Rail Baltica

RBDG-MAN-022-0103

Design guidelines

Railway Control-Command Signalling system

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1. Standards

The standards applicable to design Signalling and Telecommunication system are the followings:

- European Standards (EN for European Norms);
- European Committee for Electrotechnical Standardization (CENELEC);
- International ISO standards.

EN 50121 series	Railway Applications – Electromagnetic Compatibility
EN 50122 series	Railway applications - Fixed installations - Electrical safety, earthing and the return circuit
EN 50124	Railway applications - Insulation coordination
EN 50125	Railway applications - Environmental conditions for equipment
EN 50126	Railway applications — The specification and demonstration of reliability, availability, maintainability and safety (RAMS)
EN 50128	Railway applications - Communication, signalling and processing systems - Software for railway control and protection systems
EN 50129	Railway applications — Communication, signalling and processing systems — Safety related electronic systems for signalling
EN 50159	Railway applications - Communication, signalling and processing systems - Safety-related communication in transmission systems
EN 50289-1-6	Communication cables - Specifications for test methods - Part 1-6: electrical test methods - Electromagnetic performance
EN 50238	Railway applications - Compatibility between rolling stock and train detection systems
EN 61000-6 series	Electromagnetic compatibility (EMC) - generic standards
EN 62305	Protection against lightning
EN 50164	Lightning Protection Components
EN 50173 series	Information technology - Generic cabling systems
EN 50174	Information technology - Cabling installation
IEC 60331	Tests for electric cables under fire conditions
EN 50310	Application of equipotential bonding and earthing in buildings with information technology equipment
EN 55024	Information technology equipment. Immunity characteristics. Limits and methods of measurement.
EN 60297-3	Mechanical structures for electronic equipment - Dimensions of mechanical structures of the 482,6 mm (19 in) series - Part 3-100: basic dimensions of front panels, subracks, chassis, racks and cabinets
EN 61034 series	Measurement of smoke density of cables burning under defined conditions
EN 61508 series	Functional safety of electrical/electronic/programmable electronic safety-related systems
IEEE 1220	IEEE Standard for Application and Management of the Systems Engineering Process

ISO/IEC 15288	Systems engineering - Systems life cycle processes
EN 45011	General requirements for bodies operating product certification systems.
EN 60038	CENELEC standard voltages
ISO 9001	Quality management systems - Requirements
ISO 9000	Quality management systems - Fundamentals and vocabulary
ISO 11064 series	Ergonomic design of control centres
IEC 60793-1	Tests for electric cables under fire conditions
IEC 60364 series	Low-voltage electrical installations
IEC 60068 series	Environmental testing
IEC 62395	(Parts 1 & 2) Electrical resistance trace heating systems for industrial and commercial applications
IEC 60794-1-2	Optical fibre cables - Part 1-2: Generic specification - Cross reference table for optical cable test procedures
IEC 60794-1-22	Optical fibre cables - Part 1-22: Generic specification - Basic optical cable test procedures - Environmental tests methods
IEC 60794-1-23	Optical fibre cables - Part 1-23: Generic specification - Basic optical cable test procedures - Cable element test methods
ITU-T G.652	Characteristics of a single-mode optical fibre and cable

2. Signalling system main purpose

The Signalling system shall ensure the continuous supervision of the Rail Baltica line. Signalling system shall ensure protections against following hazardous situations:

- Collision of trains;
- Train derailment;
- Train running above the speed permitted by the infrastructure and traffic conditions;
- Operation mishandling of the train dispatcher.

The signalling system shall enable:

- 24h service all year round (with required traffic stops for maintenance work);
- management of train movements along the line with the given headway;
- bidirectional operation on main line;
- management of interfaces with other sub-systems of railway system;
- recording of the diagnostic information and alarms to maintenance purpose.

The Signalling system shall comply with the operational rules applicable on the Rail Baltica line and shall allow safe movement of the all train configuration defined for Rail Baltica line at maximum design speed.

Nominal operation of the Rail Baltica line shall be ensured by centralised traffic control. The signalling system shall allow the operation of the line in nominal and degraded cases. **Nominal operation** shall be ensured from the Operations Control Centre (OCC) via Centralised Traffic Control (CTC) or CTC back up.

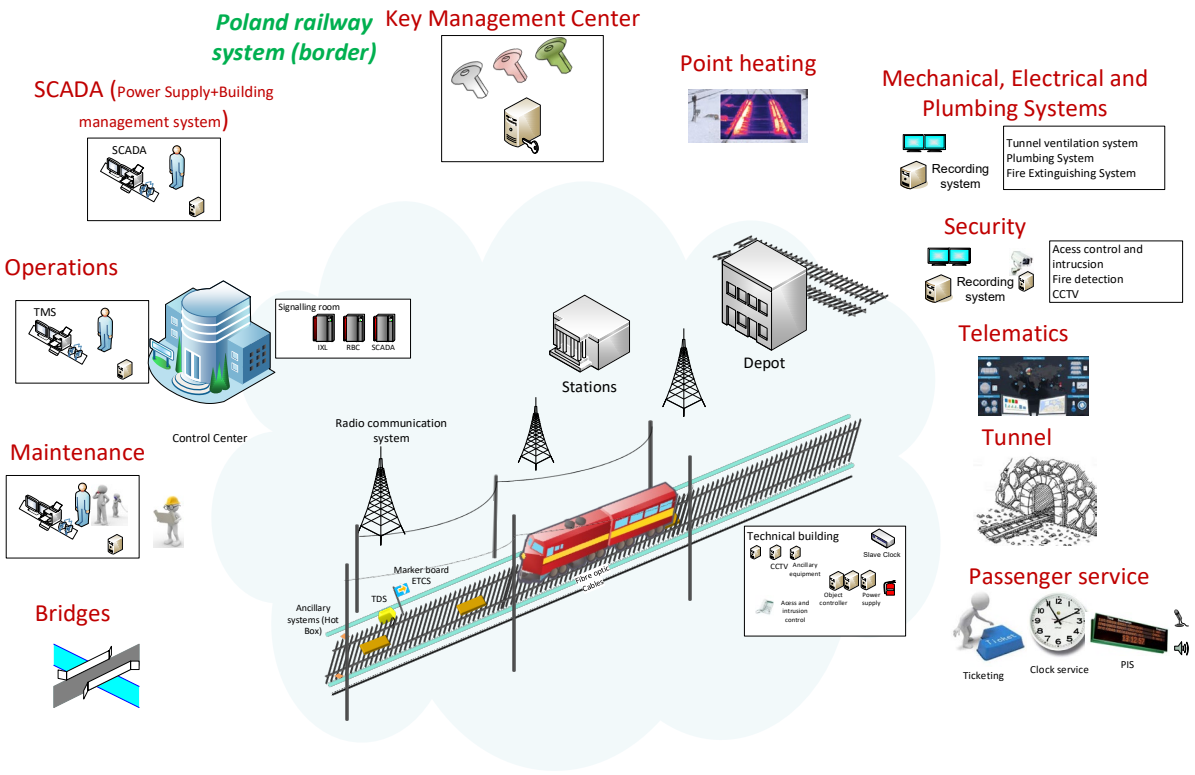
In case of **degraded operation**, the signalling system shall allow:

- **Local operation** (allowed only in few main stations): the command and control functions will be handled at a station level. Communication between the OCC and the field facilities is available. The system should allow takeover by a station. The procedure will consist of a request from the station staff to be granted by the OCC. Operations staff works under OCC instructions (via radio or telephone) and all instructions will be issued by the OCC;
- **Field operation** (Actions are taken directly in the field, acting under the control and on the instructions of the OCC or under the control and on the instructions of a station, using radio or telephone communications).

2.1. Signalling system context

The signalling system shall allow the circulation of the different rolling stock types (freights, regional trains and high-speed trains) operating with different speeds.

The Signalling system shall be designed taking into account the environment of the Rail Baltica line:



1. SIGNALLING SYSTEM CONTEXT

Legend:
RED: Systems in the scope of the Design guideline
GREEN: Adjacent railway system

2.2. Signalling system main functions

Design life time of signalling shall comply with the requirements written in RBDG-MAN-012 general requirements.

To allow the safe operation of the Rail Baltica line, the Signalling system shall include the following main functions:

Functions	Sub-system to cover the function
Train protection	Automatic Train Protection (ETCS trackside)
	Interlocking
	Wayside equipment
	Ancillary systems
Train detection	Axle counters
Point heating	Point heating
Key Management	Key management centre
	Public key Infrastructure
Traffic management	TMS
	Local command (if required)
Maintenance	Signalling maintenance
	Interface with Central Maintenance System
Power supply	Power Supply
	Earthing

2.3. Definition of signalling functions

Train protection: Signalling system shall manage a route setting in safe manner.

Signalling system shall allow a safe train operation at the operation speeds and headway in both directions on all main tracks and through interlocking function.

Signalling system monitors speed continuously and if the train exceeds the permitted speed, the train unit applies either emergency brake or service brake.

The management of the interface between different Signalling Systems and components allows safe train operations.

The signalling systems shall insure the protection of the train based on information received from ancillary systems (as the for example, detectors for crosswind, rainfall, snowfall, landslide detection, Broken Rail Detection, intrusion detection, Hot Box and Hot Wheel detection, dragging detection).

Train protection function consists of**:**

- Automatic train protection function,
- Interlocking,
- Detection (ancillary system**).**

Train detection: To ensure that the track ahead is free of other trains, signalling system utilizes track detection system.

Traffic management: Signalling system shall perform a centralised traffic control from the Operations Control Centre (OCC).

Key management: Signalling system shall guarantee the integrity and authentication of messages sent to on-board unit. ERTMS/ETCS applications use cryptographic techniques with secret keys.

In addition of the listed function the signalling system shall allow at least following functions:

- Train operation in nominal mode,
- Train operation in degraded mode,

- Shunting movement,
- Permanent and Temporary speed restriction,
- Jointing/splitting of the trains,
- Emergency stop of the train in degraded situation,
- Track maintenance work protection,
- Implementation of train-specific functions (orders relating to traction tunnels etc.),
- Train rescue,
- Movement of maintenance trains,
- Continuous train supervision in Rail Baltica area (RBC/RBC handover, IXL/IXL interface)
- Secure communication with ETCS on-board,
- Entry from and exit to Depot.

