start of wheel movement at one planned Stopping Point to stop of wheel movement at the next planned Stopping Point.

⌘ Passenger Exchange

Passenger Exchange is a part of Stop Segment specific to a situation in which Passengers move from Platform Area to Train Unit Area or vice versa.

⌘ Stop Segment

A part of a Mission that represents the standing still of the Train Unit (incl. possible Train Unit joins and splits) at a planned Stopping Location from stop of wheel movement (arrival) to start of wheel movement (departure).

4.3 Area related concepts

The Area domain provides concepts needed by System RCA to represent specific areas. ToDo: This domain is currently incomplete and will be enhanced in a future release.

- None -

4.3.1 Description of Area related concepts

⌘ Warning Area

A Warning Area describes an extent of a TrackArea in which Authorised Trackside Person must be protected while performing trackside works.

4.4 Localisation related concepts

The Localisation domain provides concepts needed by System RCA to represent localisation information. ToDo: This domain is currently incomplete and will be enhanced in a future release.

4.4.1 Description of Localisation related concepts

⌘ Absolute Location

Absolute location provides the geodetic measurements based on an appropriate coordinate system.

5 Abstract Concepts Draft

Abstract Concepts Draft are defined similar to Abstract Concepts, but with the only difference that these concepts are in draft status, i.e. not yet approved with all stakeholders. However it is deemed worthwhile publishing them to share on-going work.

5.1 Safety Logic

The Safety Logic domain provides concepts needed by System RCA to ensure safe movements of Trackbound Movable Objects and support safety of Non Trackbound Movable Objects in the Track Area (e.g. construction sites).

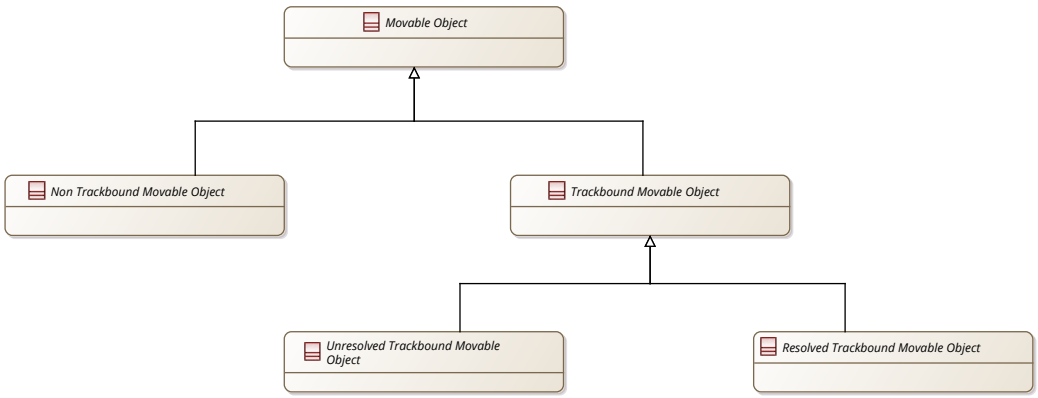


Figure 5: [O.CDB][AMOD-025] Movable object taxonomy [Abstract concepts]

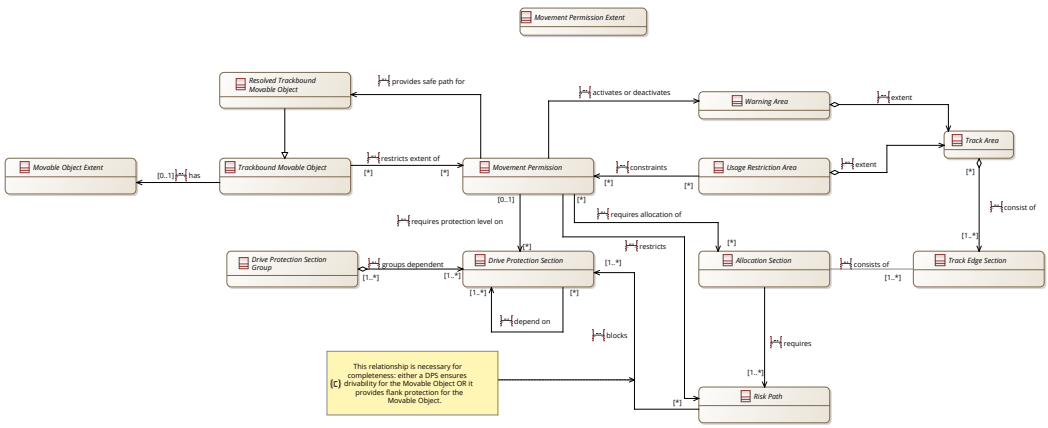


Figure 6: [O.CDB][AMOD-025] Safety Logic domain [Abstract concepts]

- None -

5.1.1 Description of Safety Logic

⌘ End of Movement Permission

The End of a Movement Permission (EoP) describes the position up to which a Train Unit is allowed to move. The Risk Buffer connects gap-free behind to it.

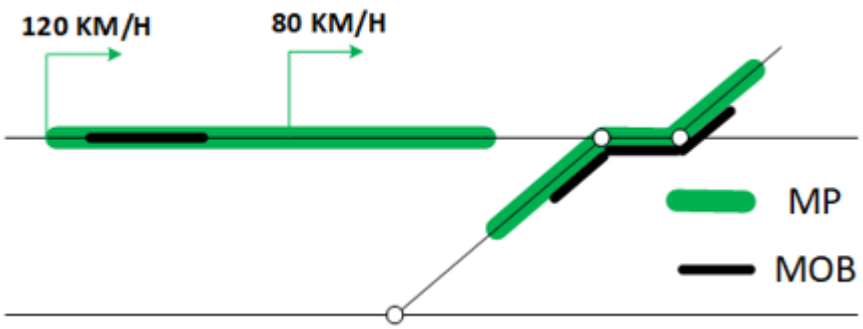
⌘ Movable Object

A Movable Object (MOB) is a representation of a real world movable object in the Operating State. Such Movable Objects can be trackbound (such as trains) or non-trackbound (such as workers).
Any real Movable Object which is detected as such by a person or system with safety responsibility will be represented as a Movable Object in System RCA.

