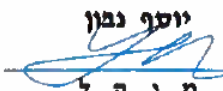
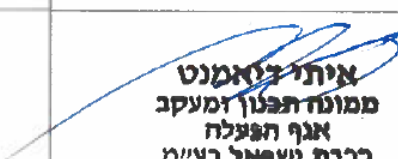


Technical Specification No. M -05-575

Tender No. 42240

For the supply of Timetabling & Track Possession System

Functional and Non-Functional Requirements Specifications

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Change history

Version	Date	Changes	Responsible
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Part A: Timetabling & Track possession system

1 Introduction

1.1 Initial situation and history

Israel Railways is undergoing a process of operational planning that includes all necessary operations (planning train timetables, scheduling trains, organising train platforms, assigning employees to trains) and adapting it to changing realities that consider various constraints, such as the number of trains available and railway infrastructure maintenance, all while meeting the required level of service.

Operational planning is performed using several central systems:

- TPS (by Hacon) – used to plan periodic train timetables
- ARAMIS (by Thales) – used to manage train traffic
- RAILSYS (by Rmcon) – used for multiyear planning (5-20 years ahead)
- OPTIRAIL (by ESI) – used to organise trains
- OPTIWISE (by ESI) – used to organise and assign drivers and inspectors, etc.
- PSIFAS (self-development) – used to operate the trains based on the information required for travel (train number, visa issuance etc.)

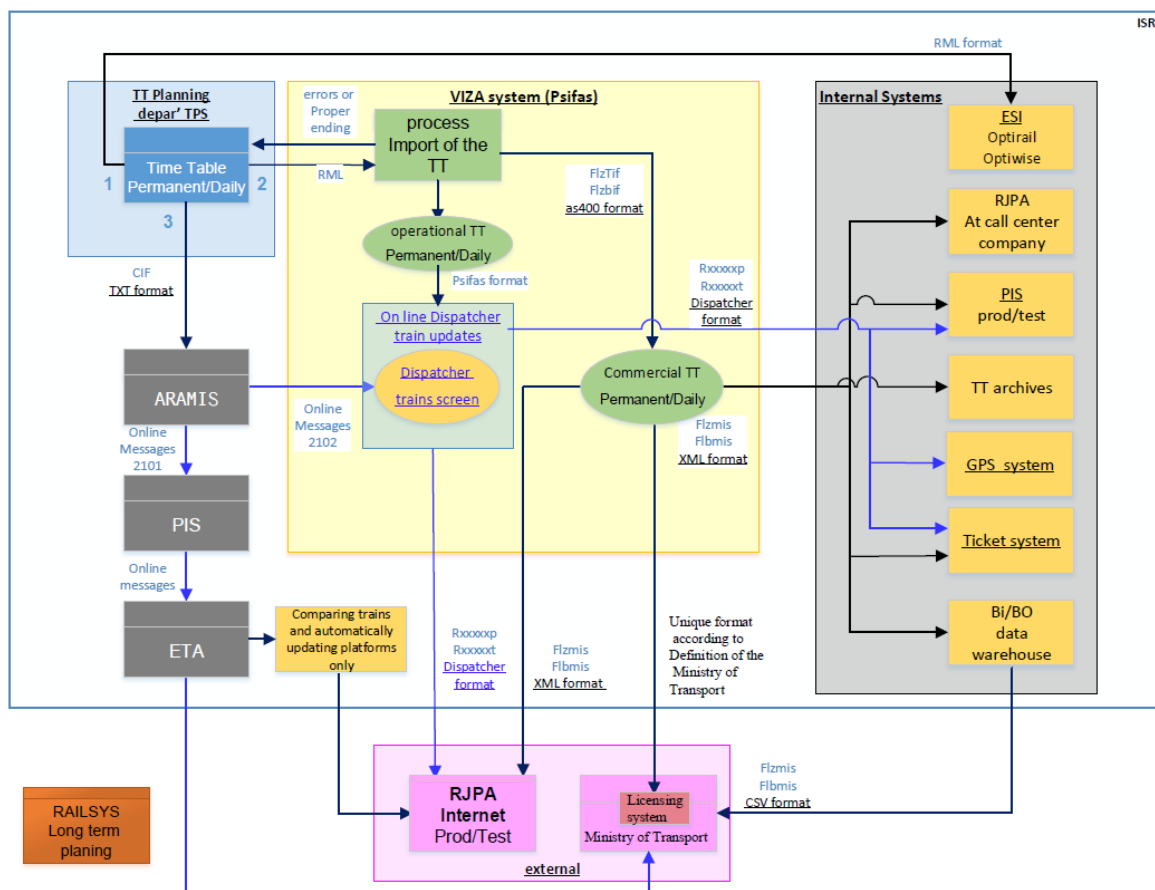


Figure 1: Current system environment for timetabling

1.2 Purpose of the product

Israel Railways is interested in a new product enabling end-to-end train timetable planning with integrated decision support capabilities that can assist and optimize operational planning by upgrading or replacing the systems used for planning (short-term, periodic, multiyear) timetables (TPS, RAILSYS). The systems for organising trains and staff (OPTIRAIL, OPTIWISE) and timetable processing (PSIFAS) shall be retained. The system for traffic management (ARAMIS) shall also be retained, but the scope of the work within this system can be adjusted.

1.3 List of stakeholders

Timetable planning at Israel Railways is performed by four different departments:

- **Department for Multiyear Timetable Planning** – train timetable planning based in RAILSYS
- **Department for Periodic Timetable Planning** – train timetable planning based in TPS
 - Uses TPS to plan timetables for calendar days of the week and determine the list of trains traveling each day.
 - Product: Periodic train timetables
- **Department for Short-Term (Day-to-Day) Timetable Planning** – changes applied directly to the ARAMIS traffic management system without the use of any dedicated scheduling software
 - Makes changes to timetables using ARAMIS. The responsibility of the DPTP is to update for regularly occurring changes (occupied railway tracks, malfunctions, special requests, etc.).
 - Product: Train timetables for the next few days with adjustments for various constraints
- **Command** (ad hoc day-to-day planning) – changes applied directly to the ARAMIS traffic management system without the use of any scheduling software
 - Responsible for real-time timetable updates through ARAMIS (e.g. traffic disruptions, emergencies, occupied railway tracks, etc.).
- **The Cargo Division** – train scheduling based on the requirements received from the PTPT. Optirail serves the Cargo Division as a tool for building periodic and day-today timetables. The Cargo Division has main line drivers and end drivers. A driver and an assistant are assigned to every shift. Optiwise is used for assigning employees.
- **The Rolling Stock Division** – The Rolling Stock Division performs several key functions: investigating malfunctions, providing technical assistance to the train crew, and implementing work plans in train schedules. The purpose of Optirail is to schedule trains efficiently and effectively in order to implement the daily maintenance and operational plans. Optirail serves the Rolling Stock Division's maintenance centre as a tool for assigning inspections that support SAP decisions. The Rolling Stock Division has line technicians and maintenance centre orkers for assignment.
- **The Passenger Division** – Optirail serves the Passenger Division's Planning and Supervision Unit as a tool for planning daily and weekly links that are ultimately reflected in the Optiwise system for assigning drivers. The planning and supervision team build temporary daily links based on permanent daily links (sets of trains that form the work schedule for a driver for each separate day) in accordance with the train bank assembled by the PTPT for train scheduling. Based on these daily links, the team builds the weekly links (weekly shift cycles), and once confirmed, the system performs a comparison with permanent daily links and bridges the gaps by creating new shifts on Gantt for Optiwise.

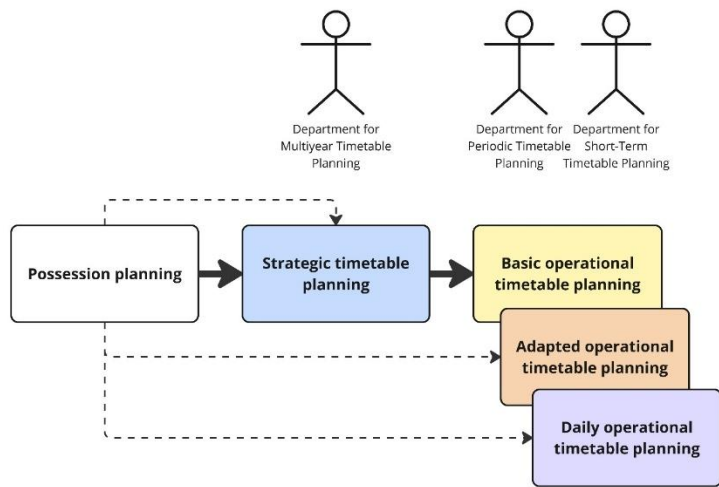


Figure 2: Assignment of the departments to the revised timetable planning phases

1.4 Rights and scope of delivery of the supplier's specifications

The specifications are the intellectual property of Israel Railways Ltd. The copyright to the tender documents and their content lies with the contracting party. Their dissemination in the original or as a copy, their modification, commercial utilisation or use is not permitted. No separate remuneration shall be paid for rights of use or exploitation. This is covered by the price offered. The designation ISR stands for Israel Railways Ltd. and its successor organizations.

As part of the commissioning process, a specification sheet must be created in which all aspects of the implementation of all described IDs of the requirements are described. This subdivision is also the basis for creating the service specifications.

Visualization of the target capacity allocation process

2.1 Definition of timetables

The capacity allocation process distinguishes different types of timetables, each with specific characteristics regarding validity period, running times, service concept, level of detail of infrastructure, inclusion of possessions, and dependency to circulation.

	 Validity period	 Running times	 Service concept	 Infrastructure	 Possessions	 Circulation
Strategic timetable („target network“)	Target year of the network YYYY	macroscopic, node-to-node	Peak time services	macroscopic, node-to-node, gradients, speed, signalling system, electrification	not included	to estimate the necessary amount of rolling stock
Strategic timetable (staged)	Time period depending on project phase DD/MM - DD/MM/YYYY				Possessions according to staging plans	plausibility check related to project phase
Basic operational timetable	Fix timetable period DD/MM - DD/MM/YYYY	microscopic according to blocking times	Operation hours, standard days	microscopic, interlocking logic, CCS elements	Possessions according to staging plans, major maintenance	to realize service concept
Adapted timetable	Part of timetable period DD/MM - DD/MM/YYYY		Operation hours, adapted to specific days		Possessions for regular maintenance	
Daily operational timetable	Day in timetable period DD/MM/YYYY		Operation hours, adapted to one day		Possessions in case of emergency	

Figure 3: Timetabling horizons

The **Strategic Timetable ("target network")** is designed for a target year of the network and focuses on macroscopic, node-to-node running times and peak time services. It includes rough infrastructure details such as gradients, speed, signaling systems, and electrification, but excludes possessions. Circulation is considered roughly to estimate the required rolling stock.

The **Strategic Timetable ("staged")** applies to a period defined by a specific project phase. The level of detail is like the strategic timetable for a target network, but possessions are included now according to staging plans and if known already.

The **Basic Operational Timetable** is valid for a fixed timetable period and includes microscopic running times according to blocking times. The service concept contradicts operation hours for standard days, and the infrastructure is enriched with microscopic information like interlocking logic and CCS elements. Possessions are planned according to staging plans and major maintenance activities. Circulation is planned in detail to realize the planned service concept.

The **Adapted Basic Operational Timetable** covers part of the timetable period and adapts standard days to specific days and their possible particularities. Possessions for regular maintenance are included.

Finally, the **Daily Operational Timetable** is tailored to a specific day within the timetable period. It also includes possessions in case of emergencies.

The following diagram shows a timeline that outlines the preparation phases for operational timetables, divided into four main stages, and also highlights two timetable periods summer and winter:

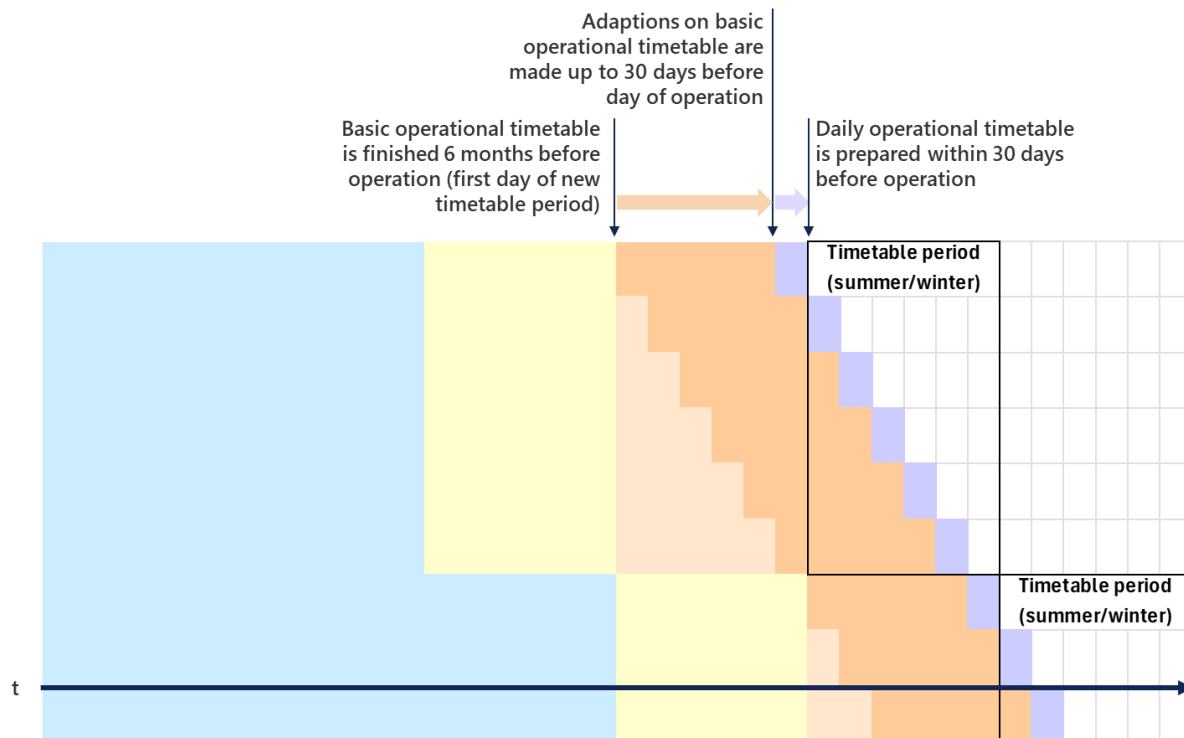


Figure 4: Timetable planning cycles for the operational timetable

Strategic Timetable (blue) – Completed 1 year before the start of the new timetable period.

Basic Operational Timetable (yellow) – Completed 6 months before the start of the new timetable period (time to work on it = 6 months).

Adaptations Phase (orange) – Adjustments to the basic timetable are made up to 30 days before the day of operation (time to work on it = 5 months, staggered for each timetable week).

Daily Operational Timetable (violet) – Finalized within the last 30 days before the day of operation (time to work on it = 30 days, staggered for each timetable week).

2.2 Description of the capacity allocation process

The digital capacity management process at ISR is structured across strategic, operational, and real-time planning stages. It begins with long-term strategic timetabling based on demand forecasts, service concepts, and infrastructure planning, coordinated with the Ministry of Transport. Once approved, a macroscopic timetable is developed and frozen one year before operation. This evolves into a basic operational timetable, updated regularly to reflect infrastructure works and rolling stock changes, and frozen six months before use. Closer to the operation date, daily timetables are derived, adjusted for short-term requests, and finalized one day in advance. Real-time updates are managed in ARAMIS during operations to handle disruptions. Parallel to this, track possession planning ensures maintenance and construction works are integrated into the timetable through a structured approval process.

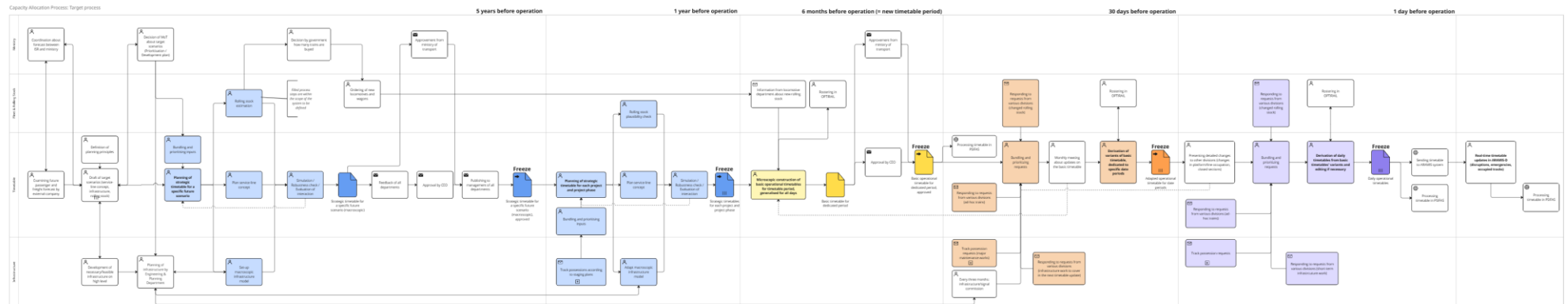


Figure 5: Capacity Allocation Process

2.1.1 Strategic timetabling

The strategic timetable delivers the basis for basic timetable and is divided in staged timetable variants for each project phase.

The strategic timetabling process is a structured approach used to plan future railway operations based on long-term forecasts and infrastructure development goals. It begins with an external company analyzing future passenger and freight demand. Based on these forecasts and defined planning principles, target scenarios are drafted, which include service-line concepts, rough infrastructure requirements and rolling stock needs. These scenarios are then coordinated between ISR and the Ministry of Transport (MoT), which ultimately decides on the prioritization and development plans.

Once the target scenarios are approved, a macroscopic (high-level) strategic timetable is developed for each specific future scenario, including setting up the infrastructure model, estimation of rolling stock needed and the service-line concept. At this stage, the system to be developed will be involved. It should be possible to check roughly the robustness of the timetable with the information already entered in the system. If needed, the model is adapted and re-simulated to ensure feasibility.

Throughout the process, input from other departments is bundled and prioritized, and final approvals are obtained from both the Ministry and the company's executive leadership. This ensures that the strategic timetable is realistic, robust, and aligned with national transport goals. The strategic timetable is frozen five years before the planned operation and published to management of all departments.

The timetable is then further developed for each project and each project phase up to one year before operation. Track possessions (windows for construction and maintenance) are also considered according to staging plans.

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על הטקסט שברצונך שיופיע כאן.1 Überschrift! השתמש בכרטיסיה בית כדי להחיל

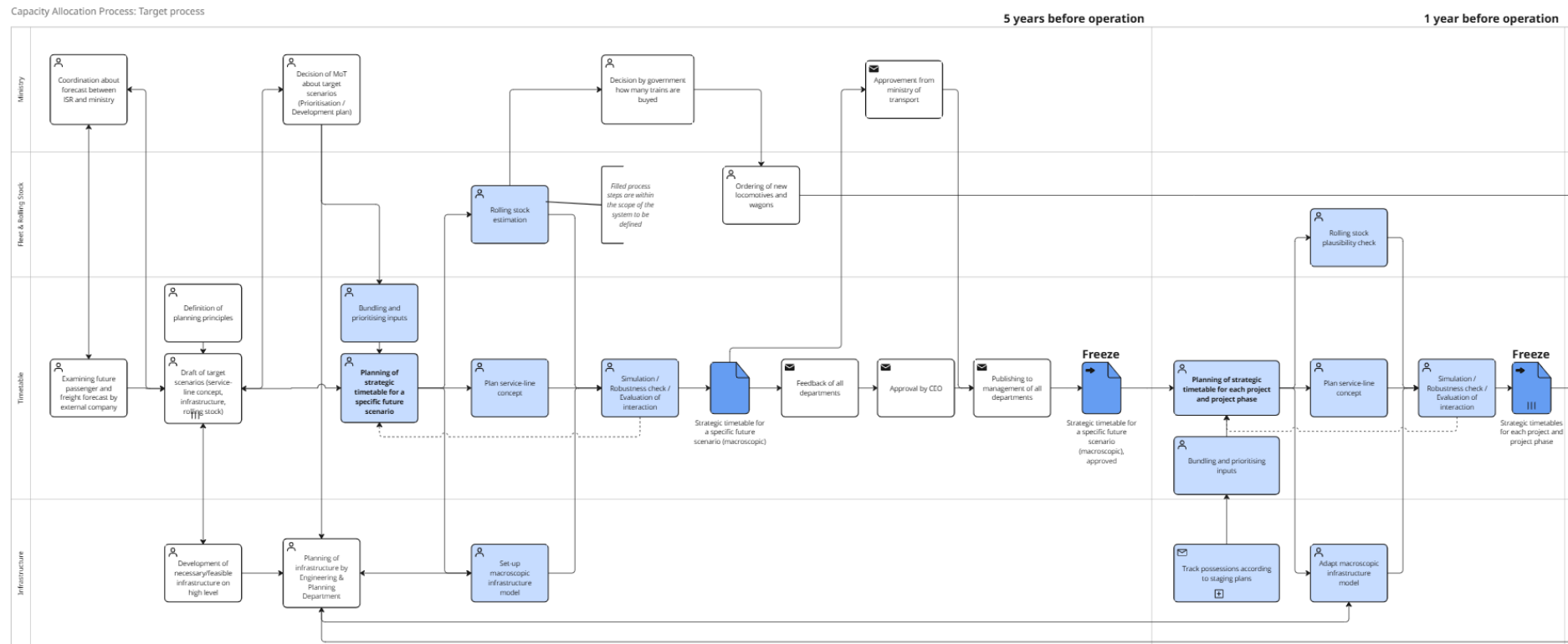


Figure 6: Subprocess: Strategic timetable

2.1.2 Basic operational timetabling

The basic timetable is the basis for derived variants, dedicated to specific date periods.

The operational timetabling process begins with the current timetable, input from the strategic timetable for the period to be planned and locomotive department regarding new rolling stock. Based on this, a microscopic construction of the basic operational timetable is carried out, generalized for all days within the timetable period. The rostering in OPTIRAIL runs in parallel but always in exchange with the timetable construction. After approval by the CEO and MoT, six months before the start of the new timetable period, the basic timetable for the dedicated period (summer/winter) is frozen and can be processed in the PSIFAS system.

The frozen basic operational timetable is then adapted up to 30 days before operation and leads to derived variants of the basic operations timetable which are dedicated to specific date periods. The adaptations include requests from various divisions (changed rolling stock, infrastructure work to cover, major maintenance works) and outcomes of infrastructure/signal commission meeting every three months. All requests are bundled, prioritized and discussed during monthly meetings before transferring into the adapted timetable.



