EULYNX Initiative

EULYNX Domain Knowledge

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Contents

ID	Type	Domain knowledge
Eu.DK.1	Head	# 1 Introduction
Eu.DK.5	Head	## 1.1 Release information
Eu.DK.2	Info	[Eu.Doc.10] EULYNX Domain Knowledge CENELEC Phase: 1-5 Version: 1.18 (0.A) Approval date: 29.05.2024
Eu.DK.175	Info	**Version history**
Eu.DK.487	Info	version number: 1.14 (0.A) date: 16.05.2022 author: Nico Huurman review: CCB changes: EUGDK-150, EUGDK-154
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Eu.DK.572	Info	version number: 1.15 (1.A) date: 10.05.2023 author: Nico Huurman review: cluster changes: EUGDK-172, EUGDK-173
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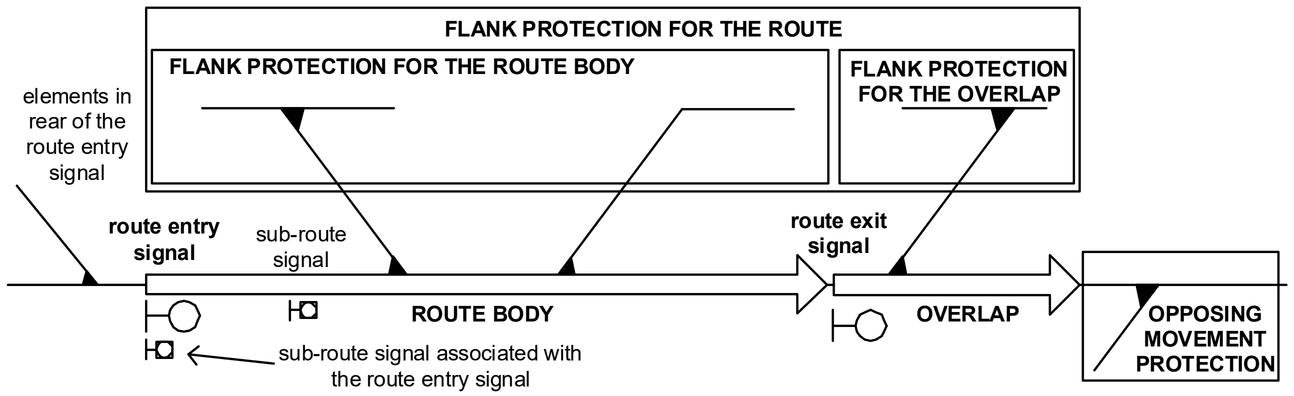
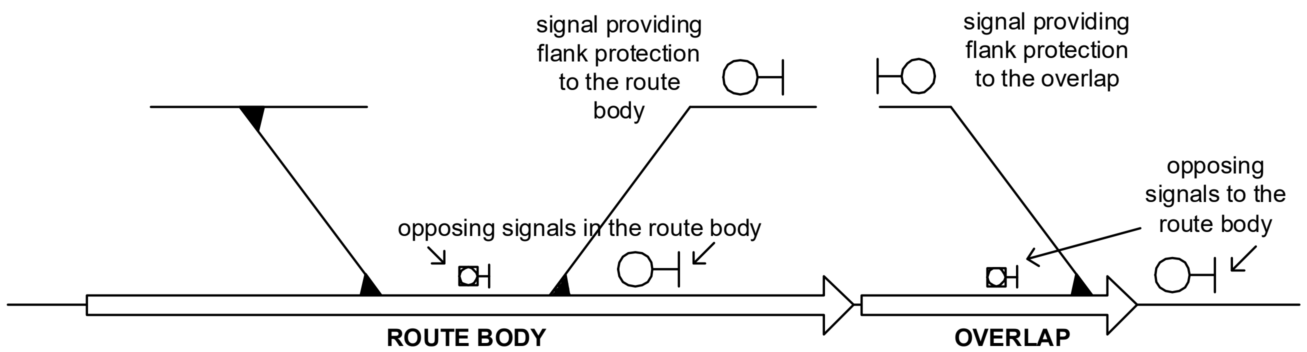
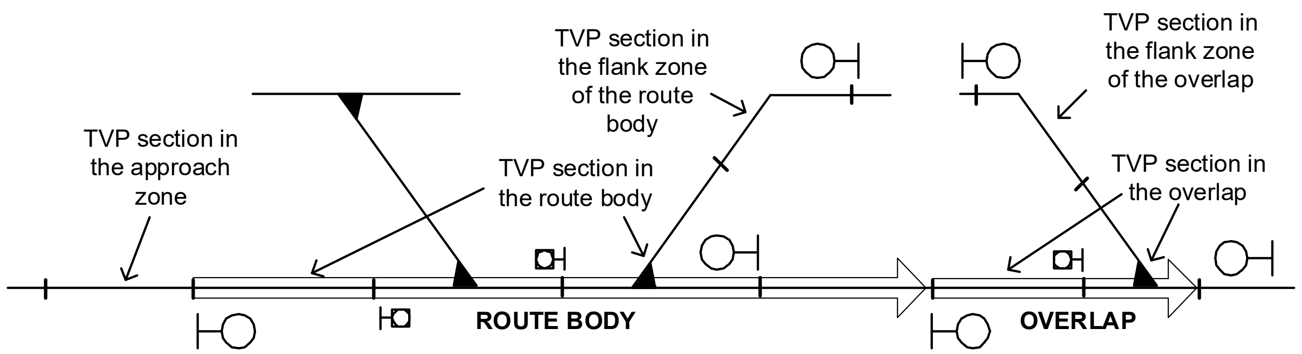
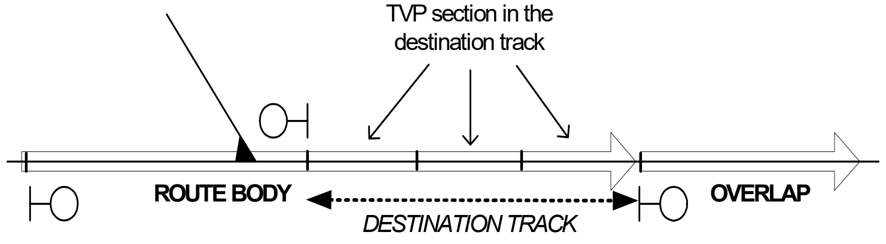
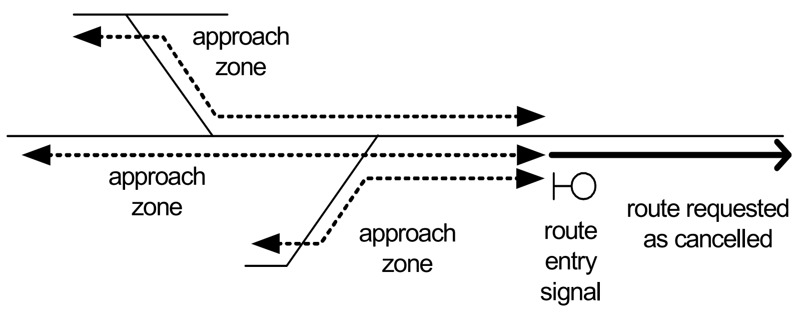
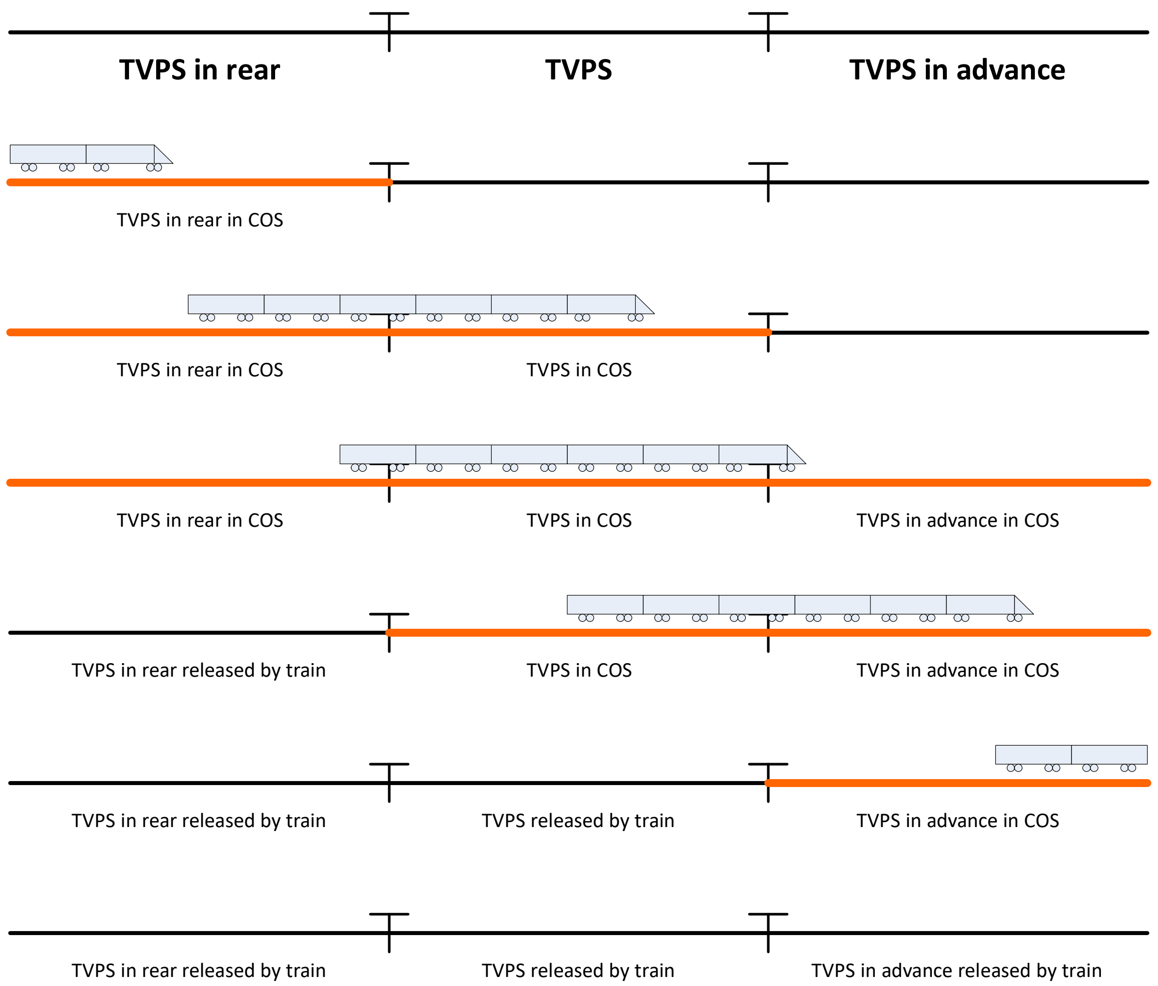
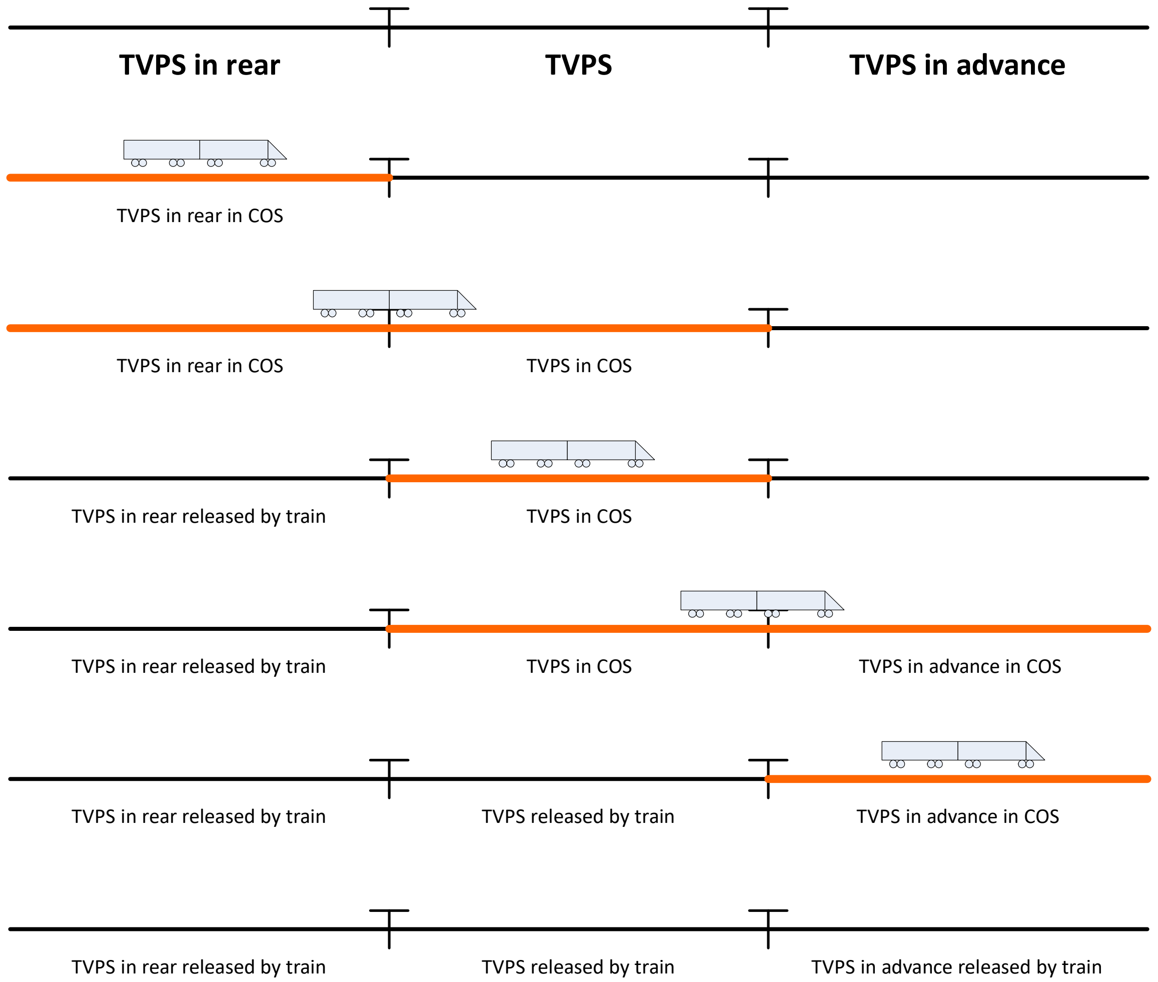
Eu.DK.645	Info	version number: 1.18 (0.A) date: 18.06.2024 author: Nico Huurman review: CCB changes: EUGDK-190, EUGDK-203, , EUGDK-207, EUGDK-208, EUGDK-211
Eu.DK.3	Head	## 1.2 Impressum
Eu.DK.4	Info	Publisher: **EULYNX Initiative** A full list of the **EULYNX Partners** can be found on https://eulynx.eu/.
Eu.DK.6	Info	Responsible for this document: EULYNX Project Management Office www.eulynx.eu

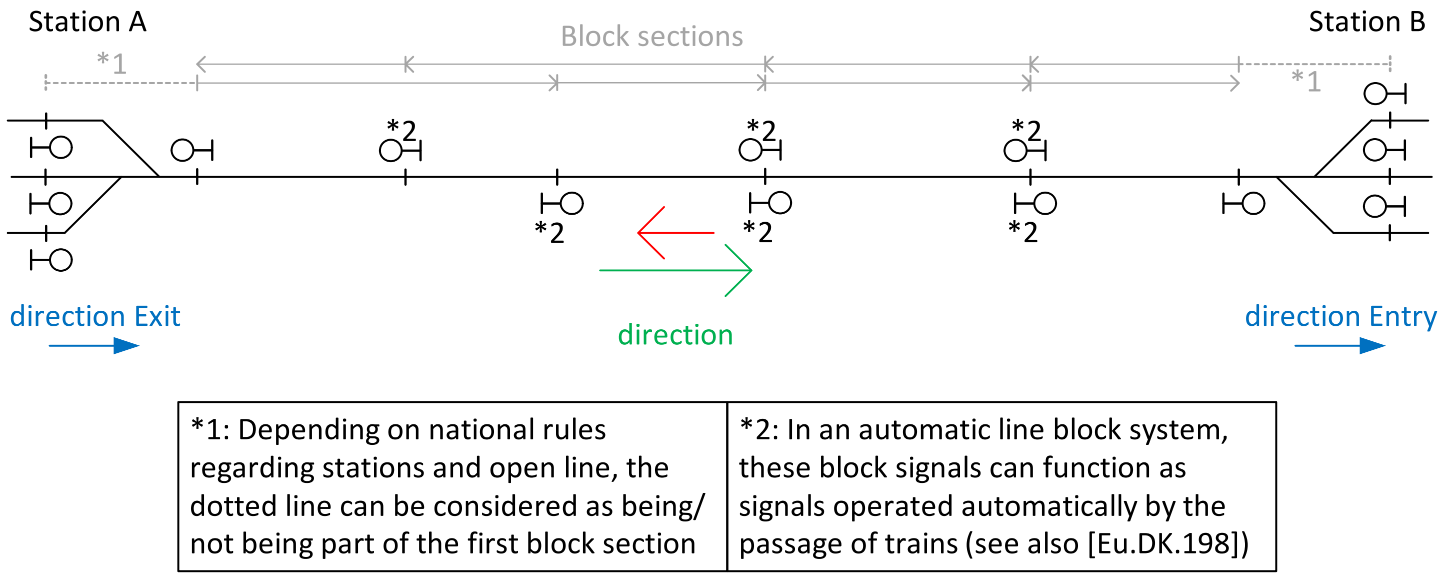
ID	Type	Domain knowledge
Eu.DK.177	Info	
Eu.DK.7	Head	**1.3 Purpose**
Eu.DK.8	Info	The purpose of this document is the provision of the domain knowledge relevant for textual and modelled specifications of the EULYNX system.
Eu.DK.10	Head	**2 Routes**
Eu.DK.190	Head	**2.1 General definitions**
Eu.DK.191	Info	'Locking' is the supervision in an interlocking system that prevents the movement of elements or their use in another route or area.
Eu.DK.192	Info	'Monitoring' is an interlocking system process ensuring that the conditions in a route for the display of a movement authority are continuously met.
Eu.DK.193	Info	'Releasing' is the process of unlocking elements from a route.
Eu.DK.194	Info	'Cancellation' is the revocation or annulment of a route or part of a route following a request from the signaller.
Eu.DK.195	Info	'Blocking' is the process of immobilising equipment or provision of protection against train movement into blocked elements or areas.
Eu.DK.11	Head	**2.2 Route Definition**
Eu.DK.12	Info	A route is a predetermined path for a traffic movement. It may consist of the following: • *the route body* • *flank protection for the route body* • *the overlap* • *flank protection for the overlap* • *the route elements in rear of the route entry signal*
Eu.DK.181	Info	Overlap is a defined section of track in advance of the route exit signal, which must be kept clear to avoid the risk of collision should a train inadvertently run past the signal.
Eu.DK.15	Info	The following diagram displays the terminology for the route and its possible elements.
Eu.DK.16	Info	

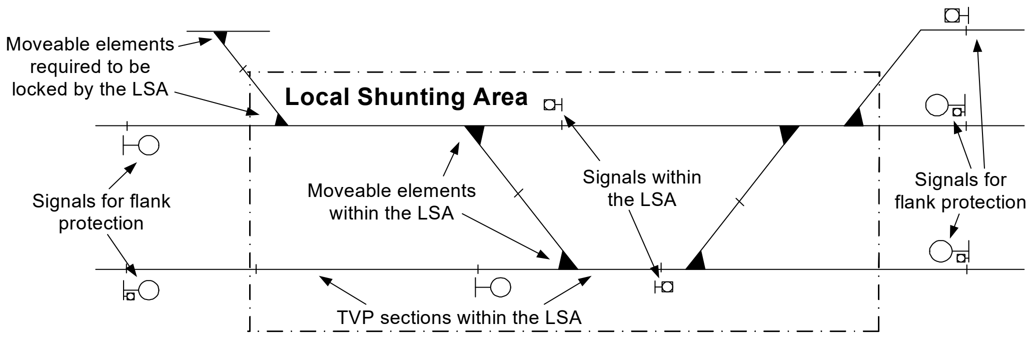
ID	Type	Domain knowledge
Eu.DK.17	Info	The elements that are considered as part of the route are: • *route entry signal* • *route exit signal* • *sub-route signal (can be a main or a shunting signal)* • *TVP sections in the route body* • *TVP sections in the overlap* • *moveable elements in the route body* • *moveable elements in the overlap* • *moveable elements for flank protection* • *moveable elements in rear of the route entry signal, such as middle points* • *TVP sections in rear of the route entry signal* • *lockable devices*
Eu.DK.18	Info	The elements that are not considered as part of the route, but are driven and/or supervised by the route, are: • *signals providing flank protection to the route body* • *signals providing flank protection to the overlap* • *opposing signals in the route body* • *opposing signals to the route body* • *TVP sections in the flank zone of the route body* • *TVP sections in the flank zone of the overlap* • *detection devices* • *level crossings* • *line blocks*
Eu.DK.19	Info	Virtual route exit signals may be any of the following: • *dark territory* • *end of track* • *open line* • *stop sign*
Eu.DK.20	Info	The following diagram displays the monitored signals that are not part of the route.
Eu.DK.21	Info	
Eu.DK.22	Info	The following diagram displays the use of TVP sections by a route.
Eu.DK.23	Info	

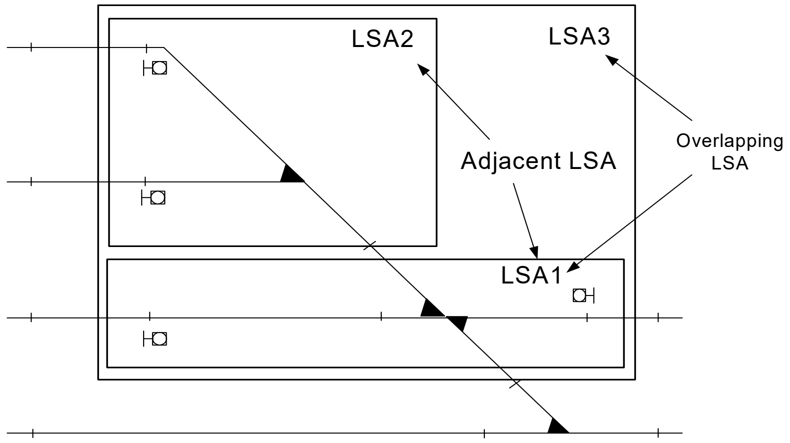
ID	Type	Domain knowledge
Eu.DK.24	Info	The following diagram displays the use of the destination track and its TVP sections.
Eu.DK.25	Info	
Eu.DK.26	Info	The destination track may also contain a middle point. A middle point is a point locked by a route, although located in rear of the route body.
Eu.DK.27	Info	The destination track may be a dead-end track.
Eu.DK.28	Head	**2.3 Route Life Cycle**
Eu.DK.182	Info	Route setting is the interlocking system process of allocating, positioning and locking moveable track elements into a route.
Eu.DK.29	Info	A route is considered as: • *'requested' if a request for a route is received by the interlocking system* • *'rejected' in a situation when the conditions for setting a route are not fulfilled and the route is not set* • *'prepared' if the route has been requested, but not all objects of the route are available at the time of the request (route preparation ensures operational optimisation by reduction of switching time of route elements)* • *'initiated' if the route request was accepted, until the moment the route becomes locked* • *'locked' if all the route elements required to be locked are locked*
Eu.DK.30	Info	An element is considered as: • *'used' if the element is part of a route that is 'initiated' or 'locked'* • *'locked' if a route requires the element to be locked and the element is locked*
Eu.DK.31	Info	An element is considered as a 'route element' only while it is 'used' by a route. For example, a signal is a route entry signal only if a route exists that uses that signal as a route entry.
Eu.DK.32	Info	An individual route is intended to be traversed by one train only.
Eu.DK.33	Info	The use and locking of a route element is particular to an individual route. If the same route is set again, the route element is used and locked in the new route.
Eu.DK.461	Info	If no contradicting conditions are present, an element can be used and locked in more than one route. For example a point can be in the route body of one route and act as flank protection for another route, if both routes require the point to be locked in the same position.
Eu.DK.34	Info	A route element that is used and locked in multiple routes shall have the locking applied independently by the different individual routes.
Eu.DK.183	Info	A 'residual route' remains if part of a route is not released after the passage of a train (e.g. incorrect train operated route release, stopped train, turnback movement).
Eu.DK.35	Head	**2.4 Approach Zone Definition**
Eu.DK.36	Info	The approach zone is used to detect a vehicle on a valid approach towards the route entry signal. It provides the conditions governing a delayed or immediate route release after a cancellation request.
Eu.DK.37	Info	The following diagram displays the use of multiple approach zones for a route.
Eu.DK.38	Info	
Eu.DK.39	Head	**2.5 Route Release**

ID	Type	Domain knowledge
Eu.DK.40	Info	The following diagrams display the elements used to determine the correct 'occupancy sequence' for train operated route release.
Eu.DK.372	Info	**Correct occupancy sequence (COS) - variant 1** 

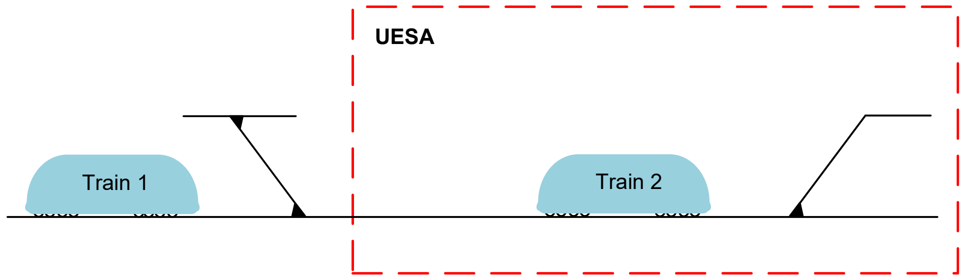
ID	Type	Domain knowledge
Eu.DK.373	Info	**Correct occupancy sequence (COS) - variant 2** 
Eu.DK.432	Info	For specific train types (e.g. a special transport which does not duly occupy the track sections), the train operated route release may be inhibited. This function can be used as a mitigating measure against a premature release of a train route which can cause a too early locking of a new conflicting train route.
Eu.DK.196	Head	**3 Line block**
Eu.DK.197	Info	A line block is a section of the railway between two stations controlled by a line block system.
Eu.DK.198	Info	In an automatic line block system, certain fixed signals for block sections are operated automatically by the passage of trains, depending on the state of the line block track.
Eu.DK.207	Info	In a route based line block system, the fixed signals for the block sections are operated by an interlocking, based on route setting. Route setting can be performed automatically, manually or by an automatic route setting system (ARS).
Eu.DK.199	Info	A block section is a section of track between two successive block signals, which ensure the protection of trains in the section.
Eu.DK.208	Info	If the railway section controlled by a line block system consists of more than one track, the line block of each track functions independently.
Eu.DK.209	Head	**3.1 Direction**
Eu.DK.200	Info	A line block track has a determined direction of movement of trains on the track, which is synchronised between the interlocking systems of the two adjacent stations, so that rail vehicle movements can be safely performed in that direction.
Eu.DK.210	Info	The direction of each track of a railway section controlled by a line block system is set independently.
Eu.DK.211	Info	A determined direction corresponds to one of the two adjacent stations having the direction set to 'Exit' and the other having the direction set to 'Entry' for the respective track.
Eu.DK.212	Info	A station adjacent to a line block can have the direction set to 'no direction'. This state is used upon start-up of the line block system when the last known direction information is not available.