⌘ Movement Permission

A Movement Permission (MP) is an authorisation for a particular Trackbound Movable Object to move in a defined direction, with a defined speed, along a defined path (a contiguous stretch of Track Edge Sections) on the track network. A Movement Permission includes all conditions under which the movement of the Movable Object can be performed safely. A Movement Permission always refers to exactly one Movable Object.

Examples of Movement Permission:



⌘ Movement Permission Extent

The Movement Permission Extent (MP Extent) is a Linear Contiguous Track Area in a defined direction. It describes the topological extent of the running path of the Movement Permission.

⌘ Non Trackbound Movable Object

Non Trackbound Movable Objects are identified, localised Movable Objects like Construction Equipment or Trackside Person, whose movement is not constrained along the paths defined in the railway network Topology domain.

⌘ Permitted Movement Mode

The Permitted Movement Mode describes the Movement Modes allowed for a certain Track Area on the topology to be used by the Automatic Train Protection (ATP) system. The set of Permitted Movement Mode implies the split of responsibility between Safety Actors, e. g. the on-board ATP system and the train driver itself.

⌘ Resolved Trackbound Movable Object

A Resolved Trackbound Movable Object is a Trackbound Movable Object which is identified, i.e. there is a 1:1 mapping between the virtual object in the model and "a vehicle in the real world".

A Resolved Trackbound Movable Object also represents an object which is known to Advance Protection System (identified), but its position is unknown or invalid.

⌘ Risk Buffer

The Risk Buffer connects gap-free to the End of a Movement Permission (EoP) and describes the extent on the Topology that could potentially be occupied by the Resolved Trackbound Movable Object, if the risk mitigation achieved by the Automatic Train Protection is insufficient to keep the Resolved Trackbound Movable Object within its Movement Permission Extent.
The Risk Buffer is part of a Movement Permission.

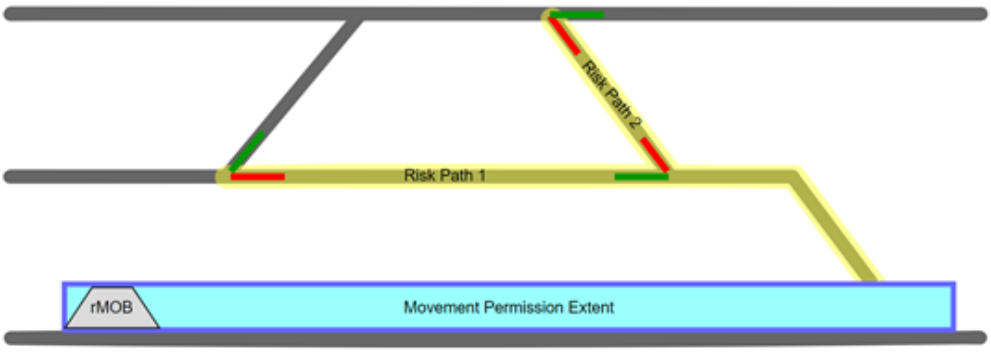
⌘ Risk Buffer Extent

The Risk Buffer Extent describes the extent of a navigable gap-free and overlap-free Track Area of the Risk Buffer on the Topology in a defined direction.

- None -

⌘ Risk Path

The Risk Path is one potential path by which a non-permitted vehicle movement could result in a flank collision with a vehicle moving along a Movement Permission Extent.
The Risk Path starts at each Allocation Area overlapping the Movement Permission Extent and the Risk Buffer (if not opted out by other configuration) - and ends at securing elements.
Those elements may be for instance buffer stops, the end of a controlled vehicle or a Drive Protection Section Group that can interrupt the flangeway of a Trackbound Movable Object.
The Risk Path is defined as a Linear Contiguous Track Area and its direction.
Each Risk Path is part of a Movement Permission.



rMOB = Resolved Trackbound Movable Object

⌘ Trackbound Movable Object

A Movable Object whose movement is strictly bound to the paths defined by the railway network Topology domain (that is, a Movable Object that is guided by the rails).
Trackbound Movable Objects are distinguished between Unresolved Trackbound Movable Objects and Resolved Trackbound Movable Objects.

- None -

⌘ Unresolved Trackbound Movable Object

Represents a Trackbound Movable Object which is not (yet) identified, i.e. there is no 1:1 mapping between the virtual object in the model and "a vehicle in the real world".

In case of using a Train Detection System (a role of TA) this occurs when a track section is occupied, but there are no train position reports available for Subsystem OA to resolve into a Resolved Trackbound Movable Object. An Unresolved Trackbound Movable Object may in reality represent zero up to several separate unregistered vehicles in the same physical block.

In areas without a Train Detection System installed, this can occur as a consequence of degraded situations. APS defines then an occupation extent by performing an internal calculation.

Notes:

- ⌘ A track section can also be occupied in case there is no vehicle located, but a disturbance of Train Detection System is given.
- ⌘ Strictly speaking, an Unresolved Trackbound Movable Object therefore only exists in case of missing knowledge that cannot be resolved by APS itself.

⌘ Usage Restriction Area

An Usage Restriction Area (URA) limits or constrains movements on an area described by an overlapping free but not necessarily connected set of Track Edge Sections.
Usage Restriction Areas can be created according to an Operational Plan (e.g. for enabling construction works) or in response to an Incident (e.g. as a mitigation measure).
Various limitations are possible for Usage Restriction Areas e.g. speed reduction or full track closure.
Under certain conditions, a Movement Permission may overlap a Usage Restriction Area (e.g. construction vehicle must enter a construction site). Usage Restriction Areas can overlap, for example when multiple construction sites overlap or specific limitations apply to the same location.

⌘ Allocation Section

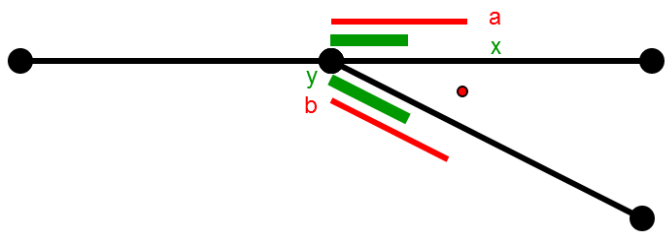
An Allocation Section (AS) is defined as a directed Linear Contiguous Track Area of 1...n Track Edge Sections and 1..n exclusive dependencies as additional information.
The direction always leads away from the dependent Allocation Section (from conflict area to non-conflict area of clearance gauge).