2.1.3 Daily operational timetabling

The daily timetable only handles short-term requests from the last 30 days, handover to ARAMIS on the day of operation.

The daily operational timetabling process focuses on the final adjustments and execution of train schedules. From the previously approved basic timetable variants, daily timetables are derived and edited as needed. Track possession requests for short-term infrastructure works and requests from other divisions (changed rolling stock, ad-hoc trains) are also considered during this phase and bundled and prioritized the same way.

The finalized daily operational timetables are then sent to the ARAMIS system and processed in PSIFAS one day before operation.

On the day of operation, real-time timetable updates are managed in ARAMIS-D to respond to disruptions, emergencies, or track occupancy issues, ensuring that the timetable remains accurate and responsive to operational conditions.

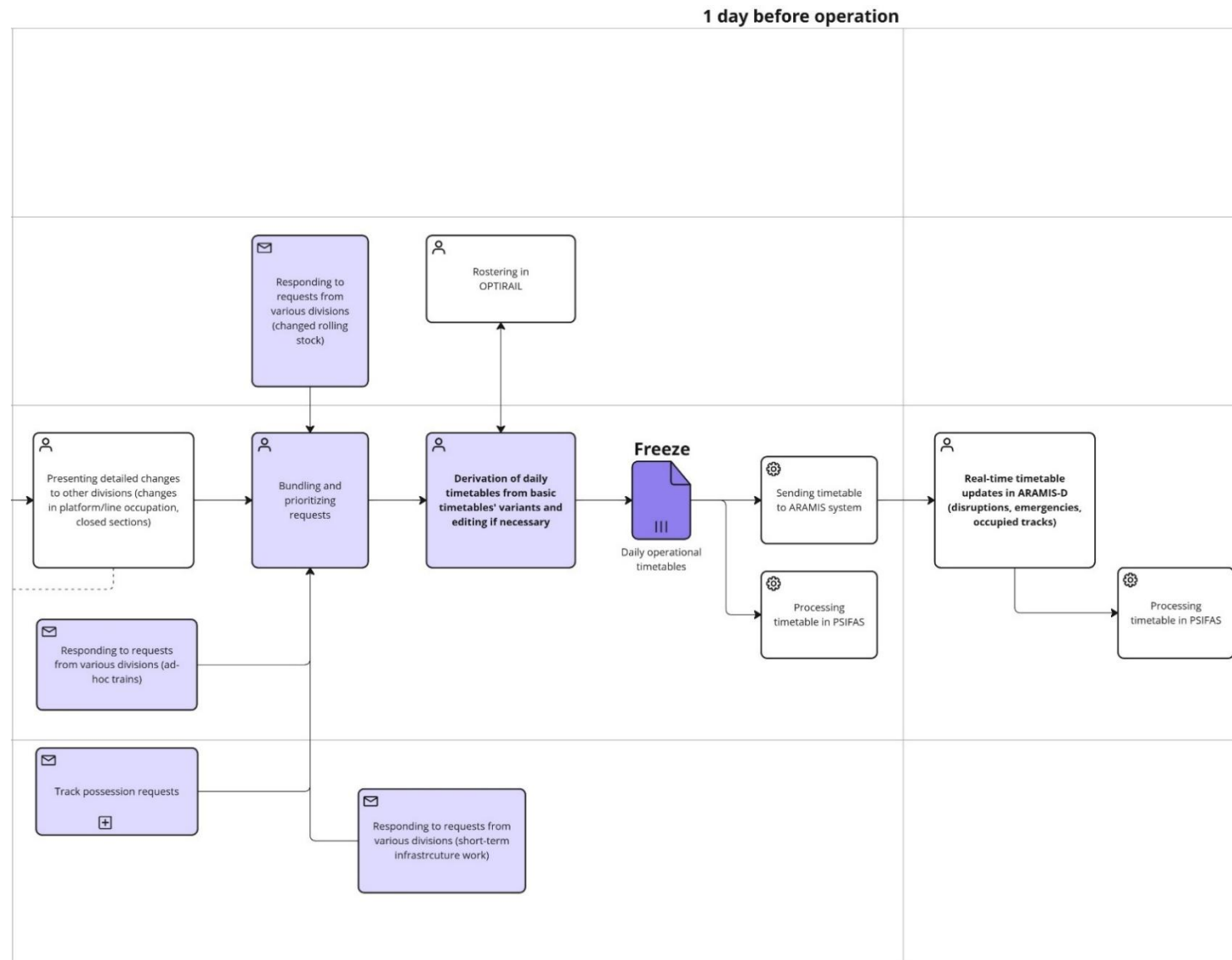
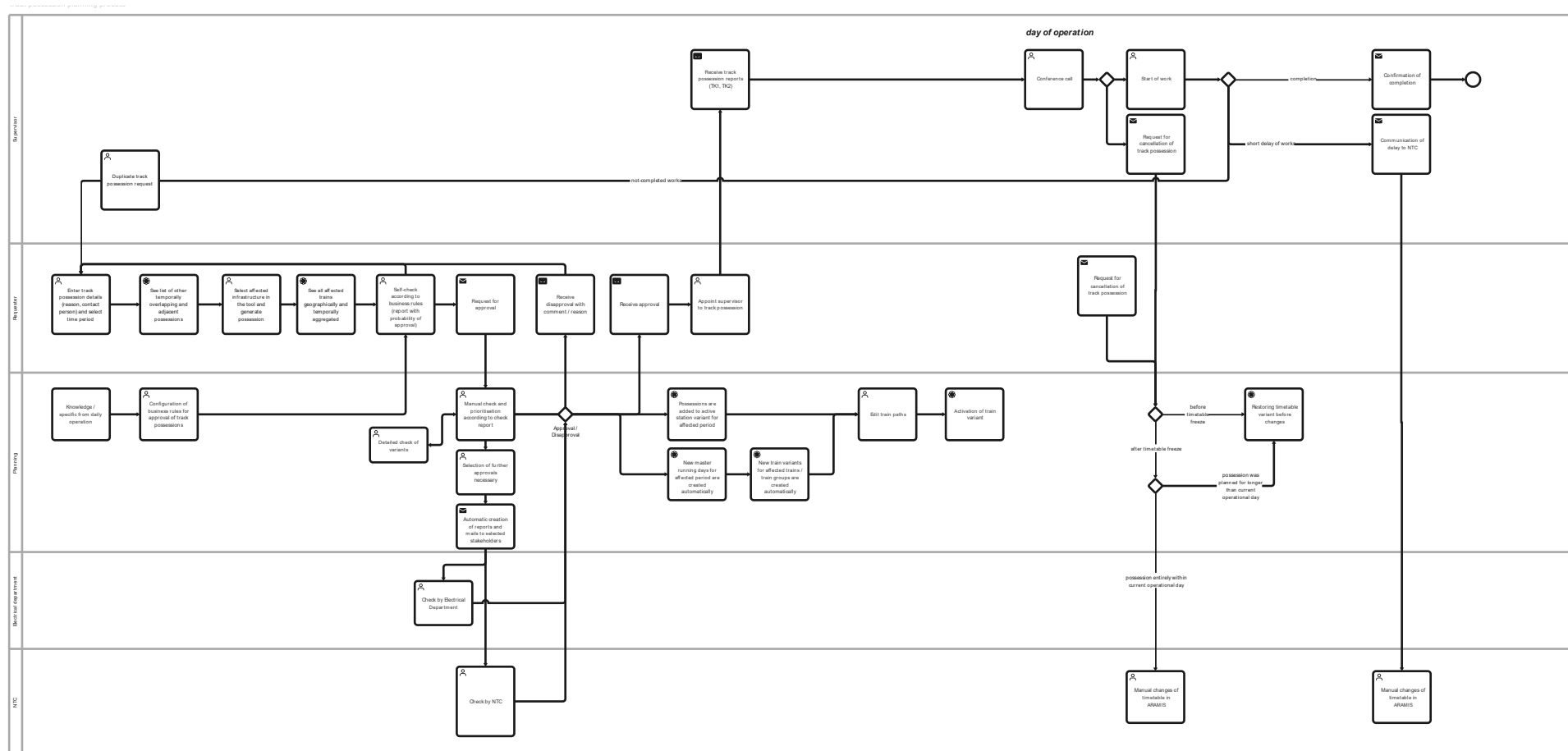


Figure 8: Subprocess: Daily Operations timetable

2.1.4 Track possessions

The track possession planning process begins with the requester selecting the affected infrastructure in the system and entering the details of the track possession. The system displays a list of other temporally overlapping or adjacent possessions, as well as all affected trains in both geographic and temporal views. A self-check can be performed based on predefined business rules, generating a report that estimates the likelihood of approval. If the request passes the initial check, it is submitted for approval. Disapprovals will be returned with comments or reasons. A manual review and prioritization are conducted by the Planning Department based on the check report, followed by a review by the NTC and the Electrical Department if necessary. If approved, possessions are added to the active station variant for the relevant period and for affected trains or train groups, new train variants are automatically created, and train paths are edited accordingly. The requester appoints a supervisor, who receives track possession reports and can coordinate the start of the work.

If a possession needs to be canceled, a request is submitted, and the timetable variant is restored to its previous state if the timetable has not yet been frozen. After the timetable freeze, manual changes can be made in ARAMIS. Upon completion, confirmation is communicated, and any delays are reported to the NTC. If the works are not completed, the timetable may be manually adjusted in ARAMIS, and a duplicate possession request for further days may be submitted if necessary.



2.3 Description of the system environment (interfaces)

The interface architecture outlines a comprehensive, modular, and highly integrated planning environment for Israel Railways. It ensures seamless data flow between strategic planning, operational scheduling, and real-time execution systems. By leveraging standardized data formats, automated workflows, and robust system interfaces, the architecture supports efficient, accurate, and collaborative timetable and possession planning across the entire railway organization. The following diagram shows the interfaces and workflows in the new Capacity Allocation Process.

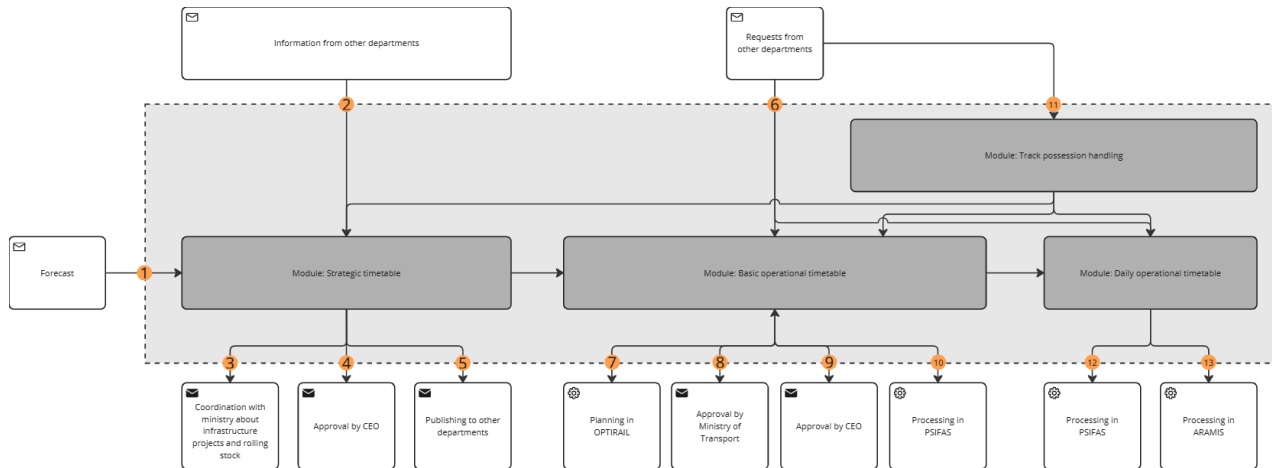


Figure 10: Interfaces and workflow diagram

2.3.1 Modular Planning Environment

The system is composed of several interconnected modules, each responsible for a specific planning function:

- **Strategic Timetable Module:** This module handles long-term planning based on passenger and freight forecasts. It supports the import of structured data formats such as CSV, XLSX, SHP, and GeoJSON, enabling integration of spatial and demand data. It also allows the import of service requirement scenarios, which include expected passenger volumes per station and time segment, facilitating demand-driven planning.
- **Basic Operational Timetable Module:** This module is central to mid-term planning and is responsible for generating the foundational timetable. It supports the import and export of infrastructure, rolling stock, and train data in compliance with the railML 2.5 standard. Once the timetable is approved, it can be exported to downstream systems such as PSIFAS and ARAMIS with a single action, ensuring consistency and reducing manual effort.
- **Track Possession Handling Module:** This module manages the scheduling and coordination of infrastructure maintenance and track closures. It supports the import/export of possession data, including metadata, affected infrastructure, and impacted train services. It also integrates with asset management systems to retrieve asset condition and maintenance history, enhancing the accuracy of possession planning.
- **Daily Operational Timetable Module:** This module finalizes the daily train schedule based on the basic timetable and real-time adjustments. It enables one-click export of the finalized daily timetable to both PSIFAS and ARAMIS, ensuring operational readiness and synchronization across systems.

2.3.1 External System Interfaces

The architecture supports robust integration with several key external systems, each serving a distinct operational role:

- **ARAMIS (by Thales):** This is the central traffic management system. The interface allows for the automated transfer of both timetable and infrastructure data, eliminating the need for manual updates. This ensures that ARAMIS always reflects the most current operational plan, supporting real-time traffic control and conflict resolution.
- **PSIFAS (in-house system):** PSIFAS is the operational backbone for train execution. It receives timetable data via CIF files and redistributes it to various subsystems, including ticketing, licensing, passenger information, and driver scheduling. The interface ensures that once a timetable is approved, it is immediately available for operational use without further intervention.
- **OPTIRAIL (by ESI):** This system is responsible for organizing rolling stock and staff. The interface is bidirectional, allowing the planning system to send updated timetables and receive feedback on train rotations and staff assignments. This ensures alignment between the planned timetable and available resources.

3. Workflow and Approval Processes

The diagram also outlines a structured approval and publishing workflow:

- **Coordination with the Ministry of Transport:** Infrastructure projects and rolling stock plans are aligned with national transport policies.
- **Approval by CEO:** Strategic and operational plans are validated at the executive level.
- **Publishing to Departments:** Once approved, plans are disseminated to relevant departments for implementation.
- **Planning in OPTIRAIL:** Staff and rolling stock are assigned based on the approved timetable.
- **Processing in PSIFAS and ARAMIS:** Finalized plans are transferred to operational systems for execution.

This workflow ensures that all stakeholders are involved in the planning process and that approvals are systematically documented and integrated into the system.

4. Data Exchange and Interoperability

The system is designed for high interoperability, supporting a wide range of data formats and exchange protocols:

- **railML 2.5 Compliance:** The system supports the import and export of infrastructure, rolling stock, and train data in railML format, ensuring compatibility with industry standards.
- **Forecast and Spatial Data:** Strategic planning modules can ingest forecast data in CSV, XLSX, SHP, and GeoJSON formats, enabling integration of demand and geographic information.
- **Possession Data:** Track possession data can be imported/exported with options to include metadata only or full infrastructure and timetable details.
- **Report Generation:** The system supports the generation of various reports (e.g., graphical timetables, possession calendars, robustness analyses) in formats such as PDF, CSV, XLSX, and SVG. Reports can be customized, scheduled, and generated on demand.

5. Collaboration and Automation

The architecture emphasizes collaboration and automation to reduce manual workload and improve data accuracy:

- **Standardized Approval Workflow:** The system facilitates stakeholder approvals through integrated workflows, reducing the need for manual data entry and minimizing errors.
- **One-Click Exports:** Approved timetables can be exported to PSIFAS and ARAMIS with a single action, streamlining the transition from planning to operations.
- **Bidirectional Interfaces:** Systems like OPTIRAIL support two-way communication, enabling real-time updates and feedback loops.
- **Integration with Asset Management:** The possession planning module interfaces with asset management systems to incorporate maintenance data, improving planning precision.

6. Reporting and Visualization

The system includes robust reporting capabilities to support decision-making and stakeholder communication:

- **Customizable Templates:** Users can create and edit report templates tailored to different audiences, including infrastructure elements, train parameters, and timetable data.
- **Graphical Outputs:** Graphical timetables, network graphics, and track occupation diagrams can be exported in vector formats for high-quality presentation.
- **Tabular Reports:** Lists of trains, running time calculations, and operation day calendars can be exported in structured formats for analysis and archival.

Part B: Functional Requirements Specification

1 Working environment

#473 State: Preliminary Severity: Responsibility:

One of the main goals is having an integrated and easy-to-use system for timetable and possession planning. The basics for the working environment are compiled in this chapter. "System" describes the subject of delivery. The system can consist of one or multiple tools, which must ensure a continuous workflow at all times. "Tool" describes a self-contained application. The tool can consist of one or multiple modules representing parts of the application used for a dedicated part of the planning process (e.g. strategic timetabling or possession planning).

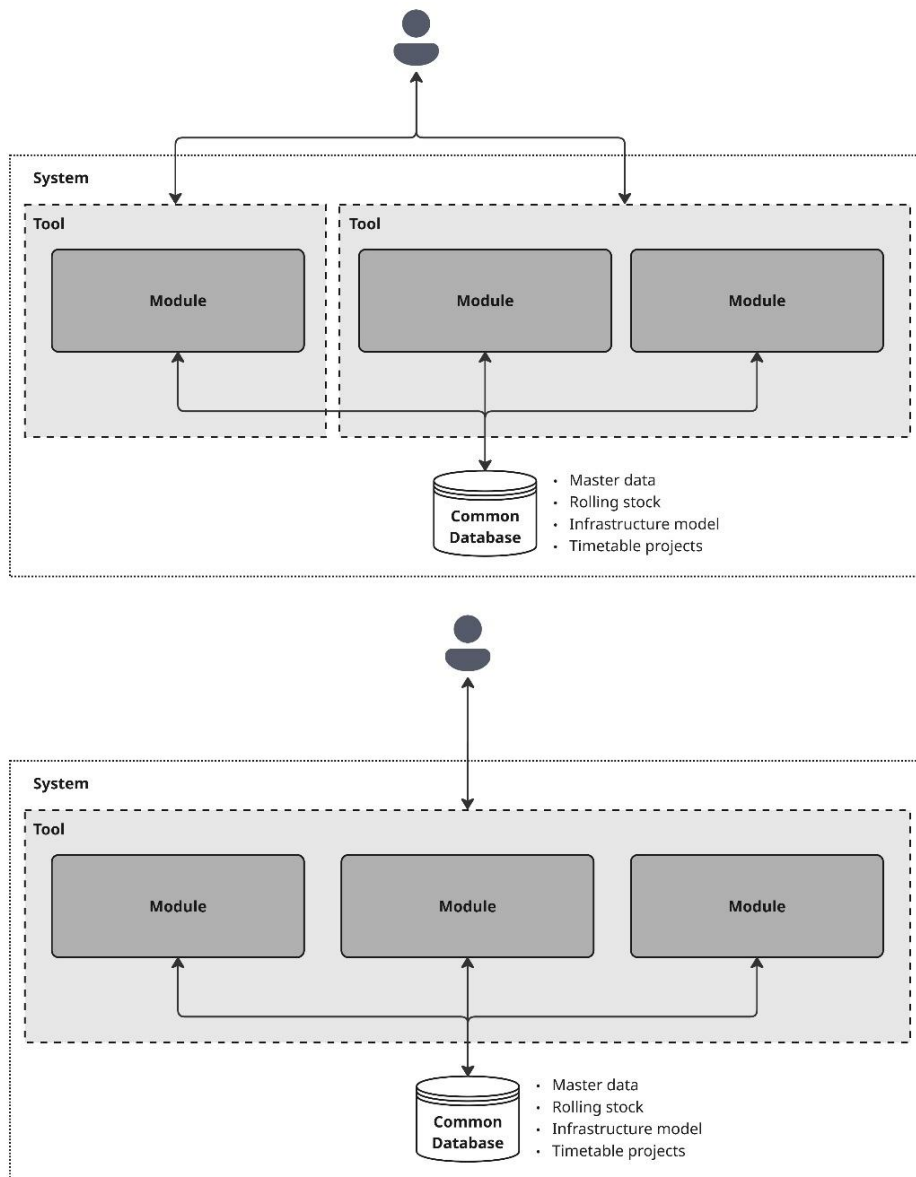


Figure 11: Variants of Architecture

Structure of the functional requirements:

The following diagram shows the structure of functional requirement chapters in Part B of this document:

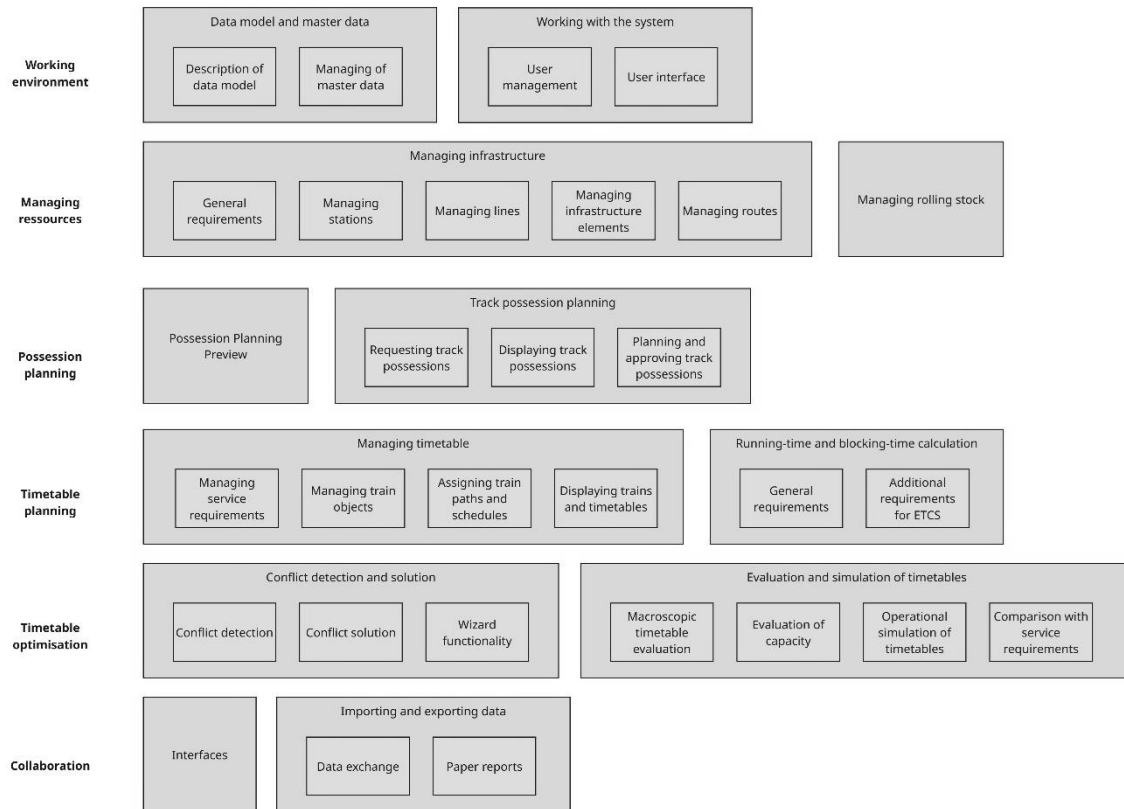


Figure 12: Structure Part B of this document

1.1 Data model and master data

#67 State: Preliminary Severity: Responsibility:

The following requirements describe the conditions that must be met for the system to support the timetable and possession planning process.