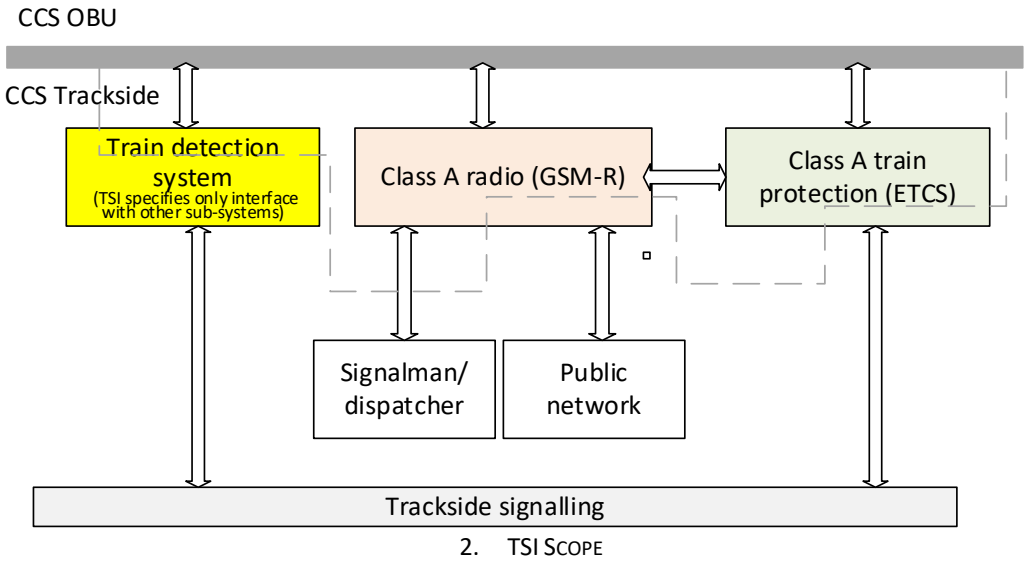
Maintenance: Signalling system shall record data for maintenance purpose and shall be able to raise alarms in order to help maintenance staff to monitor and view statistics on the Signalling System and connected physical elements, and to diagnose and repair any failures.

3. Automatic Train Protection

The Automatic Train Protection (ATP) shall ensure and maintain safe movement of the trains. The trackside ATP shall elaborate messages to be sent to the train via radio communication system on the basis of information received from interlocking and on the basis of information exchanged with the ATP on-board sub-system. The main objective of these information is to provide movement authorities (MA) to allow the safe movement of trains.

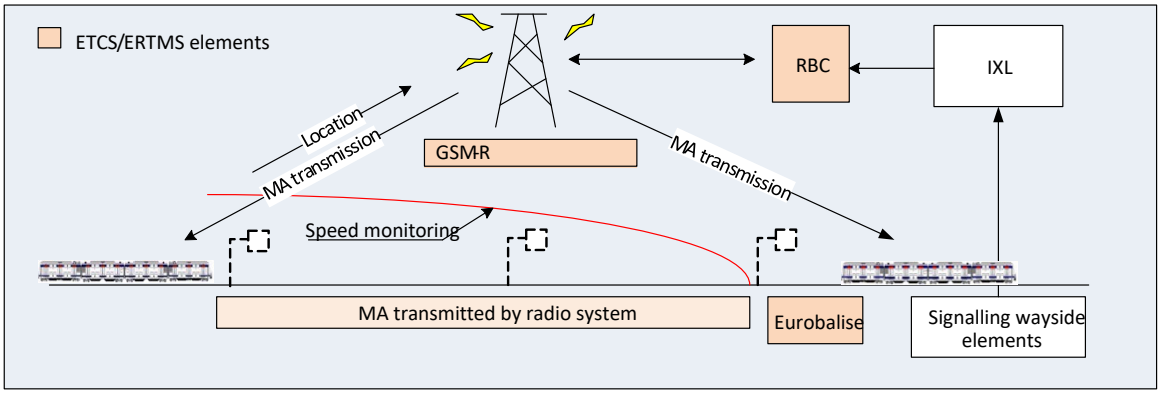
The automatic train protection function shall be performed by ERTMS Level 2, baseline 3 in order to ensure the interoperability with several types of the trains operating on the Rail Baltica part of the North-Sea Baltic corridor. The Signalling system shall be compliant with CCS TSI.

Note: The Technical Specifications of Interoperability for Control Command and Signalling (CCS TSI) is the legal basis of ERTMS specification. However, ERTMS does not cover all traffic management functions. As per CCS TSI application guideline: "*The TSI Control-Command and Signalling does not require full standardisation of all Control-Command and Signalling functions, but only of the ones that are strictly necessary to achieve interoperability while complying with the essential requirements.*" The scope of trackside part of the CCS TSI:



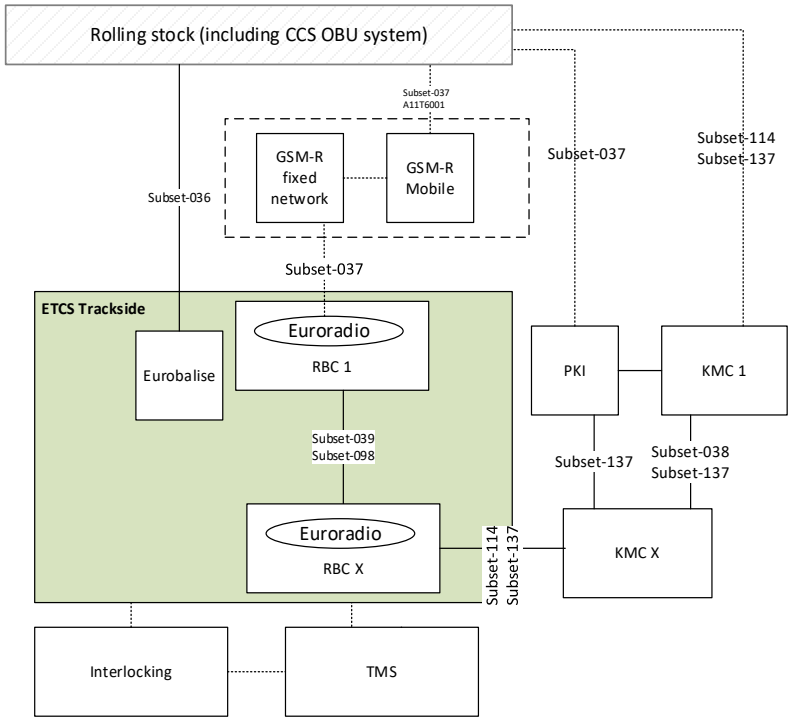
2. TSI SCOPE

ERTMS/ETCS Level 2, baseline 3 provides a continuous speed supervision, which also protects against overrun of the end of authority. ERTMS/ETCS Level 2, baseline 3 is based on Euro-radio for track to train continuous communication and on Fixed Eurobalises for location referencing.



3. TRANSMISSION OF MA WITH ERTMS LEVEL 2

ERTMS reference architecture is defined in §2 of Subset-026. The architecture of the Rail Baltica ETCS trackside shall include the following components:



4. ERTMS ARCHITECTURE

ERTMS shall provide secure and efficient communications paths between the ETCS trackside and ETCS on-board subsystems. As defined by chapter2 of Subset-026, Main ERTMS/ETCS trackside function:

- *Knowing each train equipped with and running under ERTMS/ETCS within an RBC area by its ERTMS/ETCS identity.*
- *Following each ERTMS/ETCS controlled train's location within an RBC area.*
- *Determine movement authorities according to the underlying signalling system for each train individually.*
- *Transmit movement authorities and track description to each train individually.*
- *Handing over of train control between different RBC's at the RBC-RBC borders.*

Additional functions to be performed by ETCS trackside are the followings:

- Communicating non-safety critical information to the trains (as the text messages or geographical information),
- Transmitting information from trains to the TMS subsystem to facilitate route setting (as the train running number),
- Communicating to TMS alarm and event notification to facilitate schedule regulation,
- Recording maintenance data.

ERTMS consists of two sub-systems: ETCS and GSM-R. The ETCS trackside for Rail Baltica line shall consists of the following components:

- Radio Block Centre (RBC),
- Fixed Eurobalises,
- Key Management Centre (KMC),
- Public Key Infrastructure (PKI),
- ETCS diagnostic module (as part of signalling maintenance sub-system).

Note: GSM-R part is described in telecommunication part.

3.1. Radio Block Centre

The RBC (Radio Block Centre) is a computer-based system that elaborates messages to be sent to the train on basis of information received from interlocking and Traffic Management System 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.

Note: **Movement Authority** is the vital information used by the on-board sub-system to determine the position on the track to which the train can safely move under ETCS supervision. The MA includes the speed limits both permanent and temporary to be respected between train's current position and the End of Movement Authority.

End of Authority (EoA) – Location to which the train is authorized to move.

Danger point (DP) – Location beyond the EoA that can be reached by the front end of the train without a risk for a hazardous situation.

The minimum distance between the EoA and the DP shall be designed to guarantee that the train switched to Trip mode because of overpassing the EoA, can come at standstill before reaching the DP. An example of the Danger point definition:

- *Limit of axle counter,*
- *Fouling point; and,*
- *Switch point.*

3.2. Eurobalises

The balise is a transmission device which can send telegrams to the on-board subsystem. The balise provides the up-link (the possibility to send messages from trackside to the on-board subsystem).

As ERTMS Level 2, baseline 3 will be implemented, only fixed balises shall be used. The main function of the Eurobalises is the train location.

Additional function related to degraded operation (RBC handover in SR mode, "Stop if in SR", or Danger for Shunting information) can be defined specifically for the Rail Baltica line.

3.3. Key Management Centre

The role of the Key management Centre is to manage the cryptographic keys, which are used to secure the EURORADIO communications between the ERTMS/ETCS entities (ERTMS/ETCS on-board and RBCs).

A Key Management domain is defined as one KMC and all the KMAC entities (RBC and ETCS on-boards) using that KMC for their key management.

Each KMAC entity referring to only one KMC for its key management. A KMC could administrate only trackside or on-board entities or a mix of both.

3.4. Public Key Infrastructure

The role of the PKI is to manage and distribute digital certificates, to allow a secure on-line distribution of cryptographic keys between KMCs and from a KMC to the ERTMS/ETCS entities (ERTMS/ETCS on-board and RBCs).

The authentication shall be guaranteed either by using certificates from a Public Key Infrastructure (PKI) or by using secret pre-shared keys (PSK).

Note: KMAC entity may optionally support TPL-PSK as an alternative to TLS-PKI, but only for use within a KM domain and not between two KMC.

3.5. ERTMS Operational modes

The ERTMS trackside shall allow at least the following ETCS modes:

Mode	Example of use
Stand By (SB)	Train is awaking (train is at standstill)
Full Supervision (FS)	Nominal operation
On Sight (OS)	This mode allows for example: - to entry in occupied section protected by calling-on route (for example to perform joining procedure) - To entry the section with failed axle counter or axle counter under reset procedure
Staff responsible (SR)	This mode can be used: - in the beginning of the mission in case of unknown position, - to Override the EoA or failed point control (Override EoA procedure)
Shunting (SH)	Shunting mode is used for shunting movements within a defined area: - Depot - Temporary shunting area
Reversing (RV)	This mode allows to escape from a dangerous situation (example fire in the tunnel)
Passive Shunting (PS)	Shunting operation for slave trains
Sleeping (SL)	Used for slave engines
Trip (TR)	Degraded situation (example: EoA is overpassed by the train)
Post Trip (PT)	Recovery from Trip mode

Note: No Power, Isolating and System Failure are On-board modes with no exchanges with ERTMS trackside.

3.6. Track conditions

The ERTMS trackside shall take into account the infrastructure and operational constraints in order to inform the driver and to send the commands to ETCS On-board.