Allocation sections are located in Track Areas where one or more clearance gauge conflicts between different tracks arise.
The conflict arises when the clearance gauges of different tracks overlap each other.
Out of this conflict an exclusive, symmetric interdependency between two or more Allocation Sections has to be deduced.
Exclusive dependency means that if one allocation section is fully or partially occupied by a Movable Object or if it is fully or partially contained in a granted Movement Permission Extent, no Movement Permission may be granted over any dependent Allocation Section.
Allocation Sections may overlap each other. In this case there must not be an exclusive dependency between the overlapping Allocation Section.

A non-complete list of usages is: points, diamond crossings, single and double slips, turnouts and gauntlet tracks.
All use cases and the according modelling principles can be affiliated to three basic assets: a diverging of Track Edges in a Track Node (point), a crossing of Track Edges (diamond crossing) and an interlacing track edges or there clearance profile (gauntlet).

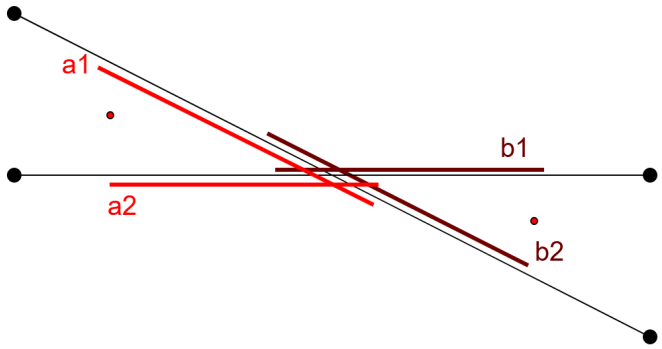
Note: In the following figures, red and brown denotes an Allocation Section and green denotes a Drive Protection Section.

Example of a point
exclusive dependency: a <=> b



Example of a diamond crossing
exclusive dependencies: a1 <=> a2, b1 <=> b2

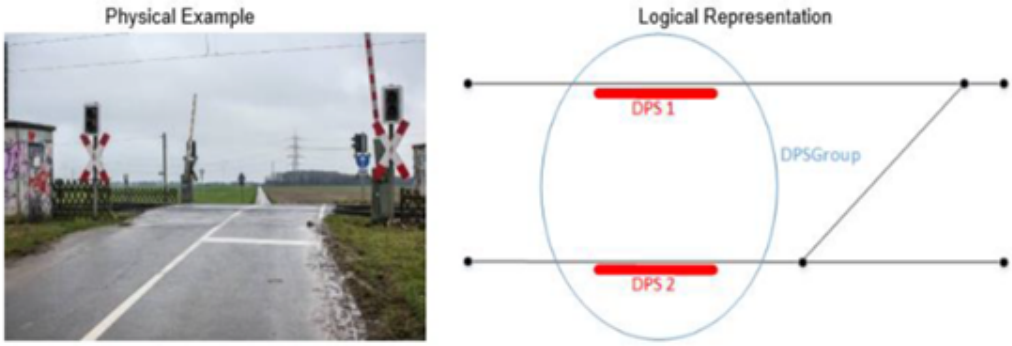
- None -



⌘ Drive Protection Section Group

A Drive Protection Section Group groups Drive Protection Sections that have interdependencies.

Example of level crossing where a Drive Protection Section Group is used:



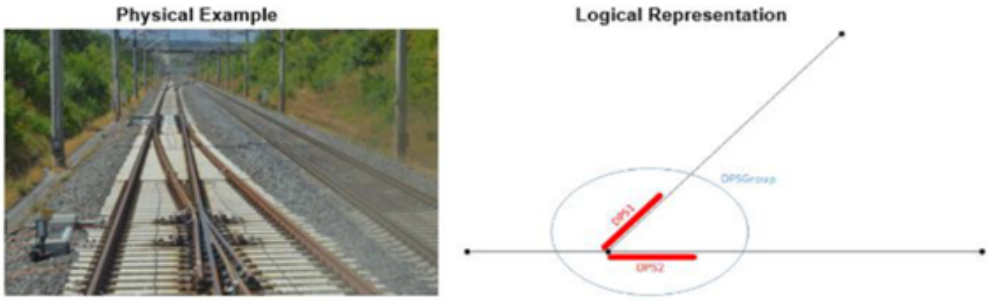
⌘ Drive Protection Section

A Drive Protection Section (DPS) is defined through an extent on the track. It logically represents a part of a trackside asset that changes driveability. A Drive Protection Section comprises one or several Track Edge Sections where, for Physical Train Units to pass safely, a controllable infrastructure element has to be set to and secured in a specific position.

Note that the Drive Protection Section does not represent the controllable element itself but rather a single track that is passing through the element. Therefore one controllable element may affect several Drive Protection Sections. A simple turnout has two Drive Protection Sections for the two branching tracks and a level crossing has as many Drive Protection Section as tracks are passing through the level crossing. Common controllable infrastructure elements that require Drive Protection Sections are (non-complete list): Points, Level Crossings, derailers, movable bridges, gates, turntables.

Drive Protection Sections of the same physical elements have typically interdependencies - e.g. the two Drive Protection Sections of a simple point can not both be drivable at the same time. This interdependency is modelled in the domain object Drive Protection Section Group.

Example of using Drive Protection Section for a point:



⌘ Movable Object Extent

The Movable Object Extent (MOB Extent) represents the safe extent of the corresponding object in the Topology. It consists of the navigable gap-free and overlap-free path between two Track Edge Points. For determination of the MOB Extent, different sources of information are used. For Resolved Trackbound Movable Object it results for example from a combination of Train Detection System information with reported front and rear end position as well as the path in between under consideration of inaccuracy of the localisation technology.

5.2 Incident

The Incident domain provides concepts for the management of incident events in System RCA.
ToDo: This domain is currently incomplete and will be enhanced in a future release.