1.1.1 Description of data model

#442 State: Preliminary Severity: Responsibility:

The following requirements describe the data model on which the system is based. Other requirements in this specification will refer to this data model.

1.1.1.1 Central Data Storage and Handling

#125 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

The system stores data on a central database instance. A change made in one module in the system will affect and be displayed in the other modules. This ensures that all stakeholders have access to the most up-to-date information, reducing the risk of discrepancies.

1.1.1.2 Enabling cross-horizon workflow through all modules

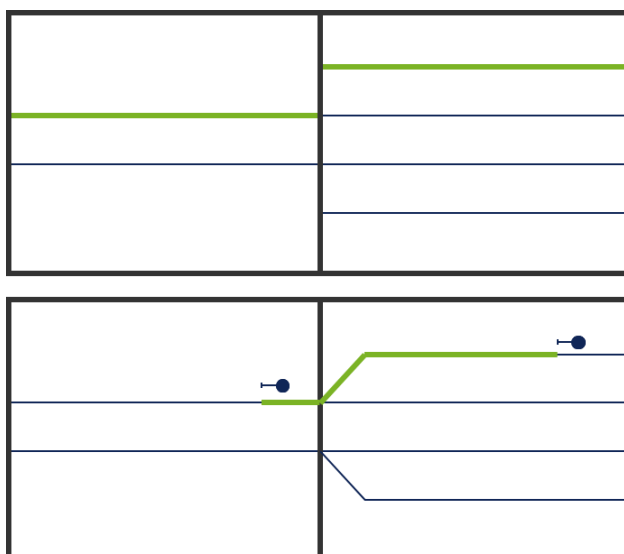
#128 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

The system supports planning for all ranges of time: strategic timetable (multiyear), basic operational timetable (periodic), daily timetable (short-term).

1.1.1.3 Structure of the infrastructure model

#149 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

The system is based on an infrastructure data model. The macroscopic and microscopic levels are formed both from the same modelled data and the selected level of detail of the view. Changes made in either macroscopic or microscopic layer affect the data model and will displayed in the other layer if the grade of detail is high enough.



Macroscopic layer:
each train has a track assigned
in each station

Microscopic layer:
supplemented with exact route
between signals

Figure 13: Macroscopic and Microscopic layer for infrastructure

1.1.1.4 Necessary structure of the macroscopic infrastructure layer

#150 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The macroscopic infrastructure model consists of operational points and lines. Lines consist of a series of operational points and are described in more detail by other parameters. These parameters are edge attributes (such as the distance between two operational points, number of tracks between two operational points, travel times, headway times on the line) and node attributes (such as the number of tracks, their usable length in operational points, headway times in stations, exclusions of train paths).

1.1.1.5 Data management of timetable variants

#156 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system allows working with different timetable variants (on the same infrastructure) and switching between timetable variants. Timetable variants consists of one or multiple train groups. Train groups are usable in multiple timetable variants.

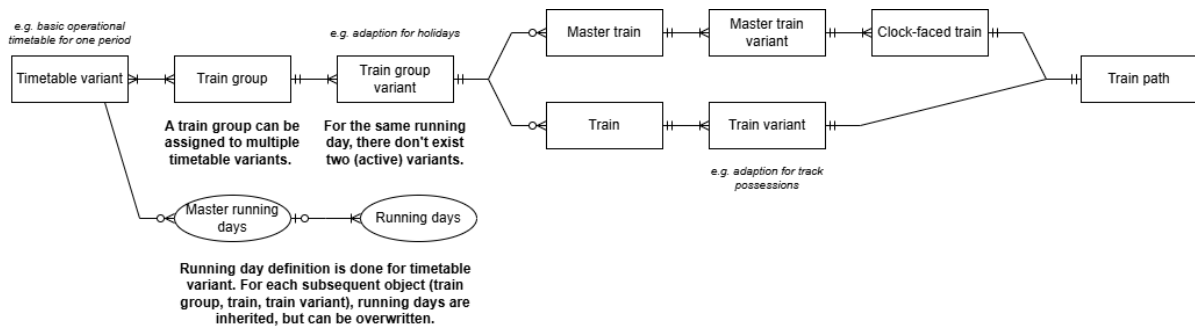


Figure 14: Timetable / train variant scheme

1.1.1.6 Data management of infrastructure variants

#157 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system allows working with different infrastructure variants (within the same timetable variant) and switching between infrastructure variants. An infrastructure variant consists of one or multiple (adjacent) station variants for each station. For each infrastructure variant, the time horizon (validity) and state (maturity) is assigned. In each station variant, infrastructure elements are activated or deactivated. Infrastructure elements are assigned to stations and edited on higher-level.

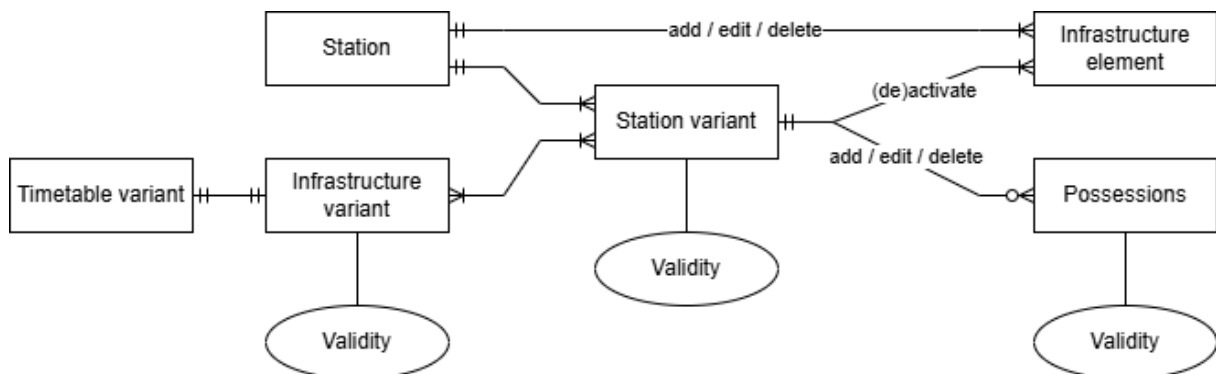


Figure 15: Infrastructure / station variant scheme

1.1.1.7 Inheritance principle

#162 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system allows the inheritance of properties of parent objects to child objects (e.g. running days of a timetable variant are inherited to train group variants and train variants, but can be overwritten for each child object).

1.1.1.8 Data management of timetable projects

#428 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

A timetable project consists of multiple infrastructure variants and one timetable variant. Infrastructure and timetable variants can be exchanged between timetable projects. A timetable project could be the basic operational timetable for one timetable period. Within these timetable projects, there could exist multiple infrastructure variants (e.g. adaptations to infrastructure during timetable period) and multiple train (group) variants (e.g. adaptations due to different infrastructure variant, track possessions, holidays, events).

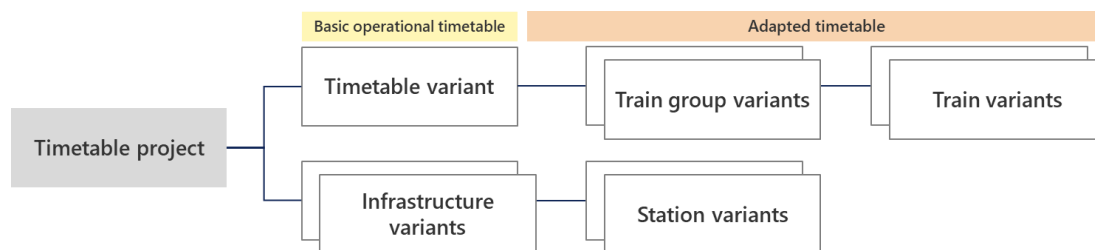


Figure 16: Timetable project schemes

1.1.1.9 Definition of objects

#432 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

Objects are variants, infrastructure elements, routes, all types of trains (train group, train, master clock train, clock train) and running days.

1.1.1.10 Upward compatibility to third-party infrastructure database

#438 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Strategic

A third-party solution may be introduced to manage infrastructure versions. This third-party solution also manages versions of operational stations. The interface is the current railML format. It must be possible to export versions of individual stations out of the here described system or import them from the thirs-party solution.

1.1.2 Managing of master data

#447 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe, what kind of general data has to be stored to be usable in various modules of the system.

1.1.2.1 Management of braking tables

#136 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system manages speed clusters for train types, brake positions and brake percentages.

1.1.2.2 Management of commercial train information

#137 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system manages commercial train information (e.g. train types, commercial line numbers) editably.

1.1.2.3 Management of unhindered brake decelerations

#139 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system stores unhindered brake decelerations as a function of train type, of type of target (standstill or speed change) and of speed interval editably.

1.1.2.4 Management of running-time computation master data per train type

#140 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system stores standard values (e.g. pairs of minimum dwell time and dwell-time supplements, minimum standstill time after brake application, maximum permitted coupling force) per train type editably.

1.1.2.5 Management of blocking-time computation master data

#141 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system manages basics of the blocking-time computation (e.g. standard values for system times per infrastructure element) editably.

1.1.2.6 Management of INDUSI I60R supervision functions

#142 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system stores the INDUSI I60R supervision functions editably. Per rolling-stock unit, the applicable supervision programs of INDUSI I60 can be stored. Depending on the train type in the timetable (e.g. passenger or freight), the program to apply is chosen.

1.1.2.7 Management of ETCS system configuration

#143 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system stores those ETCS national values plus such values relevant for running- and blocking time calculation, which are relevant for running and blocking-time computation, editably.

1.1.2.8 Defining station types

#159 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system enables the definition of a station type to apply standardised parameters (e.g. stop types (operation/commercial), standard dwell times, train headways or type of graphical presentation).

1.1.2.9 Defining stop types

#160 **State:** Reviewed internally **Severity:** can **Responsibility:** Strategic

The system allows you to define a stop type: commercial stop, operational stop, on-demand stop, embarking only, disembarking only

1.1.2.10 Defining public holidays

#161 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system allows you to set fixed public holidays to simplify the definition of operation days.

1.1.2.11 Defining and applying train types

#163 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system allows the definition of different train types to which properties (e.g. display colour) can be assigned.

1.1.2.12 Defining and applying train type categories

#164 **State:** Reviewed internally **Severity:** can **Responsibility:** Strategic

The system allows the definition of different train type categories, to which properties (e.g. display colour) and subordinate train types can be assigned.

1.1.2.13 Defining general data for running-time calculation

#166 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The general data for the running-time calculation must be stored as fixed values: headwind speed, wagon mass factor, equivalent areas of vehicle cross-section, running resistance coefficient for passenger coaches, running resistance coefficient for freight wagons, bearing friction coefficient for freight wagons, brake build-up time, jerk, stopping of trains in the centre or at the end of a stopping position

1.1.2.14 Definition of business rules for plausibility checks

#168 **State:** Reviewed internally **Severity:** can **Responsibility:** Strategic

Business rules to be followed can be defined for the interaction between train and infrastructure objects (e.g. train types not allowed in stations, allowed dwell and turnback times).

1.1.2.15 Defining and editing master operation days

#245 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions Strategic

Certain periods within a timetable period (e.g. holidays, public holidays, periods with track possessions) must be defined in advance as master running days, so that each day of validity does not have to be selected individually for each train.

1.1.2.16 Setting master operation days as favourites

#246 **State:** Reviewed internally **Severity:** can **Responsibility:** Possessions Strategic

Each editor can mark master operation days as favourite ones.

1.1.2.17 Defining calculation parameters for robustness analysis

#322 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

To carry out a robustness analysis on macroscopic level, basic calculating parameters shall be defined by the user (e.g. running-time supplements allowed to use for delay compensation).

1.1.2.18 Providing rolling-stock independent data for running-time calculation

#368 State: Reviewed internally Severity: must Responsibility: Strategic

Various parameters are used in the running time calculation, which are not (necessarily) dependent on the respective series/rolling stock. These should be kept as default values so that they are used in the running time calculation as long as nothing else is specified.

1.1.2.19 Definition of minimum duration for keeping speed

#382 State: Reviewed internally Severity: must Responsibility: Strategic

A minimum duration to keep a certain speed is ensured. The minimum duration is a function of train type.

1.1.2.20 Defining minimum buffer times

#404 State: Reviewed internally Severity: must Responsibility: Strategic

Minimum buffer times can be predefined as function of train type (category) and station.

1.1.2.21 Defining default values for simulation's limiting conditions

#501 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions

Input for operational simulation beside the infrastructure and timetable variant are disturbances (entry delays, primary delays at stops, primary delays on the line), enviromental behaviour (trimming/waiting at the signal, delay reduction) and dispatching settings (bending/intentionally slow down, modify dwell times, new operational stops, removal of operational stops, changed routes, changed station order). For all parameters, default values are defined and are editable in master data.

1.1.2.22 Defining calculation parameter for concatenation

#502 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

Handling of running-time supplements and dwell-time supplements before concatenation is editable and defined as master data.

1.1.2.23 Definition of regular running-time supplements

#504 State: Reviewed internally Severity: must Responsibility: Strategic

Regular running-time supplements can be defined as a function of location (station) and train type (category).

1.1.2.24 Definition of bending supplements

#505 State: Reviewed internally Severity: must Responsibility: Basic+Daily

Bending supplements can be defined globally as a function of location (station) and train type (category) and individually between two stations of the train itinerary.

1.2 Working with the system

#28 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe how the user will work with the tool(s) in general.

1.2.1 User management

#448 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe, how different users can work with the system and what preconditions have to be fulfilled for that.

1.2.1.1 User and rights management

#126 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

For each user, corresponding permissions must be defined. Users and permissions can be added, changed or deleted.

1.2.1.2 Role-dependent reading and editing of master data

#167 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The "Create, read, update and delete (CRUD)" user interface conventions for master data apply to definable users/user groups/roles.

1.2.1.3 Authentication and authorisation of users

#169 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system must allow use of robust identification mechanisms for stages defined in the system as critical. The system must include user authentication and authorisation features.

1.2.1.4 Multi-user support

#170 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system must support the work of multiple users simultaneously with different permission levels.

1.2.1.5 Role-based restriction of write access to objects

#173 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The editing of objects (e.g. timetable projects, timetable variants, infrastructure variants, station variants, lines and stations) can be restricted based on roles.

1.2.1.6 Unique owner of objects

#174 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

Each object has a unique owner.

1.2.1.7 Ensuring access to most up-to-date information

#186 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system must ensure that all stakeholders have access to the most up-to-date information, reducing the risk of discrepancies.

1.2.1.8 Blocking projects, variants and stations for exclusive editing

#430 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

A user can block timetable projects, timetable variants, infrastructure variants, station variants, lines and stations for exclusive editing by him.

1.2.1.9 User Roles and Permissions for Possession Planning Preview

#499 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

Different user roles (e.g., Planner, Supervisor, Technician) should have specific access rights. This ensures data integrity and security.

1.2.2 User interface

#449 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe the general appearance and functionalities of interaction with the tool(s).

1.2.2.1 Language support: Hebrew

#171 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The system can be provided in Hebrew language. Reports can be provided in Hebrew language.

1.2.2.2 Language support: English

#172 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system must be used in English language. Reports are provided in English language.

1.2.2.3 Friendly user interface

#177 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system must be easy and clear to operate and have an intuitive user interface. ISO 9241 or Nielsen's Usability Heuristics (<https://www.nngroup.com/articles/ten-usability-heuristics/>) may be applied:

- Visibility of system status: Keep users informed about what is going on.
- Match between the system and the real world: Information should appear in natural and logical order.
- User control and freedom: Guide users to back out of a process or undo actions.
- Consistency and standards
- Error prevention
- Recognition rather than recall: The user should not have to remember information from one part of the interface to another.
- Flexibility and efficiency of use

- Aesthetic and minimalist design
- Help users recognize, diagnose, and recover from errors
- Help and documentation

1.2.2.4 Navigating in plans and diagrams

#178 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system allows the user to navigate through plans and diagrams intuitively and consistently.

1.2.2.5 Filtering, searching and sorting trains

#179 **State:** Accepted **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The list of trains can be filtered, searched and sorted by day, time, train type/train type categories and operational points used.

1.2.2.6 Comparison of timetable / infrastructure variants

#184 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The system allows the comparison of different timetable or infrastructure variants. The comparison parameters can be selected by the user (e.g. train paths, train groups, infrastructure elements, parameters of infrastructure elements changed). The user can transfer objects or properties to the current variant directly from the comparison result. The comparison can be exported as a report.

1.2.2.7 Sandbox environment for reviewing timetable changes and various planning alternatives

#185 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system must have a sandbox environment. If activated, changes in infrastructure or timetable data are not saved permanently. Changes can be taken over in production environment by one click.

1.2.2.8 Editing requires permanent connection to online database

#431 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

Working with the system (editing of master data, infrastructure model, timetable projects et al.) requires a permanent connection to online database.

2 Managing ressources

#474 State: Preliminary Severity: Responsibility:

Before the possession and timetable planning can be done, it is necessary to define the ressources needed, which are the definition of the infrastructure where trains are running on and the definition of rolling stock which is used for the train runs.

2.1 Managing infrastructure

#107 State: Preliminary Severity: Responsibility:

The following requirements describe how the railway infrastructure can be modelled within the system.

2.1.1 General requirements

#454 State: Preliminary Severity: Responsibility:

The following requirements describe some main functionalities regarding working with infrastructure elements.

2.1.1.1 Attribution of running times to the macroscopic layer

#151 State: Reviewed internally Severity: must Responsibility: Strategic

Standard running times per train type and behaviour at the adjacent nodes (stopping on main track, stopping on siding track, passing) are attributed to the edges.

2.1.1.2 Consistency checks between macroscopic and microscopic layer

#153 State: Reviewed internally Severity: must Responsibility: Basic+Daily

When modeling microscopic infrastructure, consistency checks are performed, e.g. the number of specified tracks or station tracks must match the macroscopic layer. Consistency checks are performed in both directions between macroscopic and microscopic layer.

2.1.1.3 Derive topologies for microscopic layer from macroscopic models

#154 State: Reviewed internally Severity: must Responsibility: Basic+Daily

A microscopic infrastructure layer for a part of the network (e.g. set of stations) can be derived from the macroscopic layer by application of additional data

2.1.1.4 Deriving macroscopic layer from microscopic layer

#155 State: Reviewed internally Severity: must Responsibility: Strategic

A macroscopic layer of a part of the network can be derived from the microscopic representation. Attributes added in microscopic layer will overwrite entries in macroscopic layer. For example, headway times calculated in microscopic running-time calculation will overwrite manual entered headway in macroscopic layer.

2.1.1.5 Performing bulk editing for infrastructure objects

#176 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

If multiple infrastructure objects (infrastructure elements, routes, stations) are selected, all properties making sense can be edited for all selected infrastructure objects.

Examples:

- Multiple infrastructure elements of the same type are selected: It is possible to edit properties of the elements (e.g. speed in speed changes).
- Multiple infrastructure elements of different types are selected: It is possible to add them to filters, but you cannot change the properties.

2.1.1.6 Changelog in infrastructure editor

#187 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Strategic

The system gives the user an overview of actions performed and their status. Each action must be provided with a sequential number, a timestamp, user, the affected object, a category and details about the result of the action performed. The user can navigate from the status message to the affected object.

2.1.1.7 Displaying infrastructure in infrastructure graph (track schematics)

#188 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The infrastructure is displayed schematically graphically. Clear demarcation makes it clear which infrastructure elements belong to which station.

2.1.1.8 Filtering infrastructure elements to be displayed

#189 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions

It is possible to filter which infrastructure elements should be displayed in which size and color.

2.1.1.9 Displaying macroscopic network view

#190 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The macroscopic infrastructure is schematically displayed graphically as a node-edge model.

2.1.1.10 Checking infrastructure consistency

#193 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

Track number of a station boundary exists in the macroscopic station definition. The transitions between station boundaries and tracks must be consistent on macroscopic and microscopic level.

2.1.1.11 Displaying and exporting speed profiles

#225 **State:** Accepted **Severity:** must **Responsibility:** Basic+Daily Possessions

The system displays and exports the speed profile of a line in tabular form.

2.1.1.12 Displaying and exporting gradient profiles

#226 **State:** Accepted **Severity:** must **Responsibility:** Basic+Daily Possessions

The system displays and exports the elevation profile of a line in tabular form.

2.1.1.13 Creating a new infrastructure variant

#330 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Strategic

New infrastructure variants can be created within the system (with validity). A new infrastructure variant consists of a new set of station variants (with validity for each), in which certain infrastructure elements can be set active or inactive.

2.1.1.14 Displaying macroscopic network view on map

#509 **State:** Reviewed internally **Severity:** can **Responsibility:** Strategic

The macroscopic infrastructure is displayed as a node-edge model on a geographical map (e.g. on openstreetmap basis). Therefore, the station coordinates (defined in [#218](#)) are used.

2.1.1.15 Displaying infrastructure on a map

#511 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The infrastructure is displayed on a geographical map (e.g. on openstreetmap basis). Therefore, the coordinates of infrastructure elements (defined in [#510](#)) are used.

2.1.2 Managing stations

#452 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe, how stations can be defined within the system. Each infrastructure element is uniquely assigned one station (except for station border elements).

2.1.2.1 Setting validity of station variants

#214 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Strategic

A validity start and an expiration date can be set for each station variant. By default, the validity corresponds to the validity of the opened infrastructure variant.

2.1.2.2 Managing stations and operational points

#215 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system must enable the creation and editing of operational points. The following must be determined: a unique ID, the operational name, the commercial name (if available), the name in multiple languages, the type of operational point like station/junction, geocoordinates (if available).

2.1.2.3 Creating and managing of aggregated station locations

#216 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system is intended to enable the creation and editing of aggregated station locations. The user should be able to combine several stations into this.