At least following information shall be taken into account for signalling design:

- **Bridges**: non-stopping area;
- **Tunnel**: Air tightness area and Tunnel stopping area;
- **Powerless section**.

3.7. National values

Default National values are defined bySubset-026. However, the set of national values shall be used to take into account operational rules and specific requirements.

All additional parameters and national values shall be unique on the whole Rail Baltica line, able to fulfil all specific situations.

3.8. Geographical distribution of the modes

Assumption: The geographical distribution of the ETCS/ERTMS nominal modes are the following:

Main line	FS
Stations	FS or SH
Depot	SH*

*The operations inside the depot are performed in Shunting mode. This mode allows for flexibility for trains movements and doesn't require ERTMS trackside equipment in the depot.

Note: The entry in depot is performed in SH mode. When ERTMS on-board equipment transits to SH mode, it terminates the communication session with RBC and the train is no more supervised by ERTMS trackside.

4. Interlocking

4.1. Interlocking main purpose

The main function of the interlocking is to manage the route setting in a safe way. The interlocking sub-system shall be provided to the main line and the depot.

The interlocking shall perform at least following functions:

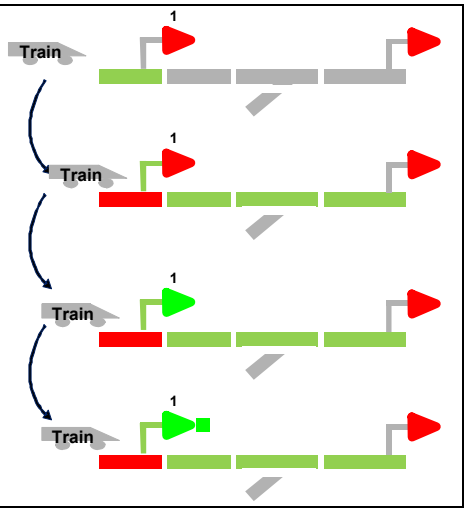
- Check and evaluate the command received from the Traffic Management Centre,
- Compile status information and report fault indication of Wayside equipment,
- Exchange information with adjacent interlocking,
- Ensure route interlocking and route protection,
- Exchange the information with ETCS trackside and transmit route status to the ETCS trackside,
- Emergency commands (such as emergency route release, signal blocking)
- Possession activation,
- Manage diagnostic information and alarms.

The IXL shall command the wayside signalling elements (points, train detection) and monitor their status.

4.2. Route setting

The IXL shall set, lock, monitor and release route for normal and shunting movement.

The Route supervision function shall ensure continuous supervision of all routes, including the status of sections, the position of the different points and their locking, protections, traction power supervision, environment supervision, ancillary system alarms detection. An example of route setting:

1. The Operator requests Main Route 1.	
2. The signalling system sets the route. The route becomes set and locked.	
3. If all the signalling conditions are satisfied, the route node becomes proved.	
4. RBC notifies the signalling system that the route node is covered by the MA.	

Note: As a modern railway, the Rail Baltica network shall be managed by a computer-based interlocking (CBI). The advantages of this technology (compared to ancient relays-based technology) are the following:

- Ease of update,
- Suits to complex and large network,
- Bi-directional exchange of information with RBC,
- Easier interface management with RBC,
- Requires less space for installation.

4.3. Mainline protection

Flank protection is a protection of main line track against unauthorised train movement coming from freight yards, sidings or passing loops. Flank protection of main line track shall be ensured by a turnout controlled in the appropriate position when track speed on the main line is higher than 160 km/h. Diverging route of the turnout shall lead away from the main line in a short dead-end siding.

In case of lower speed on the main line, application of the risk management process according to CSM-RA under consideration of expected parameters of operational program is required, in particularly:

- for tracks with speed exceeding 80 km/h at danger points where during regular operation both train and shunting movements take place;
- for tracks, where rolling away of wagons in the direction of the danger point due to negative track gradient is possible and parking of rolling stock is planned.

Derailers shall be used for flank protection only on secondary lines which are not designed for train movements.

4.4. Object controllers

The object controller is a deported vital inputs/outputs module communicating with the IXL through the telecommunications network.

The object controllers shall allow control and monitoring of one or more areas within a single IXL subsystem.

The object controllers may be single or multiple object controllers and control and monitor one or more signalling elements (e.g. point machines, signals and switches).

Object controllers shall be installed in shelters or technical buildings to allow the interface with point machines and detectors.

4.5. Local control panel

Local control panels for the setting and cancelling of routes together with the individual operation of switches shall be used only in degraded situation and only in specific defined location s (the biggest stations in order to allow train evacuation and recovery to normal operation).

The capability to take local control at the local control panel shall be protected by a log-in procedure that shall prevent unauthorized local action.

5. Train detection

In case of ERTMS Level 2, baseline 3, train detection system is required (extract of SUBSET-026: "*Train detection and train integrity supervision are performed by the trackside equipment of the underlying signalling system (interlocking, track circuits etc.) and are outside the scope of ERTMS/ETCS*").

Several proven designs train detection systems exist on the market:

- **Axle counter** (AxC): The AxC system shall be designed for detecting the number of axles passing each counting head (within defined limits of specified track sections) and from this to determine the state of the track (block section).
- **Track Circuits** (TC): The track circuits are monitored by electrical equipment to detect the absence of trains on a portion of the track (block section).

In order to minimise maintenance and Spare Parts storing expenses, the variety of train detection and train integrity monitoring systems shall be as minimal as possible.

The following table intends to give the advantages and drawbacks of these two technologies:

	Advantages	Drawbacks
Axle counters	**Block length**: The length of an axle counter section is restricted only by the communications bearer and headway requirements **Reliability**: don't get affected either by flooding of track or poor maintenance of tracks **Maintenance**: small number of trackside equipment, minimum near track maintenance activities (visual inspection, system is equipped with remote diagnostic function) **Power supply**: Axle counters consume low electrical power, simple cabling, no requirements for bonding **Track:** No insulated joints are required with axle counters **Fail safe solution**: SIL4 No specific requirements for **return current** **Easier installation**: rapid assembly through the use of rail claws and plug-in cables for sensors)	**Reset requirements**: in case of failure, axle counters may require manual reset. This can be done remotely, but requires a pro-active, manual manipulation Do not provide **broken rail detection** By very small wheel profiles (less than 12 inches in diameter), axle counters can suffer from degraded reliability **Maintenance**: "**No shunt**" – track circuits can be easily physically shunted by maintenance staff in order to protect themselves. A manual occupancy shall be provided in case of axle counters (by hand manipulation of a "metal wheel" in front of the sensor)

Track Circuits	Help to **detect broken rail** (however only limited number of rail breaks types is detected by the track circuit) **Reset requirements:** in case of failure, easier recovery (the trains can be safely localized instantaneously) **Fail safe solution**: SIL4	**Block length**: is limited (less than 2000 m) **Maintenance**: weak points for maintenance **Reliability**: can be affected by climatic condition (in case of high rate of humidity, track-circuit might not be enough reliable and available; sand) **Ballast resistance:** track circuits are sensitive to ballast resistance, power fluctuations, and other track conditions **Train shunt:** track circuits are, by design, reliant on a very specific shunting characteristic of train axles **Train loss**: "light trains" are not detected by the track circuits, in case of the sand on the rail or rail oxidation, the train detection is impacted **Track return current**: specific measures shall be taken

Conclusion: For Rail Baltica line the detection system based on axle counters technology shall be used, as this solution can offer more flexibility in term of architecture, interface management and extension solutions. This solution is available from several suppliers, requires minimal maintenance and provides reliable and fail-safe solution.

As the axle counter detection system gives no possibility to detect broken rail, the solution to continuously monitor, detect and issue the alarms in order to detect broken rail shall be installed on the Rail Baltica network.

The preventive maintenance allowing the detection of the defect of the rail shall be defined (ultrasonic inspections and use of the track supervision with recording cars and/or other equipped trains).

The train detection system shall detect only two states of a track section occupation: "occupied (occupied track section)" or "not occupied (free track section)".

The train detection system shall be able to indicate at least the following conditions:

- Clear;
- Occupied;
- Failed;
- Disturbed;
- Isolated.

The train detection device shall report disturbed, failed and isolated states as 'disturbed' to the IXL and the controller.

The axle counter shall define a track section as occupied as soon as the first axle of the train pass the axle counter border.

The equipment shall be able to handle train movements in both directions.

5.1. Technical requirements

The train detection system shall detect any type of vehicles (Passengers, freight, maintenance etc.) circulating on the line whatever the speed of movements is.

The train detection shall operate correctly for all types of rolling stock permitted to operate on the Rail Baltica network.

The traction current return shall not disrupt the train detection system.

The track detection system shall not be disrupted by electromagnetic interferences from external sources and shall be compliant with the EMC requirements.

The track detection system shall be compatible with the ballast type of track.

The train detection system shall be compatible with the following characteristics:

- electrical 2x25 kV rolling stock traction;
- Operation speed up to 250 km/h;
- Wheels defined in LOC&PAS TSI;
- All rail profiles used on Rail Baltica network;
- Rail temperatures specified for Rail Baltica line.

5.2. Installation requirements

For each axle counter installation, the environmental conditions under which axle counter is required to operate shall be taken into account.

Axle counter installation of outdoor and indoor equipment shall be compliant with EMC requirements.

The axle counters shall be mounted on rail without drilling.

Wheel sensors cables shall be lay separately from electric power lines, motors lines etc. because of EMI.

6. Wayside equipment

6.1. Points

All points in the mainline shall be:

- remote-controlled:
    - Point movement shall be initiated automatically by the route.
    - The point shall be involved as passing point or protecting point and shall be locked in the relevant position and remain locked as long as necessary to ensure safe train movement.
- individually remote-controlled:
    - The interlocking shall allow the operator to individually control and block the position of any point if the point is unlocked, i.e. free to move to the required position (normal or reverse).
    - Before setting the point in remote individual control mode or in blocked state, the interlocking shall verify that the point is not locked by another operation and that no route involving this point is set.
    - It shall also verify that the point is not already blocked by the Operator.
- locally controlled:
    - The interlocking shall allow the Operator to set any point of the track on local mode in order to permit the individual local control the position of the point.
    - This operation shall be done according to a safety procedure between the Operator and the trackside Operator.
    - The local point control shall be done by using a wayside electrical switch.

The points shall be fitted with:

- remote and local controlled electric point machines,
- point locking,
- point position detection (at)all points required by a route or as flank protection of a route in an interlocked position, the final position of each tongue shall be monitored by electrical point detectors.
- point heating,
- Devices for the monitoring of all the parameters relevant to maintenance.

The operation of points shall not be impaired by the accumulation of snow, or by frost:

- Point heating shall ensure that the snow melts between the blades and in the moveable frogs
- Point machines and point locking devices shall be equipped with heating device

All remote-controlled points shall provide at least the following indications:

- Current position;
- In transit (currently moving);
- Locked (against moving);
- Blocked (against route setting);
- Trailed;

- Out of control;
- Undefined status.