ID	Type	Domain knowledge
Eu.DK.378	Info	A station adjacent to a line block can have the direction set to 'idle'. This state is used for a specific line block configuration in which the direction is controlled by route setting and train movement.
Eu.DK.217	Info	The diagram below shows the main definitions regarding a line block system and direction. 
Eu.DK.215	Head	**3.2 Line block with level crossing**
Eu.DK.216	Info	If a track section with an automatic line block system contains a level crossing, additional functionality may be necessary to combine the automatic functioning of line block (direction and/or line block signals) with the functioning of the level crossing.
Eu.DK.46	Head	**4 Areas**
Eu.DK.95	Head	**4.1 General**
Eu.DK.96	Info	Objects in a defined area may be grouped together into areas in order to perform tasks together.
Eu.DK.97	Info	All areas are implemented during the engineering process, and require an operational identifier assigned to each of them. These identifiers are used by the interlocking system, Radio Block Centre and Traffic Control System for communication about activation and deactivation of the different areas.
Eu.DK.47	Head	**4.2 Local Shunting Area**
Eu.DK.48	Head	**4.2.1 Local Shunting Area Definition**
Eu.DK.49	Info	A local shunting area consists of the following elements: • *the TVP sections within the local shunting area* • *the signals within the local shunting area* • *the moveable elements within the local shunting area* • *the lockable devices within the local shunting area* • *the signals required to display a 'stop' aspect for flank protection* • *the moveable elements required to be 'locked' before enabling the local shunting area* • *the lockable devices required to be 'locked' before enabling the local shunting area*
Eu.DK.51	Info	The following diagram displays the terminology for the local shunting area:

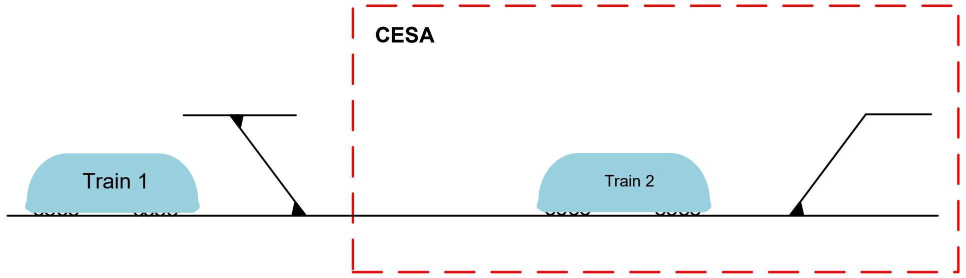
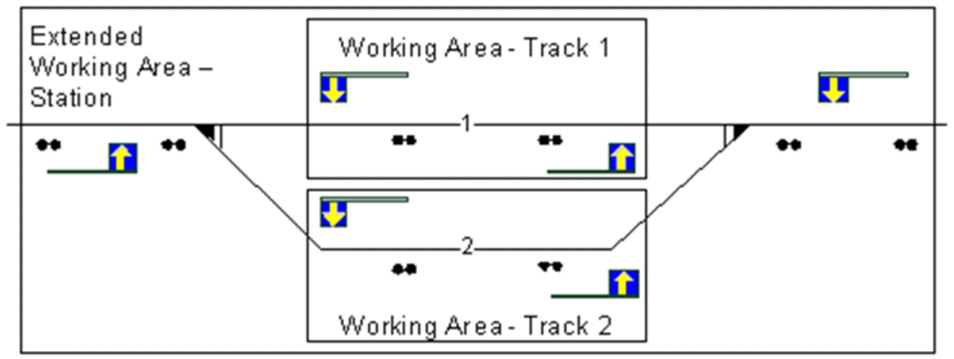
<table>
<tr><th>ID</th><th>Type</th><th>Domain knowledge</th></tr>
<tr><td>Eu.DK.52</td><td>Info</td><td>


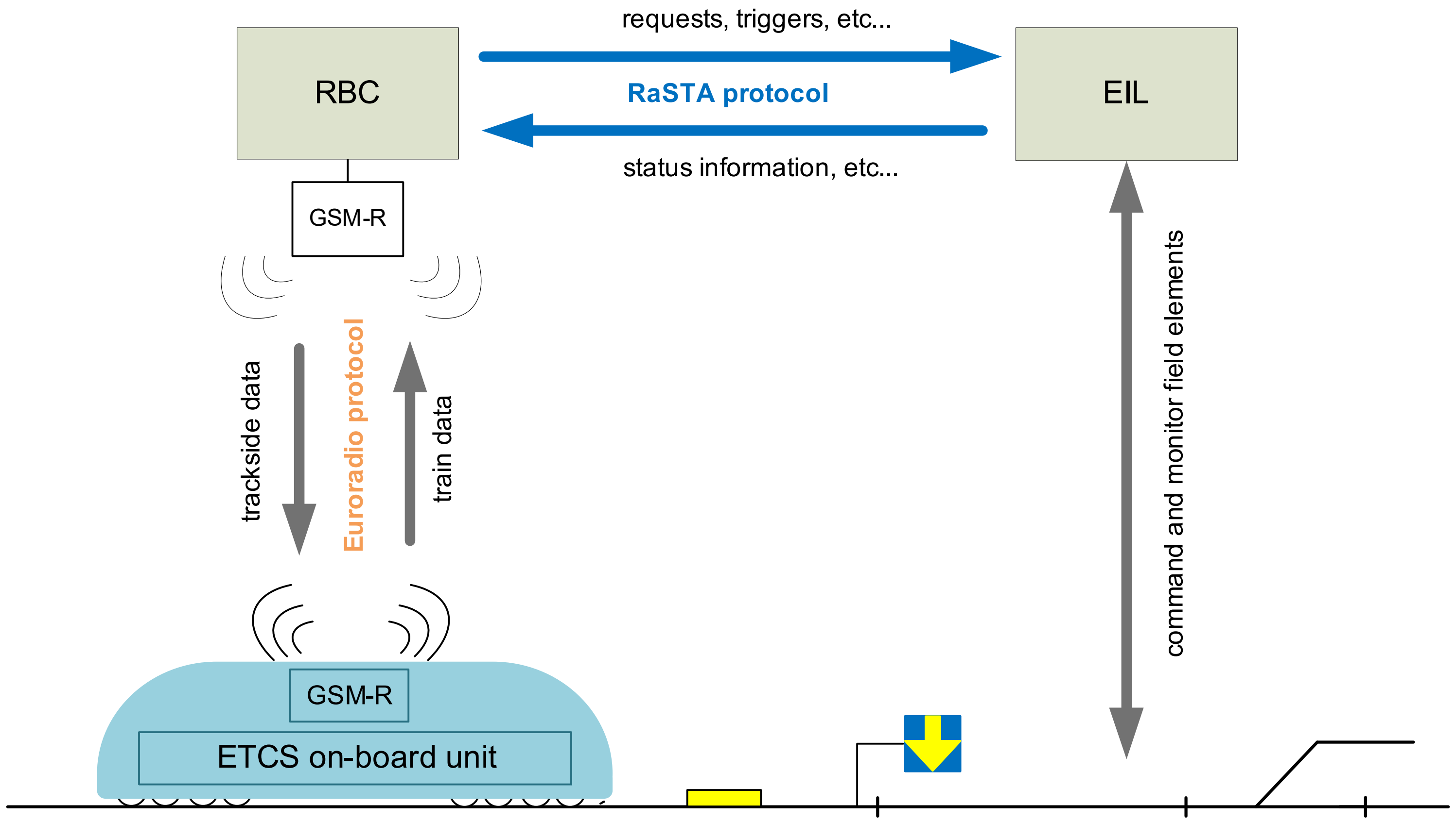
</td></tr>
<tr><td>Eu.DK.53</td><td>Info</td><td>The LECP (Local Element Control Panel) is an external panel located trackside which allows the shunter to manipulate with an enabled local shunting area.</td></tr>
<tr><td>Eu.DK.54</td><td>Head</td><td>4.2.2 Adjacent or Overlapping Local Shunting Area</td></tr>
<tr><td>Eu.DK.55</td><td>Info</td><td>Adjacent or overlapping local shunting areas may be enabled, simultaneously or one after the other.</td></tr>
<tr><td>Eu.DK.56</td><td>Info</td><td>All released elements in the resulting local shunting area shall have flank protection when the resulting local shunting area is enabled.</td></tr>
<tr><td>Eu.DK.57</td><td>Info</td><td>


</td></tr>
<tr><td>Eu.DK.58</td><td>Head</td><td>4.2.3 Local Shunting Area Life Cycle</td></tr>
<tr><td>Eu.DK.59</td><td>Info</td><td>A local shunting area is considered as:

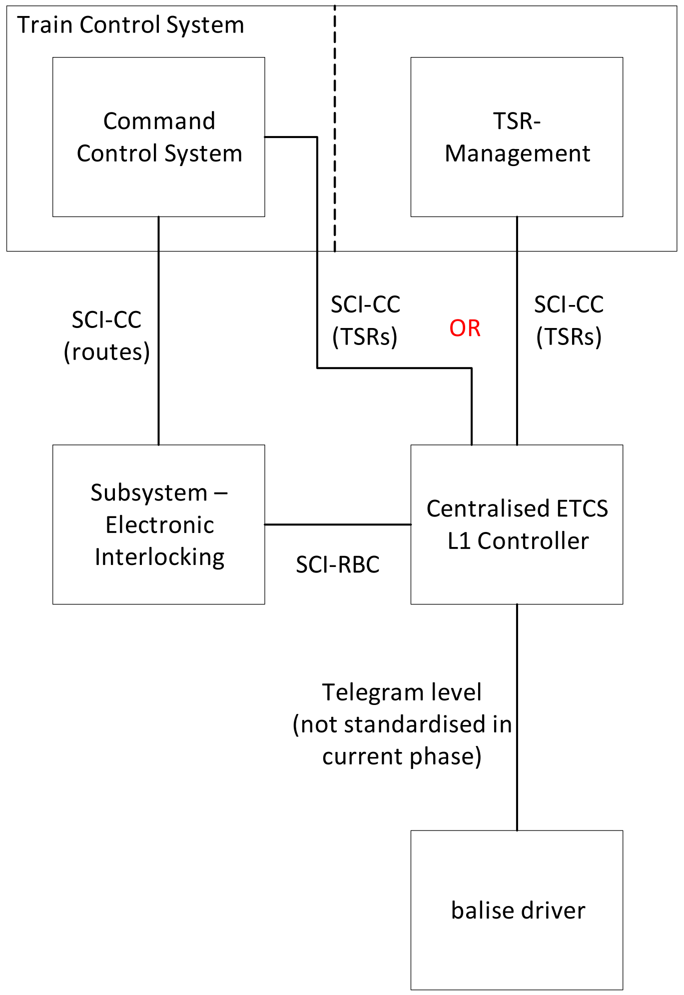
´initiated´ if the request is not rejected, until the local shunting area becomes enabled in the activation process or disabled in the deactivation process
´enabled´ if the initiation of the local shunting area is completed
´disabled´ if the withdrawal of an initiated or enabled local shunting area is completed
</td></tr>
<tr><td>Eu.DK.98</td><td>Head</td><td>4.3 Emergency Stop Area</td></tr>
<tr><td>Eu.DK.99</td><td>Info</td><td>Emergency stop areas are used when unwanted situations occur. These areas are divided into two categories, unconditional emergency stop areas (UESA) and conditional emergency stop areas (CESA).</td></tr>
<tr><td>Eu.DK.100</td><td>Head</td><td>4.3.1 Unconditional Emergency Stop Area</td></tr>
<tr><td>Eu.DK.102</td><td>Info</td><td>UESA is also referred to as Emergency stop area. When the area is activated, trains approaching the area (Train 1) will receive a conditional emergency stop. Trains inside the area (Train 2) will receive an unconditional emergency stop. The following diagram displays the UESA scenario:</td></tr>
<tr><td>Eu.DK.154</td><td>Info</td><td>UESA scenario


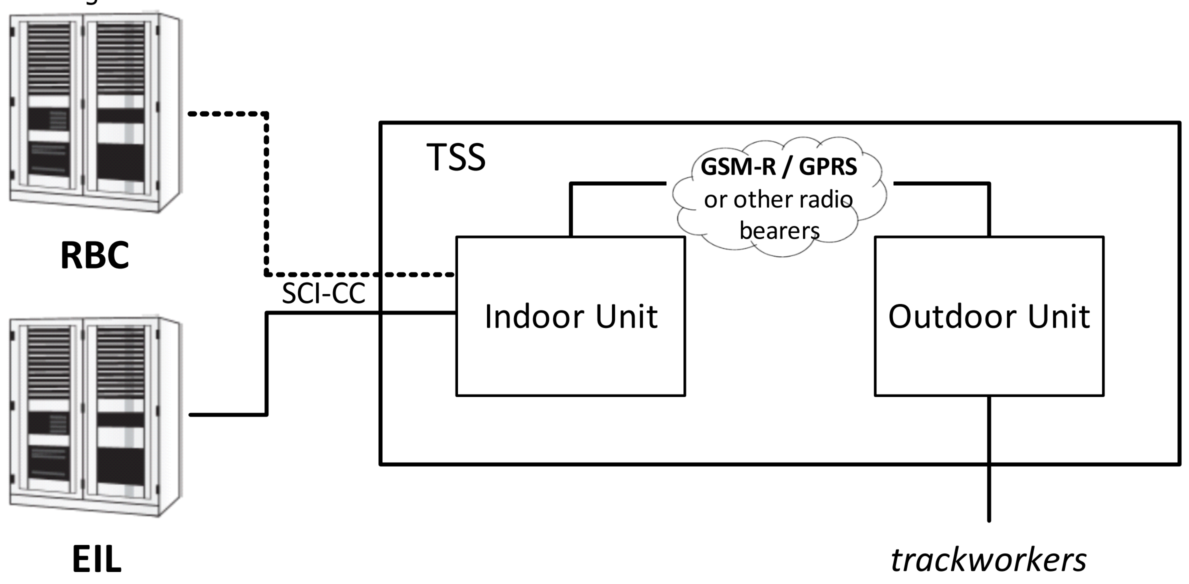
</td></tr>
</table>

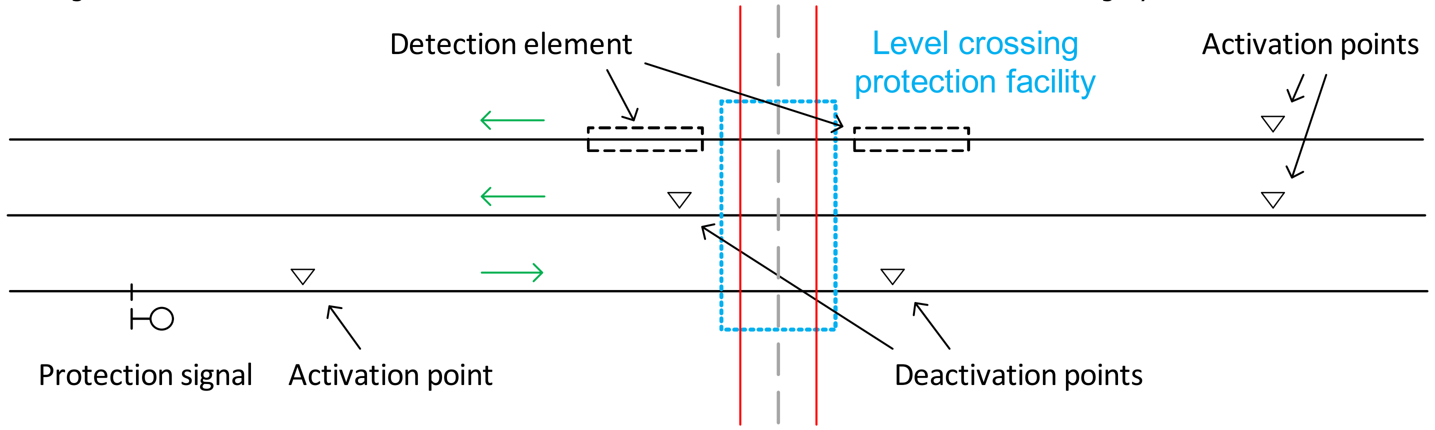
ID	Type	Domain knowledge
Eu.DK.101	Head	**4.3.2** Conditional Emergency Stop Area
Eu.DK.104	Info	CESA is also referred to as Escape area. When this area is activated, trains outside the area (Train 1) will receive a conditional emergency stop. Trains inside the area will not receive any stop messages. The following diagram displays the CESA scenario:
Eu.DK.155	Info	CESA scenario 
Eu.DK.106	Head	**4.4 Working Area**
Eu.DK.107	Info	Maintenance staff shall be protected technically against train traffic. A working area (WA) is a predefined area where maintenance work can be done safely. Maintenance staff will be able to operate objects (such as points, derailers, level crossings and tunnel gates) within an activated WA.
Eu.DK.108	Head	**4.4.1 Working Area Activation**
Eu.DK.109	Info	For activating the working area several steps are required: 1. *The signaller activates the area according to a work order* 2. *The interlocking system receives the activation command, and performs necessary actions to activate the area.* 3. *The interlocking confirms that the area is activated.* 4. *Maintainer confirms presence in the relevant area. This can for example be done with a hand held terminal. The confirmation results in sending the securing command to the interlocking system.* 5. *The interlocking system receives the securing command, and performs necessary actions to secure the area.* 6. *The interlocking confirms that the area is activated and secured.* When the working area becomes secured, the signaller will have the possibility to enable transitions to shunting mode.
Eu.DK.110	Head	**4.4.2 Working Area Life Cycle**
Eu.DK.111	Info	A working area is considered as: • *´activated´ if the activation request is not rejected, until the working area becomes secured in the activation process* • *´secured´ if the activation of the working area is completed by confirmation from the maintainer* • *´not activated´ if the withdrawal of an activated or secured working area is completed*
Eu.DK.112	Head	**4.4.3 Extended Working Area**
Eu.DK.113	Info	An extended WA will typically consist of two or more adjacent working areas. If a second WA is activated nearby an activated WA it is considered as extended also when the WAs are not overlapping.
Eu.DK.156	Info	Example of Extended Working Areas 

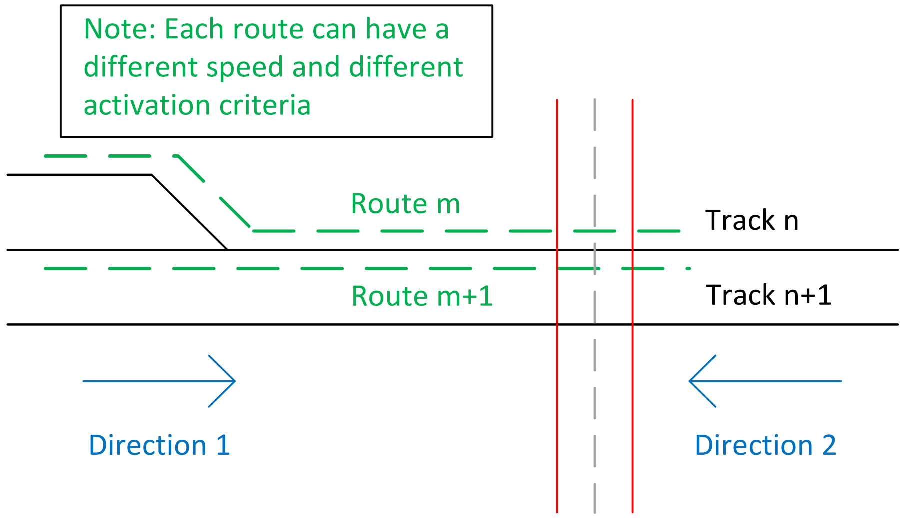
ID	Type	Domain knowledge
Eu.DK.60	Head	**5 Adjacent Systems**
Eu.DK.70	Head	**5.1 Radio Block Centre**
Eu.DK.71	Info	This section contains domain knowledge related to the functionality between the interlocking system (EIL) and the Radio Block Centre (RBC).
Eu.DK.116	Head	**5.1.1 RBC General**
Eu.DK.117	Info	The RBC is a computer-based system that elaborates messages to be sent to the train on basis of information received from external trackside systems and on basis of information exchanged with the on-board subsystems. The main objective of these messages is to provide movement authorities to allow the safe movement of trains on the Railway infrastructure area under the responsibility of the RBC. The RBC is used in ETCS level 2. In this level there is a permanent communication between the train and the RBC. The RBC generates the movement authority (MA) considering dynamic and static data from train and track. The static data are part of planning procedure and include for example the position of points and Eurobalises as well as the speed restrictions or gradients on the track. The dynamic data are received by the RBC from the interlocking system and the train.
Eu.DK.157	Info	The relation between the RBC and the interlocking system 
Eu.DK.119	Head	**5.1.2 Definition of functions between the interlocking system and the RBC**
Eu.DK.120	Info	**Overlap release:** The release of overlap section on the track. Normally the EIL will release the overlap timer-driven. With ETCS L2 (or higher) the EIL may release the overlap after a signal which is reserved for overlap release by the ETCS if the RBC has sent permission for the release of the overlap and all of the internal conditions of the EIL are fulfilled.
Eu.DK.121	Info	**Route/sub-route request:** The request from the RBC to the interlocking system to lock a particular route or sub-route for a train. A sub-route may be set during start of mission up to the next signal.
Eu.DK.122	Info	**Route release:** The release of a route triggered by the RBC.
Eu.DK.123	Info	**Setting signals to dark:** Used in German LZB train protection system and ETCS Level 2 (or higher). A line is divided into blocks. If there is no train in the entire line, the entry signal into the first block would be green. If the first block is occupied, the signal would be red. But if the first block is free and an LZB-or-ETCS-led train is approaching, the signal would set to dark and the train would continue just under the LZB/ETCS supervision. The purpose of using dark signals is to not let the driver get used to pass a red light signal.
Eu.DK.124	Info	**Route setting trigger:** The train runs over designated location and triggers the request for a route.

ID	Type	Domain knowledge
Eu.DK.125	Info	**Blocking of mixed traffic in defined sections:** Functionality used to prevent meeting of passenger trains and freight trains in defined sections, such as tunnels. Operational requirement dictates that passenger trains and freight trains must not encounter in a single-tube (double-tracked) tunnel. The German term for this functionality is 'Tunnelbegegnungsverbot', abbreviated as TBV.
Eu.DK.126	Info	**Group failure:** Field elements connected to an EIL may be partitioned into groups of elements due to the HW-architecture of an EIL. If the elements of a group are failed, the EIL sends a group failure message to the RBC in order to avoid a mass of single failure messages, individually for every single element. If elements of more than one group are out of order, the EIL sends to the RBC a separate failure message for each group.
Eu.DK.383	Head	**5.2 Centralised ETCS L1 Controller**
Eu.DK.384	Info	This section contains domain knowledge related to the functionality between the interlocking system (EIL) and the Centralised ETCS L1 Controller (CEC).
Eu.DK.385	Head	**5.2.1 CEC General**
Eu.DK.386	Info	The CEC receives status information from the interlocking system, in a similar way as the RBC receives such information. The CEC then determines, according to engineering data and internal logic, which balise groups should transmit which messages and sends the relevant telegrams into the corresponding Eurobalises via a balise driver.
Eu.DK.387	Info	The CEC can control the Eurobalises for a whole signalling area (one or several stations). It switches them according to its internal logic and status information from the interlocking system.
Eu.DK.388	Info	The CEC also incorporates information about temporary speed restrictions (TSRs). This information can be received from the Command Control system or from a dedicated system for TSR management.
Eu.DK.389	Head	**5.2.2 Interfaces**
Eu.DK.390	Info	The CEC receives status information from the interlocking system via the EULYNX interface SCI-RBC.
Eu.DK.465	Info	The status information received from the interlocking may contain only light signal status, or also include information about the status of other track elements (e.g. points, TVP sections, level crossings). The required status information depends on national specifications for the CEC.
Eu.DK.391	Info	The CEC receives TSR information from the CC system or the TSR management system via the interface SCI-CC.
Eu.DK.392	Info	The CEC controls balise drivers via an interface that is not standardised in EULYNX.