2.1.2.4 Defining and editing macroscopic station topology

#217 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system allows the definition and editing of macroscopic station topologies. The user defines the track layout with station tracks (direction-specific usable length, platform side, purpose: depot/through-track, optional: availability of disposal facilities) and platforms (optional: platform height, equipment), connects tracks, enters entry and exit speeds and defines track restrictions and route exclusions.

2.1.2.5 Importing and editing station coordinates

#218 **State:** Reviewed internally **Severity:** can **Responsibility:** Strategic

The system is intended to enable the import and editing of operational point coordinates.

2.1.2.6 List of stations and operational points

#222 **State:** Reviewed internally **Severity:** can **Responsibility:** Strategic

The system is intended to display a list of all operational points present in the model.

2.1.2.7 Defining and editing separation times

#320 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

Separation times determine how long the time interval between two trains must be in macroscopic view.

2.1.3 Managing lines

#453 **State:** Preliminary **Severity:** **Responsibility:**

2.1.3.1 Defining macroscopic definition of lines

#219 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system supports macroscopic line definition. At a minimum, this includes entering the distances between operating points, the number of tracks, speed profiles, elevation profiles, curve band and tunnel.

2.1.3.2 Defining or assigning line status

#220 **State:** Reviewed internally **Severity:** can **Responsibility:** Strategic

The system is intended to enable the assignment of a line status (e.g. active/inactive). This information is inherited to infrastructure elements on this line.

2.1.3.3 List of lines

#223 **State:** Reviewed internally **Severity:** can **Responsibility:** Strategic

The system is intended to display a list of all lines available in the model.

2.1.3.4 Creating and editing lines

#224 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system must allow the creation and editing of lines as a sequence of defined infrastructure elements. Each line can be assigned a line number and designation. Lines can be used to filter elements.

2.1.4 Managing infrastructure elements

#451 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe, how infrastructure elements can be defined within the system.
Infrastructure elements represent the topology and equipment of the railway infrastructure within the model.

2.1.4.1 Adapting infrastructure elements

#191 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

Infrastructure elements can be edited by selecting them in the infrastructure graphic or infrastructure list.

2.1.4.2 Copying existing infrastructure elements

#192 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

Existing infrastructure elements are duplicable.

2.1.4.3 Managing infrastructure elements: tracks

#194 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

A track is defined by two track ends each with position in kilometers.

2.1.4.4 Managing infrastructure elements: station boundaries

#195 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The infrastructure element "station boundary" is included and delimits the begin and end of an operational point. The mileage and adjacent operational points must be selected. A track number must be indicated.

2.1.4.5 Managing infrastructure elements: mileage break

#196 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The infrastructure element "mileage break" is included. At a specific position, the current and new mileage can be entered.

2.1.4.6 Managing infrastructure elements: change of line

#197 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The infrastructure element "change of line" is included. At a specific position, the current and new line can be selected.

2.1.4.7 Managing infrastructure elements: switches/crossings

#198 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The infrastructure element "Switch"/"Crossing" is included and contains information on the location of the center of the switch and the direction of travel. The tangent length of the switch or crossing can be entered to get information about the location of effect for speed changes under ETCS.

2.1.4.8 Managing infrastructure elements: main signal

#199 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The infrastructure element "main signal" is included and contains information about the location and direction of validity. Optionally it can represent attributes: ensure passage yes/no, no approaching time yes/no, release speed, specific distant signal allocation, approach speed (maximum permissible speed between the distant signal/infill balise and the stop indicating main signal).

2.1.4.9 Managing infrastructure elements: protection signal

#200 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The infrastructure element "protection signal" is included and contains information about the location and direction of validity. Optionally, an overlap release time can be specified.

2.1.4.10 Managing infrastructure elements: distant signal

#201 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The infrastructure element "distant signal" is included and contains information about the location and direction of validity.

2.1.4.11 Managing infrastructure elements: speed

#202 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The infrastructure element "Speed change" is included and contains information about the location (from here, from signal, from switch), direction of validity, train control system valid for, speed limit, train type category valid for, rolling-stock type valid for.

2.1.4.12 Managing infrastructure elements: train detection

#203 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The infrastructure element "train detection" (axle counter, track circuit) is included and contains information on the location, direction of validity and supervised location.

2.1.4.13 Managing infrastructure elements: INDUSI 500 Hz magnet

#204 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The infrastructure element "500 Hz magnet" is included and contains information on the location and direction of validity. At main and distant signals, INDUSI magnets (1000 Hz, 2000 Hz) are considered automatically.

2.1.4.14 Managing infrastructure elements: ETCS equipment

#205 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

It is possible to define on the infrastructure which area is equipped with which ETCS level. ETCS stop marker boards (SMB) and ETCS location marker boards (LMB) are included. Route-setup time, release speed, overlap-release time can be specified.

2.1.4.15 Managing infrastructure elements: alignment

#206 State: Accepted Severity: must Responsibility: Basic+Daily

The system allows to insert and edit changes of gradient and curve radius.

2.1.4.16 Managing infrastructure elements: platform

#207 State: Accepted Severity: must Responsibility: Basic+Daily

The infrastructure element "platform" is included, which shows the length, usable length of the platform and sections on the platform as well as the position to the track.

2.1.4.17 Managing infrastructure elements: stopping position

#208 State: Reviewed internally Severity: must Responsibility: Basic+Daily

The user specifies the usual stopping positions for trains for each direction. The maximum permitted train length must be determined for each stopping position. If the stopping position is on a platform, the plausibility check can be used to check whether the usable length of the platform is exceeded.

2.1.4.18 Managing infrastructure elements: railway crossing

#209 State: Reviewed internally Severity: must Responsibility: Basic+Daily

The infrastructure element "railway crossing" is included and contains information on the location and length.

2.1.4.19 Definition of no-stopping zones

#211 State: Reviewed internally Severity: must Responsibility: Basic+Daily

Parts of tracks can be marked as no-stopping zones. The train mass can be used to restrict the validity of the no stopping zone to heavy trains, i.e. it only applies to trains with a mass $\geq$ the input.

2.1.4.20 Catenary equipment of track sections

#213 State: Reviewed internally Severity: must Responsibility: Basic+Daily

The infrastructure model shall include also the catenary equipment of the track sections. It is possible to define *current limitation voltage areas* with voltage, frequency, voltage type.

2.1.4.21 List of infrastructure elements

#221 State: Reviewed internally Severity: can Responsibility: Basic+Daily

There is a list of all modeled infrastructure elements and their properties. The list can be filtered by item type. The user can set which properties are displayed.

2.1.4.22 Definition of line class and axle load

#503 State: Reviewed internally Severity: can Responsibility: Basic+Daily

Line class and axle load can be assigned to track sections.

2.1.4.23 Importing and editing coordinates of infrastructure elements

#510 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily

The system is intended to enable the import and editing of coordinates of infrastructure elements.

2.1.4.24 Deactivation of infrastructure elements in station variants

#512 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Strategic

Each infrastructure element can be set active or inactive for a certain station variant.

2.1.5 Managing routes

#450 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe, how routes can be defined within the system. Routes are realised by interlockings and ensure by signal dependency the safe realisation of train runs.

2.1.5.1 Changelog in route editor

#228 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily

The system gives the user an overview of actions performed and their status. Each action must be provided with a sequential number, a timestamp, user, the affected object, a category and details about the result of the action performed. The user can navigate from the status message to the affected object.

2.1.5.2 Creating and editing routes

#229 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

Routes can be created from signal to signal to map the interlocking logic. For each route, a route-setup and route-release time must be defined.

2.1.5.3 Prioritising routes

#230 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

Routes between signals can be prioritized to enable automatic routing when deriving macroscopic paths, rerouting or operational simulations.

2.1.5.4 Extending and reducing overlaps

#231 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

An overlap is a safety margin and describes the length of track beyond a stop signal that is proved to be clear of vehicles in the controls of the previous signal. Overlaps can be entered, extended and reduced in the system.

2.1.5.5 Managing of stopping positions

#232 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

For each route, stopping positions can be defined differentiated according to train type and usable track length. It is mandatory to distinguish whether the train stops in the middle of the usable track length or at the end of it (because of interaction with speed monitoring).

2.1.5.6 List of routes

#233 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily

The system is intended to display a list of all routes available in the model.

2.1.5.7 Suppressing infrastructure elements within a route

#508 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

It can be specified, if there are main signals or any other infrastructure elements within the route to be omitted.

2.2 Managing rolling-stock

#108 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe how the rolling stock can be defined within the system.

2.2.1 Management of rolling-stock data

#144 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system manages rolling-stock master data editably. (...)

2.2.2 Storing SRS of ETCS onboard unit

#146 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

Per rolling-stock unit, the System Requirements Specification (SRS) of the ETCS onboard-unit (SRS 3.4.0 or SRS 3.6.0) can be stored.

2.2.3 Storing of gamma-model

#147 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

Per rolling-stock unit, the parameters of the ETCS gamma-model can be stored. It is sufficient, that one confidence level for emergency brake safe deceleration on dry rails (M_NVEBCL) can be handled.

2.2.4 Automatic filling in platform occupancy time between two trains during turnbacks

#279 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily

If two train runs are constructed that are connected with a circulation link (turnback), the platform occupancy time between the arrival of the first train and departure of the following train can be automatically filled in.

3 Possession planning

#475 State: Preliminary Severity: Responsibility:

One part of the process describes the handling of track possessions due to maintenance or construction works. The requirements for requesting, approving and considering of these possessions in the timetable planning are compiled in the following chapters.

3.1 Possession Planning Preview

#470 State: Preliminary Severity: Responsibility:

The following requirements describe how expected track possessions due to maintenance work can be considered in planning at an early stage.

3.1.1 Define Master Data for Possession Plan Preview

#480 State: Reviewed internally Severity: must Responsibility: Possessions

The module allows users to input and manage essential master data required for each Possession Plan Preview. This data forms the foundation for planning, scheduling and executing possession planning activities.

Mandatory Master Data Elements:

- ID of the Possession Plan Preview
- Possession Discipline (e.g., trackworks, signalling, telecommunication, civil engineering-bridges, civil engineering-tunnels, station, catenary system,...). Additional categories can be added by users depending on their user rights
- Possession Work Type (e.g., inspection, renewal, grinding,...) Additional categories can be added by users depending on their user rights
- Priority Level
- Access Requirements (e.g., possession, isolation)
- Affected location for the possession (station, area, infrastructure element or line section) assigned via an interactive infrastructure map (mapping on track topology takes place in track possession planning at the latest, see [#348](#)).
- Planned Start and End Dates (breakdown for each day within the period is possible)
- Historical Reference (if based on previous plan or preview)

Optional Master Data Elements:

- GPS Coordinates or Geolocations of the elements affected by the possession
- Asset ID(s) involved
- Responsible Team or Department
- Assigned Supervisor
- External Contractors (if applicable)
- Work Shift or Time Window
- Required Equipment and Modules
- Standard Task Templates
- Safety Requirements and Risk Classifications
- Linked Work Orders or Job Packages
- Budget Code or Cost Center
- Regulatory or Compliance References

3.1.2 Copy Existing Possession Plan Previews

#481 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

The module allows users to duplicate an existing Possession Plan Preview with all associated data. This feature supports efficient planning for recurring or similar maintenance tasks.

3.1.3 Edit Copied Plan Details

#482 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

After copying a plan, users should be able to modify key attributes such as dates, locations, ...

3.1.4 Interactive Infrastructure Graph/Map Integration

#483 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

An interactive infrastructure graph/map should display the location of planned possessions. with highlighted maintenance zones. Users can zoom, pan, and click on segments to view details. This helps planners visualise spatial distribution and conflicts.

3.1.5 Conflict Detection for Possession Planning Preview

#484 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

The module automatically detects overlapping Possession Plannings in the same segment or nearby segments during the same or an overlapping period. It should alert users to potential scheduling conflicts but allows overriding the alert.

3.1.6 Derive Possession Requests

#485 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

Users should be able to derive multiple possession requests from the Possession Plan Preview (see [#465](#)).

3.1.7 Calendar View

#486 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

A calendar interface should display all planned possession planning activities. Users can at least filter by date, location, or possession work type.

3.1.8 Mobile Access to Possession Planning Preview

#487 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

A mobile-friendly version should allow field teams to view and update Possession Plan Previews. This ensures real-time communication and updates.

3.1.9 Audit Trail

#488 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

All changes to Possession Plan Previews should be logged with timestamps and user IDs. This supports accountability and traceability.

3.1.10 Historical Data Access

#489 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

Users should be able to view past possession planning activities for any element/section. This supports trend analysis and future planning.

3.1.11 Track Source of Copied Plans

#490 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

Each copied plan should retain a reference to the original plan it was derived from. This helps in tracking dependencies and understanding planning lineage.

3.1.12 Notification System

#491 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

The module should send notifications for upcoming possessions, changes, or conflicts. Notifications can be via email, SMS, or in-app alerts.

3.1.13 Customizable Templates

#492 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

Users should be able to create and reuse templates for recurring maintenance tasks. This speeds up planning and ensures consistency.

3.1.14 Generate Work Orders

#493 **State:** Reviewed internally **Severity:** can **Responsibility:** Possessions

The system must generate detailed work orders from the Possession Plan Preview. Each work order should include task type, location, time, and required resources.

3.1.15 Resource Allocation

#494 **State:** Reviewed internally **Severity:** can **Responsibility:** Possessions

Users should be able to assign teams, equipment, and materials to each maintenance task. Example: Team A, Ballast Regulator, 50m of rail.

3.1.16 Priority Tagging

#495 **State:** Reviewed internally **Severity:** can **Responsibility:** Possessions

Each maintenance task should have a priority level (e.g., High, Medium, Low). This helps in scheduling and resource allocation.

3.1.17 Weather Impact Integration

#496 **State:** Reviewed internally **Severity:** can **Responsibility:** Possessions

The module should allow users to input or integrate weather forecasts. This helps assess risks and adjust plans accordingly.

3.2 Track possession planning

#68 State: Preliminary Severity: Responsibility:

The following requirements describe how track possessions can be requested, approved and further processed in timetable planning.

3.2.1 Requesting track possessions

#465 State: Preliminary Severity: Responsibility:

The following requirements describe how track possessions can be requested and what kind of data must be processed by the system for that. Essential is the selection of affected infrastructure in the infrastructure map and visibility of adjacent possessions or affected trains.

3.2.1.1 Check of business rules before request for approval

#343 State: Reviewed internally Severity: must Responsibility: Possessions

It is displayed whether the business rules for track possession are complied with. It is shown the probability for approval. The user can do a self-check if his requested track possession is likely to get an approval.

3.2.1.2 Definition of unique ID for track possessions

#345 State: Reviewed internally Severity: must Responsibility: Possessions

Each track possession is given a unique name/unique number.

3.2.1.3 Definition of duration for track possessions

#347 State: Reviewed internally Severity: must Responsibility: Possessions

Each track possession is given a start date and an end date within an existing timetable variant (e.g. basic operational timetable).

3.2.1.4 Element-precise definition of track possessions

#348 State: Reviewed internally Severity: must Responsibility: Possessions

The track possession must be element-specific. The accuracy depends on the time horizon, whether you are on the macroscopic or microscopic layer.

3.2.1.5 Selection of infrastructure affected by track possession

#349 State: Reviewed internally Severity: must Responsibility: Possessions

Track section between two signals or switches should be selectable by the user in the infrastructure graph. The user can click and select tracks between signals or switches and the system shows automatically the area between the selected signals or switches. The user can select signals or switches as start/end point of the track possession. After selection of start and end point, all intermediate infrastructure elements are also selected.

3.2.1.6 Defining and editing line closures

#350 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

To create a restriction of the line closure type, the affected sections of a line and one or more affected tracks are selected. An individual start and end time of the closure can be assigned for each operational point.

3.2.1.7 Defining and editing station closures

#351 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

For the creation of a restriction of the type station closure, the affected operational points of a line and one or more affected station tracks are selected. An individual start and end time of the closure can be assigned for each operational point.

3.2.1.8 Defining and editing temporary speed restrictions

#352 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

For the creation of a temporary speed restriction (TSR), the affected sections of a line and one or more affected tracks are selected. An individual start and end time of the closure can be assigned for each operational point.

3.2.1.9 Including type of work in request

#364 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

Type of work shall be included in track possession request and visualisation.

3.2.1.10 Displaying dependencies and conflicts between requests

#365 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

Display dependencies and possible conflicts (in terms of spatial and temporal overlaps) between requests.

3.2.1.11 Reminder for double-check/updating possession request

#367 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

If requests are entered in the strategic period, a reminder should remind the processor to check/update the planning again as soon as the basic operational timetable has been completed.

3.2.1.12 Deselection of intermediate infrastructure elements

#406 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

It is possible to deselect infrastructure elements manually, if possible. If not all intermediate elements between the start and end point (signal/switch) are selected, a hint is shown to the user.

3.2.1.13 Hint for adjacent track possessions

#407 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

If there is an adjacent track possession, a hint is shown to the user.

3.2.1.14 Differentiation of track possession duration

#408 State: Reviewed internally Severity: must Responsibility: Possessions

The exact date and time of the track possession must be entered. It is possible to enter specific affection times or just select the whole track possession duration.

3.2.2 Displaying track possessions

#467 State: Preliminary Severity: Responsibility:

The following requirements describe how track possessions are displayed in the different modules of the system. In particular, this is about consistency within the system.

3.2.2.1 Displaying restrictions in the graphical timetable

#353 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions

Restrictions are displayed in the graphical timetable.

3.2.2.2 Displaying restrictions in the track-occupation diagram

#354 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions

Restrictions are displayed in the track-occupation diagram.

3.2.2.3 Displaying restrictions in the network view

#355 State: Reviewed internally Severity: can Responsibility: Basic+Daily Possessions

Restrictions are displayed in the network view.

3.2.2.4 Displaying restrictions in the infrastructure graph

#356 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions

Restrictions are displayed in the infrastructure graph.

3.2.2.5 Displaying restrictions in the time-distance diagram

#357 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions

Restrictions are displayed in the time-distance diagram.

3.2.2.6 Displaying affected trains in trains list

#361 State: Reviewed internally Severity: must Responsibility: Possessions

The trains that are affected by the track possession in place (all trains pass at least one affected infrastructure element) or trains linked with track possession ID are displayed filtered in the trains list. The trains that are affected or not affected by the track possession in time are displayed in the trains list, indicated by separate fields. This is in case, for example, if trains on a line are to be diverted in their entirety during a track possession, even if the closure does not last the whole time.

3.2.2.7 Showing all requested and approved possessions on infrastructure map

#363 State: Reviewed internally Severity: must Responsibility: Possessions

Dynamic map shall show all requested and approved track possessions in parallel.

3.2.2.8 Displaying affected trains in bar chart

#409 State: Reviewed internally Severity: must Responsibility: Possessions

The time periods, where the track possession affects trains, is displayed graphically as a bar chart.

3.2.2.9 Showing track possessions with state in list

#411 State: Reviewed internally Severity: must Responsibility: Possessions

The user can see his own or other track possessions and their state (in preparation, requested, to revise, approved). The list can be filtered.

3.2.2.10 Output of affected track kilometres or train path kilometres per time

#507 State: Reviewed internally Severity: must Responsibility: Possessions

The number of track kilometres or train path kilometres affected over time should be displayed (out of the timetable in which the track possession has not yet been incorporated).

3.2.3 Planning and approving track possessions

#466 State: Preliminary Severity: Responsibility:

The following requirements describe, how the track possession requests will be submitted to the users responsible for planning and how they can implement them into the timetable easily.

3.2.3.1 Categorising and prioritising of requests

#344 State: Reviewed internally Severity: must Responsibility: Possessions

Requests can be prioritised, which gives the planner an indication for which requests should be handled first.

3.2.3.2 Freezing track possessions for approval

#362 State: Reviewed internally Severity: must Responsibility: Possessions

The requester can confirm his input, the track possession is frozen and gets a new state "requested", a notification is sent to specific roles/users. The roles/users to be notified can be configured.

3.2.3.3 Definition of business rules for track possession approval

#410 State: Reviewed internally Severity: must Responsibility: Possessions

Business rules for approval of track possessions (e.g. adjacent or parallel possessions in stations of the same or different type, allowed durations or time periods for possessions) can be defined, based on knowledge from daily operation. Rules can be defined as allowed / not allowed / manual check necessary.

3.2.3.4 Disapproving of track possession requests

#412 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

If a request is disapproved, it changes its state to "to revise", a notification is sent to the requester. The roles/users to be notified can be configured.

3.2.3.5 Adding track possessions to station variants

#413 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

Before selecting affected infrastructure, a station variant has to be selected. Per default, the active station variant for the entered track possession validity is selected. If the track possession validity overlapping multiple station variants, track possession has to be divided, because a timetable must be linked to only one station/infrastructure variant.

3.2.3.6 Linking trains to track possession after approval

#414 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

If a request is approved, each affected train is linked to the track possession ID.

3.2.3.7 Linking trains to track possession manually

#415 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

Trains can be linked to track possession ID manually. This is needed, if auxiliary trains or additional trains are necessary due to the track possession. If trains are linked to a track possession, their running days must match the track possession period.

3.2.3.8 Automatic creation of master running days

#416 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

If a request is approved, new master running days for the affected time period are created automatically. If the time period of the possession is splitted into multiple time periods, master running days are created for the whole time period and each splitted period. They are named according to the track possession.

3.2.3.9 Deriving new train variants for track possession

#417 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

For each train (group) or multiple train (groups), a new variant can be created by the user, based on the train list, which is filtered to the affected trains according to. The user assigns (master) running days.

3.2.3.10 Displaying warning for trains affected by multiple track possessions

#418 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

If a train (group) is affected by multiple (approved) track possessions, a warning is shown to the user.

3.2.3.11 Activation of train variants

#419 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

The user can activate the train variant after editing. With this step, the train variant is considered in further timetabling process (e.g. daily timetable) up to operation.

3.2.3.12 Show state of affected trains in train list

#420 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

The train list is filtered to trains affected according to. The list shows whether new variants have already been created for affected trains and whether a measure has been defined. It is also shown whether the train variant has a conflict in the timetable.

3.2.3.13 Splitting of trains

#424 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

The user can select a train in the train list for splitting. The original train is splitted, leaving out the track possession. A new train is created automatically. All properties are adopted from the original train, but the user has to enter a new train number for the new train.

3.2.3.14 Forcing approval by electrical department

#425 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

A business rule can be configured defining in which cases approval by electrical department is necessary. In this case, the planner can only approve the track possession if the electrical department has approved it before.

3.2.3.15 Notification about track possessions

#426 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

During the approval process, it could be that other users or roles must be involved in the process. Therefore, the planner can notify other users or roles to look at specific track possessions. These notified users can comment the track possessions. Notifications, recipients and comments are visible in the list of track possessions.