Space adjacent to turnouts shall be reserved for the mounting of point machines to move the points, along with power and data cabling for those machines. This space shall be provided along one side of the turnouts.

6.2. Point machine

The turnout used for HSL allows the high speeds in diverted direction.

Swing nose crossings can be used.

For swing nose crossings, at least two motors controlled by the interlocking shall be used.

All point motors shall be controlled by Signalling system via the same standardised physical and logical interface.

Point machine shall be non-trailable type.

Note: For points operated locally and not interlocked in shunting yards/depots (where the speed is low (40 km/h)) with no access to main line, the trailable point machines can be used.

If a point machine is trailable, the point machine shall be equipped to detect mechanically that the point has been trailed.

If all point machines operating a point are not trailable, the signalling system shall implement the solution to detect that the point has been trailed.

The point machine shall be designed to permit manual operation by use of a crank handle.

The point machines on mainline shall be fitted with locked device.

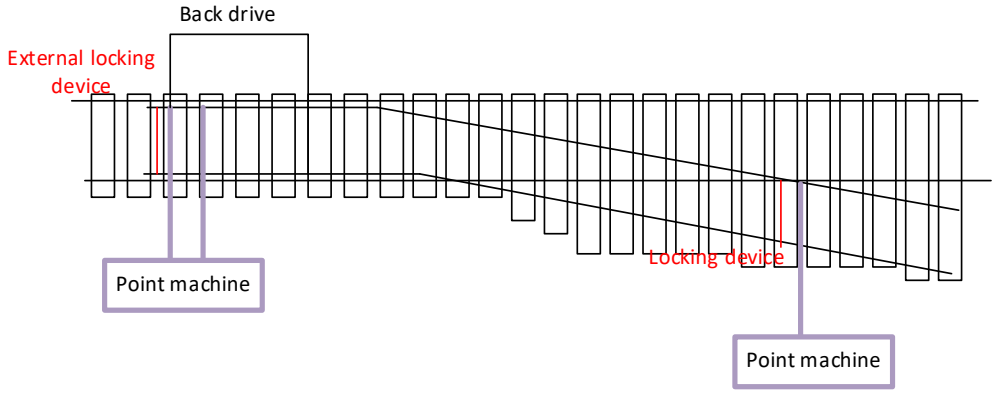
The point machines on mainline shall be fitted with back drive if the solution with two motors is chosen.

Point machines shall include an automatic power cut-off to the motor in case of an obstruction or a failure to detect the points.

The point machine shall be powered until:

- Operation terminates successfully OR
- Operation is aborted (e.g. due to timeout).

The point machine shall work with voltages comprised between 75% and 125% of the normal voltage.



5. EXAMPLE OF POINT MACHINE FOR HIGH SPEED TURNOUT

AC three phase motors shall be used.

The points of Rail Baltica network shall be fitted with point machines, bars, external locking devices shall feet to track elements of Rail Baltica line. This includes, but is not limited to:

- Fixing elements onto sleepers;
- Fixing elements onto rails;
- Fixing onto blades.

Scope of supply of the point machine shall include, but is not limited to:

- Point motor;
- Point end detector (if needed);
- Crank handle;
- Clamp lock;
- Fastenings;
- Frame;
- Junction box;
- Local point control with key lock;
- Installation and adjustment tools.

Available space shall be taken into account to define appropriate type of point machine (left/right hand point machine, middle track point machine, sleeper integrated point machine).

In case of viaducts or bridges or elevated structures, solution to allow correct operation of the turnouts shall be provided. Possible options are (but limited to these options):

- Shelter with signalling equipment such as object controllers can be put underneath the structure;
- Additional place on the structure in order to install:
    - Object controller elements;
    - Point heating panel;
    - Local point control with key lock.

The cabinet width to be taken into account is 60 cm. The interface with power supply shall be provided.

6.3. Point locking

The turnouts shall be equipped with a locking device authorising the trains to run at the maximum speed on a direct direction, and on a diverted direction at the authorised speed by the geometrical characteristics of the turnout.

The position and the effective locking of the turnout in both positions shall be electrically checked.

6.4. Point heating

A point heating system shall perform at least the following functions:

- Prevent the moving switch rail from freezing to the fixed stock rail,
- Prevent the switch rail from freezing to the supporting slide plates,
- Prevent any accumulation of snow, sleet or hail between the switch rail and the stock rail that could compact and prevent the point system from operating correctly.

The Signalling system shall control and monitor the point heating and transmit the point heating state and status information to TMS.

Point heating control systems shall regulate the power needed according to temperature (the points shall be heated in accordance with the actual need. Constant temperature shall be kept in order to avoid strong and excessive heating up and cooling down).
Power for point heating depends on the arrangement of point and environmental conditions, as an example, turnouts of 1/26 size are equipped with heating power in the range of 20-40 kW.
Sometimes the automatic regulation is necessary to override by applying full power if for example there has been a heavy snowfall.

The control of point heating devices shall be possible:

- automatically, using temperature threshold detection,
- on commands from the Operator from the OCC and from the station.

Point heating power consumption depends on the solution chosen during the design stage and environmental conditions.

6.5. Derailers

Derailers shall be installed to ensure staff safety in maintenance workshops and depots.

Derailers shall be able to derail any vehicle passing over it, hence protecting staff operation and maintenance under process beyond the derailer.

Derailers could also be used to ensure other functions, such as protection of the main lines against unauthorised vehicles coming from sidings or yards.

6.6. Marker boards

No wayside signals shall be used on the mainline and the stations. The driver interface is done via DMI (driver-machine-interface).

The ETCS marker boards are used to identify the end of a block section as a potential End of Authority.

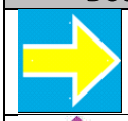
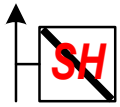
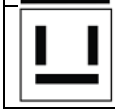
The colours of the ETCS marker board shall be implemented according to Class R1 of the European Norm EN 12899-1 – Fixed traffic signs.

The dimensions for Marker boards are defined in the document “06E068” ETCS marker-board definition.

The marker boards shall be reflective. The reflecting marker board material shall withstand the climatic conditions.

The Marker boards shall be fastened to a prefabricated concrete base.

Markers and indication boards are used for complementary information to the driver to physically localize on trackside some equipment and information given by cab signalling. A few examples of markers and indication boards are provided below:

Board	Description
	Stop marker at the beginning of a route (with switch ahead) for lines equipped with ERTMS Level 2
	Located at the start of Shunting areas. The driver shall stop in front of that board when there is a shunting movement.
	Located at the end of Shunting areas. The driver shall not pass the marker with shunting mode.
	Indicates to the driver to lower the pantograph.
	Indicates to the driver to cut the traction current before the neutral section.

The following signals shall be indicated with marker boards:

- Main signals;
- Block signals; and
- Shunting signals.

The visibility of the marker boards shall be the following:

- Main and block Marker Boards: ≥ 400 m (200 m on rough terrain) according to the national regulation;
- Shunting signals: ≥ 100 m.

Marker board foundation shall be compliant with European standards or equivalent.

7. Ancillary systems

7.1. Purpose

The ancillary systems are the systems can be grouped in Detectors management system. The DMS is a system that helps the operator:

- To organize the management of vehicle movement taking into account the meteorological conditions;
- To monitor the rolling stock defects in order to ensure the safe operation of the line;
- To organise the maintenance of the rolling stock.

When it comes to railway safety, every national operator has its own rules implemented over European Regulation. The national regulation shall apply with regards to the disaster prevention and safety monitoring system. The disaster prevention and safety monitoring systems are made of monitoring sub-system as, for example, wind speed & wind direction, rainfall amount, snowfall, Earthquake, object intrusion etc.

7.2. Vehicle Health Monitoring

The detection of conditions related to Rolling stock, such as a hot box, axle load and dragging objects can be defined as part of Vehicle Health Monitoring system.

The different detector functions can be performed by one detector or several detectors. Hereunder the list of functions shall be performed on Rail Baltica line:

- **Wheel geometry detection:** axles running hot and locked brakes are the greatest dangers facing an operating system:
    - A hot box can lead to fractures of axle which might cause a derailment.
    - The defect in wheel geometry (oval, eccentric, flat or polygonal wheels) can causes extra-loads that can lead to the damaging of the rolling stock and infrastructure.
- **Dynamic load conditions detection:**
    - Improper wagon loadings:
        - Overloading
        - Asymmetric load conditions
    - Axle rupture,
    - Bogie suspension defect,

As the line is used for mixed operation, at least following functions shall be used in order to protect the points of the line where the entry of the freight trains (especially from maintenance depot) is possible:

- **Dragging parts detection**

Dragging equipment detection shall be installed at the exits from depots or maintenance tracks.

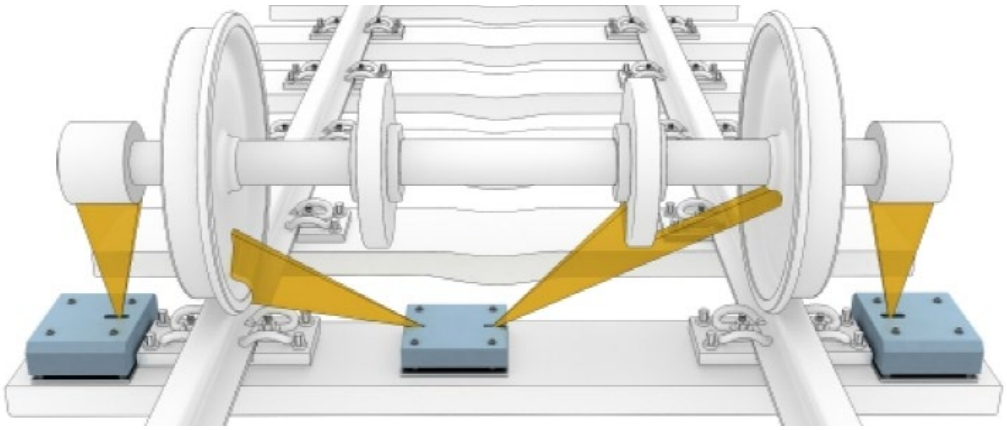
- **Gauge detection**

Gauge detectors shall be installed in entry/exit of the main line in order to prevent unauthorised rail-mounted vehicles entering the track

7.2.1. Hot box detectors

Hot Box detectors are measuring devices installed along the line and designed to monitor axle, wheel and brake temperatures indicating any overheating which could lead to train derailment.

The hot box detector scans the trains for overheated wheel bearings before they advance to a dangerous state. If undetected, overheated wheel bearings can become molten and cause wheel/axle separation endangering the train by possible derailment.



6. HOT BOX & HOT WHEEL DETECTORS

System consists of detection units located inside a special sleeper and a processing unit located at the trackside which collects the values measured by the detectors and transmits this data to the traffic control and monitoring section.

Note: Current national regulation in Estonia requires to install hot box detectors every 35 km.

It's mandatory to equip new passenger trains with integrated hot box detectors.