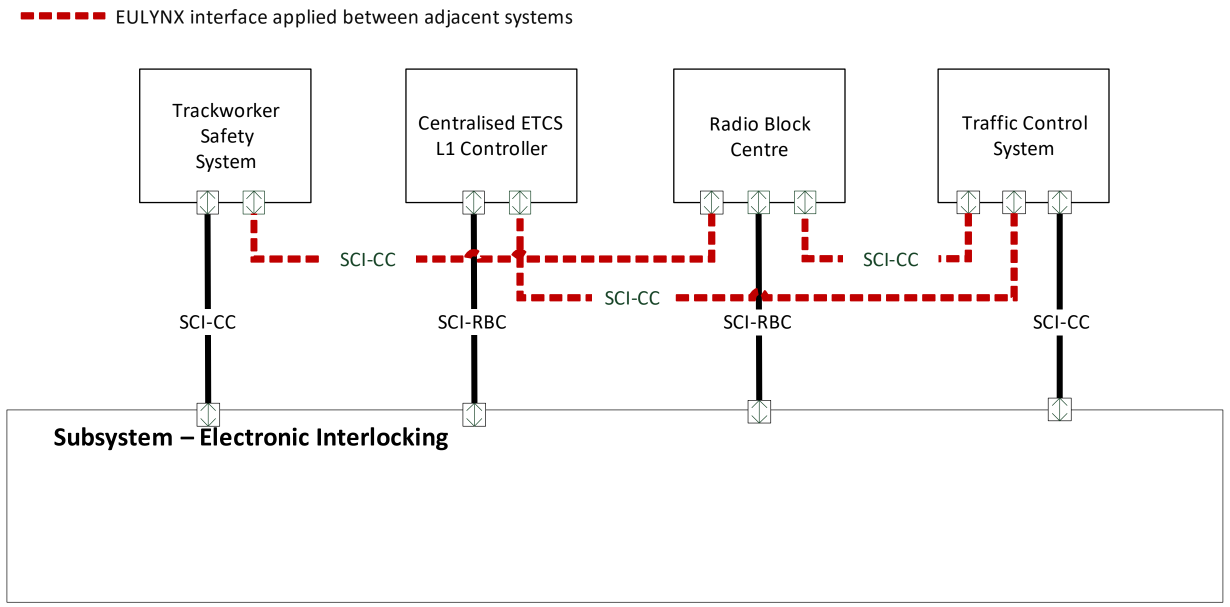
ID	Type	Domain knowledge
Eu.DK.393	Info	The diagram below shows the architectural location of the CEC and its interfaces 
Eu.DK.394	Head	**5.2.3 Switching order**
Eu.DK.466	Info	In most CEC systems, the balise groups will switch telegrams when the aspect of the associated light signal switches, or directly after the light signal aspect has been switched.
Eu.DK.395	Info	National specifications (and the followed signalling philosophy) may require that some balise groups may need to be switched before the associated light signals. If this principle is used, a distinction is made between pre-signal and post-signal balise groups.
Eu.DK.396	Info	Pre-Signal Balise Group are switched before the light signal, to which it is functionally associated, displays a more permissive aspect. The functionality of pre-signal balise groups ensures that a signal is not permitted to display a more permissive aspect in case of balise group failure. In this context, signal balise groups are generally treated as pre-signal balise groups. Signal balise groups are placed in the tracks close to a light signal to which they have a functional link.
Eu.DK.397	Info	Post-Signal Balise Group are switched after or at the same moment the light signal displays the more permissive aspect already. If there is a failure in setting the post-signal balise groups, national rules decide whether the associated light signal can remain at the permissive aspect or not. In this context, infill balise groups are generally treated as post-signal balise groups. Infill balise group transmit information that is valid for a location in advance.
Eu.DK.400	Head	**5.3 Trackworker Safety System**
Eu.DK.401	Info	This section contains domain knowledge related to the functionality between the interlocking system (EIL) and the Trackworker Safety System (TSS).
Eu.DK.402	Head	**5.3.1 TSS General**
Eu.DK.403	Info	Trackside Safety Systems provide warnings and can apply additional protection for trackside workers. The TSS collects information about the position of trains and rail vehicles from various sources, such as the electronic interlocking. The Control Unit of the TSS processes the train position information and generates a warning message when any train or rail vehicle reaches a trigger point on approach to a warning area.
Eu.DK.404	Head	**5.3.2 TSS architecture and interfaces**
Eu.DK.405	Info	The TSS in the context of EULYNX is an implementation of a signal controlled warning system (SCWS), as defined in [EN 16704-2-1], consisting of a Control Unit Indoor and a Control Unit Outdoor.

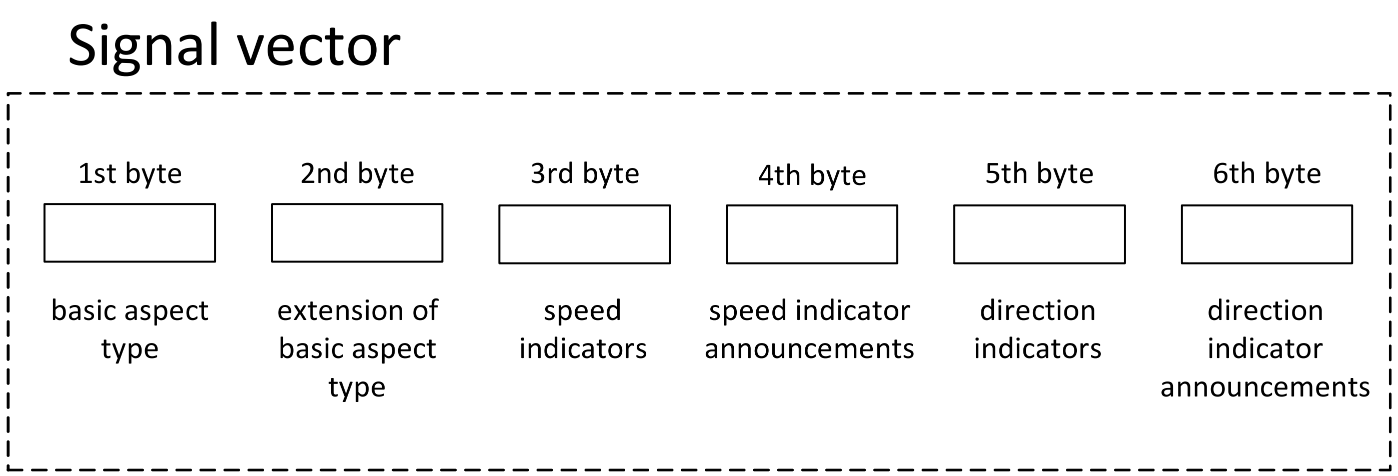
ID	Type	Domain knowledge
Eu.DK.406	Info	The Control Unit Outdoor can interface to trackside workers and warning units along the track. The interfaces and implementation of the Control Unit Outdoor are outside the scope of EULYNX. The EULYNX System interfaces only to the Control Unit Indoor, as part of the TSS.
Eu.DK.407	Info	The diagram below shows the architecture of a TSS and its interfaces 
Eu.DK.408	Head	**5.3.3 Warning functions**
Eu.DK.409	Info	To perform the functions of a signal controlled warning system, the TSS receives status information about warning conditions from the interlocking system via a dedicated interface SCI-CC.
Eu.DK.410	Info	Warning conditions include: • Routes set • Signal aspects • Positions of points • Track section occupancy
Eu.DK.411	Info	The TSS may have an additional interface to the Radio Block Centre (RBC), also using the interface SCI-CC.
Eu.DK.412	Info	Additional warning conditions can be received either from the interlocking system or from the RBC, depending on the functional apportionment between these two systems.
Eu.DK.413	Info	Additional warning conditions include: • Train location and speed • Train status
Eu.DK.414	Head	**5.3.4 Influence functions**
Eu.DK.415	Info	In addition to providing warnings to trackside workers, the TSS can use influence functions to apply additional protection.
Eu.DK.416	Info	***Manage Working Areas*** The TSS can command the interlocking system to secure / unsecure working areas, to make sure workers are protected against trains in an identified area.
Eu.DK.417	Info	***Set Signal to Stop*** In emergency situations, the TSS can command the interlocking system to set specific light signals to a Stop Aspect to stop trains from approaching a dangerous location.
Eu.DK.418	Info	***Delay route setting*** The TSS can command the interlocking system to apply a delay when setting a route and clearing the associated route entry signal. This allows trackside workers additional time to vacate the track in those cases where the route entry signal is located close to the working location.
Eu.DK.434	Head	**5.4 External Level Crossing System**
Eu.DK.438	Info	Systems to prevent collisions between trains and road users at level crossings are integrated to the interlocking system through the subsystem Level Crossing or through the adjacent system External Level Crossing System.

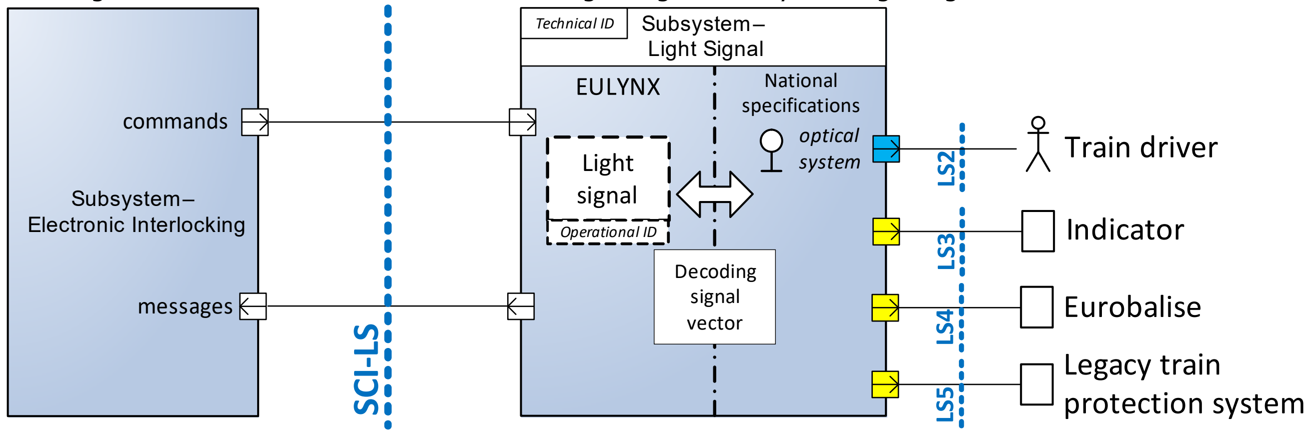
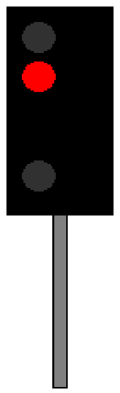
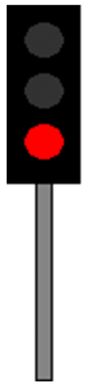
ID	Type	Domain knowledge
Eu.DK.439	Info	The adjacent system External Level Crossing System is used to integrate level crossing systems for which the activation and deactivation logic is handled primarily inside the level crossing system, based on commands from the interlocking and on the status of connected (de)activation points and detection elements.
Eu.DK.440	Info	The adjacent system External Level Crossing System controls one level crossing as a single operational element. The External Level Crossing System contains a level crossing protection facility, as defined in section 6.5 (see Eu.DK.293).
Eu.DK.441	Info	The figure below shows the main definitions of elements related to the External Level Crossing System. 
Eu.DK.442	Head	**5.4.1 Interacting functions**
Eu.DK.300	Info	Interacting functions are performed in cooperation with the interlocking and related to activation or deactivation of the level crossing protection facility. The interlocking sends activation and deactivation commands to the External Level Crossing System. Multiple principles are used to activate or deactivate the protection facility of a level crossing: • Unconditional activation and deactivation • Track/route-related activation and deactivation • Prolonged activation • Control activation point
Eu.DK.445	Head	**5.4.1.1 Unconditional activation and deactivation**
Eu.DK.443	Info	The start of the activation or deactivation sequence is directly triggered by a command from the interlocking. The unconditional activation (or deactivation) refers to all tracks of the level crossing. That means that the complete level crossing protection facility shall be activated (or deactivated) without conditions on track, direction or route.
Eu.DK.444	Info	Activation or deactivation may be commanded based on one or more conditions in the interlocking. Examples of conditions leading to an unconditional activation are: • a request resulting from a command by the signaller • a request resulting from a command by the Radio Block Centre
Eu.DK.308	Head	**5.4.1.2 Track/route-related activation and deactivation**
Eu.DK.309	Info	The interlocking commands the External Level Crossing System to expect train movement on a certain track or route. The External Level Crossing System evaluates if the conditions for activation are fulfilled and triggers the activation sequence of the level crossing protection facility as soon as it detects a train on an activated activation point corresponding to the commanded track or route. If no activation point exists for a certain track or route, the activation sequence of the protection facility is triggered immediately.
Eu.DK.310	Info	The External Level Crossing System triggers the deactivation sequence of the level crossing protection facility when it detects a train on a deactivation point or on a deactivation element corresponding to the commanded track or route (and no trigger for activation is present).

ID	Type	Domain knowledge
Eu.DK.350	Info	The figure below shows the main definitions related to track/route-related activation and deactivation. 
Eu.DK.311	Head	**5.4.1.3 Prolonged activation**
Eu.DK.312	Info	The interlocking commands the External Level Crossing System to remain activated, i.e. to maintain the protection of the level crossing protection area.
Eu.DK.313	Head	**5.4.1.4 Control activation point**
Eu.DK.314	Info	The interlocking commands the External Level Crossing System to activate or deactivate a certain activation point. The External Level Crossing System triggers the activation sequence of the level crossing protection facility as soon as it detects a train on the selected activation point.
Eu.DK.315	Head	**5.4.2 Autonomous functions**
Eu.DK.316	Info	Autonomous functions are performed inside the External Level Crossing System without interaction with the interlocking.
Eu.DK.317	Head	**5.4.2.1 Autonomous activation and deactivation**
Eu.DK.318	Info	The External Level Crossing System triggers the activation sequence of the level crossing protection facility as soon as it detects a train on an activation point configured for autonomous activation.
Eu.DK.319	Info	The External Level Crossing System triggers the deactivation sequence of the level crossing protection facility as soon as it detects a train on a deactivation point or on a detection element configured for autonomous activation (and no trigger for activation is present).
Eu.DK.320	Head	**5.4.3 Combinations**
Eu.DK.321	Info	It is possible for one External Level Crossing System to use several different principles of activation and deactivation. Depending on different tracks, routes and directions, the level crossing protection facility can be activated by unconditional activation commanded by the interlocking, by a track/route-related activation commanded by the interlocking, by an activation point commanded by the interlocking and/or by an autonomous activation point not commanded by the interlocking.
Eu.DK.322	Info	At a level crossing covering more than one track, it is possible for several activations to occur (partly) simultaneously. It is the responsibility of the External Level Crossing System to supervise the '*most protective activation envelope*', meaning the level crossing protection facility shall be activated as soon as required by one activation and remain activated until all activations have been concluded by a corresponding deactivation (either commanded or autonomous).
Eu.DK.323	Head	**5.4.4 Auxiliary functions**
Eu.DK.324	Info	Auxiliary functions are performed in cooperation with the interlocking, but not directly related to the activation or deactivation of the level crossing protection facility. The interlocking sends auxiliary commands to the External Level Crossing System.
Eu.DK.330	Head	**5.4.4.1 Set protection signals**
Eu.DK.331	Info	The interlocking can command the External Level Crossing System to set its protection signals to a stop aspect. This may be used when a signaller observes via cameras or by other means notices a dangerous situation on the level crossing protection area.
Eu.DK.448	Head	**5.4.5 Statuses**
Eu.DK.449	Info	The External Level Crossing System informs the interlocking of its status, based on different principles:

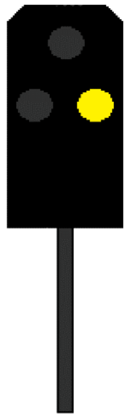
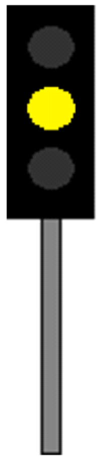
ID	Type	Domain knowledge
Eu.DK.450	Info	***Functional status*** This message is used for the statuses of the External Level Crossing System which are required within the interlocking logic.
Eu.DK.451	Info	***Monitoring status*** This message is used for the statuses of the External Level Crossing System which are required for display to the signaller.
Eu.DK.452	Info	***Failure status*** This message is used when a failure occurred or is revoked.
Eu.DK.453	Info	***Obstacle detection status*** This message is used to report an obstacle detected inside the level crossing protection area.
Eu.DK.454	Info	***Detection element status*** This message is used to report the occupancy status of detection elements.
Eu.DK.455	Info	***Status of activation point*** This message is used to report the status of activations points.
Eu.DK.456	Head	**5.4.6 Command admissibility**
Eu.DK.457	Info	The monitoring of activation and deactivation is in the logic of the External Level Crossing System. National requirements can request that the subsystem Electronic Interlocking must check the admissibility of commands received from the Traffic Control System which cause a change in the state of the External Level Crossing System. This is a feasibility check of the commands coming from the signaller.
Eu.DK.458	Info	If a command of the signaller is permitted in the current state of the External Level Crossing System, the signaller receives a confirmation with a positive processing message. If a command of the signaller is not permitted in the current state of the External Level Crossing System, the signaller receives a negative processing message and the command is rejected thereby.
Eu.DK.459	Info	To reduce the processing time of a command of the signaller and to avoid the forwarding of the admissibility check to the External Level Crossing System, the External Level Crossing System sends the scope of the currently permitted and not permitted signaller commands with each relevant change of state.
Eu.DK.460	Info	This command admissibility has to be evaluated by the subsystem Electronic Interlocking when a signaller command is received from the Traffic Control System in order to accept or to reject this command.
Eu.DK.554	Head	**5.5 Traffic Control System**
Eu.DK.555	Info	This section contains domain knowledge related to the functionality between the interlocking system (EIL) and the Traffic Control System (TCS).
Eu.DK.556	Head	**5.5.1 TCS General**
Eu.DK.557	Info	In the EULYNX System reference architecture, three systems are considered to be part of the Traffic Control System: • Command Control System • Automatic Route Setting System • Train Describer
Eu.DK.558	Info	Although train operations as well as graphic symbols of infrastructure elements are different on European level, information like the states of infrastructure elements (for example locked, occupied, vacant) may be exchanged between the EULYNX System and the Command Control System as a generic standard.
Eu.DK.559	Info	There may be multiple scenarios for interfacing the EULYNX System and/or the Radio Block Centre to the Traffic Control System, including: • single interface to the EULYNX System • separate interfaces to the EULYNX System and to the Radio Block Centre • single interface to the EULYNX System, which may integrate the functions of both the interlocking system and the Radio Block Centre • single interface to the EULYNX System, while the Radio Block Centre interfaces separately to the EULYNX System (without an interface to the TCS)
Eu.DK.560	Info	The SCI-CC interface specification will be specified in a common format and structure, regardless whether it is used for interfacing with the EULYNX System, the Radio Block Centre or the Centralised ETCS L1 Controller.
Eu.DK.561	Info	The SCI-CC interface is not intended for communication between two Traffic Control Systems.
Eu.DK.562	Info	It is foreseen that individual implementations of the SCI-CC interface protocol will use a full set or a partial subset of the application data, depending on the applied scenario, as defined by national specifications.
Eu.DK.424	Head	**5.6 EULYNX Interfaces between adjacent systems**
Eu.DK.425	Info	Certain EULYNX interface specifications can also be used to directly connect two adjacent systems to each other.

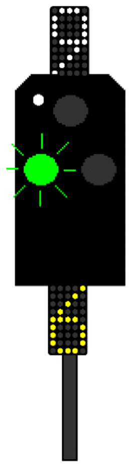
ID	Type	Domain knowledge
Eu.DK.426	Info	The SCI-CC interface specification can also be applied for connecting the Traffic Control System directly to the following adjacent systems: • the Radio Block Centre • the Centralised ETCS L1 Controller
Eu.DK.427	Info	The SCI-CC interface specification can also be applied for connecting the Trackworker Safety System directly to the following adjacent systems: • the Radio Block Centre
Eu.DK.428	Info	In such cases the functional apportionment must be completed from the perspective of the adjacent system by the system integrator.
Eu.DK.429	Info	The diagram below displays the use of EULYNX interfaces between adjacent systems 
Eu.DK.72	Head	**6 Elements**
Eu.DK.73	Info	This section contains domain knowledge related to individual elements.
Eu.DK.174	Head	**6.1 Light Signals**
Eu.DK.249	Info	Wayside light signal and indicator lamps are integrated to the interlocking system through the subsystem Light Signal.
Eu.DK.248	Info	The subsystem Light Signal controls one light signal as a single operational element.
Eu.DK.237	Head	**6.1.1 Signal aspect table**
Eu.DK.250	Info	Since signal aspects are different on European level, the aspects are managed on an abstract level and defined through the signal aspect table [Eu.Doc.37].
Eu.DK.251	Info	In the signal aspect table, all national signal elements or aspects are assigned to generic signal element or aspect names.
Eu.DK.252	Info	For each generic signal element or aspect name, the signal aspect table defines a value of the corresponding signal vector byte.
Eu.DK.253	Info	The signal vector value is the expression of signal aspects used in the communication between the subsystem Light Signal and the subsystem Electronic Interlocking.
Eu.DK.239	Head	**6.1.2 Signal vector**
Eu.DK.254	Info	The signal vector consists of 6 bytes of information. The following diagram displays the structure of the signal vector.

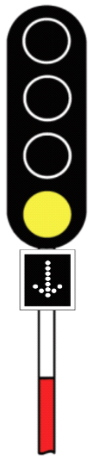
ID	Type	Domain knowledge
Eu.DK.255	Info	
Eu.DK.256	Info	The coding of the bytes of the signal vector corresponds to the coding used in the signal aspect table [Eu.Doc.37] and to the telegrams Command "Indicate Signal Aspect" and Message "Indicated Signal Aspect" in the Interface specification SCI-LS [Eu.Doc.33].
Eu.DK.257	Info	The 6 bytes of the signal vector represent the following information: • First byte: code for basic aspect types • Second byte: code for extension of basic aspect types • Third byte: speed indicators • Fourth byte: speed indicator announcements • Fifth byte: direction indicators • Sixth byte: direction indicator announcements
Eu.DK.258	Info	The meaning of each byte value and the relation to corresponding national signal elements or aspects can be found in the signal aspect table [Eu.Doc.37] and related national specification documents.
Eu.DK.259	Info	The bytes of the signal vector are independent. As an example, the speed indicator byte can take any value described in the signal aspect table, independent of the value of the bytes for the basic aspect, extension, speed indicator announcements and direction indicators. Configuration and engineering data define which combinations of the signal vector byte values constitute a valid signal aspect at an individual signal.
Eu.DK.260	Head	**6.1.3 Commanding the signal aspect**
Eu.DK.261	Info	The subsystem Electronic Interlocking sends the signal vector corresponding to the desired signal aspect to the subsystem Light Signal. It can send additional information that specifies additional rules to be taken into account when transforming the signal vector into a signal aspect.
Eu.DK.262	Info	The subsystem Light Signal decodes the received signal vector and transforms it into a signal aspect. National specifications govern the interpretation of the signal vector byte values and any additional rules to drive: • Signal optics • Indicators • Eurobalises • Legacy train protection systems
Eu.DK.263	Info	The national specifications that are needed to drive the above mentioned components shall be covered by the configuration of the national part on the subsystem Light Signal.

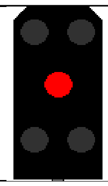
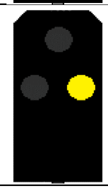
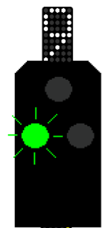
<table>
<tr><th>ID</th><th>Type</th><th>Domain knowledge</th></tr>
<tr><td>Eu.DK.264</td><td>Info</td><td>The diagram below shows the main definitions regarding the subsystem Light Signal.

</td></tr>
<tr><td>Eu.DK.268</td><td>Info</td><td>Examples of simple signal vector values</td></tr>
<tr><td>Eu.DK.280</td><td>Info</td><td>Example 1: Stop / Danger (1)
<table>
<tr><td>1st byte</td><td>2nd byte</td><td>3rd byte</td><td>4th byte</td><td>5th byte</td><td>6th byte</td></tr>
<tr><td>Basic aspect type</td><td>Extension of basic aspect types</td><td>Speed indicators</td><td>Speed indicator announcements</td><td>Direction indicators</td><td>Direction indicator announcements</td></tr>
<tr><td>0x01</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>0xFF</td></tr>
</table></td></tr>
<tr><td>Eu.DK.282</td><td>Info</td><td>
DB: Hp 0

NR: Red/Stop/On

SŽ: SZ1</td></tr>
<tr><td>Eu.DK.283</td><td>Info</td><td>Example 2: Approach / Caution
<table>
<tr><td>1st byte</td><td>2nd byte</td><td>3rd byte</td><td>4th byte</td><td>5th byte</td><td>6th byte</td></tr>
<tr><td>Basic aspect type</td><td>Extension of basic aspect types</td><td>Speed indicators</td><td>Speed indicator announcements</td><td>Direction indicators</td><td>Direction indicator announcements</td></tr>
<tr><td>0x07</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>0xFF</td></tr>
</table></td></tr>
<tr><td>Eu.DK.284</td><td>Info</td><td></td></tr>
</table>

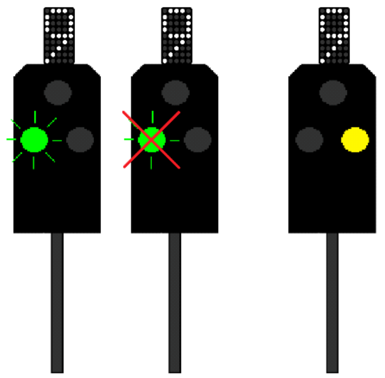
<table>
<tr><th>ID</th><th>Type</th><th>Domain knowledge</th></tr>
<tr><td></td><td></td><td>
DB: Ks 2

NR: Yellow

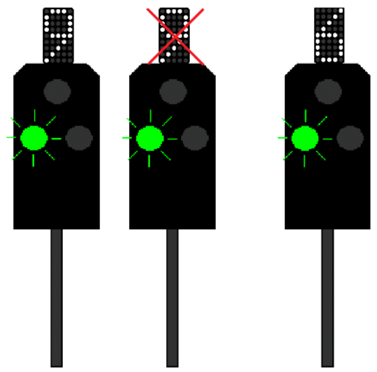
SŽ: SZ3</td></tr>
<tr><td>Eu.DK.269</td><td>Info</td><td>Examples of compound signal vector values</td></tr>
<tr><td>Eu.DK.285</td><td>Info</td><td>Example 3: Flashing clear (2) with speed indicator and speed indicator announcement
90 km/h in advance of signal, 60km/h at next signal
<table>
<tr><td>1st byte</td><td>2nd byte</td><td>3rd byte</td><td>4th byte</td><td>5th byte</td><td>6th byte</td></tr>
<tr><td>Basic aspect type</td><td>Extension of basic aspect types</td><td>Speed indicators</td><td>Speed indicator announcements</td><td>Direction indicators</td><td>Direction indicator announcements</td></tr>
<tr><td>0x06</td><td>0xFF</td><td>0x09</td><td>0x06</td><td>0xFF</td><td>0xFF</td></tr>
</table></td></tr>
<tr><td>Eu.DK.286</td><td>Info</td><td>
DB: Ks 1 with Zs 3, Zs 3v and Zusatzlicht (indicating shortened braking distance)</td></tr>
<tr><td>Eu.DK.287</td><td>Info</td><td>Example 4: Approach / Caution with indicator ‘no overlap’
<table>
<tr><td>1st byte</td><td>2nd byte</td><td>3rd byte</td><td>4th byte</td><td>5th byte</td><td>6th byte</td></tr>
<tr><td>Basic aspect type</td><td>Extension of basic aspect types</td><td>Speed indicators</td><td>Speed indicator announcements</td><td>Direction indicators</td><td>Direction indicator announcements</td></tr>
<tr><td>0x07</td><td>0x13</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>0xFF</td></tr>
</table></td></tr>
<tr><td>Eu.DK.288</td><td>Info</td><td></td></tr>
</table>