3.2.3.16 Change and cancellation of approvals

#515 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

Approvals can be changed or cancelled by defined roles. In this case, the request gets the state before the approval and needs a new approval. All changes are tracked audit-prooffly.

3.2.3.17 Confirmation of track possession completeness

#516 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

It should be possible to confirm the successful completeness of a planned track possession.

4 Timetable planning

#476 State: Preliminary Severity: Responsibility:

The following chapters are about the main functionality of the system: the creating and editing of timetables.

4.1 Managing timetable

#443 State: Preliminary Severity: Responsibility:

The following requirements describe, how timetables are developed within the system; starting from the including of service requirements over the creation of train objects, assigning train paths and schedules and the displaying of trains within the different modules of the system.

4.1.1 Managing service requirements

#472 State: Preliminary Severity: Responsibility:

The following requirements define, how service requirements from upstream demand analysis flow into the process of timetabling.

4.1.1.1 Defining and editing service requirement types

#270 State: Reviewed internally Severity: can Responsibility: Strategic

The system enables the creation and management of service requirement types, such as the number of seats and standing capacity per train as well as the accessibility, the capacity utilization rates, the number of vehicles and trains, the number of trains per hour, the requirements of a circulation and of the rostering, also maintenance boundary conditions for the vehicles. Equipment attributes are also desirable. Additional service requirements coming from the infrastructure need to be includable. Further service requirements should be definable as quantitative or qualitative variables.

4.1.1.2 Defining and editing service requirement scenarios

#271 State: Reviewed internally Severity: can Responsibility: Strategic

The system enables the creation and management of service requirement scenarios. In one scenario, the requirement is recorded according to the defined requirement types and checked for plausibility by assigning train objects or train groups.

4.1.2 Managing train objects

#455 State: Preliminary Severity: Responsibility:

The following requirements define how train objects and their properties are organised and managed.

4.1.2.1 Defining train attributes

#165 State: Reviewed internally Severity: can Responsibility: Basic+Daily Possessions Strategic

The system allows assigning information such as train status, commercial line number, notes on a train or part of a train.

4.1.2.2 Creating timetable variants

#234 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Strategic

The system allows the creation of a new timetable variant, provided with a validity period.

4.1.2.3 Copying and moving train groups in timetable variants

#235 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Strategic

Train groups can be copied or moved in one or multiple timetable variants.

4.1.2.4 Defining or editing train groups

#236 **State:** Accepted **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

Train groups can be created and edited. Any number of individual trains or master clock trains can be assigned to a train group.

4.1.2.5 Changelog in train editor

#237 **State:** Accepted **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system gives the user an overview of actions performed and their status. Each action must be provided with a sequential number, a timestamp, user, the affected object, a category and details about the result of the action performed. The user can navigate from the status message to the affected object.

4.1.2.6 Hierarchy of train objects

#238 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The top level is a train group to which several individual trains or master trains with similar characteristics (e.g. train type, commercial line) are assigned. Clock-faced trains can be derived from master trains.

4.1.2.7 Creating and editing train objects

#239 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The user is enabled to create and edit train objects.

4.1.2.8 Entering train data

#240 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

When creating a train object, higher-level train objects are assigned, a commercial line or train number is assigned, a timetable variant is selected, the train type and train type group are defined, and a validity is set. According to the inheritance principle, properties of the parent train object are adopted, but can be overwritten for the specific train object.

4.1.2.9 Entering train configuration and vehicle dynamics

#241 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

When creating a train object, train configuration and vehicle dynamics are entered. Train vehicle dynamics are derived from the master data after selecting a traction vehicle. Additional information can be provided on wagon train length, wagon train weight, CCS equipment, speed limit, brake percentages.

4.1.2.10 Setting or changing train validity (operation days)

#247 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

A validity can be set for each train object. The validity can be inherited from higher-level train objects.

4.1.2.11 Creating or editing clock-faced trains

#252 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

From the master train, clock-faced trains can be derived on the basis of a reference station, first departure time, last departure time and the time interval and grouped to a clock-faced train group.

4.1.2.12 Performing bulk editing for train objects

#268 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

If parent train objects are selected, all properties relevant for all child train objects can be edited. If multiple train objects are selected, all properties making sense can be edited for all selected train objects.

Examples:

- A train group is selected: It is possible to edit the train type. The new train type applies for all trains within this train group.
- Multiple train groups are selected: It is possible to edit the train type. The new train type applies for all selected train groups and trains within these train groups.

4.1.2.13 Comparing train objects

#272 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The characteristics of train objects can be compared with each other.

4.1.2.14 Defining new timetable variant for new basic operational timetable

#331 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The user can chose, which timetable variant should be the basis for the new timetable variant. Train groups or deviating properties of train groups from other timetable variants can be combined in the new timetable variant.

4.1.2.15 Defining new timetable variant for adapted basic operational timetable

#332 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

From the basic operational timetable, an adapted operational timetable for a more specific timetable period can be derived.

4.1.2.16 Ability to manage daily timetable for a specific train's basic operational timetable

#341 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

From a basic operational or adapted timetable, a daily timetable for a specific day can be derived.

4.1.3 Assigning train paths and schedules

#456 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe how train paths (sequence of stations) and schedules (arrival and departure times in stations) are assigned to the train objects.

4.1.3.1 Entering macroscopic train path

#242 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

It is possible to enter the macroscopic train path. For this purpose, the operational points used are selected. Line tracks and station tracks for the train run are to be defined.

4.1.3.2 Entering or editing train run timetables

#243 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

For each operational point, an arrival or departure time as well as a dwell time can be defined. Time components can be fixed. A reserve time (percentage or absolute) can be entered for each operational point.

4.1.3.3 Adding microscopic information to train path definition

#244 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The macroscopic train path (track in each station) can be supplemented with microscopic information by selecting an exact route between signals.

4.1.3.4 Derive microscopic train path from macroscopic train path

#249 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The system allows the microscopic path to be derived from the macroscopic path based on priorities set in the routes.

4.1.3.5 Diverting trains via other stations/lines

#250 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system enables the rerouting of train objects by selecting an alternative path on a macroscopic level. This may result in a different sequence of operational points. Once returning to the initial course, the microscopic information is applied again.

4.1.3.6 Definition of turn-arounds

#251 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The system allows the definition of turn-around / circulation links between two train journeys synchronized with Optirail ([#399](#)) .

4.1.3.7 Reversing train paths

#253 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The train path can be reversed. When a clock train's path is reversed, all other clock trains are also reversed. Individual trains are reversed symmetrically to the original train path.

4.1.3.8 Truncating train paths

#254 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The train path can be shortened. Circulation links must be broken.

4.1.3.9 Checking train consistency

#266 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

If the infrastructure is changed or a timetable variant is linked to another infrastructure variant, the train objects are initially inconsistent. That means, new arrival and departure times are resulting from the new running times between stations or new routing because of missing tracks. Inconsistencies can be repaired automatically (e.g. adaption of running-time supplements to reach original running times or choosing new routes within stations). After the repair, the steps taken can be seen in the changelog.

4.1.3.10 Separating and merging train runs

#269 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The system enables the mapping of separating and merging train runs.

4.1.3.11 Moving trains to station tracks in track-occupation diagram

#278 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

Train objects that run through the selected station can be assigned to tracks in the track occupancy plan.

4.1.3.12 Overruling usable length of assigned stop

#402 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

For a train, it can be defined that the train is using a stop with usable length smaller than the train length.

4.1.3.13 Automatic adaption to full arrival or departure minutes

#434 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

If the user wants to, the system can adapt the running-time supplements of one or multiple train objects to full arrival or departure minutes in one or multiple stations automatically.

4.1.3.14 Expanding train paths

#469 **State:** Accepted **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The train paths can be expanded. It is possible to enter the desired destination station, and trains running to this station are suggested. The train path can be taken from these trains. The running times are adjusted based on the departure time at the last original station of the train.

4.1.4 Displaying trains and timetable

#457 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe the ways in which trains and timetables can be displayed within the system.

4.1.4.1 List of trains

#255 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions

The system is supposed to display a list of all modeled train objects. The displayed columns should be parameterizable by the user. The list should be filterable.

4.1.4.2 Displaying train runs in blocking-time diagram

#257 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

The system displays the train runs in a blocking-time diagram. This illustration shows the blocking times of each train run.

4.1.4.3 Displaying train runs in track-occupation diagram

#258 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system displays the train runs in a track-occupation diagram. Any filter applies in this visualisation. The track-occupation diagram shows all available tracks within a station on one axis and the time is plotted on the other axis. The occupancy of the track by stopping or passing trains is displayed.

4.1.4.4 Displaying train runs in graphical timetable

#259 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system displays the train runs in a graphical timetable diagram. In this illustration, the trajectory of each train run is displayed.

4.1.4.5 Displaying train runs in infrastructure graph

#260 **State:** Accepted **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system displays the number of modeled train runs in the infrastructure graph as a flow graph. At each switch, an arrow and the number of trains running this direction is displayed.

4.1.4.6 Displaying train runs as daily load curve

#261 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The system displays the number of modeled train runs in a daily load curve.

4.1.4.7 Displaying speed-distance diagram of train run

#262 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

The system displays the train run in a speed-distance diagram.

4.1.4.8 Displaying energy diagram of selected train run

#263 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions

The system displays the modeled train run in an energy diagram.

4.1.4.9 Displaying running-time calculation of train run

#264 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

The system displays the running-time calculation of the train run in a table with all infrastructure elements used.

4.1.4.10 Display blocking-time conflicts in blocking-time diagram

#274 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

Display all blocking-time conflicts.

4.1.4.11 Display construction conflicts in blocking-time diagram

#275 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

Display all construction conflicts arising from insufficient buffer times, predefined in settings.

4.1.4.12 Creating a network graphic

#312 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

Train runs are shown in a network graphic. In a network graphic, selected stations and lines are shown schematically. For each station, arrival and departure minutes of trains stopping are displayed. For clock trains, the interval is indicated. Any filter applies in this visualisation.

4.1.4.13 Inserting or removing stations in network graphic

#313 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The user can select the stations to be displayed.

4.1.4.14 Inserting, editing, or removing trains in network graphic

#314 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The user can select the train objects to display using the train filter.

4.1.4.15 Copying network graphics

#317 **State:** Reviewed internally **Severity:** can **Responsibility:** Strategic

Network graphics can be copied independently of the underlying timetable variant.

4.1.4.16 Determining circulation requirements

#319 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The macroscopic timetable can be used to derive the rough rolling stock demand on the basis of the defined turnbacks in the timetable.

4.1.4.17 Displaying trains in tabular timetable frameworks

#335 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

Train objects are displayed in a tabular timetable. Train objects to be displayed can be filtered using the train filter.

4.1.4.18 Creating arrival/departure boards

#338 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily

Train objects can be displayed for a selected operational point in a departure/arrival list. The resolution can be switched between displaying times in minutes or seconds.

4.2 Running-time and blocking-time calculation

#65 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe the functionality of the running-time and blocking-time calculation which forms the basis for a consistent timetabling in all planning phases.

4.2.1 General requirements

#458 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements cover the general principle and boundary conditions of the running-time and blocking-time calculation.

4.2.1.1 Consideration of speed changes

#369 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The running-time calculation shall consider the monitoring of speed changes using INDUSI I60R.

4.2.1.2 Considering entry with closed exit signal (INDUSI)

#371 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

Entry with closed exit signal if the exit train route has not yet been set at the time of the running time calculation shall be considered using INDUSI I60R.

4.2.1.3 Computation of technical running times

#374 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The system computes technical running times in either delta-v oder delta-t oder delta-s steps with an appropriate precision.

4.2.1.4 Consideration of relevant infrastructure parameters

#375 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The running-time computation takes into account all relevant parameters resulting from infrastructure (e.g. inclination, tunnel profile and train profile), rolling-stock, train type, permitted speed profile.

4.2.1.5 Consideration of permitted coupling force

#376 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily

The running-time computation takes into account the maximum permitted coupling force of the train type.

4.2.1.6 Limiting permitted jerk

#377 State: Reviewed internally Severity: can Responsibility: Basic+Daily

The running-time computation limits the permitted jerk of the train type.

4.2.1.7 Consideration of recreation of brake pressure

#378 State: Reviewed internally Severity: can Responsibility: Basic+Daily

The running-time computation ensures a minimum duration at standstill after brake application to ensure recreation of brake pressure.

4.2.1.8 Consideration of INDUSI speed supervision

#379 State: Reviewed internally Severity: must Responsibility: Basic+Daily

The running-time computation takes into account speed supervision resulting from INDUSI I60R, if approaching to a closed signal or to a supervised speed change.

4.2.1.9 Application of regular running-time supplements

#383 State: Reviewed internally Severity: must Responsibility: Basic+Daily

The technical running time is amended by regular running-time supplements (for definition see [#504](#), the values can be overridden on the train paths). Result is the regular running time.

4.2.1.10 Application of bending supplements

#384 State: Reviewed internally Severity: must Responsibility: Basic+Daily

The regular running time is amended by bending supplements. Result is the standard running time.

4.2.1.11 Adjusting of bending supplements to full arrival minutes

#385 State: Accepted Severity: must Responsibility: Basic+Daily

Bending supplements can be automatically adjusted in such a manner, that the next commercial stop starts at an integer minute.

4.2.1.12 Distribution of supplements

#386 State: Reviewed internally Severity: must Responsibility: Basic+Daily

Fixed points to distribute time supplements are supported (e.g. arrival, departure, junction). Between those spots, time surpluses are attributed by limiting the effective maximum speed.

4.2.1.13 Computation of blocking times for short-block sectioning

#387 State: Reviewed internally Severity: must Responsibility: Basic+Daily

Blocking times for short-block sectioning (ETCS with LMB) needs to be represented precisely.

4.2.1.14 Computation of approaching times

#388 State: Reviewed internally Severity: must Responsibility: Basic+Daily

Approaching times are calculated with the speed profile related to the technical running time or for the speed profile after attribution of time surpluses.

4.2.1.15 Reaction times for conventional signalling

#389 State: Reviewed internally Severity: must Responsibility: Basic+Daily

Reaction times for conventional signalling are defined as a function of distance.

4.2.1.16 Time-dependent overlaps

#390 State: Reviewed internally Severity: must Responsibility: Basic+Daily

Time-dependent overlaps are considered in pre-occupation of infrastructure elements and route release.

4.2.1.17 Ability to plan down to minutes and seconds

#391 State: Reviewed internally Severity: must Responsibility: Basic+Daily

Running times are calculated in seconds. If times are displayed in minutes, standard rounding rules apply.

4.2.1.18 Computation of energy consumption

#433 State: Reviewed internally Severity: must Responsibility: Basic+Daily

The running-time calculation includes the computation of the energy consumption at the traction wheel.

4.2.1.19 Consideration of track possessions

#435 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions

Track possessions are considered in the running-time and occupation calculation as occupying elements temporary (as defined) blocking infrastructure the same way trains do.

4.2.1.20 Application of construction supplements

#506 State: Reviewed internally Severity: must Responsibility: Basic+Daily

The standard running time is amended by construction supplements. Construction supplements are defined in minutes per station. Result is the standard running time, compensating running-time loss due to unscheduled construction works.

4.2.2 Additional requirements for ETCS

#459 State: Preliminary Severity: Responsibility:

The following requirements define additions to the running-time and blocking-time calculation regarding ETCS.

4.2.2.1 Considering entry with closed exit signal (ETCS)

#370 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

Entry with closed exit signal if the exit train route has not yet been set at the time of the running time calculation shall be considered using ETCS.

4.2.2.2 Consideration of Start of Mission (ETCS)

#372 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

At the first stop (or change of train number or direction of travel), it is assumed that V_NVSTFF applies until the train reaches the exit signal with the head of the train.

4.2.2.3 Consideration of ETCS speed supervision

#380 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The running-time computation takes into account speed supervision resulting from ETCS, if approaching to a closed signal or to a speed change. Parameters can vary per Movement Authority (e.g. Release Speed, Supervised Location). Speed supervision may result from Permitted Curve or Warning Curve, depending on the local situation.

4.2.2.4 Consideration of ETCS lambda curve

#381 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

Running time calculation shall support ETCS L2-based planning using the Lambda curve.

5 Timetable optimisation

#477 State: Preliminary Severity: Responsibility:

During the process of timetable planning, it is required to provide the user with assistance like conflict detection and solution or evaluation and simulation.

5.1 Conflict detection and solution

#110 State: Preliminary Severity: Responsibility:

An essential functionality of the timetable planning system is an integrated conflict detection and solution. Conflicts essentially describe the situation when two trains are blocking the same infrastructure, although there are a number of other types of conflicts.

5.1.1 Conflict detection

#460 State: Preliminary Severity: Responsibility:

The following requirements describe what types of conflicts should be detected by the system.

5.1.1.1 Conflict detection: Track accessibility

#292 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

It is detected when a track is used in an unapproved direction, with electric traction vehicles in the absence of electrification, without appropriate ETCS onboard equipment or with vehicles don't matching line class and axle load.

5.1.1.2 Conflict detection: Headway

#293 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

It is detected if the headway time applicable on a section of track for a specific train sequence case is undercut on a track. With this, it is also detected when two trains meet in opposite directions on the same track. This applies for macroscopic layer only.

5.1.1.3 Conflict detection: Arrival separation time

#295 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

It is detected when the separation time between two entries into the same operational point is independent or is not complied with by the direction of travel or if the separation times for arrival/departure on the same track and arrival/passage on the same track are not observed at an operational point.

5.1.1.4 Conflict detection: Train length

#296 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

It is detected when the usable length of the assigned stop is shorter than the length of the stopping train.

5.1.1.5 Conflict detection: Route restrictions

#297 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

It is detected when the route restrictions defined for a station or separation times for route exclusions between two consecutive routes are not complied with. This applies for macrosopic layer only.

5.1.1.6 Conflict detection: Overlap

#298 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

It is detected when the defined overlap of the train affects the route of another train. In the case of overlaps, the separation times for route exclusions are applied. This applies for macroscopic layer only. In microscopic layer, overlaps are considered in blocking-time calculation and detected as part of [#427](#).

5.1.1.7 Defining conflict types to be detected

#299 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The user can define which conflict types are part of the conflict detection.

5.1.1.8 Conflict detection: Minimum buffer time

#401 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

It is detected when the required minimum buffer time is fallen short of during timetable construction.

5.1.1.9 Conflict detection: Blocking-time conflict

#427 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

It is detected, if two trains have a blocking-time conflict in at least one occupation element (switch, signal, stopping position). This is based on the running-time and blocking-time calculation. Conflicts are detected as well, if trains move in different directions without occupying the same direction-based occupation elements. This applies for microscopic layer only.

5.1.2 Conflict solution

#461 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe what types of conflict solutions can be applied.

5.1.2.1 Locking and unlocking train objects

#282 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

Train objects in the blocking time diagram or graphical timetable are initially locked for editing, but can be unlocked.

5.1.2.2 Manipulating dwell times

#283 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

After selecting a train and an operational point, the dwell time in this operational point can be adjusted.

5.1.2.3 Manipulating desired time of departure

#284 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

Departure time of an operational point can be altered.

5.1.2.4 Running-time alteration

#286 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The running time between the current station and one succeeding it on the train path can be altered.

5.1.2.5 Route alteration

#287 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

The route of the train object in the operational point selected can be altered.

5.1.2.6 Preview of manipulating actions

#288 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

For each manipulating action, a preview can first be generated, which is displayed in the blocking time diagram or graphical timetable. The action can then be discarded or adopted.

5.1.2.7 Moving trains in place and time

#289 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

Unlocked trains can be moved with the mouse in the blocking-time diagram and graphical timetable and thus their temporal position can be adjusted.

5.1.2.8 Transfer of changes between clock trains

#290 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

When changes are made to a (master) clock train, the user can decide whether the changes are applied to all parent, coordinate, or child train objects.

5.1.2.9 Cancellation of trains

#421 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The user can select a train in the train list for cancellation. The train in this variant is not shown in timetable anymore. The user can assign the property "with/without bus replacement" for information purpose.

5.1.2.10 Rerouting of trains

#422 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The user can select a train in the train list for rerouting. In the train path editor he can chose another train path for this train variant.

5.1.2.11 Bulk assignment of manipulations to trains

#423 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The user can select multiple train groups or trains in train list and chose one manipulation. Some manipulations are not possible for multiple trains selected (e.g. rerouting multiple trains with different train paths).

5.1.3 Wizard functionality

#468 State: Preliminary Severity: Responsibility:

The following requirements describe what kind of assistance functionalities shall be included to support the user in conflict detection and conflict solution.

5.1.3.1 Criteria-based timetable optimisation

#291 State: Reviewed internally Severity: can Responsibility: Basic+Daily Possessions Strategic

The system's ability to offer automatic schedule optimization based on various criteria (e.g. minimizing wait times, improving connectivity, trains of line x may only depart several minutes after trains of line y).

5.1.3.2 Conflict solution recommendations

#300 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

The system shall show recommendations for conflict solution. The user can accept and adopt them. The system chooses the best actions based on the conflict detected, the options compiled in [#109](#) and parameters defined in [#439](#).

5.1.3.3 Conflict solution recommendations based on artificial intelligence

#301 State: Reviewed internally Severity: can Responsibility: Basic+Daily Possessions Strategic

The system shall show recommendations for conflict solution based on artificial intelligence. The user can accept and adopt them.

5.1.3.4 Recommendation of planning alternatives to timetable changes

#333 State: Accepted Severity: must Responsibility: Basic+Daily Possessions Strategic

The system recommends alternatives (routing, routes) to suit required timetable changes.

5.1.3.5 Defining bonus and malus for conflict solutions

#439 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

It is possible to define bonus and malus for different conflict solution options described in [#109](#).

5.2 Evaluation and simulation of timetables

#111 State: Preliminary Severity: Responsibility:

Once a timetable has been planned, it should be tested for various characteristics (e.g. journey times, expected operational performance). There are various evaluation options with different levels of detail during the different planning phases.

5.2.1 Comparison with service requirements

#471 State: Preliminary Severity: Responsibility:

The following requirements describe how the service requirements defined in [#472](#) are checked for adherence. There must be the possibility of a plausibility check that verifies whether the requirements of the demand or the defined service requirements defined in [#472](#) and other product requirements are met within the scenarios. For example, the number of seats should be compared with the calculated demand or

the vehicle rotations with the number of vehicles and the rostering. As a result, a test report is to be created which highlights any deviations.

5.2.1.1 Fulfilment of service requirement scenarios

#763 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The system allows to evaluate the fulfilment of defined service requirement scenarios (see #270), e.g. comparison of number of trains per hour with the planned timetable. As a result, a test report is to be created which highlights any deviations.