- None -

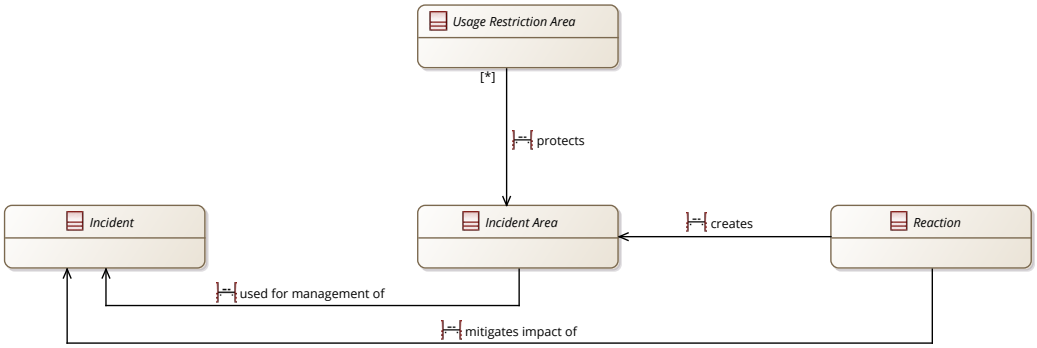


Figure 7: [O.CDB][AMOD-025] Incident domain [Abstract concepts]

5.2.1 Description of Incident

⌘ Incident

An event that has an impact concerning safety, security or performance of the railway.

⌘ Incident Area

A specific area around an Incident to prevent or mitigate the potential impact of the Incident. An Incident Area is not limited to space near the track. For example, an Incident Area can be defined on a station platform or concourse, completely independently of the track.

⌘ Reaction

A Reaction is defined as the triggering or execution of a measure to prevent or mitigate the impact of an Incident.

5.3 Localisation

The Localisation domain provides concepts needed by System RCA to represent localisation information. ToDo: This domain is currently incomplete and will be enhanced in a future release.

5.3.1 Description of Localisation

⌘ Max Safe Front End (maxSFE)

The Maximum Safe Front End position differs from the estimated position by the under-reading error of the localisation system.

⌘ Min Safe Front End (minSFE)

The Minimum Safe Front End position differs from the estimated position by the over-reading error of the localisation system.

⌘ Max Safe Rear End (maxSRE)

The Maximum Safe Rear End position differs from the estimated position by the under-reading error of the localisation system.

⌘ Min Safe Rear End (minSRE)

The Minimum Safe Rear End position differs from the estimated position by the over-reading error of the localisation system.

- None -

5.4 Maintenance and Monitoring

The Maintenance and Monitoring domain provides the concepts needed for the maintaining and monitoring systems of RCA. ToDo: This domain is currently incomplete and will be enhanced in a future release.

5.5 Object Realisation

The Object Realisation domain realises the abstract concepts of System RCA and represents real world objects (like Actors) as well as their properties and state.

This includes for example:

The representation of certain Field Elements as Drive Protection Sections
The representation of e.g. Physical Train Unit, Authorised Trackside Person as Movable Objects
The realisation of Movement Permissions as Movement Authorities

5.5.1 Description of Object Realisation

- Journey Profile

  The Journey Profile contains the set of dynamic infrastructure data and operational data required by the Subsystem AV (called ATO-OB in the ETCS specification Subset-126) in order to drive the train. The operational data contains the list of Timing Points to be traversed by the train along its journey. This list is defined in real time on the basis of the scheduled timetable and on-line traffic regulation. The Journey Profile may be updated during the journey.
  Source: ATO over ETCS Glossary, EUG Reference: 13E154, V1.6

- Movement Authority

  Permission for a train unit to run to a specific location within the constraints of the infrastructure and supervision of speed.

5.6 Operational Plan

The Operational Plan domain provides concepts for Operational Movements, Operational Warning Measures and Operational Restrictions, as well as for reporting the Operating State and the Operational Plan Execution progress.

- None -

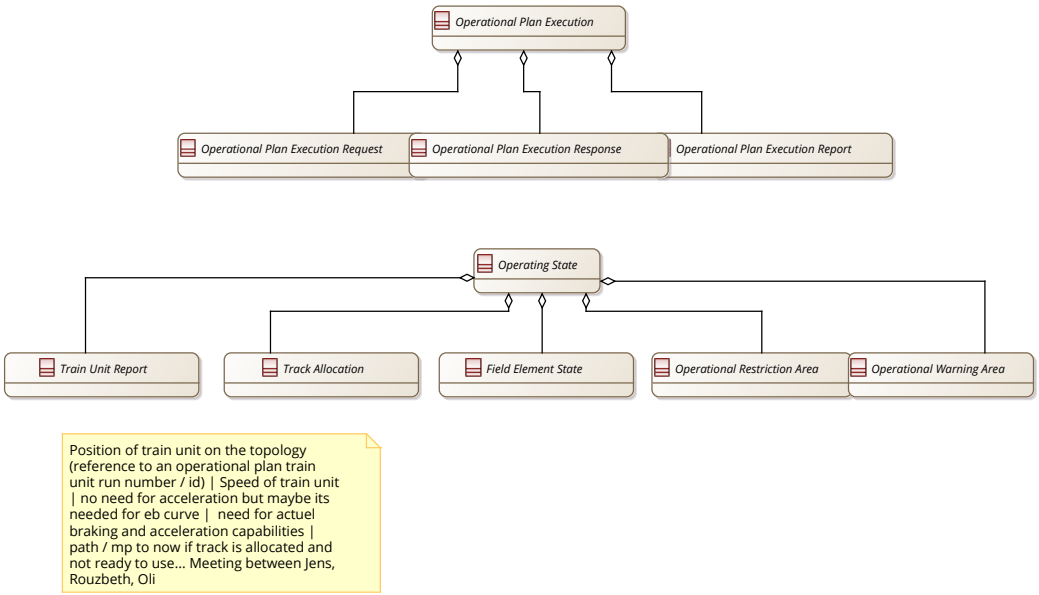


Figure 8: [O.CDB][AMOD-025] Operating State and Operational Plan Execution [Abstract concepts]