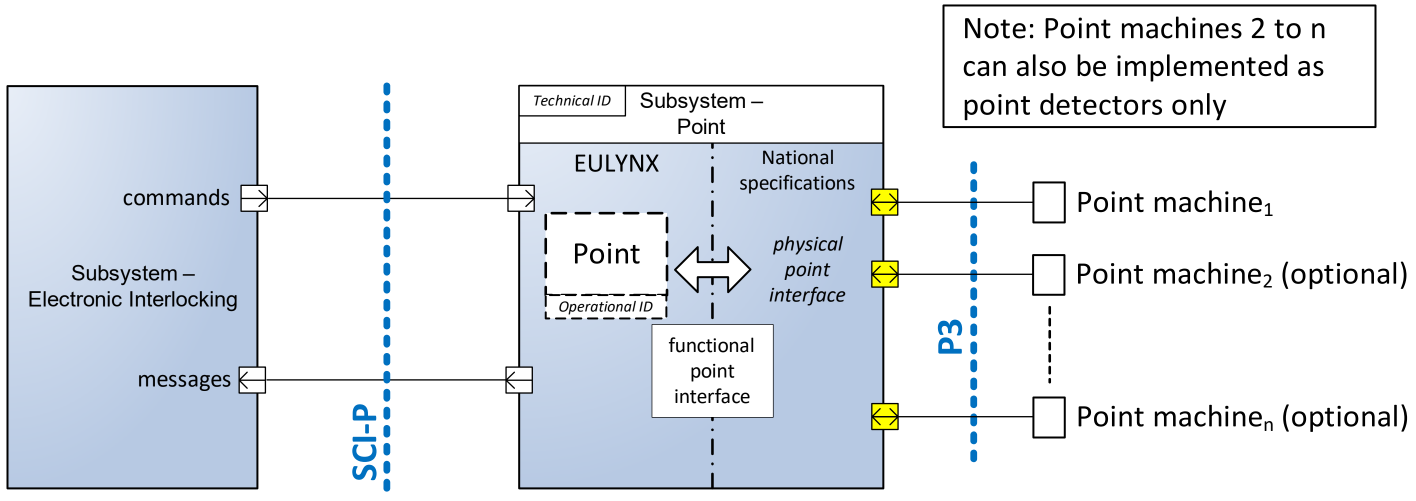
ID	Type	Domain knowledge
		 SŽ: SZ3 with SZ23
Eu.DK.265	Head	**6.1.4 Degradation**
Eu.DK.266	Info	If, for example because of a lamp failure, a light signal cannot show the commanded signal aspect, it must show another valid signal aspect. The alternative aspect shown shall always give a more restrictive instruction to the train driver. The choice of alternative signal aspects to be used in case of degradation is governed by national specifications and must be included in the configuration of the national part on the subsystem Light Signal.
Eu.DK.267	Info	The process of degradation takes place within the subsystem Light Signal, based on information that has been configured. After applying degradation, the subsystem Light Signal reports to the subsystem Electronic Interlocking the signal aspect that is indicated to the train driver. There is no further interaction with the interlocking.
Eu.DK.270	Info	**Example of degradation**
Eu.DK.281	Info	(see table below)

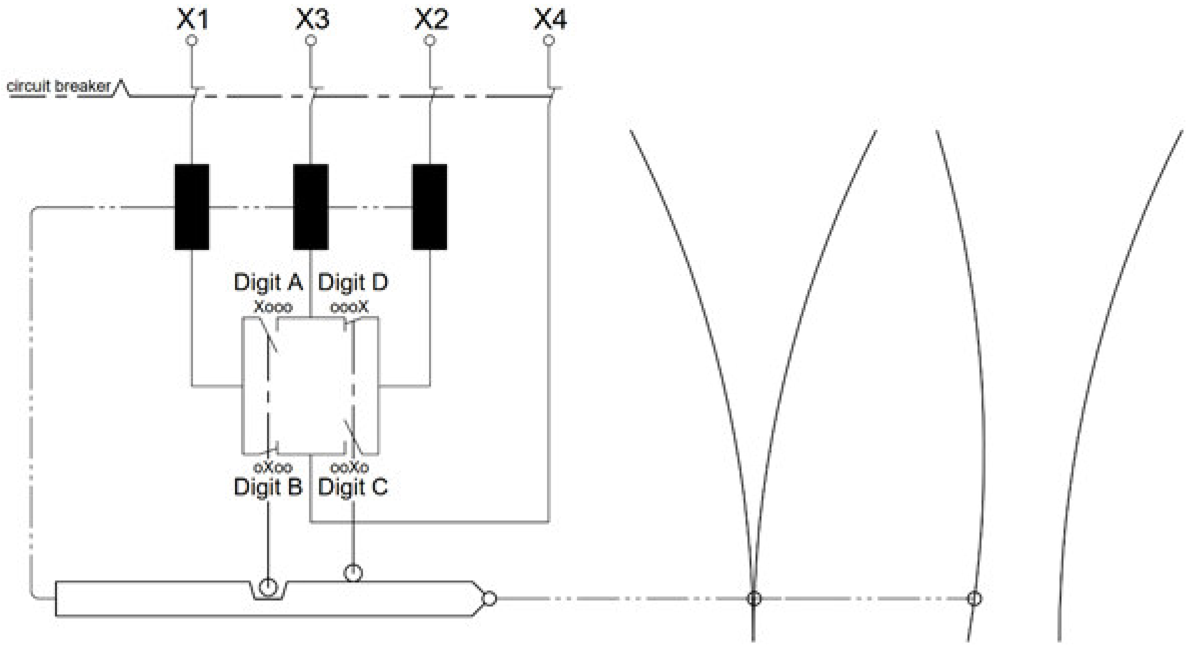
Aspect index	Signal vector value						Example aspect	When not available, degrade to aspect index
	1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte		
#1	0x01	0xFF	0xFF	0xFF	0xFF	0xFF		N/A
#2	0x07	0xFF	0xFF	0xFF	0xFF	0xFF		#1
#3	0x05	0xFF	0x09	0xFF	0xFF	0xFF		#2
#4	0x04	0xFF	0xFF	0xFF	0xFF	0xFF		#2 (not #3)

ID	Type	Domain knowledge
Eu.DK.271	Head	**6.1.4.1 Lamp dependent degradation**

<table>
<tr><th>ID</th><th>Type</th><th>Domain knowledge</th></tr>
<tr><td>Eu.DK.272</td><td>Info</td><td>If a signal aspect consists of more than one lamp, the degradation can depend on individual lamp failures.</td></tr>
<tr><td>Eu.DK.273</td><td>Info</td><td>Example of lamp dependent degradation</td></tr>
<tr><td>Eu.DK.289</td><td>Info</td><td>
<table>
<tr><th>Aspect nr.</th><th colspan="6">Signal vector value</th><th>When not available, degrade to aspect nr.</th></tr>
<tr><td></td><td>1st byte</td><td>2nd byte</td><td>3rd byte</td><td>4th byte</td><td>5th byte</td><td>6th byte</td><td></td></tr>
<tr><td>#1</td><td>0x01</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>N/A</td></tr>
<tr><td>#2</td><td>0x07</td><td>0xFF</td><td>0x06</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>#1</td></tr>
<tr><td>#3</td><td>0x07</td><td>0xFF</td><td>0x09</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>#1 or #2, depending on which lamp fails</td></tr>
<tr><td>#4</td><td>0x05</td><td>0xFF</td><td>0x06</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>#2 or #1, depending on which lamp fails</td></tr>
<tr><td>#5</td><td>0x05</td><td>0xFF</td><td>0x09</td><td>0xFF</td><td>0xFF</td><td>0xFF</td><td>#3 or #4, depending on which lamp fails</td></tr>
</table>
</td></tr>
<tr><td>Eu.DK.290</td><td>Info</td><td>

Case 1: Flashing green lamp fails >
yellow lamp lighted instead
Ks 1 + Sv 3 (9) > Ks 2 + Sv 3 (9)


Case 2: Speed indicator 9 fails >
speed indicator 6 lighted instead
Ks 1 + Sv 3 (9) > Ks 1 + Sv 3 (6)
</td></tr>
<tr><td>Eu.DK.274</td><td>Head</td><td>6.1.4.2 Additional degradation information</td></tr>
<tr><td>Eu.DK.275</td><td>Info</td><td>In specific cases, the subsystem Electronic Interlocking can send additional degradation information to the subsystem Light Signal. This can be used when there is more than one option how to apply degradation and the preferred choice depends on which route has been set.</td></tr>
<tr><td>Eu.DK.276</td><td>Info</td><td>The subsystem Electronic Interlocking will send this additional information with the commanded signal aspect, independent of the fact whether degradation needs to be applied. If degradation needs to be applied, the subsystem Light Signal will take this additional information into account without further interaction with the interlocking.</td></tr>
<tr><td>Eu.DK.277</td><td>Head</td><td>6.1.5 Luminosity</td></tr>
<tr><td>Eu.DK.278</td><td>Info</td><td>The brightness of the background of a light signal differs greatly between daylight and night conditions. To ensure optimum visibility of the signal lamps, the luminosity of the light signal is managed. During the daylight period, the signal lamps will be illuminated more brightly, to ensure they stand out against the background. During the night, the lamps are dimmed, to avoid blinding of the train driver.</td></tr>
<tr><td>Eu.DK.279</td><td>Info</td><td>Depending on national specifications and local conditions, one of the two luminosities can be defined as the default luminosity of a light signal or signal group.</td></tr>
<tr><td>Eu.DK.173</td><td>Head</td><td>6.2 Points</td></tr>
</table>

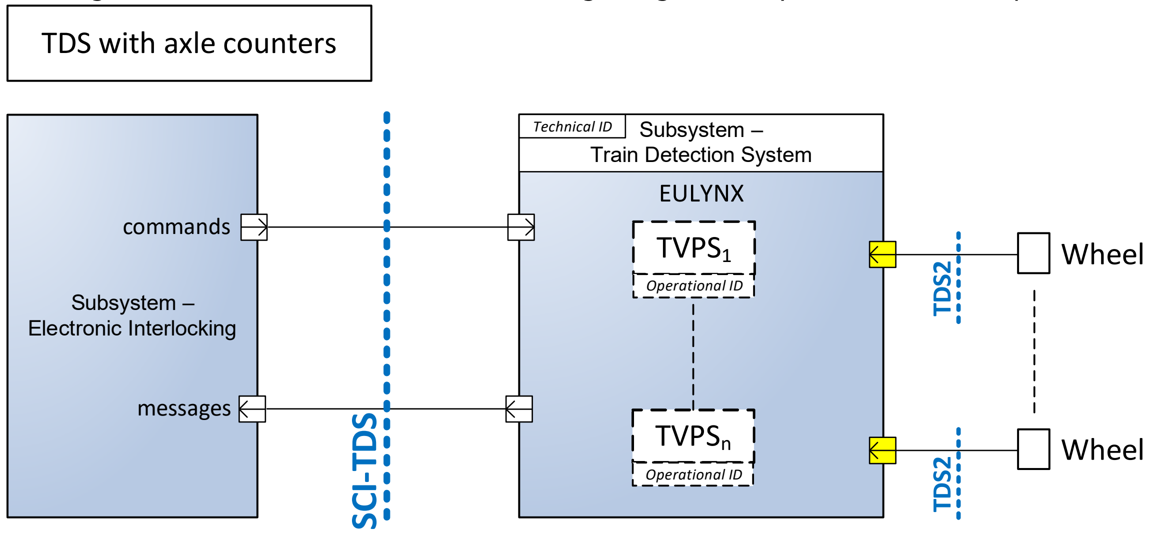
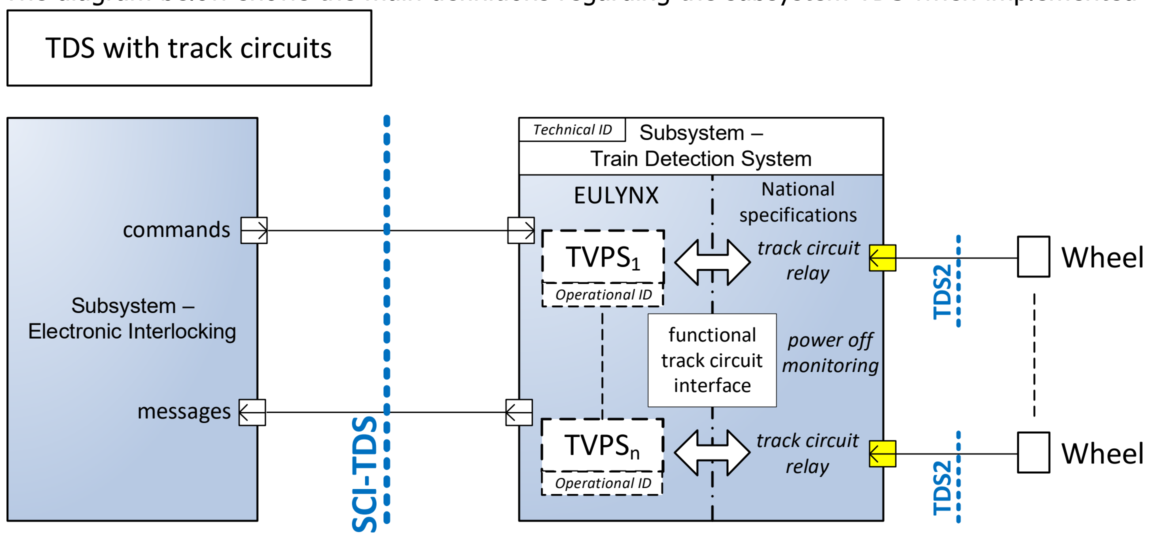
ID	Type	Domain knowledge
Eu.DK.187	Info	Moveable elements, whose position may be changed by a point machine, are integrated to the interlocking system through the subsystem Point.
Eu.DK.219	Info	The subsystem Point controls one point as a single operational element.
Eu.DK.188	Info	The subsystem Point is used to control and monitor the point machines of the following elements: • simple points • double slip points (as two operational elements) • single slip points (as two operational elements) • moveable switch diamond crossings • moveable crossing noses on any of the above (as part of the operational element) • derailers
Eu.DK.468	Info	A point machine has 2 functionalities: a. Moving the point b. Detecting the point position
Eu.DK.469	Info	There are two possible configurations: - 'Point detector': A point machine with only functionality b. - 'Full functionality': A point machine with functionality a and b.
Eu.DK.220	Info	A point can be equipped with one or more point machines. In case of more than one point machine, it is possible that some point machines only function as a point detector, without moving the point blades.
Eu.DK.221	Info	EULYNX specifies the functional interface to the point machine. The physical interface to the point machine is covered by national specifications.
Eu.DK.222	Info	The diagram below shows the main definitions regarding the subsystem Point. 
Eu.DK.470	Info	There are 2 implementation variants of the functional interface to the point machine: - non-4-wire - 4-wire
Eu.DK.471	Info	For the non-4-wire implementation, EULYNX only defines functional input and output information.
Eu.DK.472	Info	For the 4-wire implementation, the input information is represented as 4-wire patterns.
Eu.DK.473	Info	The 4-wire pattern consists of four digits, each being in a state of „1" or „0". The state of „1" represents a closed contact in the 4-wire circuit while „0" represents an open contact in the 4-wire circuit.
Eu.DK.474	Info	There are four contact pairs, where each pair is represented by a specific digit in the 4-wire pattern (ABCD): Contact 1+3 -> Digit A Contact 1+4 -> Digit B Contact 2+4 -> Digit C Contact 2+3 -> Digit D

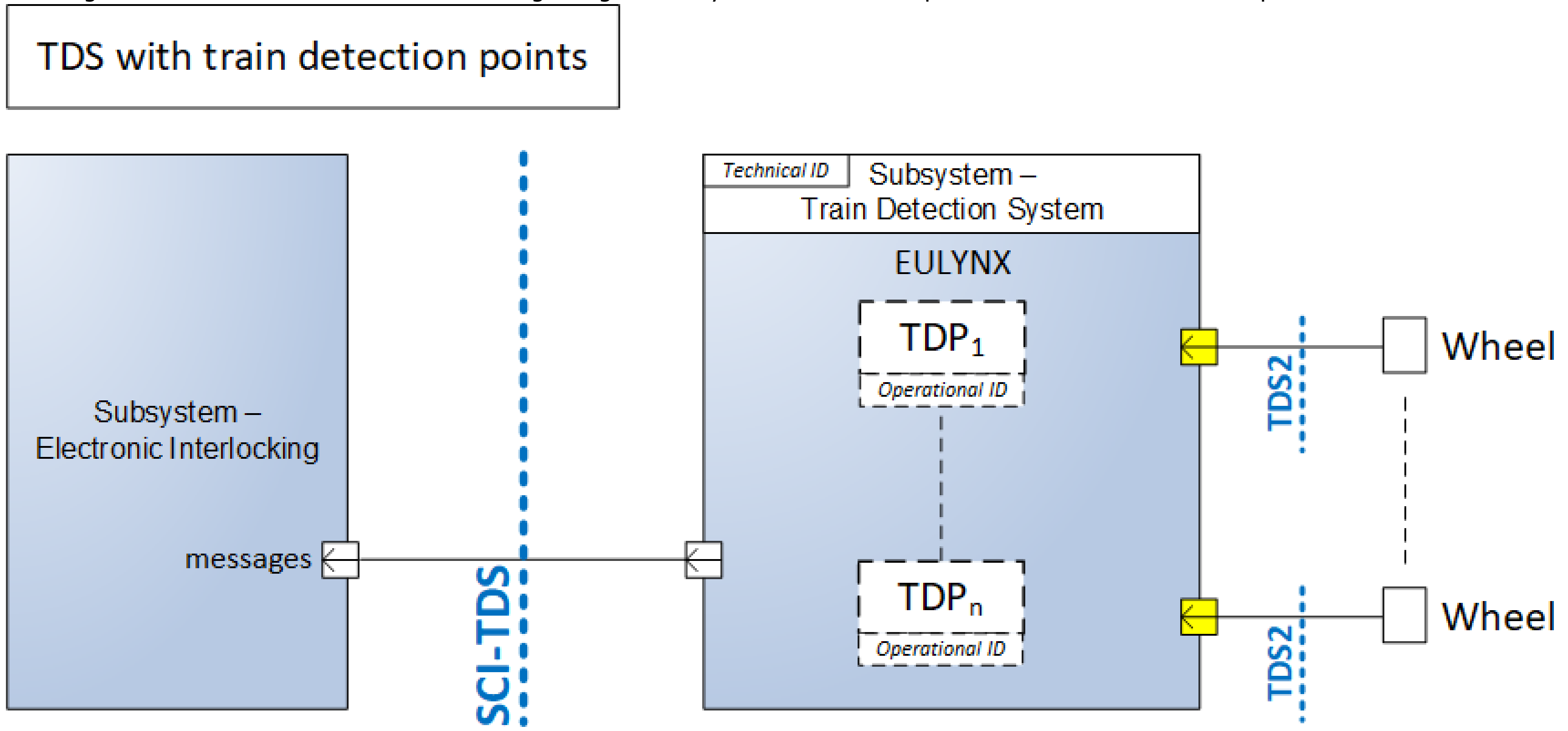
ID	Type	Domain knowledge
Eu.DK.476	Info	The figure shows a schematic representation of the 4-wire circuit 
Eu.DK.585	Head	**6.2.1 Point position**
Eu.DK.587	Head	**6.2.1.1 Commanded point position**
Eu.DK.586	Info	The position of the point as commanded from the Subsystem - Electronic Interlocking to Subsystem - Point. It can be one of the following positions: ‘End position (commanded)’ with value either left or right.
Eu.DK.588	Info	***End position (commanded)*** Command to move the Moveable element to the left or right ‘End position (physical)’.
Eu.DK.589	Head	**6.2.1.2 Physical point position**
Eu.DK.590	Info	The position of the point as physically present and detectable at the moveable component. It can be one of the following positions: 'End position (physical)' with value either left or right or ‘Intermediate position (physical)’.
Eu.DK.591	Info	***End position (physical)*** Detectable position of the moveable component that safely guides a rail vehicle to either the left or right branch.
Eu.DK.592	Info	***Intermediate position (physical)*** Position of the moveable component that cannot guarantee safe guidance of a rail vehicle. This position may be caused by trailing, obstruction of the moveable element or other unforeseen events.
Eu.DK.499	Head	**6.2.1.3 Detected point position**
Eu.DK.500	Info	The subsystem Point interprets the signal at the point machine or point detector interface, corresponding to the physical position of the moveable component. As a simplification, this is expressed as the point machine or point detector ‘detecting’ the position of the moveable component.
Eu.DK.593	Info	The position of the point as interpreted by the Subsystem – Point for a single Point machine can be one of the following positions: 'End position (detected)' with value either left or right, ‘No end position (detected)’ or ‘Unintended position (detected)’.
Eu.DK.501	Info	***End position (detected)*** The point machine reliably detects that the moveable component of the point is in a ‘End position (physical)’ (left or right) at the location of a point machine. In case the subsystem Point is implemented with the 4-wire variant of the interface to the point machine, the ‘End position (detected)’ corresponds to the ‘End position (physical)’ only if it also corresponds to the last received ‘End position (commanded)’.
Eu.DK.503	Info	***Unintended position (detected)*** The point machine is able to reliably detect that the moveable component of the point is in an ‘Intermediate position (physical)'. In case the subsystem Point is implemented with the 4-wire variant of the interface to the point machine, this detected point position also occurs when the moveable component of the point is in an ‘End position (physical)’

ID	Type	Domain knowledge
		that does not correspond to the last received 'End position (commanded)' at the location of a point machine. This detection of an 'unintended position' may be caused by a trailing movement or occur for other reasons. This detected point position is always used if the subsystem Point is implemented with the 4-wire variant of the interface to the point machine. If the subsystem Point is implemented with the non-4-wire variant of the interface to the point machine, this detected point position is only used in implementations that can reliable detect the 'Intermediate position (physical)'.
Eu.DK.502	Info	***No end position (detected)*** In case the subsystem Point is implemented such that it uses the Unintended position (detected), the No end position (detected) means that the point machine is not able to reliably detect that the moveable component of the point is either in an 'End position (detected)' or in a 'Unintended position (detected)' at the location of a point machine. In case the subsystem Point is implemented such that it does not use the Unintended position (detected), the No end position (detected) means that the point machine is not able to detect that the moveable component of the point is in an 'End position (detected)' at the location of a point machine.
Eu.DK.504	Head	**6.2.1.4 Overall point position**
Eu.DK.505	Info	When a moveable element is equipped with more than one point machine interface to the subsystem Point (some of them may be only point detectors), their inputs must be combined and consolidated into an overall point position that is reported to the interlocking. When a moveable element is equipped with only one point machine interface, the overall point position directly corresponds to the detected point position.
Eu.DK.594	Info	The point position as consolidated by the subsystem Point based on the detected point position of each point machine can be one of the following positions: 'End position (overall)' with value either left or right, 'No end position (overall)', or 'Unintended position (overall)'.
Eu.DK.507	Info	***End position (overall)*** This overall position is reported to the interlocking only when all configured point machines of the subsystem Point detect the corresponding 'End position (detected)', either left or right.
Eu.DK.508	Info	***Unintended position (overall)*** This overall position is reported to the interlocking as soon as at least one point machine of the subsystem Point detects an 'Unintended position (detected)'.
Eu.DK.509	Info	***No end position (overall)*** This overall position is reported to the interlocking whenever the detected inputs from the configured point machines of the subsystem Point don't correspond to an 'End position (overall)' or to an 'Unintended position (overall)'.
Eu.DK.595	Head	**6.2.1.5 Reported point position**
Eu.DK.596	Info	Point position report sent from the subsystem Point to the electronic interlocking, directly corresponding to the overall point position. It can be one of the following positions: 'End position (reported)' with value either left or right, 'No end position (reported)' or 'Unintended position (reported)'.
Eu.DK.506	Info	The functionality of the subsystem Point does not contain any 'memory' of the reported state. As soon as the conditions are fulfilled to report a different state, the new state is reported to the EIL.
Eu.DK.477	Head	**6.2.2 Degraded point position**
Eu.DK.475	Info	When a moveable element is equipped with more than one point machine interfaces to the subsystem Point (some of them may be only point detectors), more elaborate information about the overall position of the element is available in the subsystem. Some of this information can be useful for the interlocking system to increase availability of the infrastructure.
Eu.DK.597	Info	The 'degraded point position' is determined independently from the 'overall point position', based on the 'detected point position' of each configured point machine. The 'degraded point position' is reported to the electronic interlocking independently from the 'reported point position'.
Eu.DK.478	Info	In certain 'degraded' states, the point position may be deemed reliable enough to provide flank protection to other routes. It is not reliable enough to drive over the point with normal speed. The use of the 'degraded' position depends on national implementation in the interlocking logic.
Eu.DK.479	Info	For this purpose, two levels of reliability are defined for detected point positions.
Eu.DK.480	Info	***End position (left or right)*** The moveable element can be used to satisfy any operational need. E.g., points in route body and overlap or flank protection.
Eu.DK.481	Info	***Degraded position (left or right)*** The moveable element can only be used for specific operational needs. E.g., only limited flank protection can be accepted.
Eu.DK.482	Info	To determine the level of reliability of the detected overall position, each point machine must be configured as 'crucial' or as 'non-crucial', depending on how crucial the position detected by that point machine is to determine the overall position. At least one point machine (the only point machine when the moveable element is equipped with only one point machine interface) must be configured as 'crucial'.