5.2.2 Journey Time Analysis

#500 **State:** Preliminary **Severity:** **Responsibility:**

5.2.2.1 Setting transfer times

#325 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

Transfer times are the minimum amount of time that must elapse between an arriving and departing train in order for the transfer between these two trains to be taken into account.

5.2.2.2 Defining sources and destinations

#326 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

In a source-destination scenario, it is determined which operational points should be considered as source and destination in a travel time analysis.

5.2.2.3 Calculating connections

#327 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The Journey Time Analysis is performed for a selection according to the train filter, a source-destination scenario, and the defined transfer times.

5.2.3 Macroscopic timetable evaluation

#462 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe how a timetable evaluation at an early stage is possible, only incorporating the macroscopic level (for example, to check variants of strategic timetable).

5.2.3.1 Checking train plausibility

#267 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The plausibility check determines whether the defined business rules ([#168](#)) are adhered to by the modeled train objects. Such checks verify the interaction between train and infrastructure objects (e.g. train types not allowed in stations, allowed dwell and turnback times).

5.2.3.2 Defining delay scenario for robustness analysis

#321 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

A delay scenario is a list of primary delays for a given train, with a defined location, time, and duration of the delay.

5.2.3.3 Executing the robustness analysis

#323 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

With defined delay scenario ([#321](#)) and calculation parameters ([#322](#)), a robustness analysis can be carried out.

5.2.4 Evaluation of capacity

#464 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe how track capacity could be checked during timetable planning.

5.2.4.1 Calculating track capacity

#310 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

There should be an indication of remaining track capacity.

5.2.4.2 Evaluation of occupation ratio according to UIC Leaflet 406

#405 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

The system allows an evaluation of the timetable following a calculation of occupation ratio according to UIC Leaflet 406. Evaluation areas and investigation areas can be stored in the model.

5.2.5 Operational simulation of timetables

#463 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe how the operational simulation of timetables on the microscopic layer should be implemented. The aim is to provide information on the quality of operations in terms of punctuality and delay values.

5.2.5.1 Simulation of the planned timetable

#302 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

The system must enable an operational simulation of the timetable in order to review the strengths/weaknesses of the planned timetable. The occurrence and propagation of delays under boundary conditions are simulated with the aim of evaluating the operational quality (punctuality, robustness) of a timetable and infrastructure variant. The timetable variant does not necessarily need to be conflict-free.

5.2.5.2 Simulation allows comparing different timetable or infrastructure variants

#303 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

The simulation will allow the timetable to be reviewed after making changes in infrastructure or timetable, such as occupied railway tracks, electrical repairs, work (long-term work being performed in the vicinity of the railway track).

5.2.5.3 Simulation follows Monte-Carlo approach

#304 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

Simulation multiple sets of disturbances and generalising related sets of outcomes is denoted Monte-Carlo Approach. Simulation of environment shall run time-synchronous. Anticipatory dispatching shall run event-synchronous. The most likely event is the detection of a conflict in the prognosis horizon. Dispatching component may apply two-train heuristics or linear optimisation.

5.2.5.4 Simulation shall consider boundary conditions

#305 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

Input for operational simulation beside the infrastructure and timetable variant are disturbances (entry delays, primary delays at stops, primary delays on the line), enviromental behaviour (trimming/waiting at the signal, delay reduction) and dispatching settings (bending/intentionally slow down, modify dwell times, new operational stops, removal of operational stops, changed routes, changed station order). All parameters should be adjustable.

5.2.5.5 Configuration of conflict resolution options

#306 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

Chosen conflict solution is subject to a configurable objective function. Conflict resolution options can be configured train and station specific. Additional penalties (e.g. for operational stops, see also the list below) can be taken into account. Consideration of partial or absolute priority possible.

- route change (one end / both ends)
- change of stopping position
- opposite track operation
- platform change

5.2.5.6 Creating sets of primary delays

#307 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

Primary delay is the delay that does not occur due to interaction with other trains. They are interspersed in the simulation model. Primary delays are randomly generated based on delay probabilities (Monte Carlo approach). Primary delays can occur at the stop and during the journey. The system shall generate sets of realisations of random numbers (per train number and station). One set shall be generated per simulation run.

5.2.5.7 Aggregation of simulation results

#309 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

Outcomes shall be aggregated to key figures like average delays, median of delay, standard deviation of delay, punctuality, conflicts. Eliminate such simulation runs, whose outcomes are not statistically representative/sound. Optionally, disposition decisions (conflict solutions) can be output in protocol format.

5.2.5.8 Animation of simulation runs

#440 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions

Already conducted simulation runs can be visualised on the infrastructure map. It is possible to control the animation with basic navigation buttons like play, pause, time selection, time slider, animation speed.

5.2.5.9 Display of simulation results in blocking-time diagram

#441 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

The result of a simulation can be displayed in the blocking-time diagram. The blocking times of the simulated train runs and time-distance curve of the original train path are shown.

6 Collaboration

#478 State: Preliminary Severity: Responsibility:

Collaboration functionalities make it possible to optimally integrate the system into existing system environments and to continue using the results of the timetabling in operations.

6.1 Interfaces

#7 State: Preliminary Severity: Responsibility:

The following requirements describe technically which interfaces shall be provided by the system to other systems.

6.1.1 Interface to import forecast data

#392 State: Reviewed internally Severity: must Responsibility: Strategic

The system must incorporate data from passenger and freight forecast for strategic planning. This means the possibility to import .csv/.txt-format as well as .xls/.xlsx-data-format. Additionally spatial-formats as .shp- or geoJSON-format must be importable.

6.1.2 Interface to ARAMIS for transferring timetable

#397 State: Reviewed internally Severity: must Responsibility: Basic+Daily

A fixed timetable can be transferred to ARAMIS without the need for manual adjustments in ARAMIS.

6.1.3 Interface to PSIFAS

#398 State: Reviewed internally Severity: must Responsibility: Basic+Daily

A fixed timetable can be transferred to PSIFAS via CIF file without the need for manual adjustments in PSIFAS. PSIFAS is the leading system for redistribution of data to operational systems (data processing in EIS data warehouse, storing data in timetable archives, ticket sale, passenger information, licensing system, operation timetable for train driver).

6.1.4 Interface to OPTIRAIL

#399 State: Reviewed internally Severity: must Responsibility: Basic+Daily

A bidirectional interface to Optirail enables the current timetable status to be transmitted. Adjustments to rotations in Optirail can be imported. Optirail is the leading system for rostering staff and rolling stock.

6.1.5 Standardised stakeholder approval workflow

#400 State: Reviewed internally Severity: can Responsibility: Basic+Daily

The system should facilitate the integration of approval workflows, reducing the need for manual data entry and minimizing errors. This especially applies for publishing infrastructure and timetable variants for getting feedback or approval.

6.1.6 Interface to ARAMIS for transferring infrastructure

#429 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily

A fixed infrastructure can be transferred to ARAMIS without the need for manual adjustments in ARAMIS.

6.1.7 Integration with Asset Management Systems

#497 **State:** Reviewed internally **Severity:** can **Responsibility:** Possessions

The Possession Planning Preview module integrates with asset management systems to fetch asset conditions and maintenance history.

6.2 Importing and exporting data

#444 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe functionally the process of importing data into the system environment and exporting data out of the system environment.

6.2.1 Data exchange

#445 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe what kind of data shall be importable or exportable by the system.

6.2.1.1 Import of railML infrastructure data

#130 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Strategic

The system imports infrastructure data in accordance with the current railML specification (at least railML 2.5).

6.2.1.2 Import of railML rolling-stock data

#131 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Strategic

The system imports vehicle master data and vehicle properties in accordance with the current railML specification (at least railML 2.5).

6.2.1.3 Import of railML train data

#132 **State:** Accepted **Severity:** must **Responsibility:** Basic+Daily Strategic

The system imports timetable data in accordance with the current railML specification (at least railML 2.5).

6.2.1.4 Export of railML infrastructure data

#133 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Strategic

The system export infrastructure data in accordance with the current railML specification (at least railML 2.5).

6.2.1.5 Export of railML rolling-stock data

#134 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Strategic

The system exports vehicles and vehicle properties in accordance with the current railML specification (at least railML 2.5).

6.2.1.6 Export of railML train data

#135 **State:** Accepted **Severity:** must **Responsibility:** Basic+Daily Strategic

The system imports timetable data in accordance with the current railML specification (at least railML 2.5).

6.2.1.7 Importing service requirement scenarios

#158 **State:** Reviewed internally **Severity:** can **Responsibility:** Strategic

The system enables the import of service requirement scenarios to check the plausibility of demand and transport offered. Service requirement scenarios contain expected amount of passengers for every station and different time slides.

6.2.1.8 Export basic operational timetable to PSIFAS with one click

#339 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

Once the basic operational timetable is approved, an export to PSIFAS (via CIF file) is started with one click.

6.2.1.9 Export daily operational timetable to PSIFAS and ARAMIS with one click

#342 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

Once the basic operational timetable is approved, an export to PSIFAS (via CIF file) and ARAMIS is started with one click.

6.2.1.10 Importing and exporting track possessions

#346 **State:** Reviewed internally **Severity:** can **Responsibility:** Possessions

The system allows the import and export of track possessions. The export includes information about the track possession, the affected infrastructure and affected and linked trains. The user can decide for export of meta data only or the infrastructure/timetable data included.

6.2.1.11 Import and export of Possession Planning Previews

#498 **State:** Reviewed internally **Severity:** can **Responsibility:** Possessions

The module must support importing and exporting Annual Possession Plan Previews in formats like CSV, Excel, and XML.

6.2.2 Content of paper reports

#446 **State:** Preliminary **Severity:** **Responsibility:**

The following requirements describe what kinds of reports shall be produced by the system.

6.2.2.1 Saving report settings

#180 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The filtered train and infrastructure selection for creating a report can be saved.

6.2.2.2 Creating and editing report templates

#181 **State:** Accepted **Severity:** must **Responsibility:** Basic+Daily Possessions Strategic

Target group-specific report templates can be created and adapted to enable a simple and reproducible export of the planning for different stakeholders. The templates can contain any text fields and information from infrastructure (e.g. elements and their parameters) or timetable (e.g. trains, their parameters, timetable times). The templates can include exports itself:

- Speed profiles [#225](#)
- Gradient profiles [#226](#)
- Graphical timetable [#277](#)
- Network graphics [#318](#)
- Track possession report [#359](#)
- Tabular timetable [#337](#)
- Track possession calendar [#360](#)
- List of trains [#256](#)
- Track-occupation diagram [#281](#)
- Running-time calculation [#265](#)
- Operation days [#248](#)

6.2.2.3 Export of the operation days calendar

#248 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily

The validity for a train object can be exported as a tabular calendar.

6.2.2.4 Exporting list of trains

#256 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Strategic

The train objects' list can be exported in a text (CSV, XML) and table format (XLSX) with the columns selected for viewing and active filter settings.

6.2.2.5 Export of running-time calculation

#265 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The running-time calculation can be exported in a text (CSV, XML) and table format (XLSX) with the columns selected for viewing and active filter settings.

6.2.2.6 Adjusting the display of the graphical timetable

#276 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Strategic

The display properties of the graphical timetable (color of stations, line thickness, label) can be varied by the user. Display properties of the train runs are defined by settings in train type settings ([#163](#), [#164](#)).

6.2.2.7 Printing or exporting the graphical timetable

#277 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Strategic

The system allows printing and exporting (vector graphics, PPTX or PDF) of the graphical timetable.

6.2.2.8 Adjusting the display of the track-occupation diagram

#280 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily

The display properties of the track-occupation diagram (general color, line thickness, label) can be varied by the user. Display properties of the train runs are defined by settings in train type settings ([#163](#), [#164](#)).

6.2.2.9 Printing or exporting the track-occupation diagram

#281 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The system allows printing and exporting (vector graphics or PDF) the track-occupation diagram.

6.2.2.10 Adjusting the display of the network graphic

#316 **State:** Reviewed internally **Severity:** can **Responsibility:** Strategic

The display properties of the stations (color, line thickness, label) can be varied by the user. Display properties of the train runs are defined by settings in train type settings ([#163](#), [#164](#)).

6.2.2.11 Exporting network graphics

#318 **State:** Reviewed internally **Severity:** must **Responsibility:** Strategic

The system allows printing and exporting (vector graphics or PDF) of the network graphic.

6.2.2.12 Export of robustness analysis results

#324 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The system allows printing and exporting (XML, CSV, XLSX and PDF) the results of the robustness analysis. The number of delayed trains, the cumulative delay duration per operational point, conflicts and their consequences must be output.

6.2.2.13 Exporting results of Journey Time Analysis

#328 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily Possessions Strategic

The system allows you to export the Journey Time Analysis as a matrix of source-destination relationships. Travel time, running time, number of transfers, number of connections, distance can be output.

6.2.2.14 Defining tabular timetable frameworks

#334 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The user can define the framework for the tabular timetable (route, operational points to be displayed).

6.2.2.15 Adjusting the display of tabular timetables

#336 **State:** Reviewed internally **Severity:** can **Responsibility:** Basic+Daily

The display properties of the tabular timetable (format, label) can be varied by the user. The resolution can be switched between displaying times in minutes or seconds.

6.2.2.16 Printing or exporting the tabular timetable

#337 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily

The system allows printing and exporting (CSV, XLSX and PDF) of the tabular timetable.

6.2.2.17 Exporting track possession reports

#359 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

The system allows printing and exporting (CSV, XLSX and PDF) a track possession report using various filters (train object filter, time period, spatial filter, track possession type). Output is a list of all track possessions and affected train runs.

6.2.2.18 Exporting track possession calendar

#360 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

The system enables the printing and export (CSV, XLSX and PDF) of a track possession calendar using various filters (train filter, period, spatial filter, restriction type). Output is a calendar showing track possessions, their duration and type.

6.2.2.19 Report for changes to trains due to possession

#366 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

For approval, display all trains that are needed to change.

6.2.2.20 Export of operational simulation results

#513 **State:** Reviewed internally **Severity:** must **Responsibility:** Basic+Daily Possessions

The system allows printing and exporting (XML, CSV, XLSX and PDF) the results of the aggregated simulation results ([#309](#)).

6.2.2.21 Export of track possession maps

#514 **State:** Reviewed internally **Severity:** must **Responsibility:** Possessions

The system allows printing and exporting a track possession map which shows the area of the track possession on the schematic infrastructure graph. Infrastructure elements to be displayed can be adjusted by the user.

6.2.3 Structure of paper reports

#530 State: Preliminary Severity: Responsibility:

6.2.3.1 Exports in XML, CSV, XLSX or SVG format

#182 State: Reviewed internally Severity: must Responsibility: Basic+Daily Possessions Strategic

All exports containing textual information are delivered in XML, CSV and XLSX format for reuse in web interfaces/dashboards. All exports containing visual information are delivered in SVG vector graphic format.

6.2.3.2 Editing XML templates

#183 State: Accepted Severity: must Responsibility: Basic+Daily Possessions Strategic

XML templates used for exports can be customized by the user.

6.2.3.3 Generation of reports in Hebrew

#754 State: Reviewed internally Severity: can Responsibility:

The system can support generation of reports in Hebrew, including full right-to-left (RTL) formatting and appropriate fonts.

6.2.3.4 Preserving Hebrew text formatting

#755 State: Reviewed internally Severity: can Responsibility:

The system can allow the export of reports in commonly used formats such as PDF and Excel, while preserving Hebrew text formatting.

6.2.3.5 Scheduled and on-demand report generation.

#756 State: Reviewed internally Severity: must Responsibility:

The system shall support scheduled and on-demand report generation.

6.2.3.6 Customizing of reports

#757 State: Reviewed internally Severity: must Responsibility:

The system shall allow users to filter, sort and customize reports based on predefined criteria (e.g., date, line, station, train ID).

6.2.3.7 Page structure of reports

#758 State: Reviewed internally Severity: must Responsibility:

Reports shall include headers, footers, page numbering, and metadata (e.g., creation date, report name) in Hebrew.

6.2.3.8 Access control for report visibility

#759 State: Reviewed internally Severity: must Responsibility:

The system shall provide access control to restrict report visibility according to user roles and permissions.

6.2.3.9 Saving of report templates

#760 **State:** Reviewed internally **Severity:** must **Responsibility:**

The system shall support saving of report templates, including Hebrew labels, for repeated use.

6.2.3.10 Generation of ad-hoc reports

#761 **State:** Reviewed internally **Severity:** must **Responsibility:**

The system shall allow users to define and generate ad-hoc reports with Hebrew field labels and content.

6.2.3.11 Display of charts and graphs with Hebrew labels

#762 **State:** Reviewed internally **Severity:** must **Responsibility:**

The system shall support the display of charts and graphs with Hebrew axis labels and legends.

Part C: Non-Functional Requirements Specification

7 General Non-functional requirements

#517 **State:** Preliminary **Severity:** **Responsibility:**

7.1 System architecture and data model

#518 **State:** Preliminary **Severity:** **Responsibility:**

7.1.1 Requirements for the system architecture

#531 **State:** Preliminary **Severity:** **Responsibility:**

7.1.1.1 Delivery of system environments

#563 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST provide a complete system environment that will later become the test environment. For the productive and development environment, IT operations management staff must be supported in the setup. All necessary licences and services must be included in the tender for the whole project and thus for the entire duration of the framework agreement.

7.1.1.2 List of technical requirements

#564 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST provide a complete list of the technical requirements for a successful project implementation with the implementation concept. Hardware is provided by the client in coordination with the supplier.

7.1.1.3 Operation on-premise

#565 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system MUST be operated on-premise.

7.1.1.4 Support of a cluster solution

#566 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system MUST support the database for its own data storage in a cluster.

7.1.1.5 Data center location

#567 **State:** Reviewed internally **Severity:** must **Responsibility:**

Timetable Planning system MUST be installed at two locations / data centers.

7.1.1.6 Load balancers

#568 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning application MUST be load-balancer capable.

7.1.1.7 Virtual web servers

#569 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning web servers MUST function virtually or as a container solution.

7.1.1.8 Virtual Application servers

#570 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning application servers can be set up virtually.

7.1.1.9 Application servers for both data centers

#571 **State:** Reviewed internally **Severity:** must **Responsibility:**

If additional application servers are required for the system, these must also be provided for both data centers.

7.1.1.10 Multi-client capability

#572 **State:** Reviewed internally **Severity:** can **Responsibility:**

The system CAN have the ability to map and delimit subsidiaries and sister companies (multi-client capability). This applies to identities, data, roles, workflows, reports, etc.

7.1.2 Requirements for the operating environment

#532 **State:** Preliminary **Severity:** **Responsibility:**

7.1.2.1 Operating system versions

#573 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system MUST run on one of the following operating systems in the version specified or higher: First Option: Windows Server 2022 (MS SQL 2022), Second Option: Windows Server 2022 (Oracle 22) including license for ORACLE DB. Newer versions are permitted as long as they are classified by the supplier as stable, ready for production or comparable, in this case the supplier will maintain and manage the DB.

7.1.2.2 Operation on virtual servers

#574 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system MUST support operation on virtual servers.

7.1.2.3 Sizing the production environment

#575 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST include a sizing for the production environment with the offering that ensures the required scalability, availability, and recoverability.

7.1.2.4 Migration between different instances

#576 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system **MUST** ensure the migration of configuration data between the different systems for the system environments required by IT (PROD, TEST, DEV, (ARCHIV)).

7.1.2.5 Automated configuration changes after cloning

#577 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system **CAN** automatically provide the necessary configuration changes for the TEST after cloning the production environment (PROD) into the test environment (TEST).

7.1.2.6 Backup

#578 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system **MUST** ensure a backup system (full backup, incremental backup and log file backup).

7.1.3 Requirements for the data scheme

#533 **State:** Preliminary **Severity:** **Responsibility:**

7.1.3.1 Enhancement of the data scheme

#579 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system **MUST** ensure the expandability of the data schema.

7.1.3.2 Protection of special data through encryption and outsourcing

#580 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system **CAN** protect particularly sensitive data, e.g. by using common encryption methods and outsourcing to external storage media.

7.1.3.3 Inventory for data schema adjustments/extensions

#581 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system **CAN** keep all data schema adjustments/extensions unchanged during updates and upgrades.

7.1.3.4 Individual configuration options for visibility of authorization data

#582 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system **CAN** offer individual configuration options to determine which employees can see which authorization data of other employees.

7.1.3.5 Field level of objects with CRUD

#583 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system CAN provide the granularity of the internal role and authorization model for all objects with the CRUD (Create, Read, Update, Delete) functions at field/attribute level.

7.1.4 Deployment requirements

#534 **State:** Preliminary **Severity:** **Responsibility:**

7.1.4.1 Low-cost deployment

#584 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system MUST support the isolated deployment of the configuration with little effort (separated from data content), e.g. when staging new or changed configurations.

7.1.4.2 Mechanisms for mass changes

#585 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system MUST provide mass change functions only through secure, testable and deployable mechanisms.

7.1.4.3 Rules for mass changes

#586 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system CAN subject mass changes to the same rules as individual changes, or a special approval process variant can be implemented.

7.1.5 User administration requirements

#535 **State:** Preliminary **Severity:** **Responsibility:**

7.1.5.1 Authorization concept

#587 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system MUST have an authorization concept with a dedicated internal role and authorization model, including an administrative role model.

7.1.5.2 Adaptability of the authorization concept

#588 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system MUST ensure that the internal role and authorization model is individually customizable and extensible.

7.1.5.3 Technical integration of an external MFA solution

#589 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system MUST support technical integration into an external MFA solution.

7.1.6 Requirements for deletion and archiving

#536 State: Preliminary Severity: Responsibility:

7.1.6.1 Data storage in the online system

#590 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system MUST keep all active objects in the online system.

7.1.6.2 Conception and configuration of the archive system

#591 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system MUST be designed in a way that all (active and inactive/deleted) business objects and protocols can be stored according to internal or legal archive requirements. If an archive system is necessary for performance or capacity reasons, it MUST be designed and configured.

7.1.6.3 Inactive objects in the online system

#592 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system MUST keep all inactive objects in the online system for at least . 3 years. This derivative action time MUST be configurable.

7.1.6.4 Deletion of personal data

#593 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system MUST delete or empty person objects and attributes in all systems for data protection reasons if they have been inactive for more than x years. The referential integrity MUST be maintained, i.e. other objects must not 'disappear'. This derivative action time MUST be configurable.

7.1.6.5 Access to archive data

#594 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system SHALL restrict access to archived data (inactive data older than 3 years) to 'read only'. All accesses MUST be logged without exception.

7.1.7 Requirements for the system administration

#537 State: Preliminary Severity: Responsibility:

7.1.7.1 Functionality in case of failure of infrastructure components

#595 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system MUST be capable of withstanding the failure of individual technical infrastructure components without compromising the functionality of the system.