Therefore, a risk analysis shall be submitted by the Contractor for Client approval to provide a recommendation for the hotbox installation and the interval required for the safety.

As mentioned in previous section, hot box detection can be performed together with other functions as dynamic load condition detection.

Contractor shall submit for Client approval the optimum solution to the implementation of these functions and the installation of related equipment on the Rail Baltica network.

7.3. Online Monitoring of Rolling Stock

Acoustic bearing: in conjunction with temperature-based detection methods, the use of acoustic allows the detection of the emergence of flaking/spalling defects in roller bearings. OMRS shall interface with maintenance system and shall send the alarms in order to stop train, concerned by the alarm and to record received alarm.

Acoustic bearing test benches or on-site monitoring can be used.

On-line monitoring is considered as preferable as allows early detection of faults in rolling stock wheels.

7.4. Broken rail

Rail Baltica line shall be equipped with rail broken detection system.

The trackside solution shall be used to detect the broken rail (axle counters with integrated rail monitoring system or broken rail detectors).

To improve the reliability and the timeliness detection of rail breaks along the railways network the methods such as inspections, testing with maintenance train equipped with ultrasonic, optical and other detectors shall be employed.

The method of the broken rail detection shall be defined taking into account the operation procedures.

7.5. Meteorological condition detection

The definition of the types of detectors to be applied on the line depend on meteorological conditions of the region. A specific study shall be conducted in order to take into account constraints applicable to the Rail Baltica line.

Several possible detectors can be used:

- Earthquake detectors,
- Cross wind detectors,
- Snowfall detectors,
- Rainfall detectors.

These detectors shall be installed, if necessary, in sensitive areas that are defined by a risk analysis. Examples of the sensitive areas: bridges, tunnels, viaducts.

The interval and the location of the detectors installation shall be defined during detailed design stage after the climatologic study.

Cross wind, snowfall and rainfall detectors can be installed together (as meteorological stations) in points of the line where the risks are identified.

- Flooded platform detectors.

Flooded platform detectors shall be installed in areas where the risk of flood is identified.

- Flooded tunnel detectors.

Risk analysis to identify the tunnels with risk of extreme flow shall be performed. In case the risk of extreme flow is identified, the tunnel shall be equipped with flooded detectors and the trains shall be prevented from entering the tunnel in case of extreme flow.

- Detectors of falling rocks/objects/vehicles.

Vehicle intrusion detectors shall be installed in road bridges crossing the railway network. Detailed requirements are defined in document RBDG-MAN-012 General requirements.

7.6. Pantograph dynamic elevation

Pantograph dynamic elevation detector monitor:

- Pantograph's condition,
- Pantograph's elevation.

A pantograph dynamic elevation detector consists of a camera spotting the catenary at an area between two catenary masts. The catenary, when stuck by the pantograph of the train, is moved upward and the camera record the movement. If this movement is abnormal due to excess of tension from the pantograph, the alarm shall be raised.

Dynamic evaluation of the pantograph shall be checked in entry points from different network (example: cross border).

7.7. Track related information

7.7.1. Strain gauge monitoring

The most common example of the application of strain gauge technology on railroads is measurement of stress and strain on rails through strain gauges bonded to each rail. They measure axial tension or compression with no impact on the rails themselves. When subsidence occurs, the strain gauges can generate a warning to OCC, so maintenance can be done early to minimize impact on rail traffic.

Structural health and operation monitoring provides an efficient way to extend the operational life of railway structures. The abnormal state of real structures is predicted using routine measurements and adapted signal processing.

Strain gauge monitoring shall be performed at least on the bridges and tunnels.

7.7.2. Rail temperature monitoring

The expansion and contraction of a rail can create great stress on joints and within its steel material. Rail Temperature Monitoring system provides continuous temperature monitoring - allowing adjustments to be made to loads and speed of travel, reducing external stresses and the likelihood of the rail suffering stress breaks.

Rail Temperature monitoring shall be installed along the track, where checks are carried out automatically. Example: in crossover areas.

7.7.3. Operation and interface

The detectors can interface with:

- **Signalling system**: in this case when alarm is received, the signalling system automatically applies speed restriction or stop the trains impacted by the received alarm.
- **Maintenance and Operation**: alarms are send to OCC and operator puts speed restriction or request the train to stop.

The type of interface depends on operational rules and safety requirements.

An advantage of use of the automatic action in case of alarm detection: is the possibility to increase the safety level of the function.

Example in France hot box, cross wind, and flooded platform detectors interface with Signalling system and signalling system sends the temporary speed restrictions or stop the trains impacted by the alarm.

Risk analysis shall be performed to define the safety level of each detector and measurements to put in place in order to achieve defined SIL.

8. Maintenance work protection

The design of the signalling system shall ensure the safety of human and material resources working on the tracks in the framework of an engineering possession.

The different means can be used in order to ensure the maintenance work protection:

- Elementary protection sections:
    - Track layout can be divided into elementary protection sections.
    - The activation of one of the elementary protection sections by the operator shall prohibit the setting of a route passing through that section.
- Trackside protection switches:
    - Track protection switches located on the trackside shall allow the maintenance staff to confirm the protected status.
    - In an open line, the TPS shall be located near the markers and ensure, when activated, the stopping of the trains before the block section concerned.
- Possession Management:
    - The engineering possessions are planned and included in the list available via TMS.
    - The operator can select possessions from this list, and automatically set the corresponding protections.

In case of use of the track protection switches, each block section shall be protected by dedicated switch.

The detailed design study shall define the location of such protection for approval by the Client.

9. Traffic Management System

9.1. Main purpose

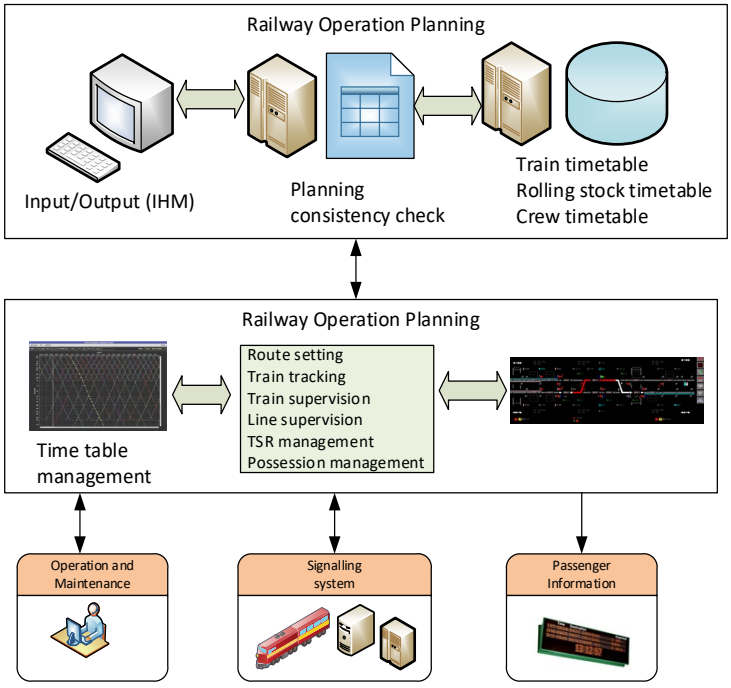
The Traffic Management system shall automatically perform the control and coordination tasks necessary to achieve full operation of trains running through Rail Baltica network.

The control area of the TMS system shall include:

- Main lines with associated stations;
- All stabling tracks along the lines;
- Connections to depots and freight yards.

The Traffic Management System shall provide at least following main functions:

- real time image of the entire line,
- permanent control across the network,
- automatic route setting,
- supervision of the train movements,
- supervision of the whole line,
- potential conflicts detection and solving,
- priority management.



7. TMS FUNCTION

The application of centralised traffic management system allows to get the following benefits:

- **Integrated human-machine interface** providing a common user interface for entire system;
- **Implementation of access and responsibility management** which improves operational efficiency, integrity and security of the network. It ensures operators only receive their allocated functions according to their identification (name and password) and the location of their workstation.
- **Consolidated alarm and event management**. It ensures an instantaneous overall view of all events and alarms happening within the Rail Baltica system. Alarms shall be filtered and directed to the appropriate operators.
- **Global view** of the operation by means of a visual control panel (VCP).
- **Direct remote control** of the major equipment of the Rail Baltica Network.

The TMS shall be integrated into the Operation Control Centre and the Backup Control Centre (BCC) with respect to its operation and maintenance functions in the various operation modes.

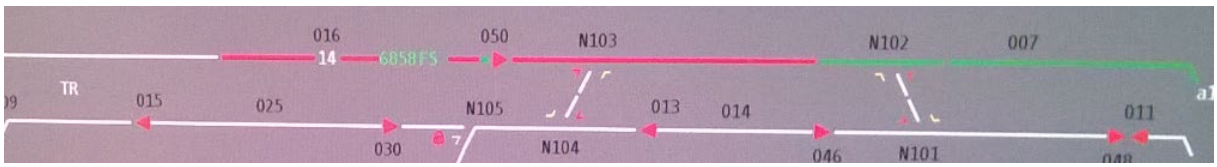
The TMS shall be available 24/7 for operation and maintenance duties and responsibilities.

The Depots and freight yard shall be managed by Depot Operation Centre. TMS shall be interfaced with depot.

9.2. Train tracking

Based on the information received from the Signalling system, the TMS shall track location of each train operating in the Rail Baltica network. The train tracking function shall:

- Detect any train movements, determine and display precisely the train locations.
- Continuously check the consistency between train location and train identification.
- Allow the setting or change of train identification by an operator.



8. TRAIN TRACKING

9.3. Line supervision

The TMS shall provide a detailed description of the railway network and it shall

- Monitor all signalling equipment such as train detection system, detection systems and points.
- Report failures or alarms such as: Unknown or incoherent position of -switch, faulty axle counter, train-RBC connection loss, transmission failure between the TMS and the Signalling system (IXL and/or RBC).

9.4. Timetable management

The timetable shall define, according to the operation program, the schedule and type of service for each train during the day. The TMS shall allow:

- Generate a complete and coherent timetable using a graphical time-distance chart providing tools for conflict detection and solving.

- Select and load the daily timetable according to the day. Besides, the system shall be able to load automatically the daily timetable according to a predefined planning.
- Adapt contents of the current timetable to suit any unexpected traffic event or operational need such as: adjustment of departure time, addition of extra journeys, modification and cancelation of existing journeys.

9.5. Operation chart management

The TMS shall manage time-distance graphic chart.

9.6. Automatic traffic regulation

The TMS shall maintain automatically the regularity of revenues services corresponding to the current timetable. The traffic regulation function shall allow to:

- Calculate the real-time schedule of trains and alarm the operators in case of critical delays.
- Automatically manage train's priority.
- Detect and display real time and extrapolated conflicts.
- Process the following requests and orders coming from operator:
    - Add or remove a specific train from the regulation process.
    - Assignment of a particular journey to a train.
    - Enable or disable the traffic regulation alarms.

9.7. Automatic route setting

Depending on the train's journey and its current location, the TMS shall determine the next route to be considered and issues commands to the interlocking for automatic execution.