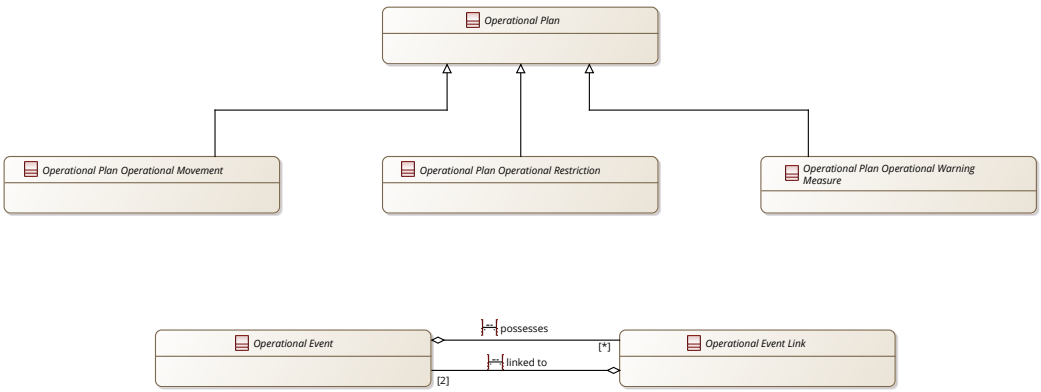


Figure 9: [O.CDB][AMOD-025] Operational plan domain [Abstract concepts]

- None -

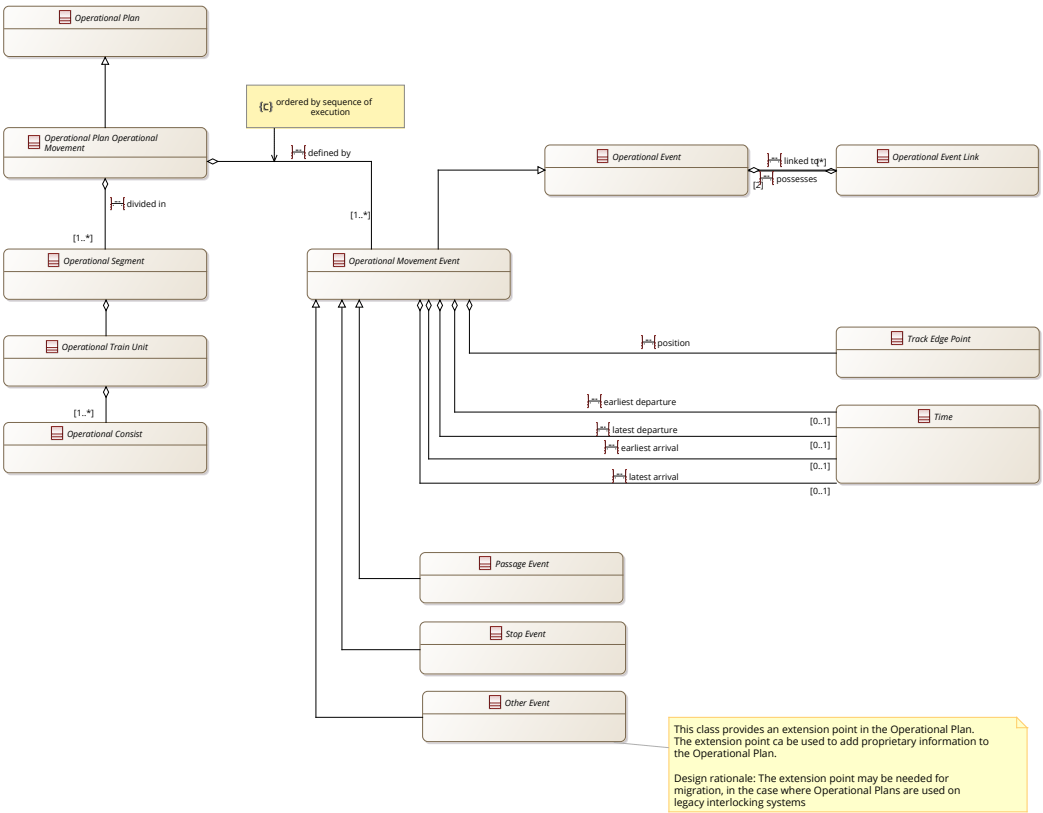


Figure 10: [O.CDB][AMOD-025] Operational plan for operational movements [Abstract concepts]

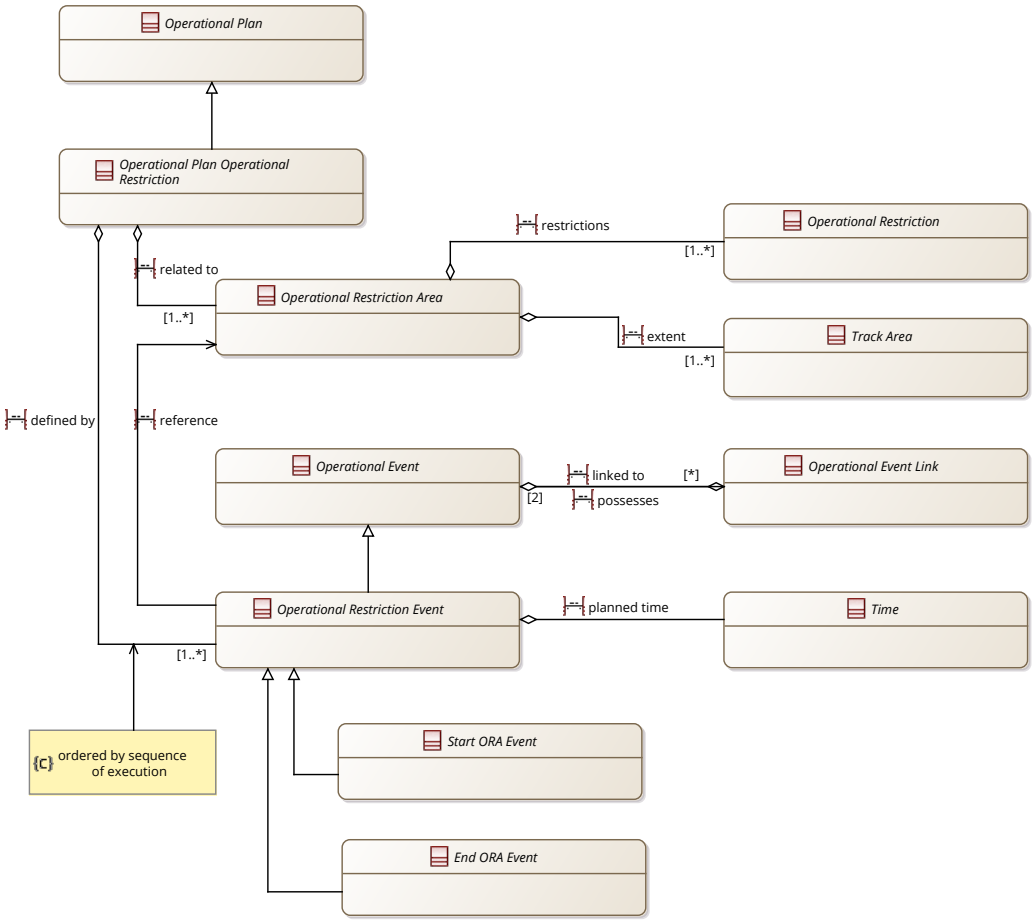


Figure 11: [O.CDB][AMOD-025] Operational plan for operational restrictions [Abstract concepts]