7.1.7.2 Data retention in the event of failure of infrastructure components

#596 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system **MUST** be capable of coping with the failure of individual technical infrastructure components without data loss.

7.1.7.3 Backups during operation

#597 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier **MUST** create rule-based backups of application data and configurations during operation and restore them on request in the event of an error.

7.1.7.4 Termination of inactive sessions

#598 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system **MUST** abort inactive sessions after a defined period of time and this period **MUST** be individually configurable.

7.1.7.5 Activation and deactivation of traces

#599 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system **CAN** switch different traces on or off at runtime.

7.1.7.6 Overriding control of hanging workflows

#600 **State:** Reviewed internally **Severity:** must **Responsibility:**

Workflows hanging in the system **MUST** be manually overridden by defined specialist administrator roles.

7.1.7.7 Assistance with the evaluation of tracing information

#601 **State:** Reviewed internally **Severity:** can **Responsibility:**

The supplier **CAN** provide help for evaluating and interpreting tracing information during a workflow process.

7.1.7.8 Error handling with interfaces

#602 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system **MUST** have error handling at all interfaces, which ensures the operation of the system and allows error analysis.

7.1.7.9 Provision of monitoring parameters

#603 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system **MUST** provide predefined, configurable, technical monitoring parameters, measurement points and log files.

7.1.7.10 Dashboard for monitoring information

#604 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system CAN display the monitoring information in a dashboard.

7.1.7.11 Provision of monitoring functions

#605 **State:** Reviewed internally **Severity:** can **Responsibility:**

The supplier CAN provide monitoring functions, e.g. for performance values, used interfaces and transferred objects, current processes/workflows (such as status, transaction data, number, times), log data for performance measurement for analysis outside the system and according to parameter specification by the client and incl. alarming and escalation.

7.1.7.12 Detailing of loggings

#606 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system CAN configure the level of detail of the logging per environment and make it adaptable during operation.

7.1.7.13 Configuration/administration via web user interface

#607 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system MUST support configuration/administration via web user interface or client component.

7.1.7.14 Homogeneous admin console

#608 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system CAN provide a homogeneous, integrated administration user interface.
Note: The administration platform should not consist of several different components.

7.1.7.15 Automatic connection establishment after interruptions

#609 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system CAN automatically re-establish connections to other systems without manual intervention if they are interrupted.

7.1.7.16 Manual fail-over

#610 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system CAN support manual failover functions (manual adjustments in the event of failover).

7.1.7.17 Automated load and performance tests

#611 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system CAN allow automated load and performance testing to be performed.

7.1.7.18 Authorization roles for administrator Tasks

#612 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning System MUST Provide Authorization Roles for Administrator Tasks

7.1.7.19 Automatic creation of incident tickets

#613 **State:** Reviewed internally **Severity:** can **Responsibility:**

If errors occur, the Timetable Planning system CAN output information with unique, meaningful error messages/error codes and create incident tickets in the ITSM system.

7.1.7.20 Evaluation of logs

#614 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system CAN offer an evaluation option for logs through filters and search functions.

7.1.7.21 Delete and overwrite system logs

#615 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system CAN automatically delete or overwrite system logs after a specified, configurable time.

7.1.7.22 Display of overload

#616 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system CAN indicate an approaching overload of the system.

7.1.7.23 Configurable thresholds

#617 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system MUST support configurable thresholds for mass change warnings.

7.2 Source and target systems

#519 **State:** Preliminary **Severity:** **Responsibility:**

7.2.1 Requirements for interfaces from the Timetable Planning system to databases

#538 **State:** Preliminary **Severity:** **Responsibility:**

7.2.1.1 Provisioning of user authorizations in databases

#618 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system MUST perform the following commissions in databases: Creating DB Users, Activating and Deactivating DB Users, Scheme Assignment, Deleting DB Users

7.2.2 Generic Requirements for Interfaces

#539 State: Preliminary Severity: Responsibility:

7.2.2.1 Tool for building interfaces/connectors for third-party systems

#619 State: Reviewed internally Severity: can Responsibility:

The system CAN provide a tool to configure and implement new interfaces/connectors to connect third party systems.

7.2.2.2 Web services support

#620 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system MUST support both client and server side web services.

7.2.2.3 Intermediate storage in case of inaccessibility

#621 State: Reviewed internally Severity: must Responsibility:

If the target system cannot be reached, the Timetable Planning system MUST store the data in the buffer and process them from the restart point in the input sequence as soon as the target system can be reached again.

7.2.2.4 Changing IP addresses

#622 State: Reviewed internally Severity: can Responsibility:

The Timetable Planning system CAN handle changing IP addresses of its interface partners and within the system. Manual intervention in the event of an IP change should not be necessary.

7.2.3 System Performance and Scalability

#540 State: Preliminary Severity: Responsibility:

7.2.3.1 Scalability during peak loads

#623 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system MUST provide a response time (at GUI end-to-end) of 0.5 seconds for simple transactions (e.g. display of the service catalog in the internal network) and 10 seconds for complex transactions for peak loads and maximum scaled volume model.

7.2.3.2 Horizontal scalability

#624 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system MUST be horizontally scalable by adding additional application/job servers.

8 Specification of services

#520 State: Preliminary Severity: Responsibility:

For the implementation of a Timetable Planning system, the supplier requires professional and technical services. These services are described in detail in the following chapters:

8.1 Service overview

#521 State: Preliminary Severity: Responsibility:

The following list shows the activities to be performed, separated into technical and professional services.

Overview technical and functional implementation

- Design of the system environments required for the introduction of the Timetable Planning system
- Creation of the necessary concepts
- Implementation of the connection of the defined source systems
- Implementation of the connection of the target systems defined for the client
- Support of the connection of the target systems defined for the supplier
- Implementation of the defined processes and the underlying workflows in the Timetable Planning system
- Implementation of the role model
- Carrying out the tests and acceptances
- Project management of the technical implementation
- Technical documentation of the solution
- Training of the future system management staff to take over the tasks independently
- Providing best practice information on market implementations of a Timetable Planning and knowledge transfer on Timetable Planning topics

8.1.1 Services for technical implementation

#541 State: Preliminary Severity: Responsibility:

8.1.1.1 Design of the system environments required for the introduction of the Timetable Planning system

#625 State: Reviewed internally Severity: must Responsibility:

The supplier MUST design, set up, document and hand over the test system of the IT Timetable Planning system. The supplier MUST set up and maintain the development systems for himself and on his own resources according to his own specifications. The supplier MUST enable the Timetable Planning operations management staff to set up and keep the productive system up to date independently and completely by providing packages and documentation. In case of error, he MUST support according to the implemented Incident Management process.

8.1.1.2 Creation of the required concepts

#626 State: Reviewed internally Severity: must Responsibility:

The supplier MUST develop the following concepts with the Timetable Planning operations management and implement them in the Timetable Planning system for the respective work packages:

- Change, migration and refresh concept of the system environments
- Cluster, backup and recovery concept
- Monitoring concept (availability, capacity)
- Emergency plan
- Test and quality assurance concept
- Deletion (and archiving concept)
- Security concept (threat model)

8.1.1.3 Implementation of the connection of the defined source systems

#627 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST connect the defined source systems in the Timetable Planning system. this role MUST support the know-how development of the IT-internal Timetable Planning project organisation 'Hands-On'. The supplier shall provide a transparent work performance that is comprehensible to the client, as well as documentation and training of the Timetable Planning management staff.

8.1.1.4 Implementation of the connection of the target systems defined for the supplier

#628 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST connect the target systems in the Timetable Planning system for which he is responsible. this role MUST support the know-how development of the IT-internal Timetable Planning project organisation 'Hands-On'. In doing so, the supplier shall provide a transparent work performance that is comprehensible for the client, as well as documentation and training for the Timetable Planning management staff. By providing packages and documentation, the supplier MUST enable the Timetable Planning operations management staff to independently and completely integrate the target systems into the production environment and keep them executable.

8.1.1.5 Support of the connection of the target systems defined for the client

#629 **State:** Reviewed internally **Severity:** must **Responsibility:**

By providing documentation and instructions, the supplier MUST enable the Timetable Planning operations management staff to independently and completely connect and maintain the target systems defined for the client.

8.1.1.6 Implementation of the defined processes through corresponding workflows in the Timetable Planning system

#630 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST implement the processes described within the functional requirements in the Timetable Planning system together with the IT-internal Timetable Planning project organisation. The supplier MUST perform the workflows and customizing in the Timetable Planning system. This role MUST support the know-how development of the IT-internal Timetable Planning project organisation 'hands-on'. The supplier shall provide a transparent work performance that is comprehensible to the client, as well as documentation and training for Timetable Planning management staff. By providing packages and documentation, the supplier MUST enable the Timetable Planning operations management staff to independently and completely take over the implementation of the processes in the production system and keep them executable.

8.1.2 System implementation services

#542 State: Preliminary Severity: Responsibility:

8.1.2.1 Best practice and knowledge building

#631 State: Reviewed internally Severity: must Responsibility:

We expect from the supplier the consulting or the mediation of the necessary information, which is necessary for the implementation of a Timetable Planning System. This can take the form of training, workshops or coaching of specific project roles.

Contents of the knowledge transfer can be:

- Basic topics such as working methods or implementation assistance
- Observation of developments based on market knowledge
- Answering questions in the course of project work

The following applies to best practice examples:

In order to gain or expand knowledge, the supplier should provide with best or good practice examples of the implementation of a Timetable Planning System.

It is therefore necessary for the supplier to have contacts with companies that have already implemented their system or are about to do so.

8.1.3 Project team

#543 State: Preliminary Severity: Responsibility:

8.1.3.1 Project team of the client

#632 State: Reviewed internally Severity: must Responsibility:

The client's project organization comprises a project team that represents and covers all relevant specialist areas (organizational and technical). All project-relevant decisions must be discussed and worked out by the project team between the client and the supplier.

8.1.3.2 Project management staff

#633 State: Reviewed internally Severity: must Responsibility:

The supplier MUST provide an English-speaking project management.

8.1.3.3 Contact persons

#634 State: Reviewed internally Severity: must Responsibility:

The contact data of the defined contact persons of the client will be announced when the contract is concluded.

8.1.3.4 Project team competencies

#635 State: Reviewed internally Severity: must Responsibility:

Multiple naming (i.e. naming a person for more than one of the roles listed) is permitted for the members of the project team to be named. However, it must be ensured that this does not lead to any conflicts in the time planning and distribution of tasks of the respective person in the project.

8.1.3.5 Project manager of the supplier

#636 State: Reviewed internally Severity: must Responsibility:

The project manager is primarily responsible for the operational planning, control and monitoring of the project. In this context, this person is responsible for the achievement of time and cost objectives in the context of project implementation.

The project manager on the supplier side reports to the IT project manager and is the representative of the supplier. Thus, the project management team leads, creates and maintains a project plan and a project manual. It is responsible for the quality and quality assurance measures of the components to be supplied. The project manager plays an essential role in the project implementation and has to accompany the project from the beginning to the operation of the system as a key person. The client and the supplier shall agree on the date on which the project manager is to be on site (Lod). The planning for this is generally done quarterly in advance, at least one month before the first of the respective quarter to be planned. The extent of the on-site presence (Lod) must be adapted to the respective requirements of the project progress. The project manager participates in the project meetings. In the event of illness, he/she must nominate a replacement.

The tasks include, among other things:

- Collaboration in the overall project management team, in particular cooperation with the client's contact persons
- Overall planning and control of supplier activities
- Representation of the project and reporting to the client and internally into the organisation of the supplier (timely provision of necessary information, communication, bringing about decisions)
- Monitoring project progress and risk provisioning as well as ultimate responsibility for all documentation
- Escalation in the event of deviations from the approved project progress with regard to scope of services, costs, deadline and quality
- Ensuring compliance with company-specific regulations and guidelines (organization manual, etc.)

Specific suitability criteria (minimum requirements):

- The person nominated has at least 5 years of professional experience in IT projects and at least 2 years of project management experience (proof by curriculum vitae).
- The person has already managed a project which involved adapting the standard software offered here to the size and complexity of a company such as ISR (proof by curriculum vitae).
- Very good knowledge of written and spoken English

8.1.3.6 System architect

#637 **State:** Reviewed internally **Severity:** must **Responsibility:**

Together with the client, the System Architect defines the technical structure and makes the fundamental decisions on the interaction and delimitation of the components and surrounding systems. This role proactively contributes its expert knowledge during all phases of the software implementation and advises the client about the definition of functional and non-functional requirements.

It also supports in the analysis of problems with interface systems and supports the client in the implementation and initial operation of the software.

The System Architect is responsible, among other things:

- the technical implementation, as well as the joint implementation with the client
- the operability of the solution
- the test of all system components
- the integration into the client's IT environment, including interfaces
- all methods, procedures and tools used in the technical implementation of the client's requirements

Specific eligibility criteria:

- In this role he/she accompanied projects for the supplier for at least 2 years, in which the solution offered here was implemented.
- this role/she has at least 5 years of architectural experience in IT projects (proof by curriculum vitae).

8.1.3.7 System testing expert

#638 **State:** Reviewed internally **Severity:** must **Responsibility:**

This role supports the senior developer in implementing the functional and non-functional requirements of the client by testing the delivered components and the overall system.

It supports you in analyzing problems caused by software releases and in customizing or scaling the software.

Specific eligibility criteria:

this role/she has at least 2 years of testing experience in IT projects (proof by curriculum vitae).

8.1.3.8 Operations manager

#639 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Operations Manager is responsible for the system operations of the Timetable Planning system and its components. this role cooperates with and supports the operations team for the Timetable Planning system.

Specific eligibility criteria:

This role/she has at least 2 years of experience in the operation of IT systems - proof by curriculum vitae.

8.1.4 Documentation

#544 State: Preliminary Severity: Responsibility:

8.1.4.1 Accounting documentation

#640 State: Reviewed internally Severity: must Responsibility:

The costs for the documentation produced within the services to be provided shall be included in the respective flat rates or in the costs for operational management support, maintenance and support.

8.1.4.2 Project documentation

#641 State: Reviewed internally Severity: must Responsibility:

The supplier shall trace the progress of the project and document it in accordance with the requirements of the client described here. In particular, this includes all planning work (including minutes of meetings), project plans, deliveries, installations carried out and configuration measures. These documents must be complete and up-to-date and handed over to the client on time (within four working days in the case of meeting minutes).

8.1.4.3 Template and formats specifications

#642 State: Reviewed internally Severity: must Responsibility:

All parts of the documentation are to be handed over to the client in computer-readable form. It MUST be ensured that these formats can be read and processed with the software used by the client.

8.1.4.4 Default communication language

#643 State: Reviewed internally Severity: must Responsibility:

Documents created and supplemented by the supplier MUST be in English as the following:

- HLD
- Technical Specification
- User manual
- Installation manual
- Product data sheet
- Configuration files
- Documentation of provided 3rd-party software
- Test Plan
- Maintenance & Support Plan

8.1.4.5 Specification of the degree of details

#644 State: Reviewed internally Severity: must Responsibility:

The technical documentation MUST be complete and written in such a way that it can be easily understood by knowledgeable third parties. The client understands technical documentation as documentation of the prerequisites for the correct operation and further development of the software. With the technical documentation, the IT service supplier of the client must be able to carry out the operational management (which services must be started for the software to run, which 3rd-party products must be available and executed in order to guarantee a flawless operation of the software).

8.1.4.6 Documentation rights

#645 **State:** Reviewed internally **Severity:** must **Responsibility:**

Any documentation supplemented or created by the contractor specifically for the client shall become the property of the client, which shall also grant the client the rights to use and reproduce the documentation without limitation.

8.1.5 Project management framework

#545 **State:** Preliminary **Severity:** **Responsibility:**

8.1.5.1 Location of meetings

#646 **State:** Reviewed internally **Severity:** must **Responsibility:**

Meetings take place, if necessary, at the client's premises in LOD and HAIFA.

8.1.5.2 Project meeting and project progress report

#647 **State:** Reviewed internally **Severity:** must **Responsibility:**

Project meetings during the implementation phase take place at least every 14 days. A monthly project progress report shall be submitted by the supplier.

8.1.5.3 Working hours during the project time

#648 **State:** Reviewed internally **Severity:** must **Responsibility:**

Working hours are defined as the following: Sunday to Thursday from 07:00 to 18:00, except public holidays in Israel.

8.1.5.4 24/7 maintenance

#649 **State:** Reviewed internally **Severity:** can **Responsibility:**

The supplier CAN offer an optional offer for 24/7 support. The client is not obliged to order the 24/7 service. Whether an assignment is made or not is at the discretion of the client.

8.1.5.5 Holidays

#650 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Israel public holidays as stipulated by law shall apply.

8.1.5.6 Service provision during working hours

#651 **State:** Reviewed internally **Severity:** must **Responsibility:**

Services are normally provided during working hours. The specifications apply to operational management support, maintenance and support.

8.1.5.7 Support level

#652 **State:** Reviewed internally **Severity:** must **Responsibility:**

Within the scope of the description of the activities of the supplier and the client with regard to operational management support the classifications 1st, 2nd and 3rd level support shall be used in this Technical Specification. The corresponding activities refer to the role definitions of ITIL (IT Infrastructure Library). Essentially, these are:

1st level support activities:

- Registration and classification of the event
- Rough fault isolation
- If possible, restore the defined operating state, otherwise include 2nd level support

2nd level support activities:

- Acceptance of fault messages from 1st level support for more complex problems (e.g. if an intervention in the application is required)
- If possible, restoration of the defined operating state, otherwise integration of 3rd level support
- If applicable, definition of a workaround

3rd-Level-Support activities (i.A. supplier):

- Takeover of fault reports from 2nd level support for complex problems
- Restoration of the defined operating state
- If necessary, support of 2nd level support in defining a workaround, coordination of solution finding (e.g. creation of software patches)

8.1.6 Project execution

#546 **State:** Preliminary **Severity:** **Responsibility:**

8.1.6.1 Detailed execution planning

#653 **State:** Reviewed internally **Severity:** must **Responsibility:**

At the beginning of the project, the supplier must carry out detailed implementation planning. In the course of this detailed implementation planning, the supplier must prepare the architecture and implementation concept in detail. The implementation concept **MUST** be based on the solution concept drawn up in the course of the tender preparation. In addition, the concept **MUST** include all necessary aspects of the implementation in detail.

8.1.6.2 Kick-off meeting

#654 **State:** Reviewed internally **Severity:** must **Responsibility:**

The detailed execution planning begins with a joint kick-off meeting. In the course of the kick-off meeting (or, where appropriate, in advance), the client shall provide the supplier with all the information required for the services to be provided in accordance with the contract or, where necessary, shall agree on joint arrangements.

Contents:

- Organizational matters such as Determination of the central and local contact persons of the supplier and client
- Definition of detailed procedures and conditions
- General requirements for operational support, maintenance and support
- Preparation of an expected timetable
- Participants: Project employees of the client and the supplier
- Duration: Full day

8.1.6.3 Architecture and implementation workshop

#655 **State:** Reviewed internally **Severity:** must **Responsibility:**

This workshop serves to define the objectives for architecture and implementation, as well as the rough coordination of the implementation plan.

Contents:

- Definition of a target in relation to the issue at hand
- Discussion of possible solution scenarios (architecture variants) incl. specification and their advantages and disadvantages
- Documentation
- Participants: Project employees of the client and the supplier
- Duration: at least full day

8.1.6.4 Creation of architecture and implementation concept

#656 **State:** Reviewed internally **Severity:** must **Responsibility:**

With the inputs from the architecture and implementation workshop, the supplier must create the architecture and implementation concept and transmit it to the client. The architecture and implementation concept MUST include the contents as agreed in the architecture and implementation workshop and specified in writing.

8.1.6.5 Acceptance of the detailed execution planning

#657 **State:** Reviewed internally **Severity:** must **Responsibility:**

The detailed implementation planning and thus the implementation concept to be prepared by the supplier within the scope of the assignment is accepted by the client. The procedure is as follows:

After the transmission the client will check the elaboration within a period to be defined. This review is concluded with a joint working session between the client and the supplier, in which the drafting is checked for completeness and applicability chapter by chapter. This process is logged together.

If serious defects are found, this procedure will be repeated after the defect has been remedied. Any defects must be remedied within 5 working days. The client understands serious defects to be defects which lead to the acceptance object not being complete, not being sufficiently specific with regard to the general conditions (technical, organizational) or not being applicable within the framework of the technical and organizational prerequisites of the client. In the case of only slight defects, the elaboration shall be declared accepted by the client upon receipt of any corrections. The client decides whether a serious defect exists. After successful rectification of all defects, the client declares acceptance of the elaboration in writing.

8.1.7 System implementation and commissioning

#547 State: Preliminary Severity: Responsibility:

8.1.7.1 Implementation

#658 State: Reviewed internally Severity: must Responsibility:

After acceptance of the detailed implementation planning, the implementation is to be carried out in accordance with the architecture and implementation concept developed and the timetable contained therein. In principle, the supplier must provide all services required in the course of the implementation which are necessary for a successful and smooth implementation. All activities required for the implementation and erection of the components must be coordinated with the client. The supplier is responsible for the successful and smooth implementation of the project. Unless otherwise agreed, all implementation steps are to be carried out in the presence of the client.

8.1.7.2 Deployment process

#659 State: Reviewed internally Severity: must Responsibility:

For a standardized approach, a common deployment process MUST be implemented. This achieves the following:

- Improving transparency
- Automated deployment on different system environments
- Quality improvement through (automated) tests
- Better scalability through division of labor (admin / developer / tester / manager)
- Minimization of tasks for administrators in the system environment
- Minimization of activities for developers in the system environment
- Acceleration of the roll-out process
- Test possibility of the roll-out process

8.1.7.3 Installation, parameterization and commissioning

#660 State: Reviewed internally Severity: must Responsibility:

It is necessary to implement a software version to be used in consultation with the supplier. The system MUST be installed and parameterized by the supplier in Lod.

8.1.7.4 System documentation

#661 State: Reviewed internally Severity: must Responsibility:

Prior to acceptance, the complete system documentation MUST be handed over from the supplier to the client. The general specifications defined apply to the documentation.

8.1.7.5 Support by the suppliers operations management staff

#662 State: Reviewed internally Severity: must Responsibility:

From the beginning of the installation and up to the productive operation (and thus the official beginning of the maintenance and support services) the supplier MUST support the client with maintenance and support services. The activities defined for operation, including the service levels defined there, must be performed. In addition, extended support from the supplier is required in this phase. This means that at least within the

standard working hours there must be direct telephone contact with an employee of the supplier who is familiar with the installation.