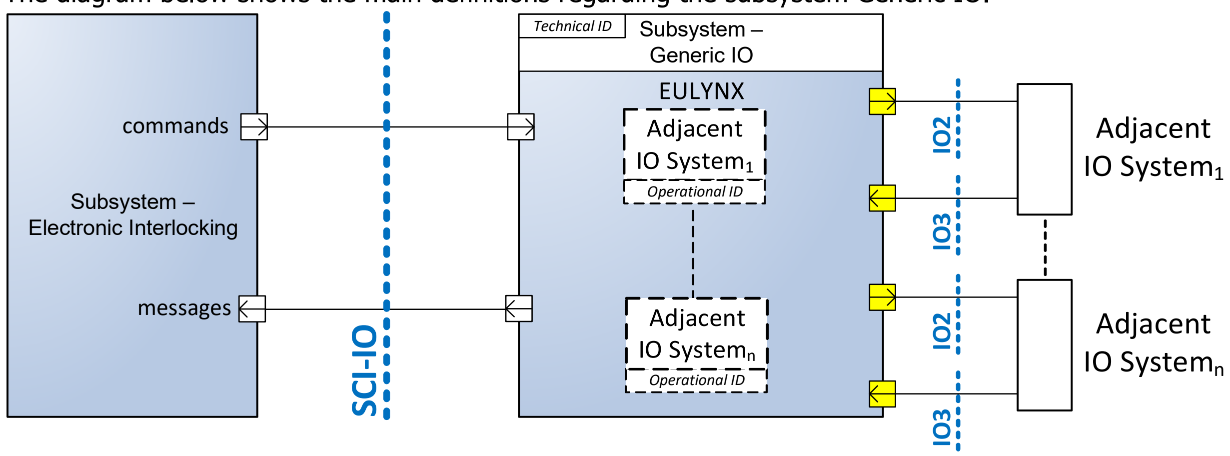
ID	Type	Domain knowledge
Eu.DK.483	Info	To be able to report an ***end position*** to the interlocking system, all point machines, whether they are configured as 'crucial' or 'non-crucial', must be detecting the same end position.
Eu.DK.484	Info	To be able to report a ***degraded position*** to the interlocking system, all point machines, which are configured as 'crucial' must be detecting the same end position. The point machines configured as 'non-crucial' don't need to detect the same end position, as long as they don't detect the opposite end position.
Eu.DK.485	Info	If there is no need to report degraded positions to the interlocking system, e.g. because the interlocking logic doesn't use this information, all point machines can be configured as 'crucial'.
Eu.DK.643	Head	**6.2.3 Point position overview diagram**
Eu.DK.644	Info	The figure below gives an overview of the terminology related to point position See Figure 1 on page 49.
Eu.DK.575	Head	**6.2.4 Point machine numbering**
Eu.DK.576	Info	If a point is equipped with more than one point machine, all point machines are numbered from 1 until n. The ordered numbering does not imply a specific position along the moveable point blades.
Eu.DK.577	Info	For the purpose of detecting the degraded position, there is a distinction between 'crucial' and 'non-crucial' point machines. There must always be at least one 'crucial' point machine.
Eu.DK.578	Info	If a point is equipped with more than one 'crucial' point machine, the 'crucial' point machines are numbered from 1 until i. The ordered numbering of 'crucial' point machines is independent from the ordered numbering of all point machines.
Eu.DK.579	Info	If a point machine is equipped with 'non-crucial' point machines, the 'non-crucial' point machines are numbered 1 until k. The ordered numbering of 'non-crucial' point machines is independent from the ordered numbering of all point machines.
Eu.DK.580	Info	The total number of point machines (n = any number starting from 1) equals the total number of 'crucial' point machines (i = any number starting from 1) plus the total number of 'non-crucial' point machines (k = any number starting from 0), n = i + k.
Eu.DK.486	Head	**6.2.5 Crank handle operation**
Eu.DK.189	Info	Crank handle operation is used to operate a point machine by hand. For staff safety reasons, point machines are isolated from the power at the point machine when a crank handle is in use.
Eu.DK.510	Head	**6.2.6 Trailing evaluation in the interlocking**
Eu.DK.511	Info	The required functionality related to detecting trailing on the functional level of the interlocking depends heavily on national signalling regulations and practices, which in their place depend on national operational rules.
Eu.DK.512	Info	On this functional level, position information from the individual point may be combined with other information available in the EIL, e.g. occupancy of TVP sections or route statuses, to conclude that a point is in a state that must be considered 'trailed'.
Eu.DK.513	Info	The conclusion that a certain point must be considered 'trailed' may also be based only on position information from the point object controller. For this, it is needed that the subsystem point reports 4 states, so it is possible to distinguish a detected 'unintended position' from a loss of position detection.
Eu.DK.514	Info	The conditions to no longer consider a certain point as 'trailed' again depend on national operational and signalling rules.
Eu.DK.603	Head	**6.2.7 Ability to move the point**
Eu.DK.604	Info	The subsystem Point may be equipped with functionality to supervise its ability to move the point and report this to the electronic interlocking.
Eu.DK.605	Info	This functionality can be used to supervise failures which cause unavailability of power to drive the point machines. Having this information available in the interlocking avoids sending futile commands to move a point, which would certainly lead to a timeout, and can thereby increase the availability of the infrastructure.
Eu.DK.606	Info	This functionality can also be used to prevent unwanted movement of a point during construction or operational restrictions, as the maintainer can set a switch that disables the movement. It is preferable to not disconnect or turn off the subsystem point, as the supervision of the point position could still be needed to provide flank protection to neighbouring routes.
Eu.DK.607	Info	The ability to move is monitored for each configured point machine and in the subsystem Point itself.
Eu.DK.608	Info	Inability to move at the level of one point machine may be caused, for example, by: • A malfunction of the point machine motor • A switch or other type of input that disables the point machine

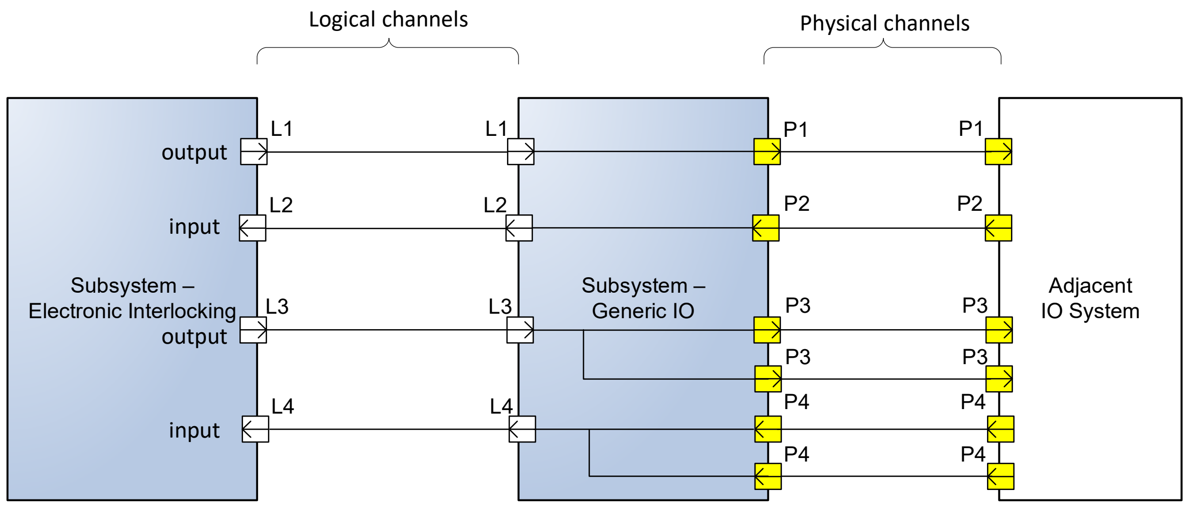
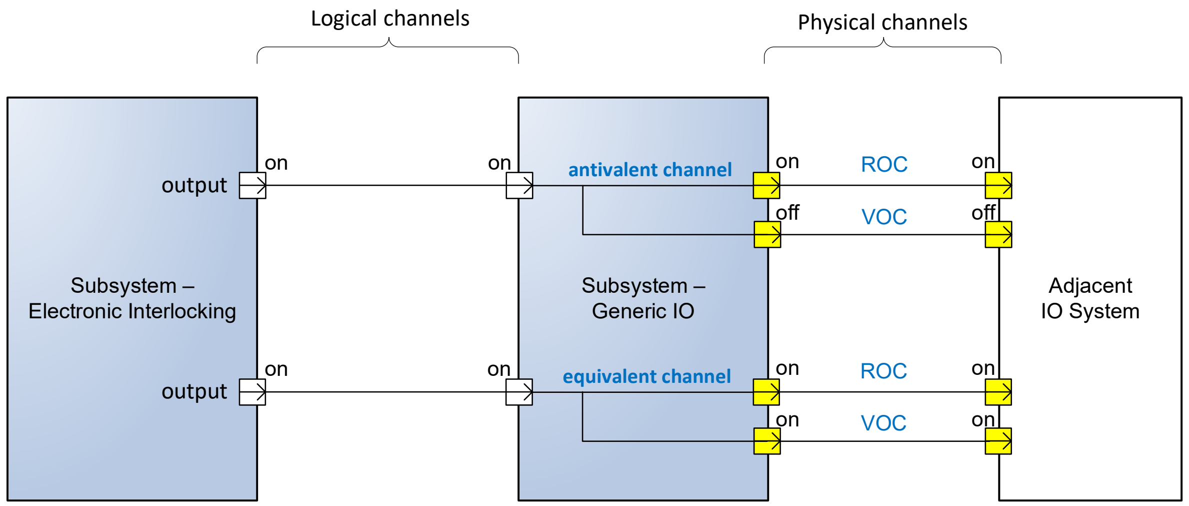
ID	Type	Domain knowledge
Eu.DK.609	Info	Inability to move at the level of the subsystem Point may be caused, for example, by: • Insufficient voltage to provide drive power to the point machines • A malfunction in the control of drive power to the point machines • A switch or other type of input that disables point movement
Eu.DK.610	Info	When the subsystem Point detects inability to move at any point machine or at the level of the subsystem itself, it reports the inability to the electronic interlocking. It also stops any ongoing point movement and does not start any new movement.
Eu.DK.611	Head	**6.2.8 Point and point machine staggering**
Eu.DK.612	Info	The moving of point machines has significant power consumption, with a characteristic peak at the start of the movement.
Eu.DK.613	Info	When multiple point machines simultaneously start a movement, the power consumption may exceed the capacity of the power supply system.
Eu.DK.614	Info	To optimise the use of the available power supply and improve availability, it may be needed to slightly delay the start of movement of points or individual point machines, called 'staggering'.
Eu.DK.615	Head	**6.2.8.1 Point staggering**
Eu.DK.616	Info	The setting of a certain route may require a change of position of several points. If the interlocking commands each subsystem Point simultaneously, the start of movement of their respective point machines will very likely overlap.
Eu.DK.617	Info	To avoid this, the interlocking can intentionally add a small delay before sending a command to move to subsequent subsystems Point. This functionality is part of the interlocking logic, which is covered by national specifications.
Eu.DK.618	Head	**6.2.8.2 Point machine staggering**
Eu.DK.619	Info	A subsystem Point may control one point with multiple point machines. If the subsystem Point starts each of its point machines simultaneously, the start of movement will overlap. This may cause the power consumption for that point to exceed the power supply limits.
Eu.DK.620	Info	To avoid this, the subsystem Point can intentionally add a small delay before starting subsequent point machines. This functionality is not in scope of the harmonised requirements, it is covered by national specifications.
Eu.DK.621	Info	Apart from the control of power consumption, there may also be reasons related to the physical design of the moveable elements that require specific timing of the movement of individual point machines.
Eu.DK.206	Head	**6.3 Train detection systems**
Eu.DK.223	Info	Track vacancy proving (TVP) and Train detection point (TDP) functions are integrated to the interlocking system through the subsystem Train Detection System (TDS). Track vacancy proving may be implemented with track circuits or axle counting systems. Train detection points may be implemented with the same wheel sensors used for track vacancy proving using an axle counter system or with separate wheel sensors. One subsystem Train Detection System may control one or many TVP sections and TDP locations.
Eu.DK.224	Head	**6.3.1 TVP Sections**
Eu.DK.225	Info	Track vacancy proving is the function that proves that a defined section of track is vacant. For this purpose, the track is divided into distinct portions, or TVP sections (TVPS). One subsystem Train Detection System may control more than one TVP section.
Eu.DK.489	Head	**6.3.2 TDP locations**
Eu.DK.490	Info	The Train detection point function proves that a train passes a defined track location. For this purpose, a wheel detection sensor is located at a position on the track to identify the passing of train wheels in a certain direction.
Eu.DK.226	Head	**6.3.3 Technical and operational identifiers**
Eu.DK.227	Info	The subsystem TDS has a technical identifier. In telegrams that are exchanged between the subsystem TDS and the subsystem Electronic Interlocking and relate to the generic behaviour of the subsystem TDS, the technical identifier of the subsystem TDS is used as identifier of the sender or receiver respectively.
Eu.DK.228	Info	Every TVPS that is controlled by a subsystem TDS has an operational identifier. In telegrams that are exchanged between the subsystem TDS and the subsystem Electronic Interlocking and regard the specific behaviour of individual TVP sections, the operational identifier of the TVPS is used as identifier of the sender or receiver respectively.
Eu.DK.491	Info	Every TDP that is controlled by a subsystem TDS has an operational identifier. In telegrams that are exchanged between the subsystem TDS and the subsystem Electronic Interlocking and concern the specific behaviour of individual TDP locations, the operational identifier of the TDP is used as identifier of the sender or receiver respectively.
Eu.DK.229	Head	**6.3.4 Types of track vacancy proving**

ID	Type	Domain knowledge
Eu.DK.230	Head	**6.3.4.1 Axle counters**
Eu.DK.231	Info	In an axle counter system, TVP sections are logical entities consisting of a section of track that is usually closed off by at least two detection points. One detection point can function as entry/exit point of more than one TVP section. On dead end tracks, one detection point can function as the sole entry/exit point of one TVP section.
Eu.DK.232	Info	In an axle counter system, one instance of the subsystem TDS usually covers several TVP sections.
Eu.DK.238	Info	The diagram below shows the main definitions regarding the subsystem TDS when implemented with axle counters. 
Eu.DK.233	Head	**6.3.4.2 Track circuits**
Eu.DK.234	Info	In a track circuit system, a TVP sections is a logical entity that usually coincides with the physical entity of one track circuit section. One logical TVP section can be composed of several track circuit sections.
Eu.DK.235	Info	In a track circuit system, one instance of the subsystem TDS covers one or several TVP sections.
Eu.DK.236	Info	EULYNX specifies the functional interface to the track circuits. The physical interface to the track circuit relays and possibly power off monitoring is covered by national specifications.
Eu.DK.240	Info	The diagram below shows the main definitions regarding the subsystem TDS when implemented with track circuits. 
Eu.DK.492	Head	**6.3.4.3 Train detection points**
Eu.DK.493	Info	In a train detection system, a TDP location is a logical entity that coincides with the physical entity of one detection point.
Eu.DK.494	Info	In a train detection system, one instance of the subsystem TDS usually covers several TDP locations.
Eu.DK.495	Info	EULYNX specifies the functional interface to the detection point. The physical interface to the implementation of the detection point is covered by national specifications.

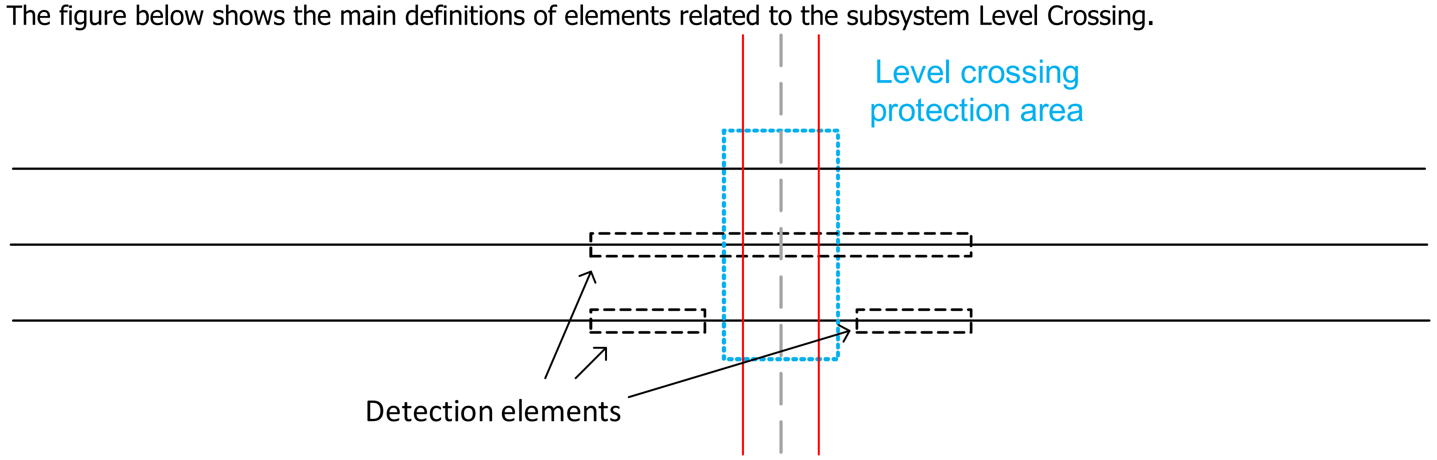
ID	Type	Domain knowledge
Eu.DK.497	Info	The diagram below shows the main definitions regarding the subsystem TDS when implemented with train detection points. 
Eu.DK.627	Head	**6.3.5 Power Off Monitoring**
Eu.DK.628	Info	In case track vacancy proving is implemented with track circuits, power off monitoring must be configurable.
Eu.DK.629	Info	The Power Off Monitoring supervises the availability of power supply to the track circuit device(s) for one or more TVP sections.
Eu.DK.630	Info	As crucial safety functionality, it must be assumed that non-availability of power supply to a track circuit device will always lead to detection of an occupancy.
Eu.DK.631	Info	The purpose of Power Off Monitoring is to distinguish between a real occupancy and an occupancy caused by a failure of the power supply to a TVP section.
Eu.DK.632	Info	In case the track circuit device detects an occupancy and the Power Off Monitoring does NOT detect a failure of the power supply, the occupancy is 'real' and very likely caused by presence of a railway vehicle in the TVP section.
Eu.DK.633	Info	In case the track circuit device detects an occupancy and the Power Off Monitoring does detect a failure of the power supply, it is not known what causes the occupancy. It may be caused by the power supply failure OR by presence of a railway vehicle in the TVP section.
Eu.DK.634	Info	The Power Off Monitoring may also fail itself. In case the availability of power supply to a track circuit device can't be determined with certainty, it must be assumed that the POM will report a power supply failure.
Eu.DK.635	Info	It is possible that the track circuit device detects, with certainty, a vacancy of a TVP section, while the POM reports a power supply failure. This can happen when the POM can't determine the power supply availability with certainty.
Eu.DK.636	Head	**6.3.5.1 Operational use of POM information**
Eu.DK.637	Info	*Case 1* Section state: Vacant POM state: OK The TVP section is certainly vacant. The power supply is certainly available.
Eu.DK.638	Info	*Case 2* Section state: Occupied POM state: OK The TVP section may be occupied. The power supply is certainly available. The occupation is most likely caused by a railway vehicle.

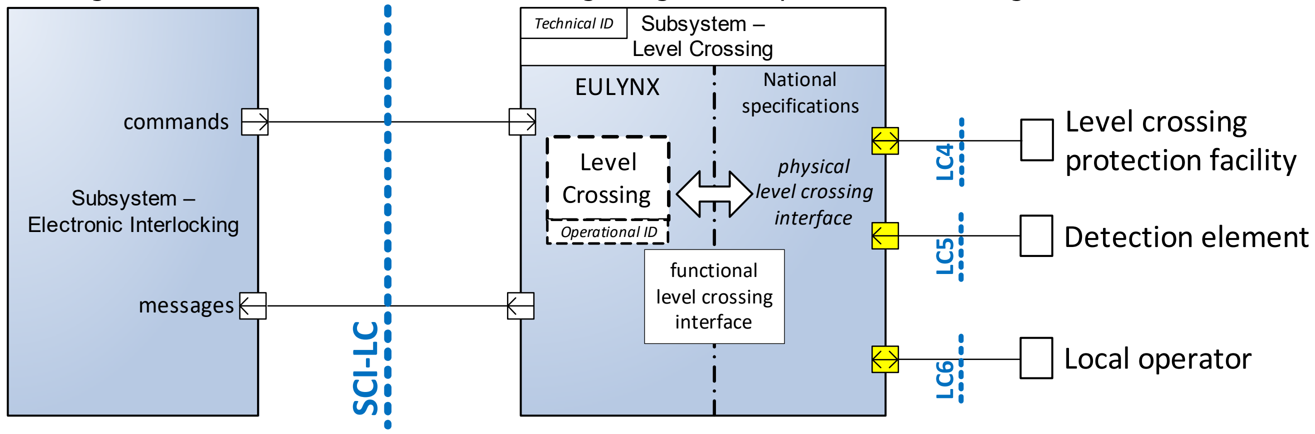
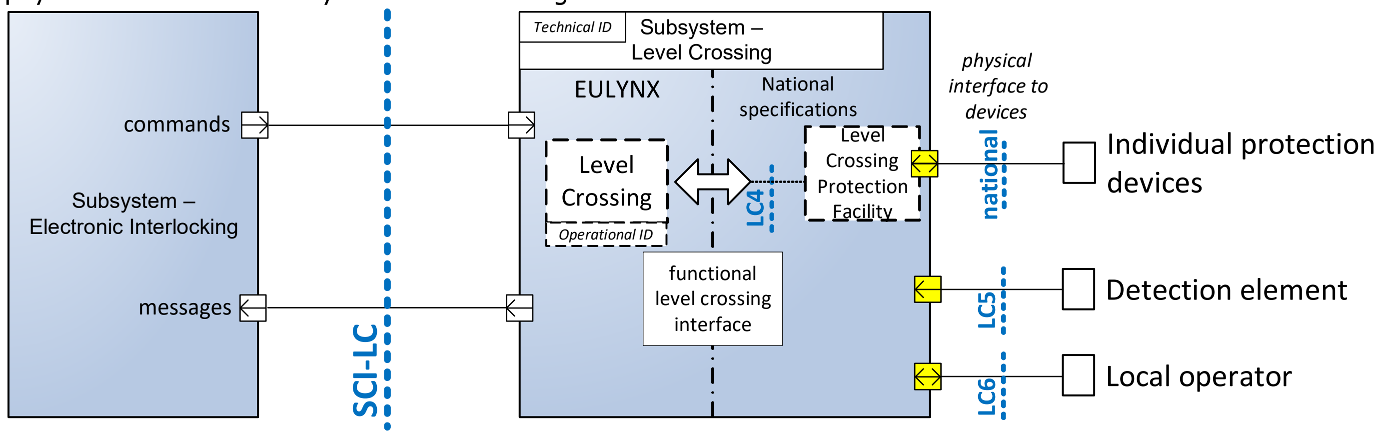
ID	Type	Domain knowledge
Eu.DK.639	Info	*Case 3* Section state: Vacant POM state: NOK The TVP section is certainly vacant. The power supply may not be available. The power supply must be sufficient for the track circuit to certainly detect a vacant section. It can therefore be concluded that the POM is not working properly.
Eu.DK.640	Info	*Case 4* Section state: Occupied POM state: NOK The TVP section may be occupied. The power supply may not be available. The occupation is most likely caused by a power supply failure, but presence of a railway vehicle can't be excluded.
Eu.DK.641	Info	In case 3, no limitations are needed in train operation, as the reliable detection of vacancy by the track circuit is a crucial safety functionality.
Eu.DK.642	Info	The distinction between case 2 and case 4 can be helpful to increase availability of railway capacity. As there is no certainty in case 4 that an occupation is NOT caused by a railway vehicle, this information can't be use for safety functions (locking a route, clearing a signal, granting movement authority). It can be used for availability functions (automatic route setting, train describer), in accordance with national specifications, for example to allow or suppress them in specific cases.
Eu.DK.115	Head	**6.4 IO elements and systems**
Eu.DK.127	Info	Individual signalling components are integrated to the interlocking system through the subsystem Generic IO. The subsystem Generic IO should not be used for interfacing with components or subsystems defined through dedicated SCI interfaces as SCI-P or SCI-LS. The controlling and monitoring of these components is performed with generic inputs and outputs, configurable for each specific application.
Eu.DK.128	Head	**6.4.1 Functional elements**
Eu.DK.129	Info	The IO elements or systems are referred to as "Adjacent IO Systems" and may be grouped according to their functionality: • elements requiring releasing and locking functionality • elements used as indicators, but not controlled as a light signal • elements used for detection • elements serving as local control panels
Eu.DK.130	Info	Functional elements used as lockable devices, requiring releasing and locking functionality, may be any of the following: • Moveable bridges • Tunnel gates / track closing gates • Key lock • Key lock on the line • Catenary elevating system
Eu.DK.131	Info	Functional elements used as indicators may be any of the following: • Warning lamp • Fouling point control lamp • Derailment and tracking indicator
Eu.DK.132	Info	Functional elements used as detectors may be any of the following: • Avalanche detection • Hot wheel box detector • Flat wheel detector • Gas detector • Fire detectors • Door sensors • Intrusion detector • Overload detector

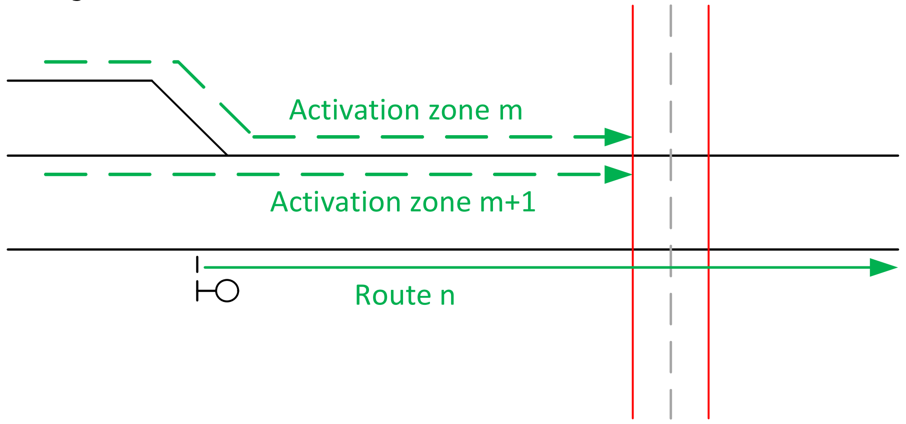
ID	Type	Domain knowledge
		• Light intensity detection • Trip wire detection • Overheating / freezing detection • Power supply status detection
Eu.DK.133	Info	Functional elements serving as local control panels may be any of the following: • Local control panel for single element - moveable bridge • Local control panel for single element - key locks • Local control panel for single element - derailer • Local control panel for single element - point • Local control panel for single element - catenary elevating system • Local control panel for single element - gates • Local control panel for - handling of transfer to verbal line block • Local control panel for areas (multiple elements)
Eu.DK.135	Info	The above lists are non-exclusive.
Eu.DK.136	Head	**6.4.2 Generic IO definition**
Eu.DK.241	Info	One subsystem Generic IO may control more than one Adjacent IO system. The Adjacent IO systems can be homogeneous or heterogeneous.
Eu.DK.242	Info	One Adjacent IO System may need to be controlled by more than one subsystem Generic IO, for example in case of a many-button local control panel (where the number of buttons exceeds the amount of channels available on one subsystem).
Eu.DK.243	Head	**6.4.2.1 Technical and operational identifiers**
Eu.DK.244	Info	The subsystem Generic IO has a technical identifier. In telegrams that are exchanged between the subsystem Generic IO and the subsystem Electronic Interlocking and relate to the generic behaviour of the subsystem Generic IO, the technical identifier of the subsystem Generic IO is used as identifier of the sender or receiver respectively.
Eu.DK.245	Info	Every Adjacent IO System that is controlled by a subsystem Generic IO has an operational identifier. In telegrams that are exchanged between the subsystem Generic IO and the subsystem Electronic Interlocking and regard the specific behaviour of individual Adjacent IO Systems, the operational identifier of the Adjacent IO System is used as identifier of the sender or receiver respectively.
Eu.DK.246	Info	The diagram below shows the main definitions regarding the subsystem Generic IO. 