- None -

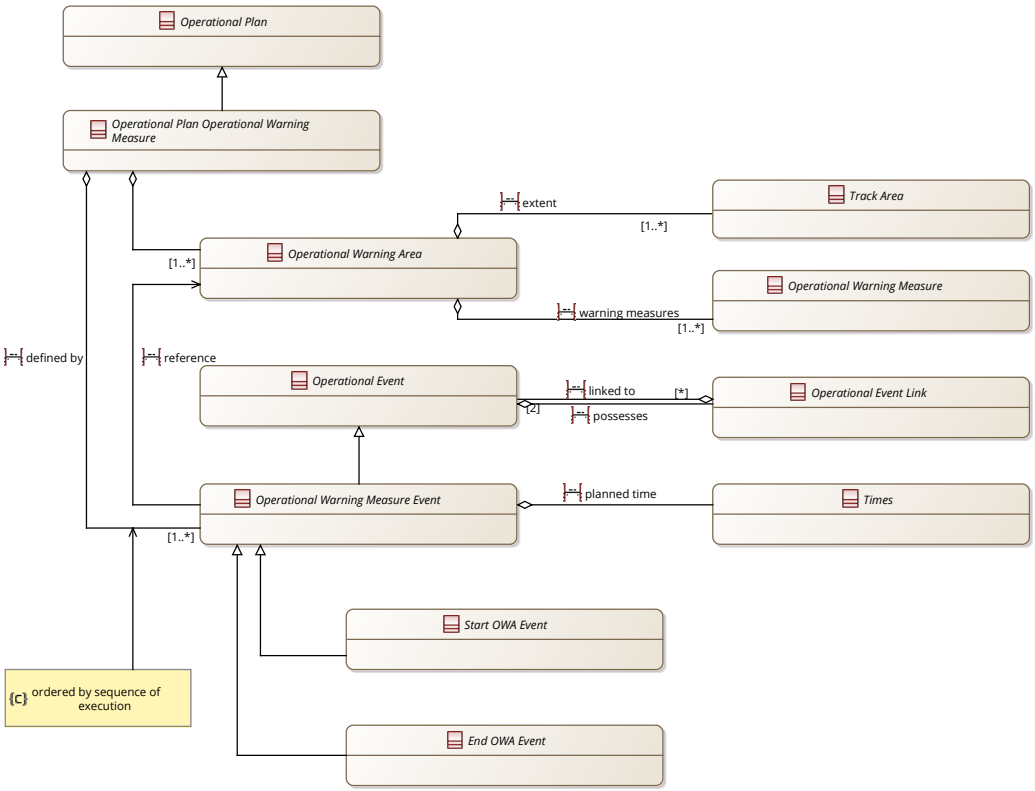


Figure 12: [O.CDB][AMOD-025] Operational plan for operationals warnings [Abstract concepts]

- None -

5.6.1 Description of Operational Plan

⌘ End ORA Event

The End ORA Event describes the planned time at which an Operational Restriction Area and all its containing Operational Restrictions shall become inactive.

⌘ End OWA Event

The End OWA Event describes the planned temporal end of an Operational Warning Area.

⌘ Execution Failure

An Execution Failure describes that at least one step for the execution of an Operational Event cannot be successfully implemented by the executing RCA Subsystem. The Execution Failure, detected by Subsystem Plan Execution PE or Subsystem ATO Execution AE during the execution of an Operational Event, cannot be resolved by the corresponding Subsystem and is therefore reported as an Operational Plan Execution Report via SCI-OP to the Planning System.

⌘ Execution Warning

An Execution Warning describes that at least one step for the execution of an Operational Event cannot be implemented as planned by the executing RCA SubSys. The Execution Warning, detected by Subsystem Plan Execution PE or Subsystem ATO Execution AE during the execution of an Operational Event, can be neglected by the corresponding SubSys but is reported as an Operational Plan Execution Report via SCI-OP to the Planning System.

⌘ Field Element State

The Field Element State describes the state of any Field Element in the Area of Control.

⌘ Operating State

The Operating State is the logical representation of the actual state of railway operations in the Area of Control. This includes for example the settings and states of Field Elements or the position of Physical Train Units.

⌘ Operational Consist

The Operational Consist describes a sequence of the Physical Vehicles and the operating parameters of the Physical Consist planned to be operated.

⌘ Operational Event

An Operational Event is a description of a single planned action (e.g. stop/passage of a Physical Train Unit, start/end of an Operational Restriction Area, start/end of an Operational Warning Area) defined in the Operational Plan.

⌘ Operational Event Link

An Operational Plan Event Link is a dependency on place and/or time between two Operational Events of the same or of two different Operational Plans.

- None -

⌘ Operational Movement

An Operational Movement is a planned or already implemented train run, which runs a defined train, at defined times, along a defined track path within the Area of Control.

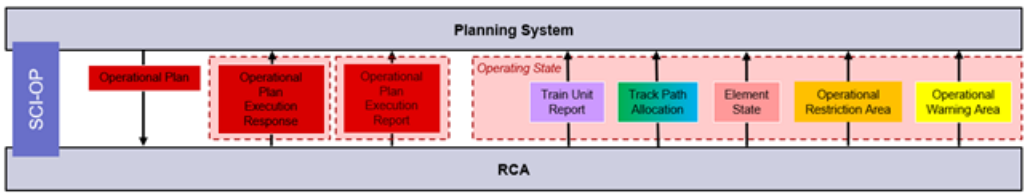
⌘ Operational Movement Event

Operational Movement Events are Operational Events specified in the Operational Plan Operational Movement. They describe an ordered sequence of actions to take place at a certain position on the Track Path at a certain time.