TMS shall also allow operators commands such as:

- Setting or cancellation of a route.
- Setting of a route for degraded modes.
- Assignment of a specific manoeuvre to a train.
- Blocking or unblocking trackside equipment (e.g.: switch, marker board).
- Restriction of a route

9.8. Temporary speed restriction

This TMS shall allow the management of Temporary Speed Restriction (TSR). The TSR function shall allow:

- To insert the TSR in the planning.
- Automatic setting of TSR (planned). These shall be submitted to traffic controller's approval.
- TSR manually set by the traffic controller.

9.9. Engineering possession management

This TMS shall help the operator in the management of zone possession (section of track) in order to ensure the safety of human and equipment resources working within the possession. This function shall allow:

- Automatic setting of zone possession (planned). These are submitted to traffic controller's approval.
- Zone possession manually set by the traffic controller or maintenance staff.
- Definition of the shunting routes.

9.10. Emergency commands

The TMS shall allow to operator to perform emergency commands such as:

- Emergency route release
- Emergency stop sent to the train
- Emergency stop sent to all train in the specific area
- Emergency stop sent to all train on the Rail Baltica network

9.11. ERTMS related information

The TMS shall display ERTMS information such as:

- RBC-train link state.
- ERTMS mode.
- Adhesion factor activation (command available for the TMS operator).
- MA sent to operator.

9.12. Data recording

TMS shall include a set of offline services providing the following support functions:

- **Playback** – Replay previously recorded events and operator actions in order to analyse any operational incidents.
- **Simulation** – Emulate the railway environment for training of future operators;
- **Reporting** – Generate, edit and print various reports based on the main data that have been gathered during daily operations; and
- **Engineering utilities** – Database administration ensuring the configuration of the TMS real-time database editor of HMI allowing the creation of displays and dialogues.

9.13. Point heating supervision

The supervision of the point heating devices is part of the TMS system functionalities and shall include:

- Monitoring of point heating status,

- Monitoring of power consumed by elements,
- Monitoring of insulation resistance for elements,
- Monitoring of rail temperature.

9.14. TMS Backup

Rail Baltica line shall be equipped with TMS backup for redundancy, training and replay purposes.

The TMS backup shall manage the following three states:

- Online: BCC controls and monitors Rail Baltica network.
- Standby: BCC only monitors Rail Baltica network.
- Offline: The BCC is totally disconnected from live network for training or replay purpose.

9.14.1. Changeover requirements

An Online/Standby strategy shall be implemented between real time servers of TMS and TMS backup

The Online Control Centre operates Rail Baltica network while Standby Control Centre is maintained up to date with all the database information necessary for a seamless take over (alarms, events, timetable, trains follow-up, etc.).

It shall be possible to command changeover from Standby Control Centre in case Online OCC is unavailable.

All necessary steps shall be taken to:

- Prevent unexpected transfers to BCC.
- Guaranty absolute priority of Rail Baltica line operations from BCC over training.

Particular attention shall be paid to delegation of control of equipment; operators shall recover delegation of control after changeover.

9.14.2. Training requirements

The system shall allow a specific user (i.e.: administrator) to change BCC from Standby mode to training mode (Offline), for training or simulation purpose (time table tests, incident play, etc.).

The system shall verify BCC status before switching to training mode. It shall not be possible to engage training mode while BCC operates Rail Baltica network.

The system shall provide the most realistic training environment. The Contractor shall propose simulated environment including, but not limited to:

- Signalling (including train movement),
- Communication Systems.

The system shall provide a Playback function allowing to replay past RB operations.

9.14.3. System capacity

The processing power of the servers and workstations, and all the relevant peripherals shall be designed to:

- Guarantee that the TMS has the capability to cope with all situations.
- Allow the operator to manage all kinds of events.

The processing power shall be able to deal with all the events functionally significant to which the system is likely to be subject, such as peak loading. The TMS shall have automatic back-up and restoration facilities for archiving data and software applications.

9.14.4. Rolling stock monitoring

The Rolling stock alarms to allow the rolling stock maintenance according to train's type, train operational status (radio, axel box temperature, power traction…) and other maintenance-oriented information shall be easily accessible to RS maintenance staff.

10. Maintenance function

The maintenance and diagnostic system shall continuously monitor the condition and behaviour of the Signalling System, its sub-systems and the interfaces state between subs-systems as well as the state of signalling system external interfaces.

The Signalling system shall be able to record and transmit to Central Maintenance system the following information:

- Incidents and alarms related to system, sub-system and component failures;
- Information records to allow to prepare preventive maintenance

The maintenance system shall help the maintenance staff to find failures in the Signalling System, its related sub-systems and the communication between them by time-stamping information and indicating the area and the impacted elements.

The maintenance system shall help the maintenance staff to define future maintenance activities based on analysis of values monitored by the diagnostic system. *Example: current consumption by a point machine.*

10.1. Local maintenance

Each signalling sub-system component (IXL, RBC) shall be equipped with local maintenance unit. The sub-systems constituting the Signalling System maintenance system shall be integrated in a manner providing a common central view of the complete Signalling System.

The Signalling maintenance sub-system shall be connected to the Central maintenance system.

As option a juridical recorder as a separate standalone unit could be requested for trackside. The main goal of the juridical recorder is to provide sufficient data and analysis tools for efficient juridical analysis in case of an accident or other irregularity.

11. Power supply

The requirements for Signalling power supply are defined in RBDG-MAN-020 Non-traction power supply.

12. Buildings

12.1. Space constraints

The signalling system equipment is installed in different location. The installation of the signalling equipment shall be taken into account by infrastructure:

- Along the line for outdoor equipment without technical buildings,
- Technical building along the line for indoor signalling system equipment (such as axle counter evaluators, object controllers, hot box automats) and power supply,
- Centralized technical room in the OCC for the centralized signalling equipment (RBC, Interlocking, TMS),
- Space dedicated to the maintenance in the OCC,
- Control room at the OCC to host operators and operating position along with VCP, if any.

12.2. Technical buildings

If signalling equipment shall be installed close to the mainline, it can be installed in the following locations:

- technical rooms located in stations,
- technical buildings located at passing loops and crossovers,
- shelters along the trackside, if necessary.

Note: the reduced number of the wayside equipment allows to reduce the number of the technical buildings along the line.

The technical buildings shall shelter at least following equipment:

- Indoor signalling equipment (object controllers, hot box automats, axle counters evaluators etc.),
- the signalling power supply equipment,
- maintenance tools,
- maintenance operator place.

The technical buildings for the signalling system shall be equipped with at least the following systems:

- Automatic lighting control,
- Air conditioning system,
- Fire detection and gas fire extinguishing system,
- Access control system,
- Intrusion detection system,
- Ventilation system.

The technical buildings shall be dust-tight and insulated to provide maximum heating and cooling system efficiency.

The technical buildings shall be protected against public access.

12.3. Equipment installed in OCC buildings

The centralized equipment such as RBC, Interlocking and TMS servers can be installed in OCC buildings.

Centralised equipment shall be installed in the buildings with Heating, Ventilation and Air-Conditioning.

The signalling equipment shall be installed in way to guarantee the accessibility for routine maintenance and fault finding during traffic hours.

12.4. OCC organization

To cope with Rail Baltica network operation, the OCC shall be organised in order to allow the optimal operation of the Rail Baltica network. The OCC building shall allow to put in place the following activities:

- **Control and supervision of the line**. The dedicated place shall be fitted with workstations to supervise and operate in real time the Rail Baltica network.
- **Maintenance supervision**: It is dedicated to the representative of Infrastructure Maintenance, in charge with the coordination between Operation and Infrastructure teams, notably for interventions on infrastructure and troubleshooting of systems. The maintenance is fitted with workstations and a printer to allow the system specialist technicians to manage sub systems status, fault alarms and maintenance.
- **Emergency and crisis management**: Dedicated place fitted out with communication facilities (e.g.: e-mail, telephone, radiotelephone, projection equipment … etc.) allowing the RB staff and external authority to manage any major incident or to discuss operational issues.
- **Offline timetable management activities.**
- **Security supervision**: It is fitted out with facilities allowing security staff to deal with security or emergency issues (CCTV, Fire detection system, Access control system, radio…).

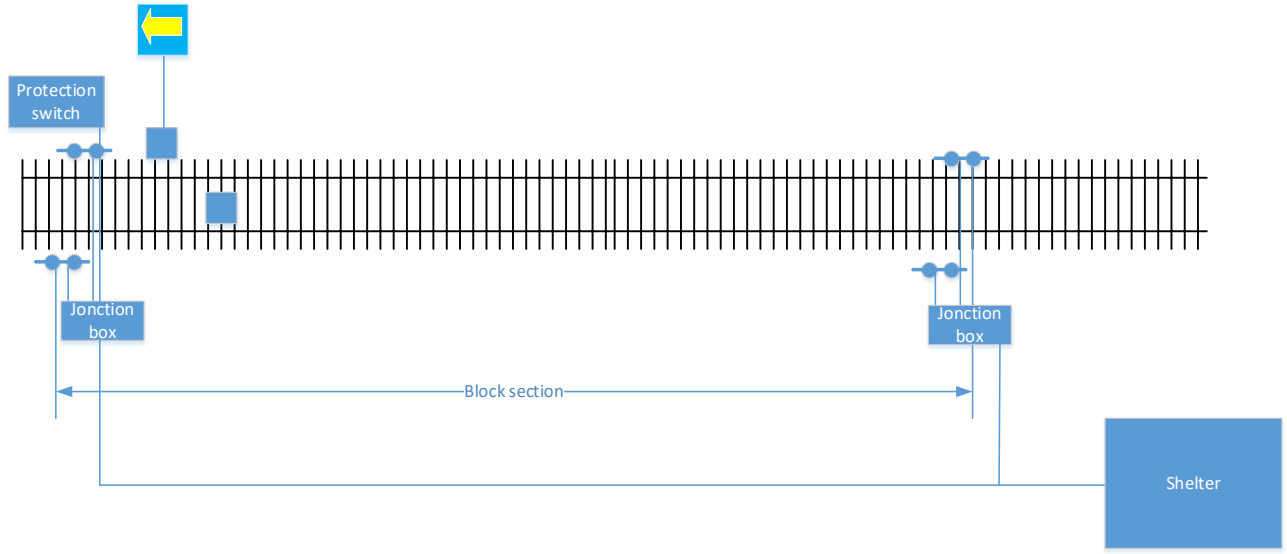
The OCC building shall contain technical rooms: with electronic devices, computers and transmission subsystems required for supervision of all systems (e.g.: Signalling, Telecommunications, SCADA etc.)

The OCC building shall contain **viewing Gallery**: adjacent to the control room, it will allow visitors to observe the OCC facility without disturbing the operation and maintenance staff.

13. Installation constraints

13.1. Block section

Each block section shall be protected by Marker Board.



9. EXAMPLE OF THE EQUIPMENT TO BE INSTALLED IN BLOCK SECTION

Marker Boards shall be placed in system place defined on the platform (0.80 cm after path and systems space in cross sections).