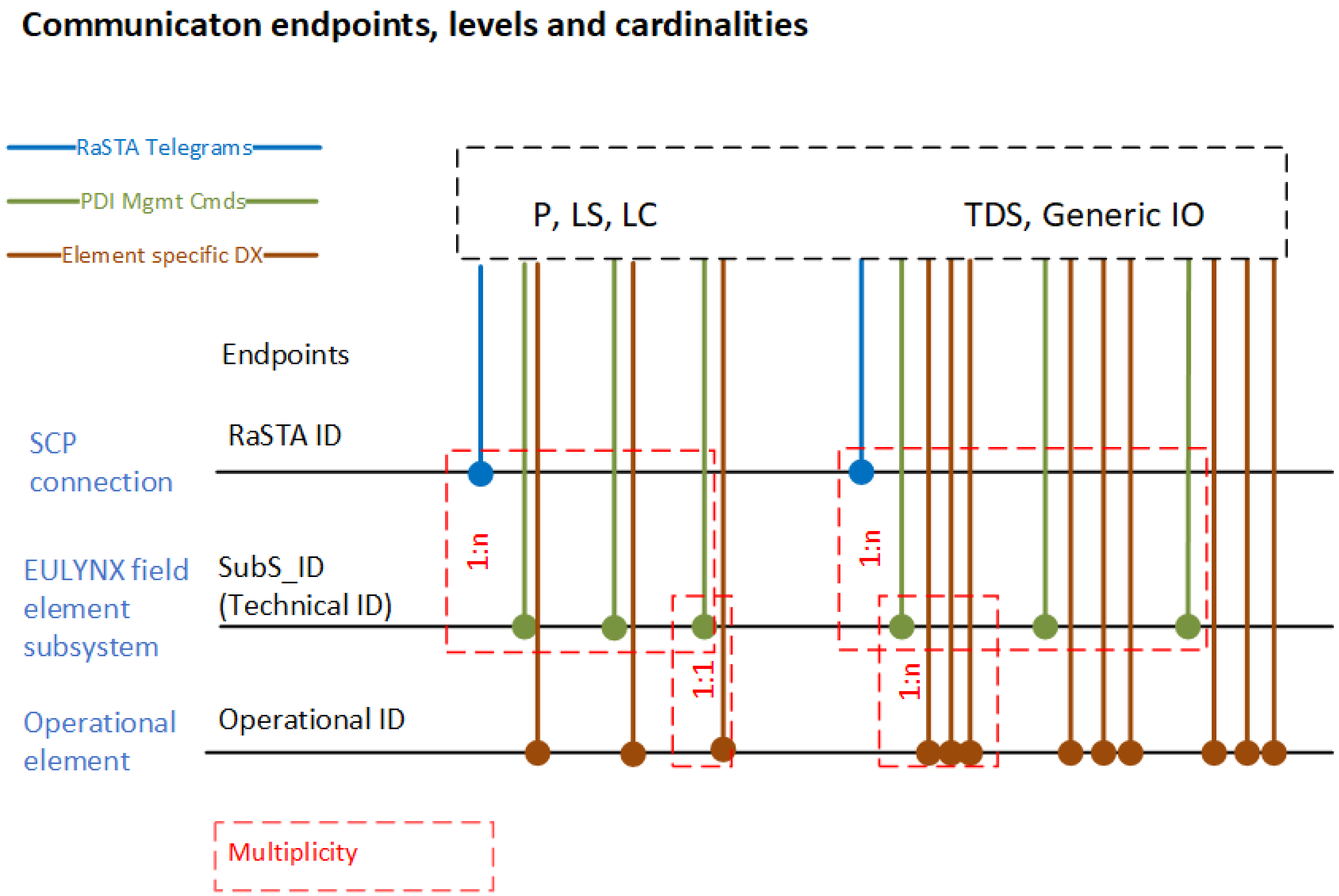
ID	Type	Domain knowledge
Eu.DK.139	Info	A logical channel represents a channel between the subsystem Electronic Interlocking and the subsystem Generic IO. A logical channel may be configured as: • input, representing the information, which is available to subsystem Electronic Interlocking • output, representing a command, which is sent from subsystem Electronic Interlocking A logical channel may be implemented as: • single channel, when assigned to one physical channel • antivalent channel, when assigned to two physical channels evaluated as antivalent • equivalent channel, when assigned to two physical channels evaluated as equivalent
Eu.DK.247	Info	Several logical channels can be addressed to the same Adjacent IO System. The logical channels can be of the same type or of differing types.
Eu.DK.137	Info	The following diagram displays the terminology of logical and physical channels for connection of an Adjacent IO Systems to the interlocking system through the subsystem Generic IO:
Eu.DK.158	Info	Channel definition 
Eu.DK.140	Info	Antivalent and equivalent configurations are displayed on the following diagram:
Eu.DK.159	Info	Example of antivalent and equivalent configurations 
Eu.DK.142	Info	A logical output channel may be configured as: • monitored, if the subsystem Generic IO proves internally that the outputs are set to the intended value (This monitoring only serves to report the technical failure of the output channel in the subsystem Generic IO. If for a specific application a fail-safe supervision of the reaction in the Adjacent IO System is required, an input channel shall be used for confirming the activation of the output in the Adjacent IO System) • not monitored (this can be used for outputs that are not safety-critical, or for outputs that are supervised indirectly via a related input channel)

<table>
<tr><th>ID</th><th>Type</th><th>Domain knowledge</th></tr>
<tr><td>Eu.DK.143</td><td>Info</td><td>A logical channel may be in one of the following states:
switched on
switched off
flashing (only output)
disturbed (operationally, when the anti/equivalence condition is not fulfilled, or technically)</td></tr>
<tr><td>Eu.DK.144</td><td>Info</td><td>A physical channel represents a channel between the subsystem Generic IO and the Adjacent IO System.
A physical channel may be configured as:
input, representing the information available to the subsystem Generic IO;
output, representing the information available from the subsystem Generic IO;</td></tr>
<tr><td>Eu.DK.145</td><td>Info</td><td>A physical channel is referred to as the following:
Reference Output Channel (ROC):
The reference output channel is a physical output channel. It is configured to be antivalent, equivalent or single channel. The reference output channel is used to represent the information of the logical output channel. The logical output channel is commanded by the subsystem Electronic Interlocking via SCI-IO.
Validation Output Channel (VOC):
The validation output channel is a physical output channel. It is always implemented in pair with a reference output channel, and is configured identically as the reference output channel. <u>The validation output channel is not used for single channels.</u>
The state of the validation output channel is switched by the subsystem Generic IO internally, in an antivalent or equivalent way to the reference output channel.
Reference Input Channel (RIC):
The reference input channel is a physical input channel. It is configured to be antivalent, equivalent or single channel.
The reference input channel is used for providing the information for the logical input channel. If no disturbance is detected, the logical input channel is reported to the subsystem Electronic Interlocking via SCI-IO.
Validation Input Channel (VIC):
The validation input channel is a physical input channel. It is always implemented in pair with a reference input channel, and is configured identically as the reference input channel. <u>The validation input channel is not used for single channels.</u>
The state of validation input channel is used by the subsystem Generic IO internally for proving the condition to the reference input channel.</td></tr>
<tr><td>Eu.DK.204</td><td>Info</td><td>The relation between physical and logical channels
<table>
<tr><th>Physical channels are configured as:</th><th>Value of RIC/ROC</th><th>Value of VIC/VOC</th><th>Value of related logical channel</th><th>Evaluation of physical channels</th></tr>
<tr><td rowspan="4">antivalent</td><td>0</td><td>0</td><td>Disturbed</td><td>Invalid</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>Valid</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>Valid</td></tr>
<tr><td>1</td><td>1</td><td>Disturbed</td><td>Invalid</td></tr>
<tr><td rowspan="4">equivalent</td><td>0</td><td>0</td><td>0</td><td>Valid</td></tr>
<tr><td>0</td><td>1</td><td>Disturbed</td><td>Invalid</td></tr>
<tr><td>1</td><td>0</td><td>Disturbed</td><td>Invalid</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>Valid</td></tr>
<tr><td rowspan="2">single</td><td>0</td><td>Not existent</td><td>0</td><td>Valid</td></tr>
<tr><td>1</td><td>Not existent</td><td>1</td><td>Valid</td></tr>
</table></td></tr>
<tr><td>Eu.DK.351</td><td>Info</td><td>The subsystem Electronic Interlocking has no knowledge whether a logical channel is implemented with a single, antivalent or equivalent physical channels.</td></tr>
<tr><td>Eu.DK.146</td><td>Head</td><td>6.4.3 Application library</td></tr>
<tr><td>Eu.DK.147</td><td>Info</td><td>The subsystem Generic IO has no functional knowledge about the attached Adjacent IO Systems, except grouping the channels connected to each Adjacent IO System. The functional knowledge about the Adjacent IO Systems is in the subsystem Electronic Interlocking. An application library may be used by IMs to describe the individual logical and physical implementation of each Adjacent IO System (such as key lock, moveable bridge…).</td></tr>
</table>

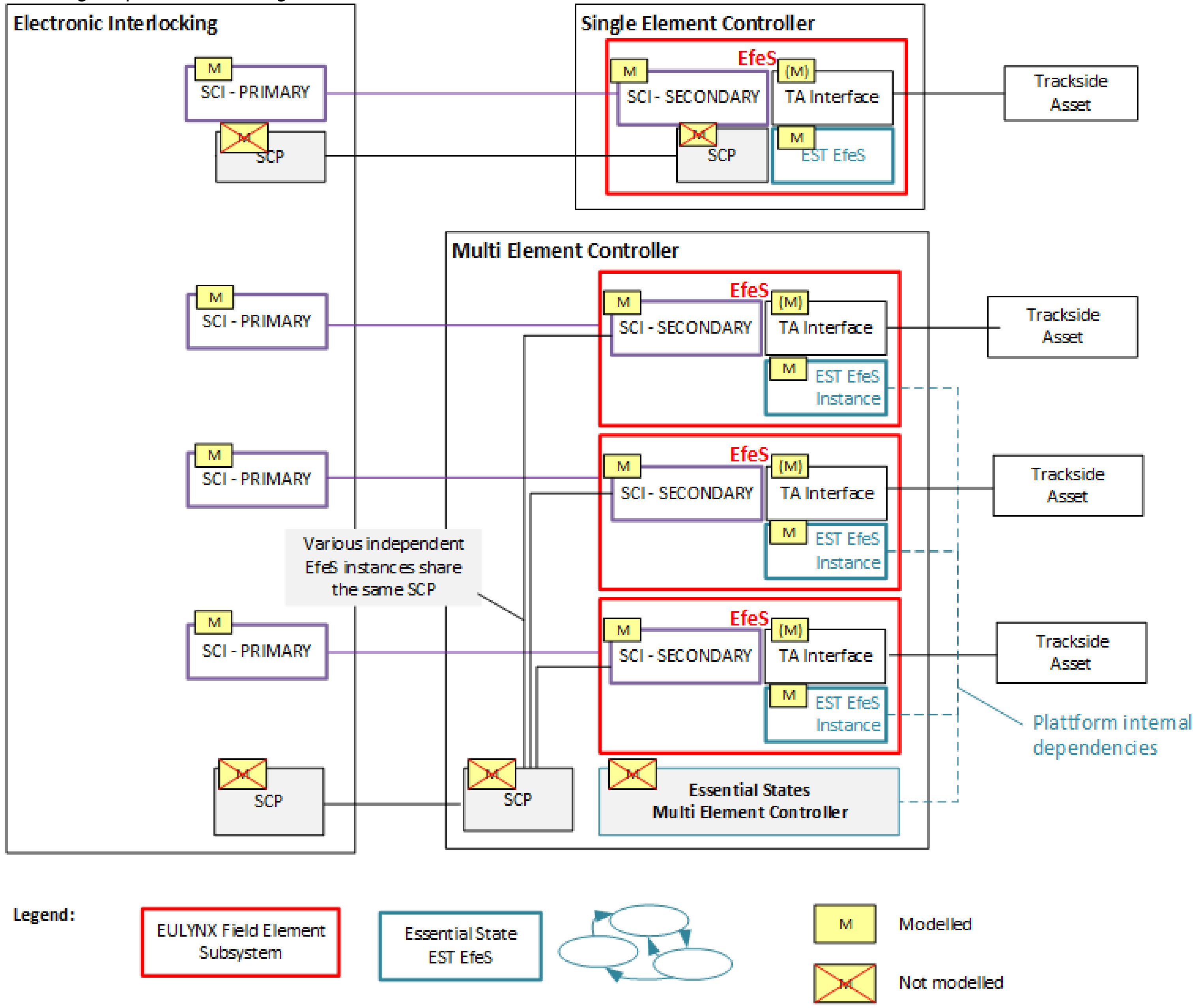
ID	Type	Domain knowledge
Eu.DK.148	Head	**6.4.4 Constraints with application of subsystem Generic IO**
Eu.DK.149	Info	The use of the subsystem Generic IO is limited to a realistic sampling rate of 1Hz.
Eu.DK.150	Info	The mitigation of bouncing effects on the input channels is not a function of the application layer, this must be handled by the physical implementation.
Eu.DK.151	Info	The following issues must be considered by the physical implementation: • debouncing of the inputs • detection of fleeting inputs shorter than the available sampling rate.
Eu.DK.61	Head	**6.5 Level Crossing**
Eu.DK.291	Info	Systems to prevent collisions between trains and road users at level crossings are integrated to the interlocking system through the subsystem Level Crossing or through the adjacent system External Level Crossing System.
Eu.DK.433	Info	The subsystem Level Crossing is used to integrate level crossing systems for which the activation and deactivation logic is handled externally of the subsystem (for example in the interlocking system or in the Radio Block Centre)
Eu.DK.292	Info	The subsystem Level Crossing controls one level crossing as a single operational element. It controls one Level Crossing Protection Facility to protect the corresponding Level Crossing protection area.
Eu.DK.348	Info	The figure below shows the main definitions of elements related to the subsystem Level Crossing. 
Eu.DK.498	Info	The Subsystem - Level Crossing does not control (de)activation points. Different track element may act as (de)activation point, depending on the activation logic, which may be handled in the interlocking or RBC. This includes detection elements of the Subsystem - Level Crossing, TVP sections, Train detection points or train position reports.
Eu.DK.584	Info	Detection elements of the Subsystem - Level Crossing are not intended to be used for the monitoring of track occupation and/or route release. Elements for those functions can be integrated to the interlocking system via the subsystem Train Detection System.
Eu.DK.581	Head	**6.5.1 Level Crossing Protection Facility**
Eu.DK.293	Info	The level crossing protection facility controls all protection devices that are used to warn and obstruct road traffic. It may contain: • Road signals (with warning lamps and/or warning bells) • Barriers • Obstacle detector • Warning signs • Other devices
Eu.DK.294	Info	The level crossing protection facility protects the area where road traffic (including motor vehicles, bicycles, pedestrians, etc.) is at risk of being hit by a passing train, called the level crossing protection area.
Eu.DK.646	Info	The level crossing protection facility has three states, defined as follows: • Protected: The activation sequence has been completed, all protection conditions are fulfilled. • Unprotected: An activation or deactivation sequence is ongoing, or a protection condition is not or no longer fulfilled (e.g. broken barrier, failed warning lamp). • Idle: The deactivation sequence has been completed, all protection has been removed.
Eu.DK.297	Info	When the level crossing protection facility is activated, it will start a sequence of warning devices and barrier movement to protect the level crossing protection area. Once this sequence has been completed, the level crossing is considered to be in the state 'protected'.
Eu.DK.298	Info	When the level crossing protection facility is deactivated, a deactivation sequence will start to remove the protection of the level crossing protection area. As soon as the level crossing protection facility starts deactivating, the level crossing is considered to be in the state 'unprotected'. Once this sequence has been completed, the level crossing is considered to be in the state 'idle'.

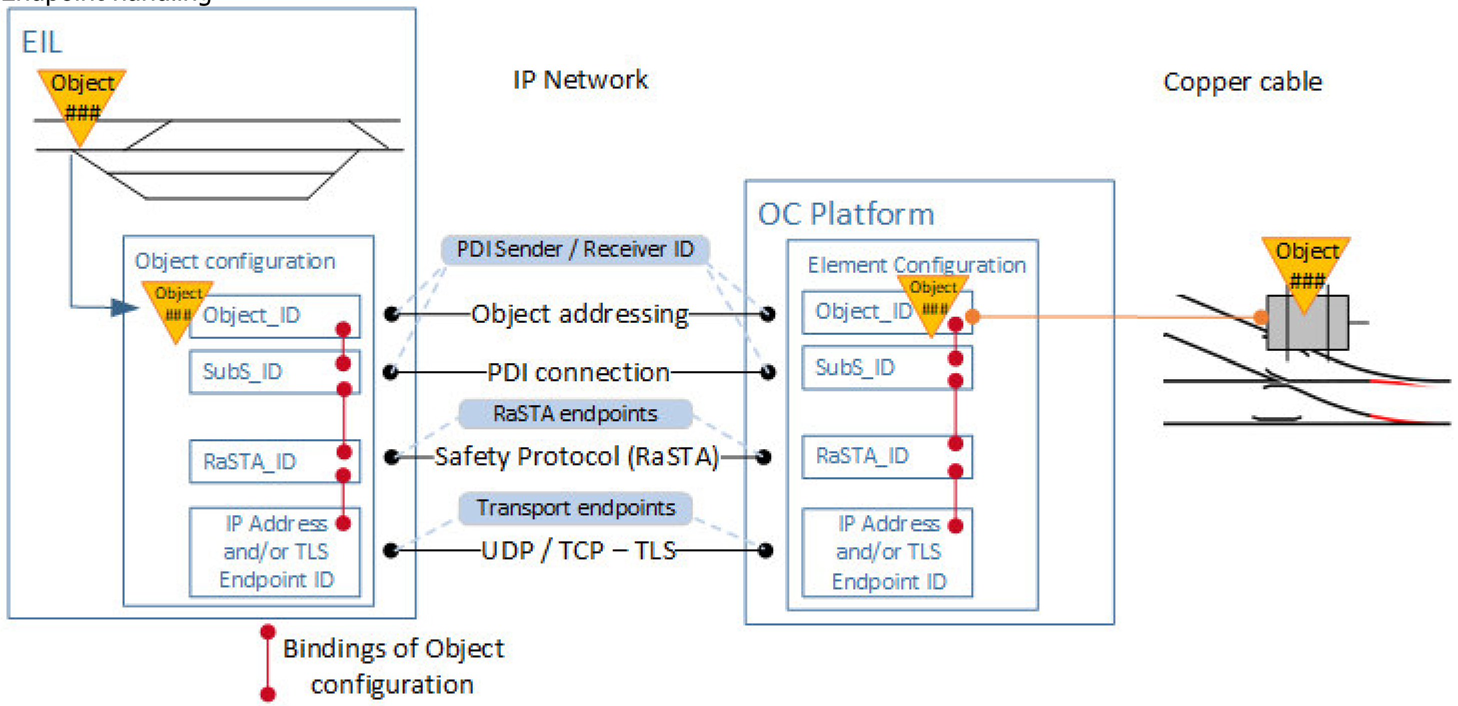
ID	Type	Domain knowledge
Eu.DK.295	Info	EULYNX specifies the functional interface to the level crossing. The physical interface to the level crossing protection facility is covered by national specifications.
Eu.DK.347	Info	The diagram below shows the main definitions regarding the subsystem Level Crossing. 
Eu.DK.582	Info	The physical interface to the level crossing protection facility may be implemented as several physical interfaces to individual protection devices (lamps, warning bells, barriers). In this case, the logic to control the activation and deactivation sequences, which is part of the functionality of the level crossing protection facility will be handled in the same physical device as the subsystem Level Crossing. The interface LC4 will in this case be a purely internal logical interface. The physical interfaces to the individual protection devices of the LCPF are in this case not part of LC4.s
Eu.DK.583	Info	The diagram below shows the main definitions regarding the subsystem Level Crossing in case the logic to control the activation and deactivation sequences of the level crossing protection facility is handled in the same physical device as the subsystem Level Crossing. 
Eu.DK.299	Head	**6.5.2 Functions of the subsystem Level Crossing**
Eu.DK.301	Head	**6.5.2.1 Activation and deactivation**
Eu.DK.302	Info	The activation (or deactivation) of the level crossing is directly triggered by a command from the interlocking. That means that the complete level crossing protection facility shall be activated (or deactivated) without an evaluation of conditions on track, direction or route by the level crossing.
Eu.DK.420	Info	Activation or deactivation may be commanded based on one or more conditions in the interlocking. Examples of conditions leading to an activation are: • route (or overlap) setting resulting in a request to activate or deactivate a level crossing • presence of a train in an activation zone • a request resulting from a command by the signaller • a request resulting from a command by the Radio Block Centre

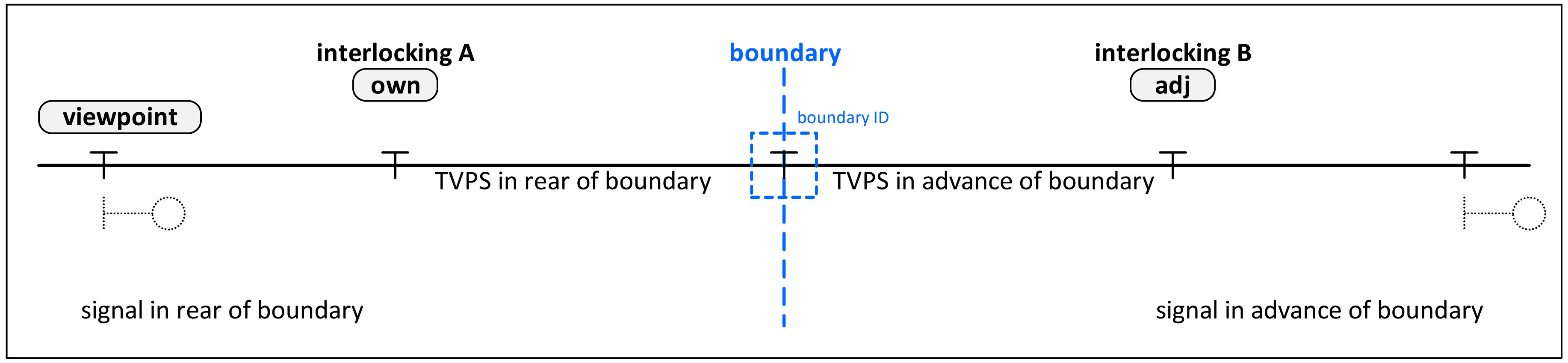
ID	Type	Domain knowledge
Eu.DK.422	Info	The figure below shows the main definitions related to conditions in the interlocking for (de)activation. 
Eu.DK.305	Head	**6.5.2.2 Pre-activation**
Eu.DK.306	Info	The interlocking commands the pre-activation of a level crossing. Pre-activation is used for pre-warning traffic lights, interrupts to control units of traffic lights etc.. Interlocking conditions for pre-activation are used as for regular activation, with the difference that a pre-activation usually start some distance in rear of the start of the corresponding activation zone.
Eu.DK.307	Info	The interlocking can revoke a pre-activation by commanding a deactivation in case a previously expected train is no longer expected to activate the level crossing (e.g. it stopped in the pre-activation zone and will not continue).
Eu.DK.462	Head	**6.5.2.3 Activation and deactivation by local request**
Eu.DK.328	Info	A local operator can request activation or deactivation of the level crossing via a local operator interface. Requests can be applied for the complete or partial (e.g. one out of two tracks) level crossing protection area, based on an index. Requests are sent to the interlocking, which will evaluate relevant conditions. After evaluation, the interlocking can send activation or deactivation commands to the subsystem Level Crossing.
Eu.DK.435	Info	The level crossing protection facility may be operated independent of the interlocking system or subsystem Level Crossing (e.g. no connection to the interlocking, subsystem Level Crossing not operational). This direct operation of the level crossing protection facility and the related operational procedures are outside of the scope of EULYNX and are subject to national specifications.
Eu.DK.327	Head	**6.5.2.4 Local operation handover**
Eu.DK.329	Info	The interlocking logic may handle a handover of responsibility of the level crossing protection area to a local operator, according to national operational procedures. For this handover, commands and messages are exchanged between the interlocking and the local operation interface connected to the subsystem Level Crossing. The handover can be applied for the complete or partial (e.g. one out of two tracks) level crossing protection area, based on an index.
Eu.DK.423	Head	**6.5.2.5 Isolation**
Eu.DK.421	Info	The interlocking can command the subsystem Level Crossing to become isolated, and not react on failure of the communication. This may be used in case of engineering works on an interlocking, in order to prevent all level crossings connected to that particular interlocking to go into a fail-safe state due to failure of communication, resulting in a protected level crossing protections facility. The interlocking system guarantees and monitors the safe application of this function. Applying the isolated mode may only be permitted if for example there are no routes locked and the route setting is blocked.
Eu.DK.342	Head	**6.5.3 Statuses**
Eu.DK.343	Info	The subsystem Level Crossing informs the interlocking of its status, based on different principles:
Eu.DK.344	Info	***Functional status*** This message is used for the statuses of the subsystem Level Crossing which are required within the interlocking logic.
Eu.DK.345	Info	***Monitoring status*** This message is used for the statuses of the subsystem Level Crossing which are required for display to the signaller.
Eu.DK.346	Info	***Failure status*** This message is used when a failure occurred or is revoked.
Eu.DK.436	Info	***Obstacle detection status*** This message is used to report an obstacle detected inside the level crossing protection area.
Eu.DK.437	Info	***Detection element status*** This message is used to report the occupancy status of detection elements.