⌘ Operational Plan

The Operational Plan is the result of the planning process performed by the Planning System. It describes a planned Operational Movement, Operational Restriction or Operational Warning Measure on a specified area through a temporal sequence of Operational Events to be implemented by Subsystem ATO Execution (AE) and/or Subsystem Plan Execution (PE) in the Area of Control.

The following figure illustrates the downstream message (Operational Plan) and the upstream messages (in the bright red boxes):



⌘ Operational Plan Event Reference

An Operational Plan Event Reference is a marker on one Operational Movement Event of an Operational Plan Operational Movement. It serves as a reference between two subsequent versions of the same Operational Plan Operational Movement to assure gap-free and unambiguous transition to the new version of an Operational Plan Operational Movement.

⌘ Operational Plan Execution

The Operational Plan Execution is the logical representation of all messages concerning the execution of Operational Plans in the Area of Control. This includes the Operational Plan Execution Request, the Operational Plan Execution Response, the Operational Plan Execution Report and the Operational Plan Execution Forecast.

⌘ Operational Plan Execution Forecast

The Operational Plan Execution Forecast describes the execution forecast of the Operational Plan. It is provided by Subsystem ATO Execution AE via SCI-OP.

⌘ Operational Plan Execution Report

The Operational Plan Execution Report describes the execution progress of the Operational Plan. It is provided by SubSys ATO Execution and SubSys Plan Execution via SCI-OP.

- None -

⌘ Operational Plan Execution Request

The Operational Plan Execution Request is the request to implement an Operational Plan. It is sent by the Planning System to Subsystem ATO Execution AE and Subsystem Plan Execution PE via SCI-OP.

⌘ Operational Plan Execution Response

The Operational Plan Execution Response is the response (acceptance or rejection) to an Operational Plan Execution Request. It is provided by Subsystem ATO Execution (AE) and Subsystem Plan Execution (PE) via SCI-OP.

⌘ Operational Plan Operational Movement

The Operational Plan Operational Movement defines the parameters for the implementation of an Operational Movement.

⌘ Operational Plan Operational Restriction

The Operational Plan Operational Restrictions defines the parameters for the implementation of Operational Restriction Area(s) and the Operational Restriction(s) therein.

⌘ Operational Plan Operational Warning Measure

The Operational Plan Operational Warning Measure defines the parameters for the implementation of Operational Warning Area(s) and the Operational Warning Measure(s) therein.

⌘ Operational Plan Reference

Unique reference to an Operational Plan. Used to refer to the corresponding Operational Plan in upstream messages of the interface SCI-OP.

⌘ Operational Restriction

An Operational Restriction is a usage limitation on the railway network.

⌘ Operational Restriction Area

The Operational Restriction Area is an entity of the Operational Plan Operational Restriction and the Operating State. It describes the spatial dimensions of a planned or already implemented Operational Plan Operational Restriction within the Area of Control.

⌘ Operational Restriction Event

Operational Restriction Events are Operational Events specified in the Operational Plan Operational Restriction.

⌘ Operational Segment

The Operational Segment divides an Operational Movement into several parts in order to represent different train compositions within the Operational Movement.

- None -

⌘ Operational Train Unit

The Operational Train Unit describes a sequence of Physical Consists and the operating parameters of the Physical Train Unit planned to be operated.

⌘ Operational Warning Area

The Operational Warning Area is an entity of the Operational Plan Operational Warning Measure and the Operating State. It describes the spatial dimensions of a planned or already implemented Operational Plan Operational Warning Measure within the Area of Control.

⌘ Operational Warning Measure

An Operational Warning Measure is a measure to warn people about dangers on the railway network.

⌘ Operational Warning Measure Event

Operational Warning Measure Events are Operational Events specified in the Operational Plan Operational Warning Measure.

⌘ Other Event

Other Event provides an extension point in the Operational Plan Operational Movement. The extension point can be used to add proprietary information to the Operational Plan.

⌘ Passage Event

The Passage Event describes the planned passage of a Physical Train Unit. The Passage Event shall specify at least the position on the track and the time range (upper and lower bound) for the planned passage.

⌘ Start ORA Event

The Start ORA Event describes the planned time at which an Operational Restriction Area and all its containing Operational Restrictions shall become active.

⌘ Start OWA Event

The Start OWA Event describes the planned temporal start of an Operational Warning Area.

⌘ Stop Event

The Stop Event describes the planned stop of a Physical Train Unit as well as all relevant planned actions to be carried out at a planned stop of a Physical Train Unit.

⌘ Time

This Element contains one timing information of an Operational Event.

⌘ Track Allocation

The Track Allocation describes the assignment of an extent on the railway network to either a Movement Permission or an Unresolved Trackbound Movable Object.

- None -

⌘ Track Path

The Track Path is a gap-free and track-specific route on the railway network. It is used for describing the path of Operational Movements in the Operational Plan Operational Movement.

⌘ Train Unit Report

The Train Unit Report is an entity of the Operating State. It describes the position, properties, and state of any identified Physical Train Unit in the Area of Control.

5.7 Other Draft

This concepts will be later on allocated to a domain. At the moment it is incomplete and will be enhanced in a future release.

- None -

5.7.1 Description of Other Draft

⌘ Engineering Data

Engineering Data is a set of resulting data from the Engineering Process of Infrastructure Manager. Typically, the data are not adapted to cope with specific views demanded by each consumer. The Engineering Data contains all the base data (i.e. track topology and topography) for deriving the Map Data during the compile process. Besides providing base data for Map Data generation, the Engineering Data should also cover the needs for configuration of systems (e.g. parameter data). The Engineering Data must fulfil engineering rules, that are influenced by requirements of Map Data.

Engineering Data contains only the updated resulting data (i.e. no several variants/ versions of the same track) that is needed for the next provisioning and operation at a certain point of time in the consuming systems.

⌘ Area of Control

A Track Area where train operations are under the control of one entity and where functionality is provided by one physical system (e.g. an instance of System RCA). The highest level of Area of Control has a boundary which is a CCS System Border with its neighbours.

Areas of Control (AoC) can be subdivided operationally (for example in a large operations centre where each individual operator has responsibility for a separate Area of Control within the overall Area of Control supervised by that centre).

The boundaries of subdivided Areas of Control can change dynamically, for example a single RCA operation manager might control a large region overnight when there is low traffic, while in the day the same region might be split into two or more Areas of Control, each controlled by an individual RCA operation manager.