The shelters to install axle counters evaluators shall be placed at least each 10 km (the distance is limited by cable length). This value depends on the technology to be used.

The shelters platforms shall be dimensioned in order to install the following equipment:

- Axle counter evaluator;
- Signalling power supply;
- Maintenance place;
- Place for reserve;

The size of the shelters depends on the technology to be used and of the equipment to be installed.

The shelter shall contain:

- Power supply room;
- Equipment room;
- Pulling chamber;

Example of dimensioning:

- 1.790m x 1.190m for pulling chamber
- Shelter foundation 8.80m x 3.5m

13.2. Crossover section

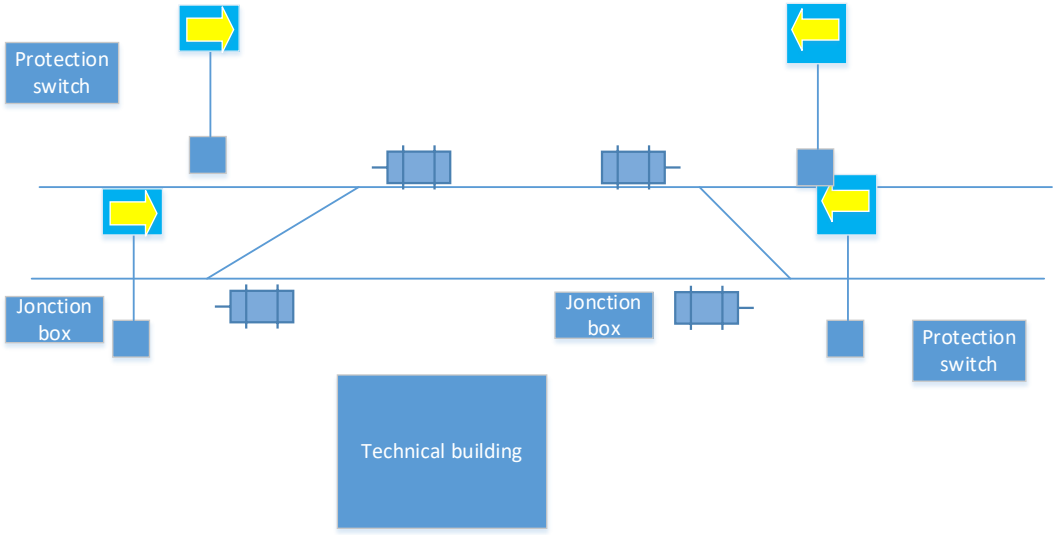
Following equipment shall be installed on the wayside:

- Marker Boards;
- Point motors;
- Protection switches;
- Axle counter.

The technical buildings shall be placed in order to shelter following equipment:

- Axle counter evaluator;
- Object controllers;
- Signalling power supply;
- Maintenance space;
- Place for reserve.

In case detectors are installed on the line, shelters close to the detectors installation shall be estimated in order to contain object controllers.



10. EXAMPLE OF THE EQUIPMENT TO BE INSTALLED IN CROSS SECTION

14. Cables requirements

Cables used for signalling equipment:

- Telecommunication cables to link wayside objects to object controllers installed in technical buildings
- Power supply (including junction box) to provide the power to wayside equipment such as axle counters, point machines and ancillary systems

- Telecommunication cables to connect centralized equipment and indoor equipment

The cable shall be compatible with the buried conditions, including under tracks (moisture and sub water resistance, acidity/alkalinity of the soil, chemical products, mechanical strength against smashing by the train weight, vibration caused by train etc.).

The buried cables shall be protected against attacks by rodents and other animals.

The cable shall be Electro Magnetic Compatible taking into account the other cables and environment conditions.

The cable that will be used for Signalling System communication, shall be designed dedicated for Signalling communication only.

All cables outside buildings shall be buried in trench. A plastic colour-warning tape shall be put on top of the cables.

In containment, the pulling of the power supply feeder shall be carried out in one separate duct.

The design of the cable route layout (along the corridor) shall ensure the full redundancy of the Fibre Optic cable.

The laying of cables shall be carried out in respect in compliance with:

- The manufacturer recommendations (example: pulling force applied on the cable for the laying works must respect the cable manufacturer values and recommendations).
- The best code of practice.

No twisting of the cables is allowed while pulling.

All wires within a cable shall each have a unique visible identifier. The terminal each wire is connected to in a terminal block shall have corresponding visible identifiers.

All cables shall have protection for water immersion.

In case the cable shall pass under the track, the cables shall not be cut for passing through any pulling chamber/manhole.

Tail cables shall be terminated to single device along the tracks, such as axle counter heads, point motors.

Tail cables shall be buried like main cables, the depth at cable exit of ground shall be safe to avoid theft issue.

Tail cables shall be laid in the same trench than main cables wherever it is possible to do.

15. Safety requirements

Each functional component and the entire System shall operate in a safe manner.

Safety critical components shall be designed according to the safety principles and incorporate the reliability, selective redundancy, warning devices, and protective elements, as required by European standards, to contribute to the achievement of the specified requirement.

All vital functions and equipment shall prevent failure from hardware defect and/or software error.

Signalling system shall be designed in compliance with Safety Integrity Level (SIL) 4.

The fail-safe principle and check-redundancy principle shall be applied to safety- critical hardware and/or software configurations and data transmission.

16. Performance

The performance targets and performance requirements to the Signalling System is closely related to the performance and line capacity of a particular line or corridor.

The performance targets definition shall be based on the following assumptions:

- Signalling System is working in normal operating mode,
- Signalling System and all its components are working properly,
- The track layout has been optimised to allow the headways defined by the performance targets,
- Established operating rules and procedures allow the headways defined in the performance targets
- The performance of the trains operating on the line or corridor is compatible with the headways defined by the performance targets.

17. Uniformity

All equipment and products including firmware and software shall be uniform throughout the project so as to simplify maintenance procedures and to minimize the spare and replacement parts holdings 1 across the project to the greatest extent practical.

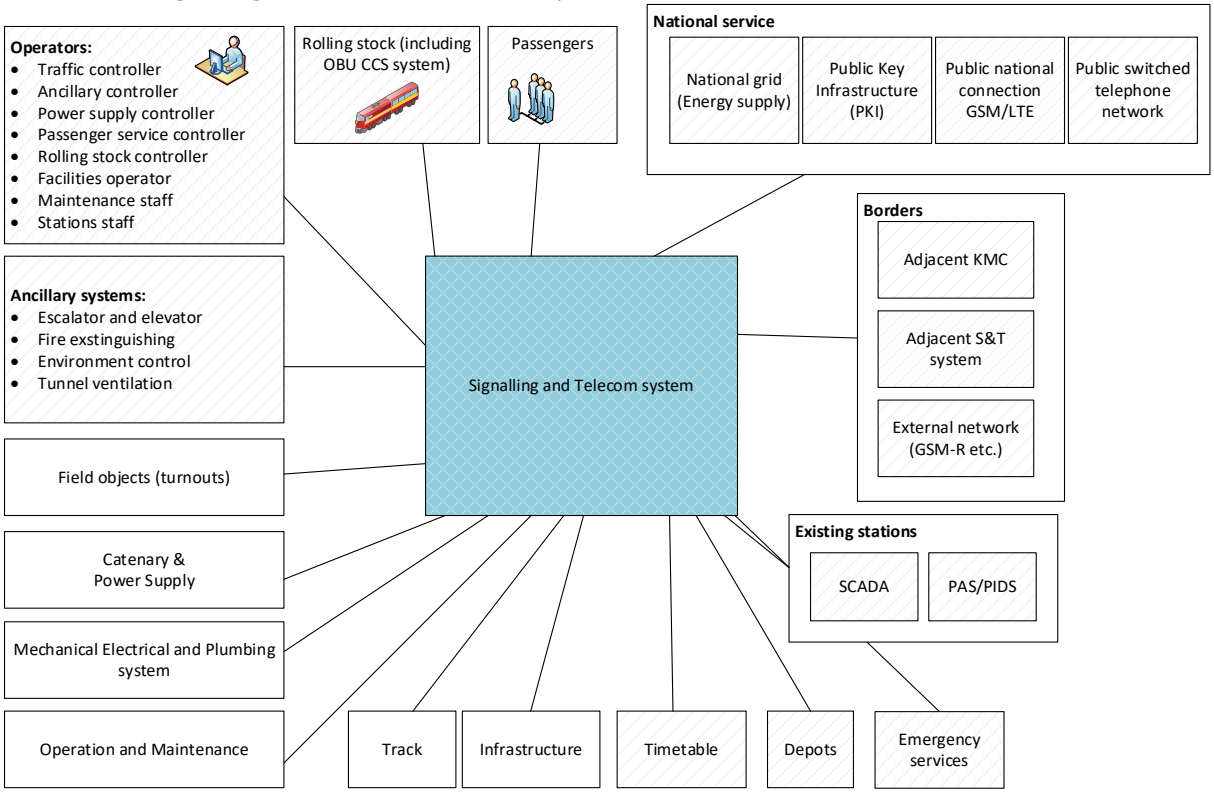
The uniformity shall be achieved by the application of the following rules:

- Definition of the global system architecture (Rail Baltica line is managed by one railway system);
- Definition of operational scenarios for whole line (example one scenario for entry in occupied block section, temporary speed restrictions management);
- Definition of the same rules for interlocking and RBC in order to reduce specific development (example: overlaps definition, timers etc.);
- Priority to the application of the European standards;
- Use of the same type of the equipment to reduce the number of the interfaces to defined (example: the use of the same type of the point machines, same type of the detectors);
- Standard interfaces between signalling equipment.