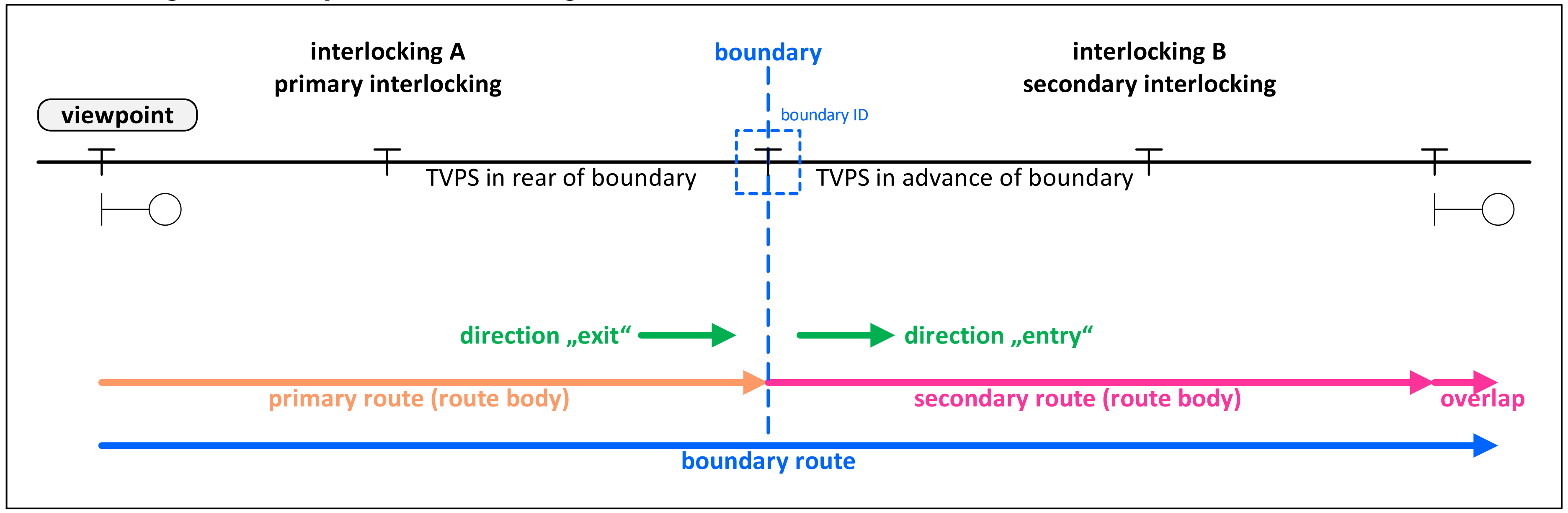
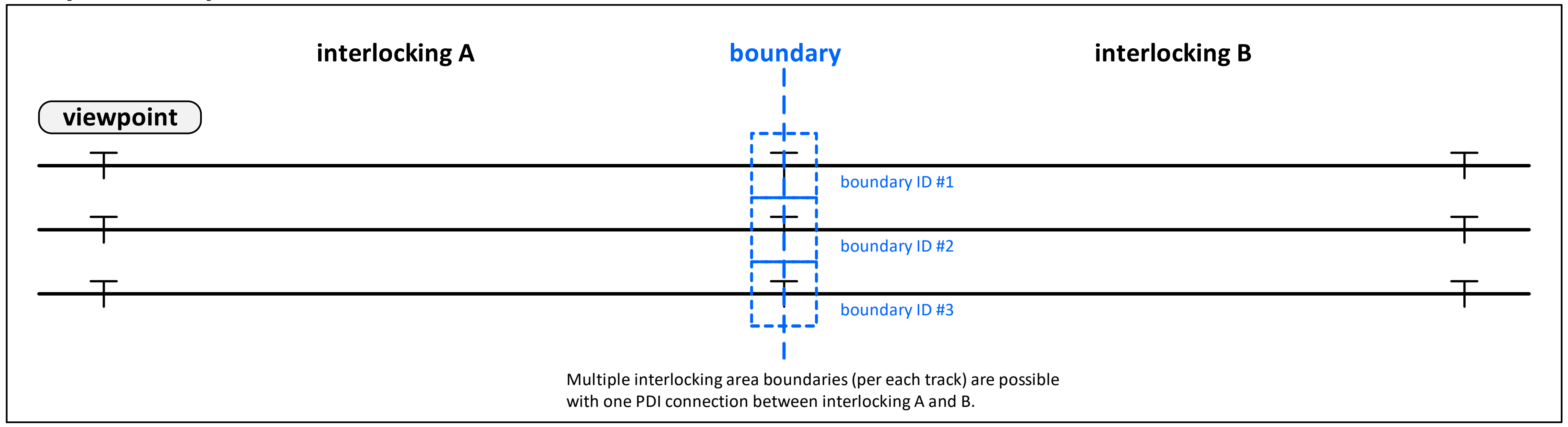
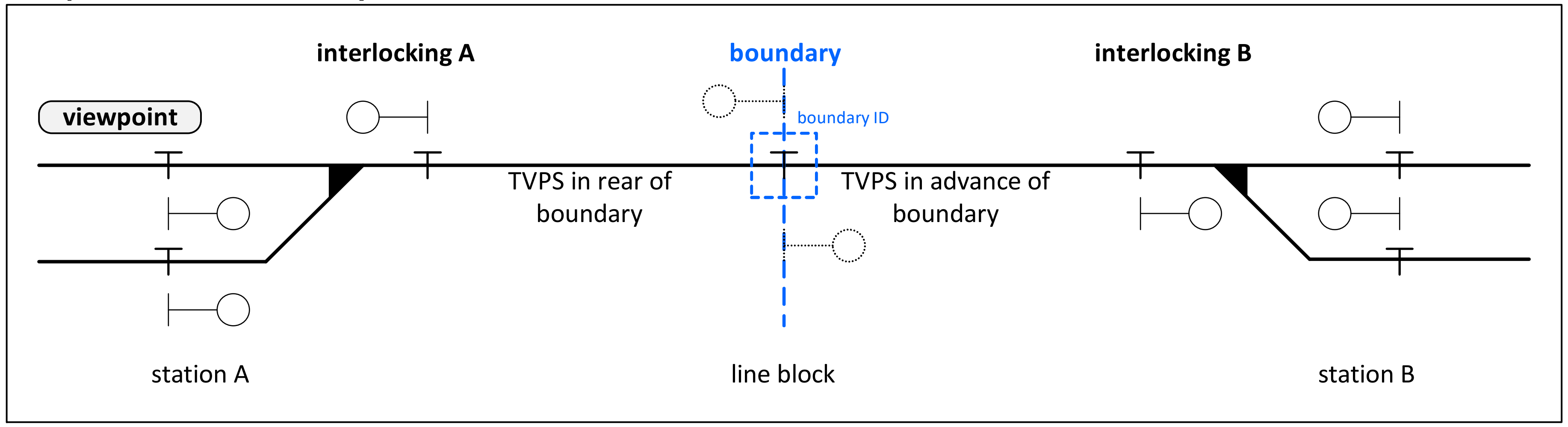
ID	Type	Domain knowledge
Eu.DK.515	Head	**6.6 Single-element and multi-element controllers**
Eu.DK.516	Info	The EULYNX field element subsystems (EfeS) can be implemented with different types of controllers.
Eu.DK.517	Info	A **single-element controller** implements one EfeS in a single physical device.
Eu.DK.518	Info	A **single type multi-element controller** implements more than one EfeS in a single physical device. All EfeS are of the same type (Light Signal, Point, Train Detection System, Generic IO or Level Crossing).
Eu.DK.519	Info	A **multi type multi-element controller** implements more than one EfeS in a single physical device. The implemented EfeS are of different types.
Eu.DK.520	Head	**6.6.1 Levels and multiplicities**
Eu.DK.521	Info	The multiplicity between one physical device and multiple controlled track elements is handled on different logical levels.
Eu.DK.551	Info	The logical levels and their multiplicities are visualised in the diagram below and described in the sections that follow. 
Eu.DK.522	Head	**6.6.1.1 Communication levels and endpoints**
Eu.DK.523	Info	<u>Operational elements</u> The lowest logical level of the communication between the electronic interlocking and the EfeS addresses a single operational element. This is a specific light signal, point, track vacancy proving section, train detection point, adjacent IO system or level crossing. The telegrams of the Process Data Interface protocol include the operational identifier as Sender or Receiver Identifier when addressing a concrete operational element.

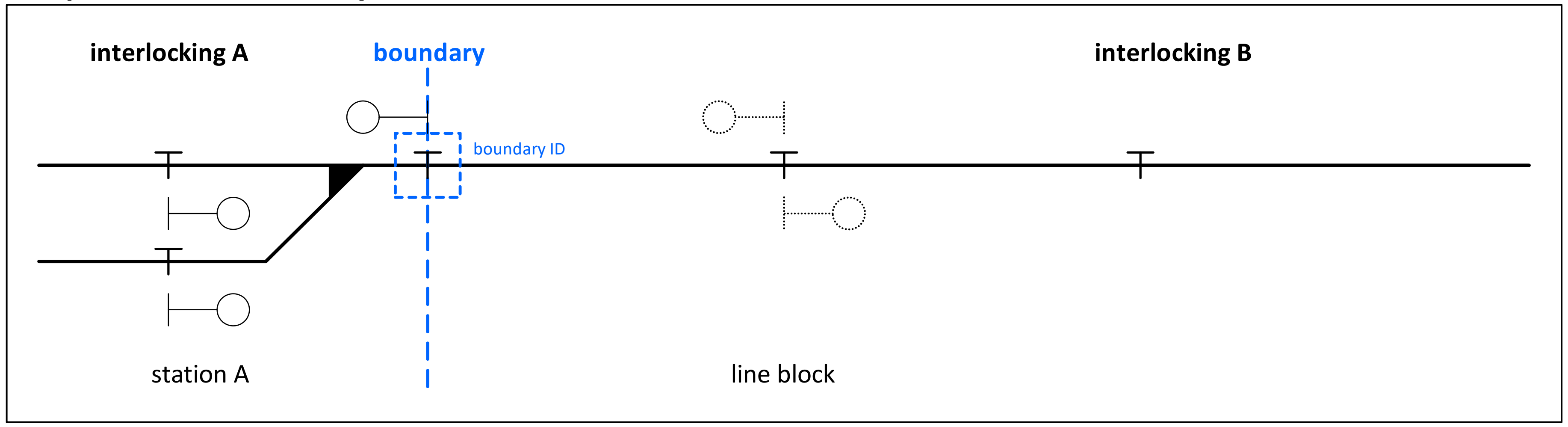
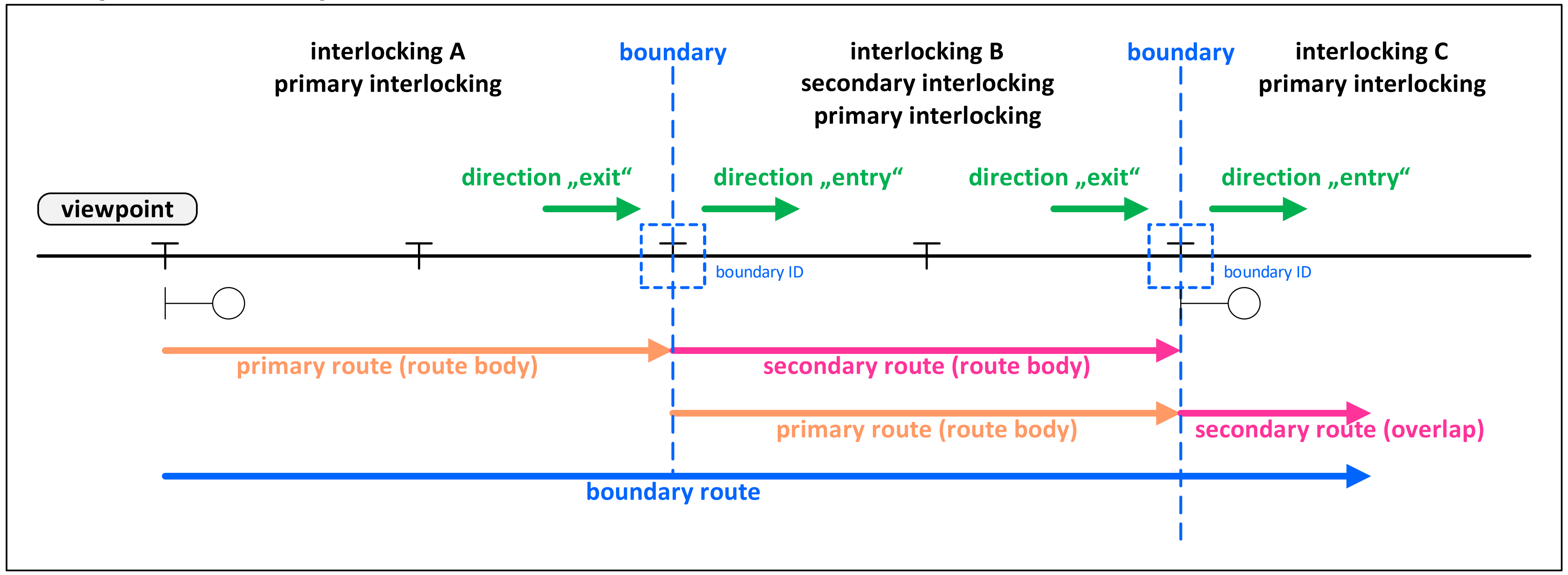
ID	Type	Domain knowledge
Eu.DK.524	Info	EULYNX field element subsystem A part of the communication between the electronic interlocking and the EfeS addresses the EfeS itself. This is the case for all generic PDI telegrams that are exchanged during the establishing and closing of the PDI connection. These generic telegrams of the Process Data Interface protocol contain the technical identifier of the EfeS as Sender or Receiver Identifier.
Eu.DK.525	Info	Safe Communication Protocol RaSTA The communication layer below the PDI protocol is the Safe Communication Protocol. The endpoints of this communication are formed by the RaSTA endpoints. For multi-element controllers, the RaSTA endpoint of the SCP connection may be located on a common system part for all the instances of EULYNX field element subsystems implemented on the device.
Eu.DK.526	Head	**6.6.1.2 Multiplicities**
Eu.DK.527	Info	Number of operational elements per EULYNX field element subsystem The EfeS for Light Signal, Point and Level Crossing control only one single operational element. The EfeS for Train Detection System and Generic IO control multiple operational elements (TVP sections, train detection points, logical input and output channels). A physical device implementing *one* subsystem TDS or Generic IO is considered a *single-element controller*, even if it controls multiple operational elements!
Eu.DK.528	Info	Number of PDI connections per EULYNX field element subsystem There is always exactly one PDI connection that connects the EULYNX field element subsystem with the interlocking system.
Eu.DK.529	Info	Number of PDI connections per SCP connection A single-element controller implements one EULYNX field element subsystem and therefore has only one PDI connection, which will be stacked on one SCP connection. The multiple PDI connections of a multi-element controller (single type or multi type) can be stacked together on one SCP connection.
Eu.DK.530	Info	Because MEC platforms can share one SCP (RaSTA) channel for multiple PDI connections, the heartbeat communication related to one EfeS instance is reduced. The bandwidth requirement per EfeS instance decreases accordingly.
Eu.DK.531	Info	No. of SCP connections per physical device A single-element controller will have only one SCP connection. A multi-element controller (single type or multi type) may have one or more SCP connections. Although possible, it may not be optimal to have a high number of PDI connections all stacked on a single SCP connection.
Eu.DK.532	Head	**6.6.2 Essential states**
Eu.DK.533	Info	For a concrete EfeS instance on a multi-element controller, the essential states must be regarded as abstract states, even if their naming implies a relation to hardware behaviour. By its nature, the status of the platform that implement a multi-element controller may impact the status of all the EfeS instances that it implements. This means that there are some dependencies between the EfeS states and the state of the multi-element controller.
Eu.DK.534	Info	The state can be BOOTING either because the underlying platform controller is booting or because the interface to a specific (set of) operational element(s) is booting. The state NO_POWER can be interpreted as meaning that the core functionality of an EfeS instance is turned off. The state INITIALISING of an EfeS has a fully identical meaning for multi-element and single-element controllers. The specific EfeS is ready to establish connection to the interlocking or ready to perform maintenance interaction with the MDM.
Eu.DK.535	Head	**6.6.3 Management of SCP connection**
Eu.DK.536	Info	The management of the SCP connection is fully decoupled from the essential state of the EfeS. This is necessary, because on a multi-element controller it is possible that the SCP connection is provided by a different part of the controller (either physically or logically separated).
Eu.DK.537	Info	On a multi-element controller, depending on the architecture, it may be possible to have an established SCP connection while one or more of the EfeS is (re-)booting. Given by its architecture, a single-element controller may have constraints to this flexibility. For a single-element controller, it will most likely not be possible to establish the SCP connection before the EfeS has finished booting and is in state INITIALISING.
Eu.DK.538	Head	**6.6.4 Scope of model-based specifications**
Eu.DK.539	Info	The model-based specifications of EULYNX don’t cover the dependencies between the state of the multi-element controller and the essential states of the implemented EfeS. The management of the SCP connection is also not in the scope of the model-based specifications.

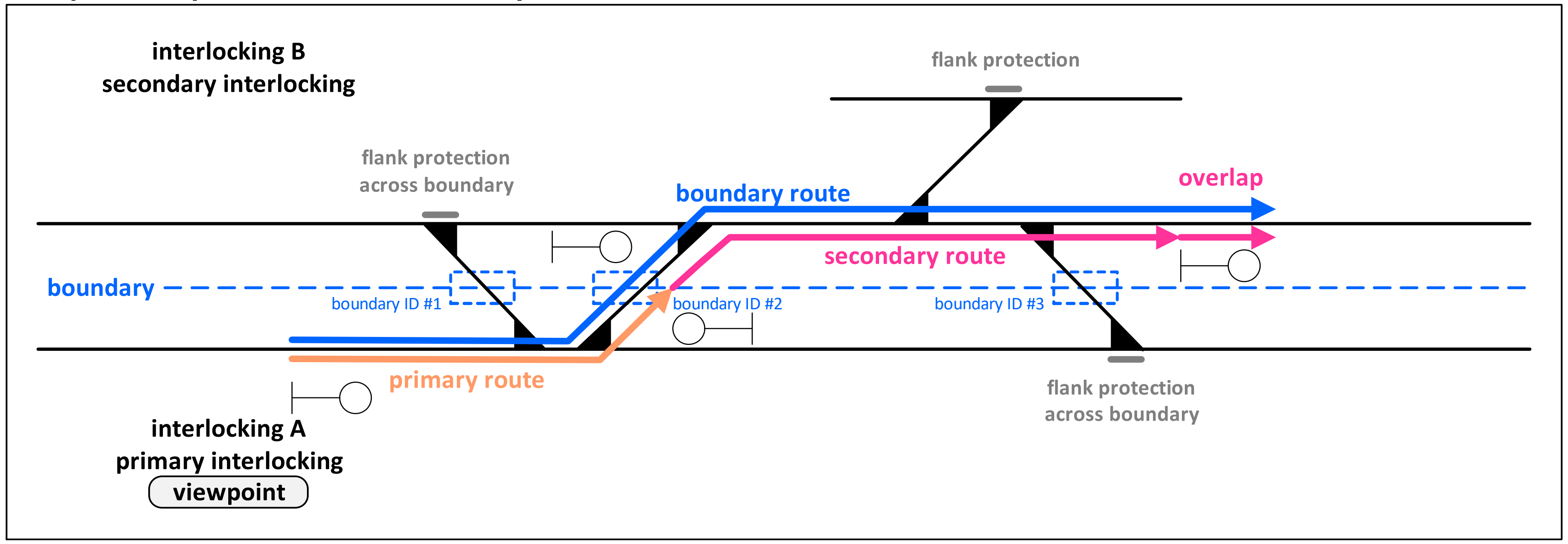
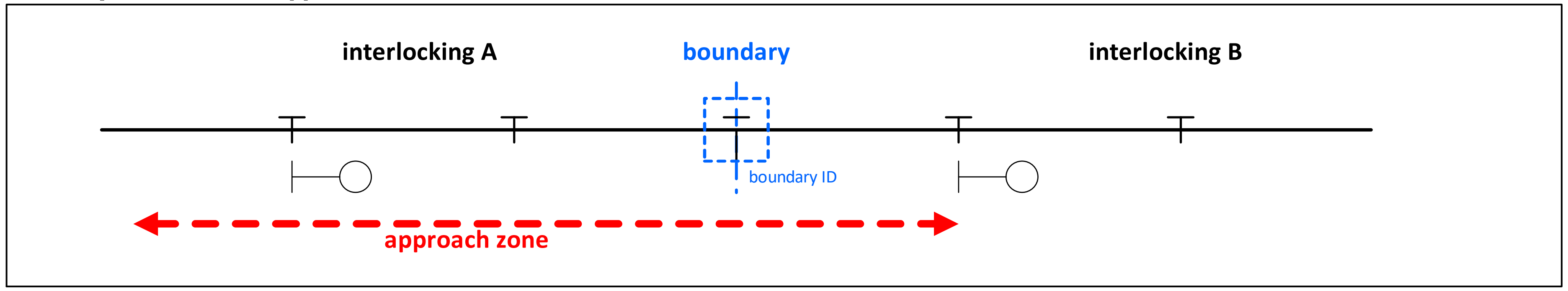
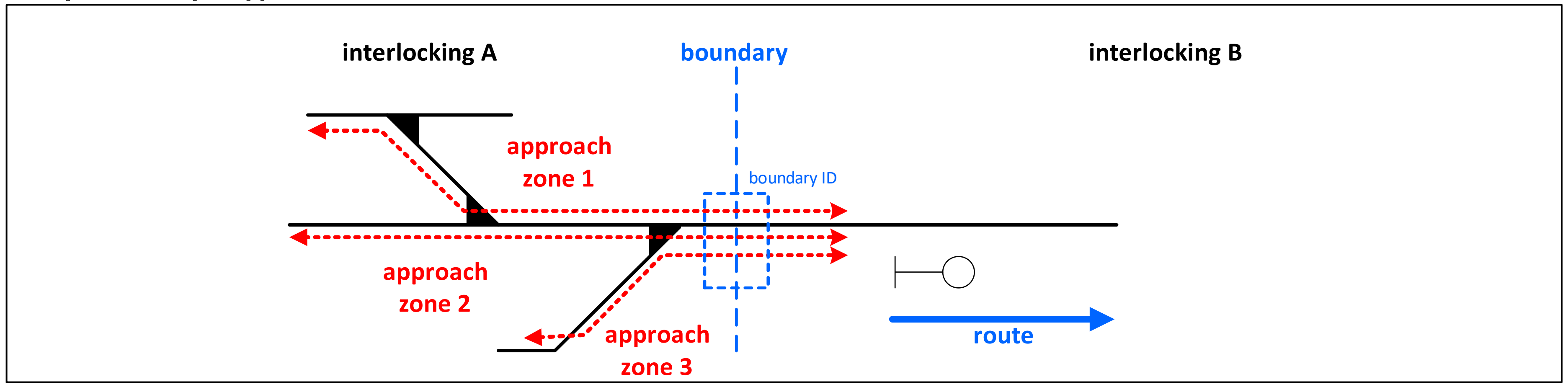
<table>
<tr><th>ID</th><th>Type</th><th>Domain knowledge</th></tr>
<tr><td>Eu.DK.552</td><td>Info</td><td>Modelling scope related to single- and multi-element controllers

</td></tr>
<tr><td>Eu.DK.540</td><td>Head</td><td>6.6.5 Handling of communication inside interlocking</td></tr>
<tr><td>Eu.DK.541</td><td>Info</td><td>The multi-element controller is transparent for communication with the interlocking. It does not form an explicit endpoint from the point of view of the interlocking. All endpoints required by the interlocking refer to the operational element to be controlled (during operation) or to the EfeS (during initialisation).</td></tr>
<tr><td>Eu.DK.542</td><td>Info</td><td>The multiplicity among communication levels may vary. This is implicitly manifested by the addressing configuration. Each operational element that occurs in the configuration and engineering data of the interlocking must be able to be controlled via the following assignment (addressing configuration): Object X -> Operational Identifier -> Technical Identifier (EfeS) -> RaSTA ID -> IP address and/or TLS Endpoint ID.</td></tr>
<tr><td>Eu.DK.543</td><td>Info</td><td>Functionally, there is no difference in commanding an EfeS hosted on a single-element controller or a multi-element controller. The different endpoints are assigned in the configuration and engineering data of the interlocking and thus the communication paths are always resolved in the same manner.</td></tr>
</table>