Please notice: An AoC might cover 1..n APS AoC.

⌘ Advanced Protection System Area of Control

The Advanced Protection System Area of Control (APS AoC) is the topologically limited extent of the Advanced Protection System with its technical components covering the specific infrastructural track assets in this area. The term is used here for defining the technical and operational responsibility of one Advanced Protection System (APS).

Please note: 1..n APS AoC might be mapped to 1 AoC.

⌘ Onboard Train Detection

Onboard Train Detection (OTD) is the abstract term for detection of rolling stock on a track. The detection technology is placed onboard.

⌘ Onboard Train Detection Area

Contiguous Track Area where OTD is used. A TDS is either not present at all or non-contiguous (for support of OTD) only.

→ Non-OTD equipped rolling stock cannot be detected in all tracks and will usually not be admitted to an OTD area.

⌘ Trackside Train Detection Area

Contiguous Track Area where a Subsystem Train Detection System is contiguously present and used.

→ Non-OTD equipped as well as OTD equipped rolling stock can be detected in all tracks and therefore will be admitted to a Trackside Train Detection area.

5.8 Rolling Stock

The Rolling Stock domain provides concepts needed by System RCA for the representation of rolling stock. ToDo: This domain is currently incomplete and will be enhanced in a future release.

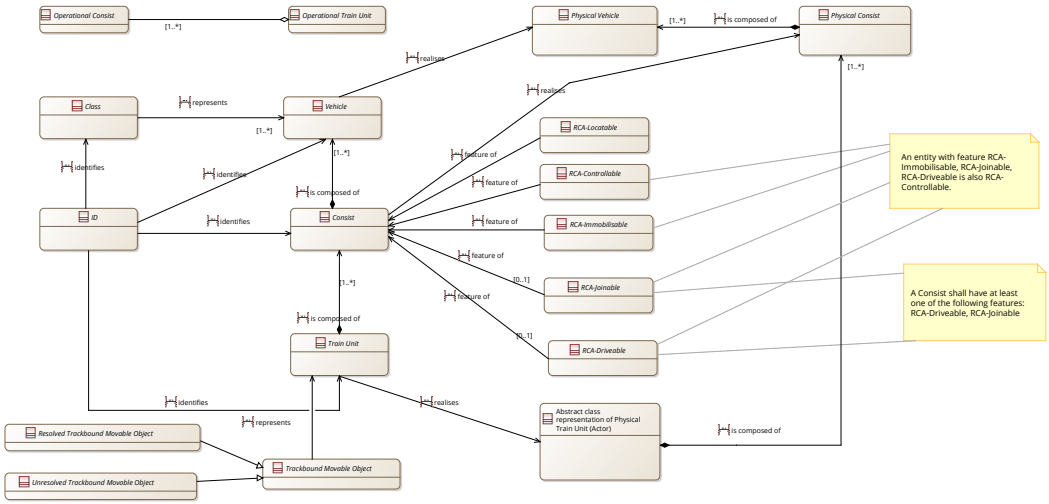


Figure 13: [O.CDB][AMOD-025] Rolling Stock relationships [Abstract concepts]

- None -

5.8.1 Description of Rolling Stock

⌘ Abstract class representation of Physical Train Unit (Actor)
None

⌘ Class

A group of rolling-stock entities built to a common design sharing the same technical and operational properties. A Class is identified by a Class ID.

⌘ Consist

A Consist is an abstract object representing a Physical Consist. A Consist is an independent item of rolling stock, comprising one or more mechanically connected Vehicles.

A Consist shall always have all of the following features:
- ⌘ RCA-Controllable
- ⌘ RCA-Immobiliseable
- ⌘ RCA-Locatable

A Consist shall have at least one of the following features:
- ⌘ RCA-Driveable
- ⌘ RCA-Joinable

⌘ ID

Any unique identifier for a given entity, depending on the usage context. ID can for instance be applied to:
- ⌘ ID of a Class - uniquely defining a Vehicle or Consist Class
- ⌘ ID of a Vehicle - uniquely defining a single Vehicle
- ⌘ ID of a Consist - uniquely defining a specific Consist
- ⌘ ID of a Train Run - uniquely defining a specific Train Run
- ⌘ ID of a Train Unit - uniquely defining a specific Train Unit
- ⌘ ID of a Track Edge - uniquely defining a specific Track Edge
- ⌘ ID of a Track Edge Section - uniquely defining a specific Track Edge Section

⌘ Physical Consist

Physical Consist is a physically existent, independent item of rolling-stock, comprising one or more mechanically connected Physical Vehicles, whose composition cannot be changed within System RCA System Borders.

⌘ Physical Vehicle

Physical Vehicle is a physically existent, single item of rolling-stock entity of a given Vehicle Class, identified with its own ID.

⌘ RCA-Controllable

A feature of a rolling-stock entity defining that at least one functionality of the Consist can be directly controlled by System RCA.

⌘ RCA-Driveable

A feature of a rolling-stock entity with its own traction system that can be automatically driven by System RCA. An entity with this feature is also RCA-Controllable.

- None -

⌘ RCA-Immobilisable

A feature of a rolling-stock entity that can be automatically immobilised by System RCA to ensure no unintended movements. An entity with this feature is also RCA-Controllable.

⌘ RCA-Joinable

A feature of a Consist, which can be joined on at least one side with another compatible Consist by System RCA. An entity with this feature is also RCA-Controllable.

⌘ RCA-Locatable

A feature of a Consist that can be automatically localised in real time by System RCA as long as the Consist is located within System RCA System Borders.

⌘ Train Run

A planned movement of Train Unit from an origin to a destination. It is described by a continuous sequence of segments from origin to destination, without gaps and branches and is operated on each segment by exactly one Train Unit, with possibly different Train Units on individual segments. The Train Run is as a whole identified by a common identifier Train Running Number.

⌘ Train Running Number

A number which, within certain limits, defines the type of train, the traffic relationship and the direction of travel and enables the unambiguous identification of the moving unit.

⌘ Train Unit

A Train Unit is an abstract object representing a Physical Train Unit. A Train Unit is RCA-Driveable and made up of a single or an ordered sequence of Consists coupled together.

⌘ Vehicle

A single item of rolling-stock entity of a given Vehicle Class, identified with its own ID.

- None -

6 Rationales and assumptions

No rationales and assumptions have been defined.