18. Signalling interface

18.1. Signalling and telecom external interfaces

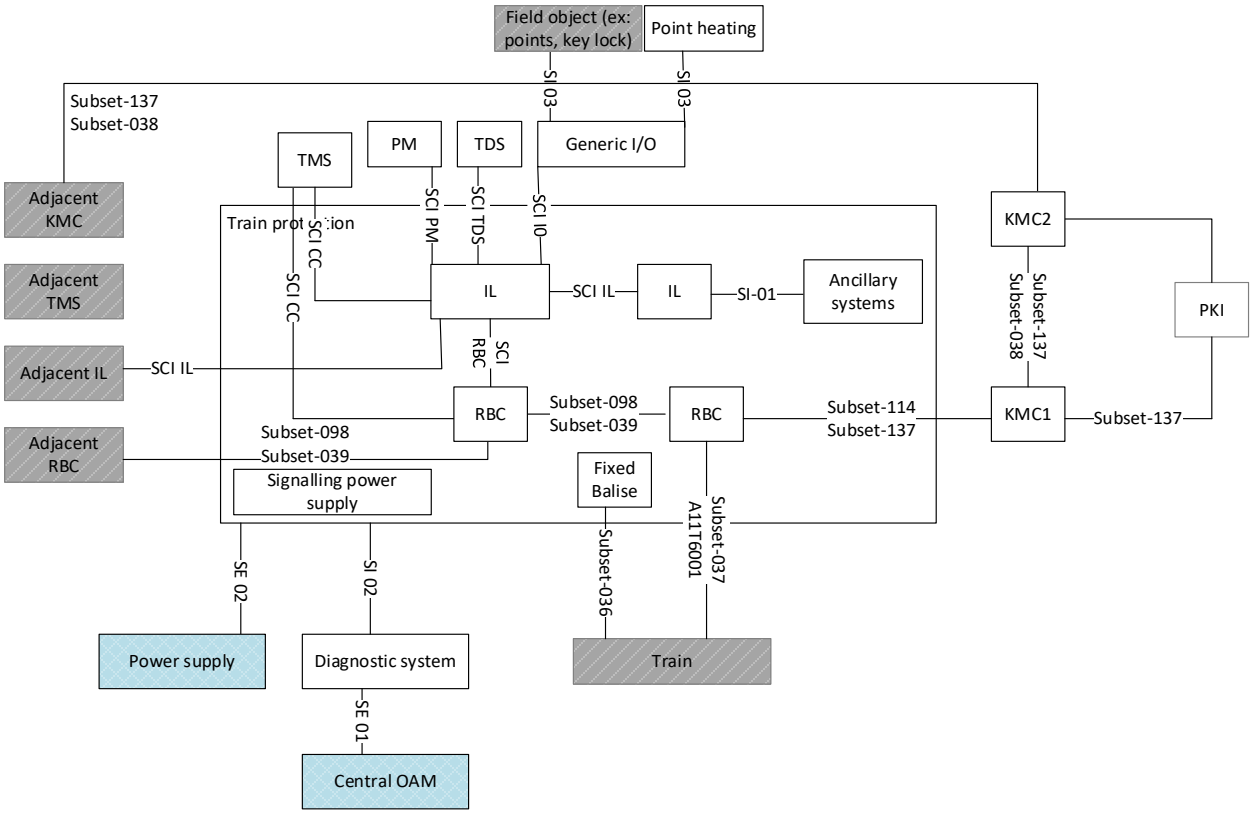
To define the Signalling and Telecommunication system, the external interfaces shall be taken into account:



11. SIGNALLING AND TELECOMMUNICATIONS SYSTEM INTERFACES

18.2. Signalling system interface

Signalling system interfaces with adjacent railway systems (as for example on Poland border) and other sub-systems of the Rail Baltica railway system are defined as below:



12. SIGNALLING SYSTEM INTERFACES

Legend:
Grey: out of signalling scope
Blue: in the Rail Baltica scope but out of signalling scope
SCI-standard communication interface
SI: non-standard internal interface
SE: non-standard external interface

Design guideline take into account only the parts regarding white box.

Standard interfaces shall be used in order to allow easier operation/maintenance and extension of the Rail Baltica line.

18.2.1. Interface with track

The Signalling system shall provide information about equipment which shall be installed in line on the tracks, including but not limited to:

- Cable layout, location and dimensioning through concrete plinth (e.g., number of cables, sizes, weights, distance requirements between cables, maximum filling ratio in cable trays), including cable trays requirements;
- Final equipment layout along the track;
- Distribution equipment (junction box) for switches;
- Axle counters modules and balise equipment locations, markers borders;
- The signalling constraints shall be taken into account by track during design phase.

18.2.2. Interface with alignment

18.2.2.1. *Gradient*

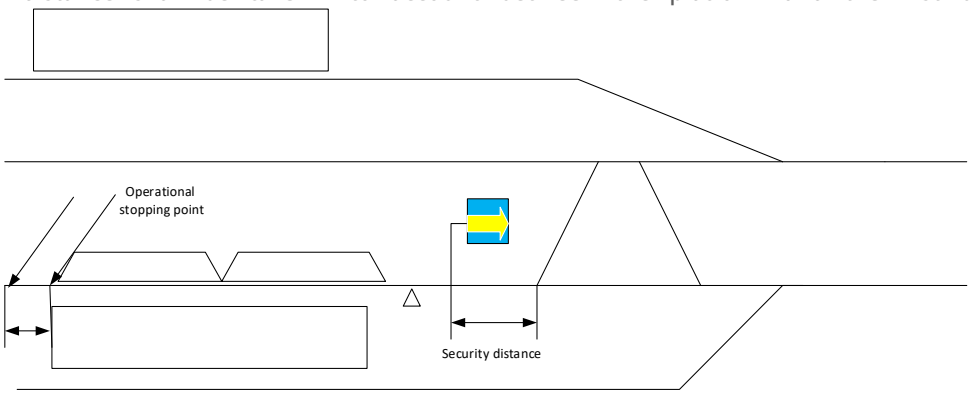
The measurement of the distance and gradient data shall ensure a high accuracy of the measurements and integrity level compliant signalling requirements.

Note: The measurement and the processing of the distance and gradient data shall rely on automated equipment and processes as much as possible (e.g. measurement equipment to be installed on train). In other words, manual measurement by geometers shall be avoided as much as possible (i.e. only reserved for the track areas that could not be accessed by the measurement train) to reduce human error in the process.

18.2.2.2. *Platform entry/exit*

The security margin distances shall be taken into account between the Marker board and the turnout.

A distance shall be taken into account between the platform and the first balises and Marker board



13. EXAMPLE OF THE SECURITY DISTANCES

Security margins shall be provided by Signalling system in order to design the platform layout.

Note: The distance from operational stopping point to buffer stop depend on the defined release speed and signalling system requirements.

The distance from marker board to turnout depend on the gradient, train characteristics, speed authorised in Staff Responsible mode etc.

18.2.3. Interface with catenary

The Signalling system constraints (as par example Marker Boards, junctions) shall be taken into account during design stage.

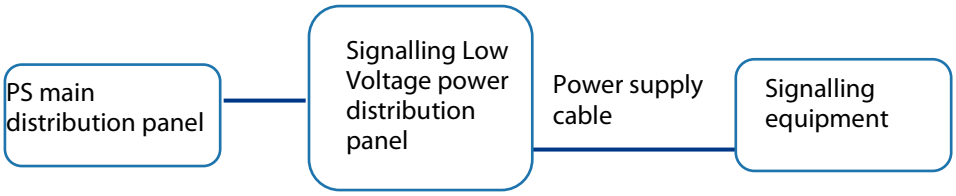
18.2.4. Interface with civil works

Interfaces between Signalling and Civil Works concern mainly the following subjects:

- Technical buildings;
- Shelters
- Equipment installation;
- Earthing and bonding connection;
- Balise installation constraints on the bridges.

18.2.5. Interface with Power supply

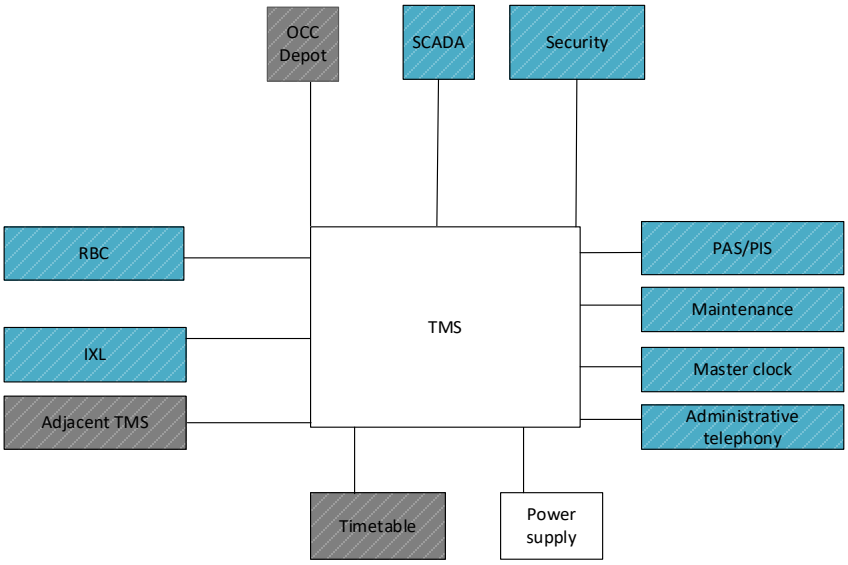
Signalling - Power Supply interface shall be designed as follows:



The Signalling equipment shall be taken into account in order to design electrical power distribution panel.

18.3. Traffic Management System

Traffic Management system interfaces with adjacent railway systems (as for example on Poland border) and other sub-systems of the Rail Baltica railway system are described below:



14. SIGNALLING SYSTEM INTERFACES

18.3.1. Interface with Passenger information system

The TMS shall be interfaced with the Passenger Information System to automatically update traffic information (e.g. arrival time, departure time, destination, etc. displayed at platforms and stations).

The TMS shall be interfaced with the Public-Address system to automatically update traffic information (e.g. train arrival, train departure, delay, etc.) for audio messages played at platforms and stations.

18.4. Depot operation

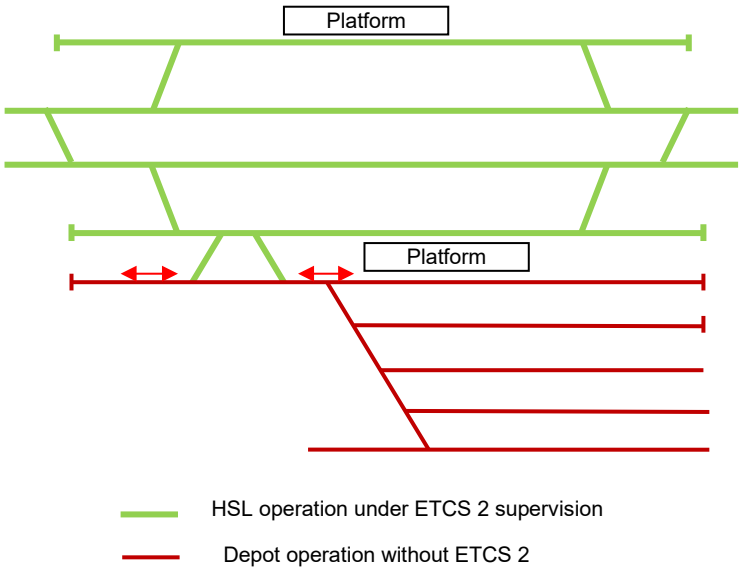
18.4.1. Signalling system

Depots Signalling System shall apply conventional fixed block signalling to allow shunting movement of the trains. No ERTMS is required inside the depots. Depots will be managed by local control.

It's possible to manage the depot from central OCC in case of the depot OCC failure. To ease the interface, the management of the depot from central OCC shall be restricted to allow minimum degraded operation.

The train movement within the depot shall be operated using the shunting route and signal aspects.

ETCS 2 domain - Limits and Transitions



15. EXAMPLE OF THE ETCS 2 DOMAIN LIMITS

18.4.2. Level crossing operation

In case the depot is equipped with level crossing, the level crossing shall be equipped with automatic announcement and shall be operated from the depot local control. Level crossing shall be operated manually or automatically.

If the level crossing is equipped with barriers, the barriers shall be close completely when a train is approaching on any track on both directions.