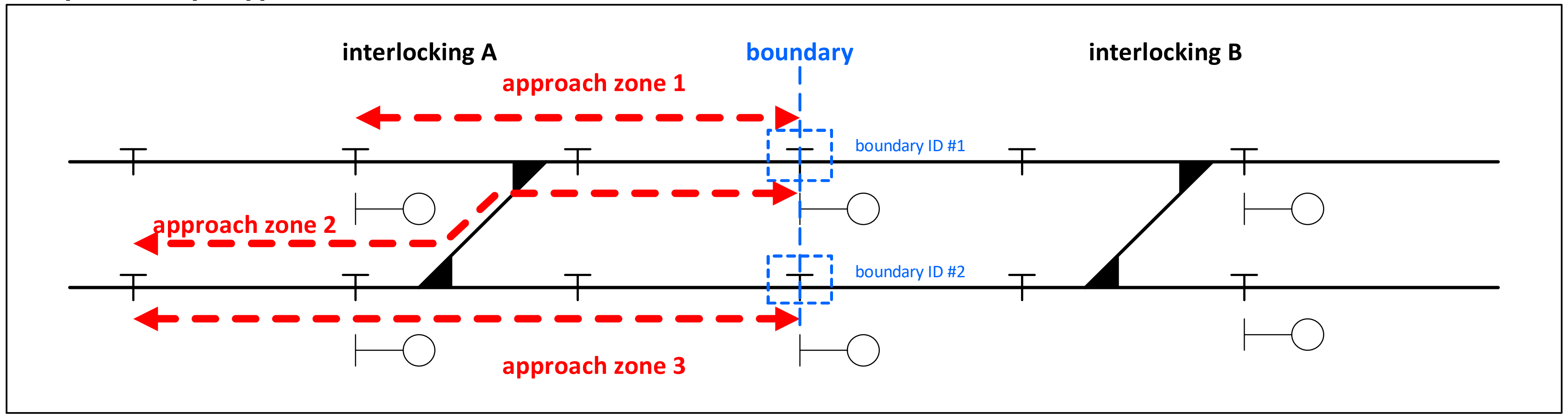
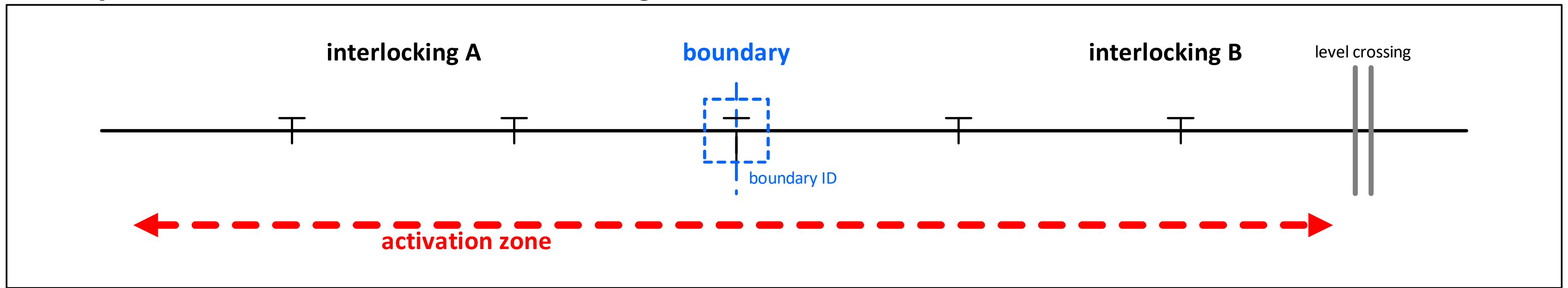
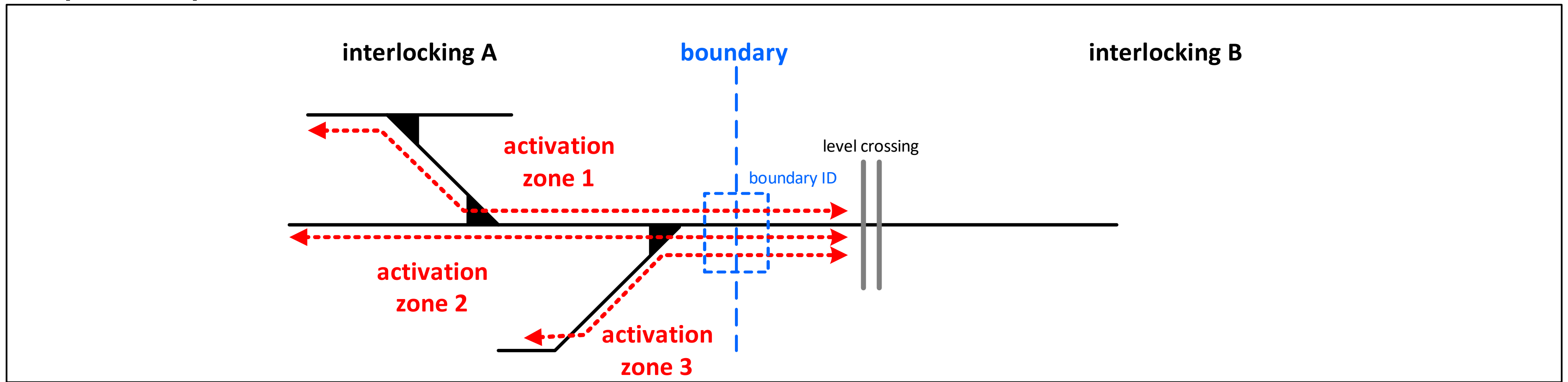
ID	Type	Domain knowledge
Eu.DK.553	Info	Endpoint handling 
Eu.DK.544	Head	**6.6.6 Handling of diagnostics, maintenance and security interfaces on multi-element controllers**
Eu.DK.545	Head	**6.6.6.1 Diagnostics interface**
Eu.DK.546	Info	EULYNX does not define how the cardinality between EfeS instances and OPC UA endpoints for SDI should be implemented. It is possible that one OPC UA endpoint can serve as a diagnostics gateway for multiple EfeS instances. Therefore, the generic SDI data model supports the addressing of both physical equipment instances and logical subsystem instances.
Eu.DK.547	Head	**6.6.6.2 Maintenance interface**
Eu.DK.548	Info	EULYNX does not define how the cardinality between EfeS instances and OPC UA endpoints for SMI should be implemented. It is possible that one OPC UA endpoint can serve as a maintenance gateway for multiple EfeS instances. Therefore, the generic SMI data model supports the addressing of a specific subsystem within a MEC by a top-level node with the SubS_ID as identifier.
Eu.DK.549	Head	**6.6.6.3 Security interface**
Eu.DK.550	Info	The manufacturer can design the placement of the SSI endpoints and the use of the Security Services in such a way that the MEC concept is supported optimally and in accordance with the security specifications.
Eu.DK.598	Head	**6.6.7 Handling basic data and basic data identifier**
Eu.DK.599	Info	Each EfeS instance requires its own set of basic data.
Eu.DK.600	Info	A part of the basic data content may be identical for several EfeS instances that are implemented on a multi-element controller. This includes the own network addresses and the network addresses of the communication partners (including the MDM).
Eu.DK.601	Info	EULYNX does not define the data structure of the basic data provided to either the multi-element controller as a whole or to each EfeS instance individually.
Eu.DK.602	Info	The physical implementation of the Basic Data identifier is left to the suppliers. The implementation must be such that there is a physical relation between the data set for a specific EfeS instance and the in/outputs related to the controlled subsystem.
Eu.DK.563	Head	**7 Overall timing requirements**
Eu.DK.564	Info	Overall timing behaviour is governed by one safety requirement. This safety requirement defines the safety response time needed between the occurrence of an infrastructure related anomaly violating route monitoring conditions until setting the safety relevant outputs (for example signal aspect) to a safe state.
Eu.DK.565	Info	The assumed overall safety response time for an undisturbed EULYNX system is 1,6 seconds. This overall assumed time is derived by summing up the values below as follows: Eu.DK.566 + Eu.DK.569 + Eu.DK.568 + Eu.DK.569 + Eu.DK.567.

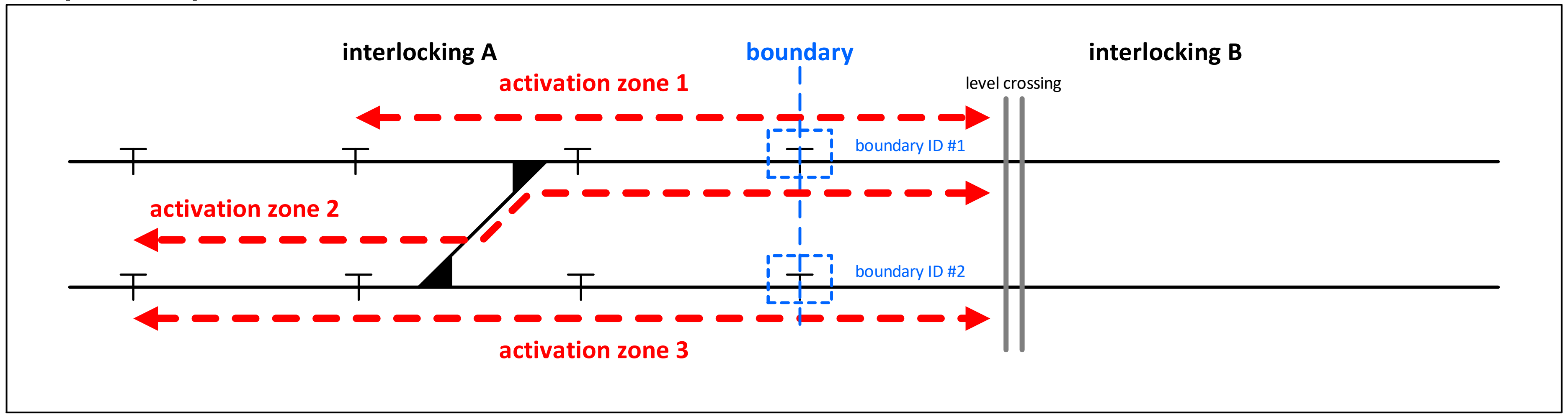
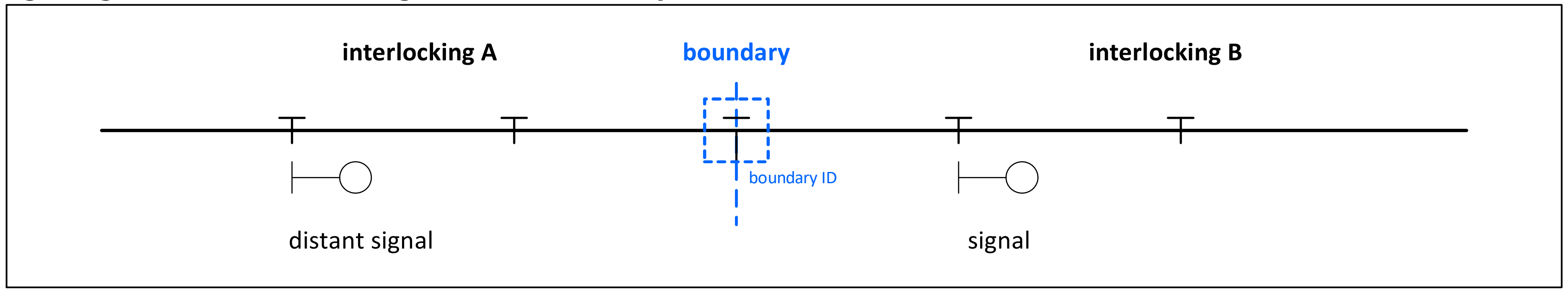
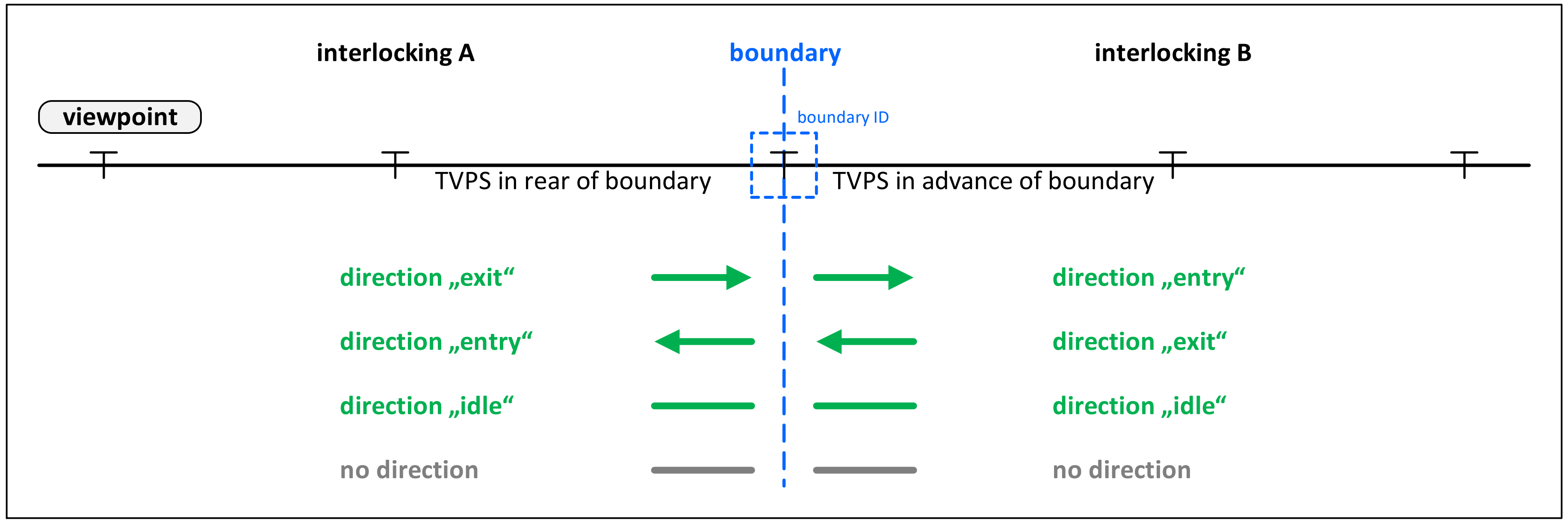
ID	Type	Domain knowledge
Eu.DK.566	Info	For a EULYNX field element subsystem, the time span between detection of a status change at the control interface (e.g. status of lamps, point position, wheel sensor) and the sending of an SCI-XX message at the PoS-Signalling reporting this is assumed to not exceed 500 ms. Note: The concrete timing requirements are defined in the requirements specification of the EULYNX field element subsystems and may differ from this value.
Eu.DK.567	Info	For a EULYNX field element subsystem, the time span between reception of an SCI-XX command at the PoS-Signalling and the respective reaction at the control interface (e.g. turning lamps on or off, start of point movement) is assumed to not exceed 500 ms. Note: The concrete timing requirements are defined in the requirements specification of the EULYNX field element subsystems and may differ from this value.
Eu.DK.568	Info	For a Subsystem - Electronic Interlocking, the time span between reception of an SCI-XX message at the PoS-Signalling reporting a status change and the sending of an SCI-XX command at the PoS-Signalling to a EULYNX field element subsystem reflecting the changed status is assumed to not exceed 500 ms. Note: The concrete timing requirements for the Subsystem - Electronic Interlocking are defined by national requirements.
Eu.DK.569	Info	The delay between the sender and the receiver at a PoS-Signalling assumed to not exceed 50 ms. Note: This concrete timing requirement is defined in [Eu.Doc.100].
Eu.DK.571	Info	In case a disturbance is present inside the EULYNX system, the safety response time can be higher. The most likely disturbance is related to the delay on the Subsystem – Communication System.
Eu.DK.74	Head	**8 Interlocking system boundaries**
Eu.DK.75	Info	This section describes the concept and terminology across interlocking system boundaries.
Eu.DK.179	Info	Boundaries may be located in a station area or on the open line.
Eu.DK.76	Info	The route across an interlocking system boundary is considered as a 'boundary route'.
Eu.DK.77	Info	A 'boundary route' consists of the following: • *primary route as part of the boundary route located in the primary interlocking* • *secondary route as part of the boundary route located in the secondary interlocking*
Eu.DK.78	Info	The primary route contains the route entry signal. The secondary route contains the route exit signal. This is the default scenario.
Eu.DK.79	Info	The direction must be accounted for applications on the line.
Eu.DK.80	Head	**8.1 Interlocking system boundary definitions**
Eu.DK.81	Info	The concepts and terminology defining the use of interlocking boundaries are displayed in the following figures.
Eu.DK.161	Info	**Basic terms** 

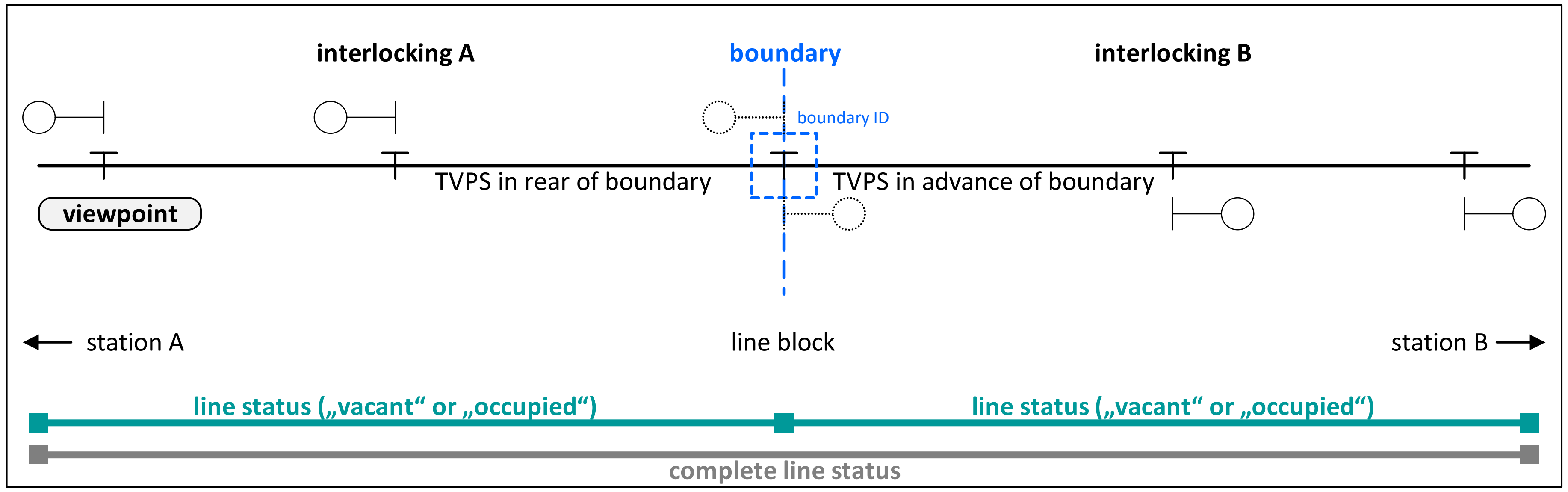
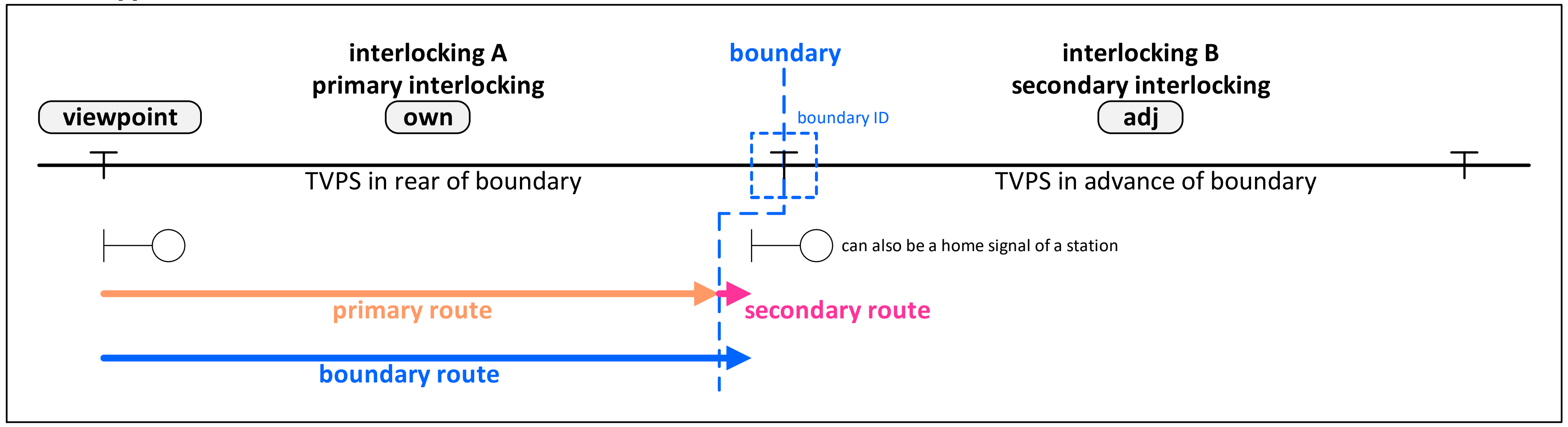
ID	Type	Domain knowledge
Eu.DK.162	Info	**Routes crossing the boundary between interlocking areas** 
Eu.DK.358	Info	**Example for multiple boundaries** 
Eu.DK.359	Info	**Example for line block boundary 1** 

ID	Type	Domain knowledge
Eu.DK.360	Info	**Example for line block boundary 2** 
Eu.DK.86	Head	**8.2 Boundary route across multiple boundaries**
Eu.DK.87	Info	A route may be a primary route and a secondary route at the same time if multiple interlocking boundaries are passed.
Eu.DK.164	Info	**Boundary route across multiple boundaries** 
Eu.DK.165	Head	**8.3 Flank protection provision across the boundary**
Eu.DK.166	Info	Flank protection may be provided across a boundary by the adjacent interlocking system.

ID	Type	Domain knowledge
Eu.DK.167	Info	**Flank protection provision across the boundary** 
Eu.DK.89	Head	**8.4 Boundary located in the approach zone of a route**
Eu.DK.168	Info	**Boundary located in the approach zone of a route** 
Eu.DK.379	Info	**Example of multiple approach zones 1** 

ID	Type	Domain knowledge
Eu.DK.357	Info	**Example of multiple approach zones 2** 
Eu.DK.92	Head	**8.5 Boundary located in the activation zone of a level crossing**
Eu.DK.169	Info	**Boundary located in the activation zone of a level crossing** 
Eu.DK.380	Info	**Example of multiple activation zones 1** 

ID	Type	Domain knowledge
Eu.DK.381	Info	**Example of multiple activation zones 2** 
Eu.DK.170	Head	**8.6 Provision of signalling information for distant signals**
Eu.DK.171	Info	**Signalling information for distant signals across a boundary** 
Eu.DK.361	Head	**8.7 Direction**
Eu.DK.365	Info	**Definition of direction** 
Eu.DK.362	Info	Description of 'no direction': An interlocking is in the state 'no direction' regarding the line direction when the last known own direction information is not available in the interlocking during the initialisation of the PDI connection. The state 'no direction' is then sent to the adjacent interlocking during status report.
Eu.DK.363	Info	If both interlockings are in state 'no direction' then the direction agreement is achieved by using the pre-configured direction information which is stored in configuration data).

ID	Type	Domain knowledge
Eu.DK.364	Info	Note: The direction 'idle' is used only for a specific line block variant in which the direction is controlled by route setting and train movement. This is valid status of the direction in a operational interface regarding this line block variant. It shall not be confused with 'no direction'.
Eu.DK.366	Head	**8.8 Line status**
Eu.DK.367	Info	**Line status** 
Eu.DK.368	Info	The line status provides information about the status of the line between the station and the interlocking system boundary regarding one interlocking area.
Eu.DK.370	Info	Vacant: No train vehicle is on the line. Detailed conditions can be defined by national specifications. Occupied: A train vehicle is on the line. Detailed conditions can be defined by national specifications.
Eu.DK.369	Info	Line status information is exchanged between two interlockings so that each interlocking can determine the status of the whole line for further purposes in the interlocking logic.
Eu.DK.374	Head	**8.9 Application variants**
Eu.DK.375	Info	**Possible application variant 1** 

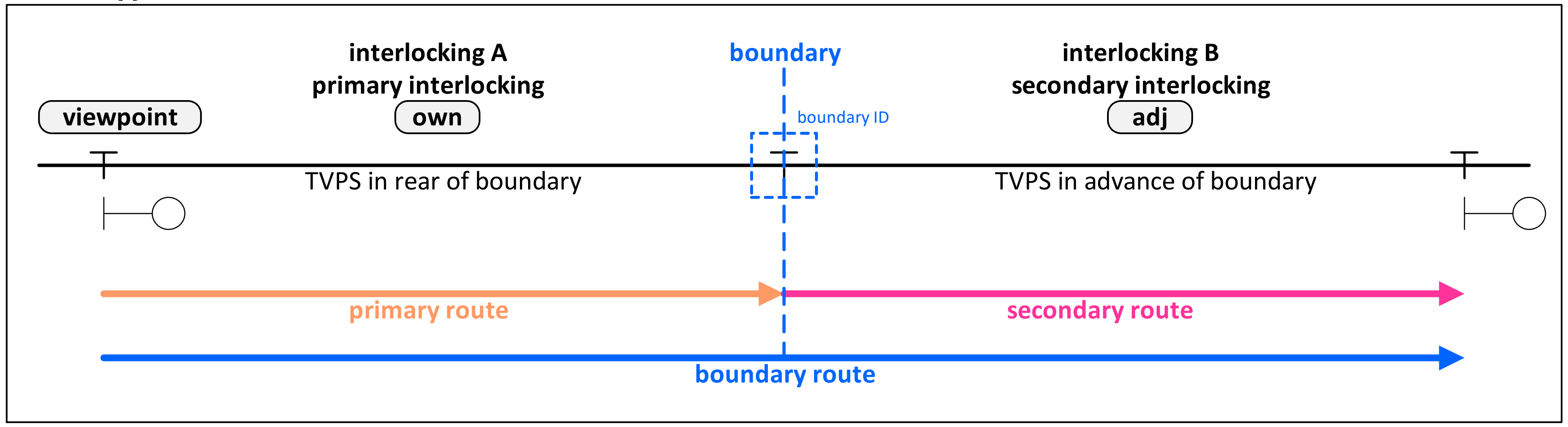
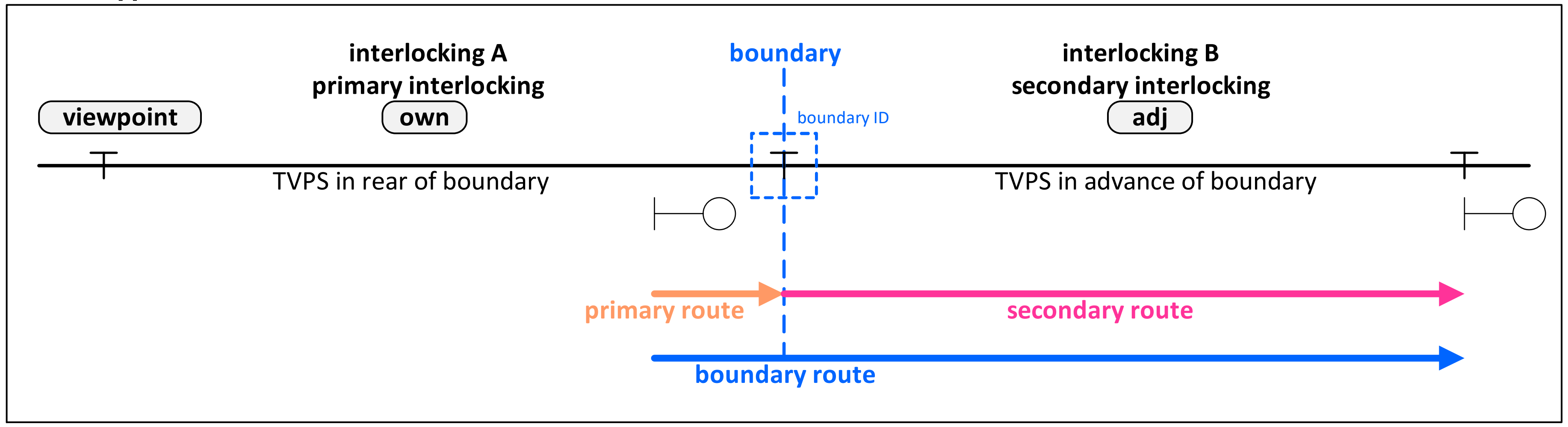
ID	Type	Domain knowledge
Eu.DK.377	Info	**Possible application variant 2** 
Eu.DK.376	Info	**Possible application variant 3** 

Figure 1: From object 644 on page 26.