8.1.8 System acceptance

#548 State: Preliminary Severity: Responsibility:

8.1.8.1 Test run in the test system

#663 State: Reviewed internally Severity: must Responsibility:

- After successful connection and acceptance of the source systems, a 20-day (working days) trial operation takes place.
- After each successful connection and acceptance of a target system, a 20-day (working days) trial operation of this interface takes place.
- After each successful implementation and acceptance a 20-day (working days) trial operation of the integrated processes takes place.

According to the deployment process, the assigned testing team checks the functions and services provided by the supplier for compliance with the requirements specified in the detailed implementation planning or in the technical specifications.

- If significant defects are found (such defects shall be defects with a disruptive effect or the lack of implementation of relevant parts of the service), the supplier shall remedy these defects immediately and test the functions.
- Insignificant defects (as such, defects that only slightly restrict the appropriate use of parts of the functions) shall not prevent acceptance as the next step, but shall be remedied by the supplier within a mutually agreed period.

The trial run shall be repeated until all significant defects have been rectified.

Direct access to the supplier's technical staff is required during the trial operation. Technicians of the supplier who are familiar with the client's environment must therefore be available to the client directly by telephone in this phase. After successful completion of the trial operation, acceptance takes place in the test system. Excluded from this acceptance are services (e.g. monthly reports), which must function over a longer period than the test run defined above in order to determine compliance with the requirements specified in the detailed implementation planning or in the technical specifications. For this purpose, a further acceptance time (for these services) after completion of the trial operation is specified in the detailed implementation planning.

8.1.8.2 Acceptance of the basic system

#664 State: Reviewed internally Severity: must Responsibility:

The completion of the system implementation of the basic system takes place by means of an acceptance. Subsequently, the general conditions and requirements for acceptance are laid down. In the acceptance test, at least the project manager or deputy and a senior developer assigned to the project must be represented on the supplier's side for the competent answering of technical questions in the course of the acceptance test.

1. The client shall check the supplier's services for compliance with the requirements specified in the detailed implementation planning and the technical specifications. Failure tests are also performed to verify the functionality of all aspects of redundancy.
2. If significant defects are found (such defects are those with a disruptive effect or the lack of implementation of relevant parts of the service), the supplier shall remedy these defects immediately, test the functions and then report readiness for acceptance again. In this case, acceptance shall begin anew. Insignificant defects (as such, defects are deemed to be defects that only slightly restrict the appropriate use of parts of the functions) do not prevent acceptance, but must be remedied by the supplier within a mutually agreed period.
3. The decision whether a serious or slight defect is present is incumbent on the client.
4. The acceptance test shall be repeated until all significant defects have been rectified.
5. The project manager of the client MUST draw up an acceptance protocol for the acceptance test and send it to the overall project manager of the supplier.

8.1.8.3 Acceptance of implementation packages

#665 State: Reviewed internally Severity: must Responsibility:

Acceptance can only take place if all MUST criteria defined and the CAN criteria promised by the supplier have been implemented and are in operation.

8.1.8.4 Standard operation

#666 State: Reviewed internally Severity: must Responsibility:

After successful acceptance, the standard operation of the respective implementation package begins. In any case, all MUST criteria and the CAN criteria promised by the supplier must be fulfilled and in operation.

8.1.8.5 Acceptance criteria and contents of the acceptances

#667 State: Reviewed internally Severity: must Responsibility:

In the detailed execution planning, the regulations for the planned acceptance tests shall be determined jointly by the client and the supplier. This includes

- the respective contents of the acceptance test and
- the criteria for a successful or unsuccessful acceptance. A catalogue with agreed criteria can be used which is defined for the various acceptance objects (e.g. installation, processes, interfaces,...).

8.2 Training

#522 State: Preliminary Severity: Responsibility:

8.2.1 Training environment

#549 State: Preliminary Severity: Responsibility:

8.2.1.1 Calculation of training costs

#668 State: Reviewed internally Severity: must Responsibility:

In the price sheet the costs for several types of training MUST be indicated.

8.2.1.2 Functional training manuals

#669 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier shall provide electronic manuals for the system functions. The level of detail and the form of the training materials must be chosen so that the materials serve as a presentation basis for the training itself but can also be used by the participants after the training as a reference in daily practice. The documents must be supplied in an editable and adaptable form (e.g. MS-Word).

8.2.1.3 Training manuals for IT operations

#670 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST provide training materials for technical administrators. The following training objectives, among others, are illustrated and methodically described in the documents:

- Ability to perform technical administration of the Timetable Planning system.
- Change in the technical configuration
- Manage identities, accounts, roles, and permissions

8.2.1.4 Training location

#671 **State:** Reviewed internally **Severity:** must **Responsibility:**

The trainings take place in a location of the client in Lod and Haifa. Training rooms with corresponding workstations are provided by the client.

8.2.1.5 Language English

#672 **State:** Reviewed internally **Severity:** must **Responsibility:**

The training courses must be held in English. The training documents in English shall be provided by the supplier.

8.2.1.6 Copying manuals

#673 **State:** Reviewed internally **Severity:** must **Responsibility:**

The client has the right to duplicate or reuse the manuals for internal training.

8.2.1.7 Training topics

#674 **State:** Reviewed internally **Severity:** must **Responsibility:**

The details of the training course must be agreed with the client prior to implementation.

8.2.1.8 Trainers

#675 **State:** Reviewed internally **Severity:** must **Responsibility:**

The training shall be conducted by trainers who have several years of experience with the supplier's software.

8.2.2 Types of training

#550 State: Preliminary Severity: Responsibility:

8.2.2.1 Administrator trainings

#676 State: Reviewed internally Severity: must Responsibility:

After completion of this training, the IT-Operations staff must be able to

- to administrate professionally
- to perform independent troubleshooting
- provide 2nd level support for system components

8.2.2.2 Application training for key users

#677 State: Reviewed internally Severity: must Responsibility:

For the qualified users of the Timetable Planning system (administrators, key users, ...) the supplier MUST provide the following services

Support the organization with initial training courses for key users and internal trainers

8.2.3 Knowledge transfer

#551 State: Preliminary Severity: Responsibility:

8.2.3.1 Instructions for independent work

#678 State: Reviewed internally Severity: must Responsibility:

The supplier MUST enable the client to carry out the IT-system operations independently.

8.2.3.2 Know-how transfer

#679 State: Reviewed internally Severity: must Responsibility:

During the implementation of the system, the supplier MUST ensure that selected specialists of the client complete the necessary training courses and ensure a know-how transfer in which they are actively involved in the implementation.

8.2.3.3 Knowledge base

#680 State: Reviewed internally Severity: can Responsibility:

The supplier CAN provide a knowledge base, a wiki, user forums, a community and user meetings.

8.3 Software lifecycle

#523 State: Preliminary Severity: Responsibility:

8.3.1 Information to clients about technical improvements and further developments

#681 State: Reviewed internally Severity: must Responsibility:

The supplier MUST regularly inform the client about technical improvements and further developments which may be of interest for the operation of the software by the client.

8.3.2 Adaptation to current databases

#682 State: Reviewed internally Severity: must Responsibility:

Within the scope of software maintenance, the supplier shall ensure that the application is executable with the version of the database software currently used by the client and agreed between the client and the supplier.

8.3.3 Release upgrades

#683 State: Reviewed internally Severity: must Responsibility:

The use of new software versions shall take place at the earliest at a point in time at which the applicability of these versions has been proven by practical experience or tests and the supplier guarantees the problem-free changeover and use of the new software versions. A changeover regarding a major version is planned, tested and carried out together with the client with his consent.
Existing IT-specific configurations MUST be fully adopted for all release upgrades.

8.3.4 Improvement of the current software version

#684 State: Reviewed internally Severity: must Responsibility:

Improvements to the current software version, which the supplier realizes on his own initiative or at the instigation of other clients, shall be made available to the client as an update upon request.

8.3.5 IT support prior to acceptance

#685 State: Reviewed internally Severity: must Responsibility:

All criteria specified apply in principle to operation after acceptance. However, these services must also be provided to the required extent during test operation or the implementation phase.

8.3.6 Removal of modules or licenses from maintenance

#686 State: Reviewed internally Severity: must Responsibility:

The client has the right to remove individual products, modules or licenses from maintenance as of 1 January of each year; in this case, the maintenance and support costs must be reduced accordingly by the supplier.

8.3.7 Contacts to the product management of the supplier

#687 State: Reviewed internally Severity: can Responsibility:

The supplier CAN enable the client to establish recurring contacts with the product management for the purpose of exchanging information on further developments.

8.3.8 Participation in the further development of the system

#688 **State:** Reviewed internally **Severity:** can **Responsibility:**

The supplier CAN enable the client to influence the further development of the system, e.g. through discussions in user forums and working groups.

8.3.9 Lead time for cancellation of functions/platforms

#689 **State:** Reviewed internally **Severity:** can **Responsibility:**

The supplier CAN assure that it will inform the supplier at least 12 months in advance of any discontinuations of functions used.

8.4 System support

#524 **State:** Preliminary **Severity:** **Responsibility:**

8.4.1 Service desk

#552 **State:** Preliminary **Severity:** **Responsibility:**

8.4.1.1 Service desk

#690 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST operate a Service desk as a single point of contact for 1st level support that handles

- all questions regarding functionality by qualified specialists of the client,
- error messages and
- receives all requirements for technical support from the client and answers, processes or forwards them accordingly.

8.4.1.2 Authorized logon users

#691 **State:** Reviewed internally **Severity:** must **Responsibility:**

Questions regarding functionality and fault messages are reported by the client's IT-Service providers.

8.4.1.3 Service desk language English

#692 **State:** Reviewed internally **Severity:** must **Responsibility:**

Communication with the supplier's Service Desk staff during initial contact MUST be in English, in accordance with the Common European Framework of Reference for Languages Level B2.

8.4.1.4 Service desk language Hebrew

#693 **State:** Reviewed internally **Severity:** can **Responsibility:**

Communication with the supplier's Service Desk staff during initial contact CAN be in Hebrew.

8.4.1.5 Communication

#694 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Service Desk of the supplier MUST accept fault reports at least by telephone and e-mail.

8.4.1.6 Information

#695 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Service Desk MUST be able to provide information on the progress of 3rd level support requests.

8.4.1.7 Availability of service desk

#696 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Service Desk MUST be available in the standard working hours.

8.4.1.8 24/7 service desk availability

#697 **State:** Reviewed internally **Severity:** can **Responsibility:**

The supplier CAN optionally offer a 24/7 service desk.

8.4.1.9 Service desk and SLA compliance

#698 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Service Desk is responsible for ensuring that all defined reaction and processing times are adhered to within its Service Level Agreement.

8.4.2 Troubleshooting

#553 **State:** Preliminary **Severity:** **Responsibility:**

8.4.2.1 Provision of 3rd level support

#699 **State:** Reviewed internally **Severity:** must **Responsibility:**

The client's management staff shall provide 1st-level and 2nd-level support with regard to the solution to be offered or its components.

The supplier MUST provide 3rd level support or have it provided by the supplier. As general supplier he is the responsible contact person.

8.4.2.2 Ticketing system for fault messages

#700 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST process the support via a ticket system and provide the client with full transparency and traceability of the respective ticket status at all times.

8.4.2.3 Communication via telephone and e-mail

#701 **State:** Reviewed internally **Severity:** must **Responsibility:**

Communication between the supplier and the client MUST be possible at least by telephone and e-mail, chat or meeting software.

8.4.2.4 Elaboration of a detailed fault process sequence

#702 **State:** Reviewed internally **Severity:** must **Responsibility:**

The detailed process of fault processing in 1st level support is defined together with the client.

8.4.2.5 Workaround solution

#703 **State:** Reviewed internally **Severity:** must **Responsibility:**

If the final correction of a defect is not possible, a workaround (provisional solution) is permissible, provided that there is no impairment of quality or functionality. The Client MUST be notified in writing of the circumvention of the defect as soon as possible, and the defect must be remedied and replaced by a remedy in accordance with the agreed standard.

8.4.2.6 Annual report

#704 **State:** Reviewed internally **Severity:** must **Responsibility:**

Once a year the supplier MUST send an annual report to the client. The annual report contains all reported malfunctions and their troubleshooting times. The format of the report must be agreed with the client before the first report is sent.

8.5 System Maintenance

#525 **State:** Preliminary **Severity:** **Responsibility:**

8.5.1 Updates

#554 **State:** Preliminary **Severity:** **Responsibility:**

8.5.1.1 Provision of updates

#705 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST provide updates/upgrades/patches (minor and major) within the existing maintenance contract.

Existing IT-specific configurations MUST be fully adopted for all updates/upgrades/patches (minor and major).

8.5.1.2 Recommendations of updates

#706 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST make recommendations for the implementation of updates. The recommendations must be duly substantiated. Important updates (bug fixes, security updates, etc.) must be reported immediately.

8.5.1.3 Tests of updates

#707 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST thoroughly test software updates in an environment that is sufficiently comparable to that of the client before carrying them out.

8.5.2 Operations management support

#555 State: Preliminary Severity: Responsibility:

8.5.2.1 Activities

#708 State: Reviewed internally Severity: must Responsibility:

If necessary, the supplier shall perform management activities. This includes all work for both the

- Administration of the system
- Configuration of the system
- Customizing activities and system parameterization
- Data analysis
- Creation of reports

The details of the activities are determined in advance between the client and the supplier.

8.5.2.2 Settlement

#709 State: Reviewed internally Severity: must Responsibility:

The activities of the operational management support are offset against expenses. These services are charged via the hourly pool offered.

8.5.2.3 Scope of performance

#710 State: Reviewed internally Severity: must Responsibility:

The scope of services and the number of hours for which the supplier intends to perform the services to be commissioned shall be determined at the beginning of the respective activity or in the course of the commissioning. The charge is based on actual expenditure, whereby the expenditure may exceed the original estimate and thus the agreed quantity by a maximum of 20%.

8.6 System Availability

#526 State: Preliminary Severity: Responsibility:

8.6.1 Requirements for system availability

#556 State: Preliminary Severity: Responsibility:

8.6.1.1 Support IT service level 1

#711 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system MUST support service level 1, i.e. ensure an automatic restart time of one hour. The criterion is the complete re-availability of all system functions. The recovery time is the next working day, which includes data consistency with all connected systems. A maximum data loss of five (5) minutes is tolerable.

8.6.1.2 System availability

#712 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system **MUST** be designed and constructed in such a way that a total availability of 98.23% (service level 1) can be achieved during operation.

8.6.2 Requirements for release management

#557 **State:** Preliminary **Severity:** **Responsibility:**

8.6.2.1 Implementation of a reliable release management system

#713 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier **MUST** provide reliable release management for the project phases defined in the performance specification. Each release note must include at least one list of all delivered configuration items (CIs) (e.g. software A in version x, framework B in version y, etc.).

8.6.2.2 Release status of new software versions

#714 **State:** Reviewed internally **Severity:** must **Responsibility:**

The use of new software versions shall take place at the earliest point in time at which the applicability of these versions has been proven by practical experience or tests and the supplier guarantees the problem-free changeover and use of the new software versions. A changeover regarding a major version is planned, tested and carried out together with the client's consent.

8.6.2.3 Configuration changes in staging environments

#715 **State:** Reviewed internally **Severity:** must **Responsibility:**

The Timetable Planning system **MUST** securely deploy configuration changes (schema, workflows, etc.) and adjustments separately from the user data to other staging environments.

8.6.2.4 Market standard version control systems and repositories

#716 **State:** Reviewed internally **Severity:** can **Responsibility:**

The supplier **CAN** transfer releases to customary repositories or version control systems.

8.6.2.5 Test automation and import of updates/patches

#717 **State:** Reviewed internally **Severity:** can **Responsibility:**

The supplier **CAN** automate the import and testing of updates and patches.

8.6.2.6 Rollback in case of unsuccessful release change

#718 **State:** Reviewed internally **Severity:** can **Responsibility:**

The Timetable Planning system **CAN** roll back to the previous version if a release upgrade was not successful.

9 Information security and data protection requirements

#527 **State:** Preliminary **Severity:** **Responsibility:**

The following internal guidelines and legal regulations must be observed when introducing a Timetable Planning system.

9.1 IT internal guidelines and legal requirements

#528 **State:** Preliminary **Severity:** **Responsibility:**

The following list shows all relevant internal IT guidelines and legal requirements from which requirements for the future Timetable Planning system were derived.

9.1.1 IT administrators (standard operation procedures)

#719 **State:** Reviewed internally **Severity:** must **Responsibility:**

The standard operation procedure for administrators describes the following aspects of information security:

- Control access rights for users
- Compliance with the password policies of the systems
- Administration of user accounts and access rights
- Regular checking of user accounts
- Adjust authorizations for staff changes
- Administration of administrator rights as separate accounts
- Delegation of administrator rights

9.2 System security requirements

#529 **State:** Preliminary **Severity:** **Responsibility:**

9.2.1 General requirements

#558 **State:** Preliminary **Severity:** **Responsibility:**

9.2.1.1 Notification of safety incidents within the responsibility of the supplier

#720 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST report any observed or suspected information security vulnerability (problems, errors, malfunctions, ...) regarding the delivered product to the client promptly. Also, if not excluded, effects on the protection of personal data at the contracting authority must be reported to the contracting authority promptly.

9.2.1.2 Evidence of personal data concerned in security incidents

#721 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST report the occurrence of security incidents to the client as soon as possible, including the data concerned and the measures taken. However, this does not include ordinary security events such as port scans.

9.2.1.3 Problem and escalation management by the supplier

#722 State: Reviewed internally Severity: must Responsibility:

The supplier MUST agree a clear problem solving and escalation process with the client to solve problems.

9.2.1.4 Measures taken by the supplier in the event of security incidents

#723 State: Reviewed internally Severity: must Responsibility:

The supplier SHALL review and implement appropriate measures to address security incidents and new vulnerabilities to reduce the associated risk and assist in the analysis and tracking of potential security incidents.

9.2.1.5 Provision of contact persons in the event of security incidents

#724 State: Reviewed internally Severity: must Responsibility:

The supplier MUST inform the client of the responsible contact points and contact data of the responsible persons in the event of a security incident and keep them up to date.

9.2.2 Information security requirements

#559 State: Preliminary Severity: Responsibility:

9.2.2.1 Prevent data theft

#725 State: Reviewed internally Severity: must Responsibility:

In particular, theft or inadvertent disclosure of information MUST be prevented: The Timetable Planning system MUST support this by accurately locking and disabling system accounts.

9.2.2.2 Documentation of changes to the Timetable Planning system

#726 State: Reviewed internally Severity: must Responsibility:

Changes to the hardware and software (installations, uninstallations and software updates, configuration) of the Timetable Planning system may only be made by authorized persons. The Timetable Planning system MUST document system changes.

9.2.2.3 Documentation of administrator passwords

#727 State: Reviewed internally Severity: must Responsibility:

The Timetable Planning system documents each change and disclosure of master/administrator passwords, which must be secured and encrypted.

9.2.2.4 No operational rights for administrators

#728 State: Reviewed internally Severity: must Responsibility:

Administrators of the Timetable Planning system must not have any authorizations within the approval processes of the Timetable Planning functionality.

9.2.2.5 Documentation of changes to access permissions

#729 **State:** Reviewed internally **Severity:** must **Responsibility:**

Applications for access rights to information systems must be documented and may only be carried out after approval has been granted.

All approvals and commissions issued via the Timetable Planning system must be fully documented.

Requests to set up, change or delete permissions must be stored in the Timetable Planning system.

9.2.2.6 Provision of security hotfixes/patches by the supplier

#730 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST immediately provide security hotfixes or patches for identified security vulnerabilities. Vulnerabilities with a CVSS value of 7-10 are to be made available to the client as quickly as possible (maximum within 4 weeks), vulnerabilities with a lower CVSS value at the latest within the framework of the next minor release.

9.2.2.7 Deactivation of backdoors

#731 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST inform the client of and deactivate all supplier's backdoors and maintenance accesses.

Note: There must be no accesses with standard or fixed passwords that cannot be adapted by the client.

9.2.2.8 Activation only of required functions

#732 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier MUST configure the Timetable Planning system so that only the required functions are enabled.

9.2.3 Disaster recovery

#560 **State:** Preliminary **Severity:** **Responsibility:**

9.2.3.1 System resilience and recovery

#733 **State:** Reviewed internally **Severity:** must **Responsibility:**

The system must include a comprehensive Disaster Recovery (DR) strategy to ensure minimal disruption and data loss in the event of a disaster (natural, technical, or cyber-related).

9.2.3.2 Recovery Time Objective (RTO)

#734 **State:** Reviewed internally **Severity:** must **Responsibility:**

The proposed solution must support an RTO (Recovery Time Objective) of no more than 4 hours, meaning the system must be restored and operational within that time frame after a disruption.

9.2.3.3 Recovery Point Objective (RPO)

#735 **State:** Reviewed internally **Severity:** must **Responsibility:**

The solution must ensure an RPO (Recovery Point Objective) of no more than 15 minutes, meaning no more than 15 minutes of data may be lost in the event of a failure.

9.2.3.4 Redundant infrastructure

#736 **State:** Reviewed internally **Severity:** must **Responsibility:**

The system must operate with geographically distributed infrastructure (e.g., across two data centers or cloud regions), ensuring service continuity even if one site is compromised.

9.2.3.5 Automatic failover

#737 **State:** Reviewed internally **Severity:** must **Responsibility:**

The solution must include automated failover mechanisms that switch operations to the backup site with minimal or no manual intervention.

9.2.3.6 Periodic DR testing

#738 **State:** Reviewed internally **Severity:** must **Responsibility:**

The vendor must conduct full DR testing at least once per year, and provide documentation and results to the client (Israel Railways) within 30 days of each test.

9.2.3.7 Data backup policy

#739 **State:** Reviewed internally **Severity:** must **Responsibility:**

Backups must be performed at least every 15 minutes, stored in encrypted format, and retained for a minimum of 30 days in a separate, secure location.

9.2.3.8 DR site accessibility

#740 **State:** Reviewed internally **Severity:** must **Responsibility:**

The DR site must be accessible to Israel Railways' authorized personnel and must comply with all regulatory and data protection requirements applicable in Israel.

9.2.3.9 Compliance and certification

#741 **State:** Reviewed internally **Severity:** must **Responsibility:**

The DR plan must align with international standards such as ISO 22301 (Business Continuity Management) or equivalent. Evidence of certification or compliance must be provided upon request.

9.2.3.10 DR documentation

#742 **State:** Reviewed internally **Severity:** must **Responsibility:**

A detailed Disaster Recovery Plan (DRP) must be delivered as part of the system documentation, including roles, responsibilities, procedures, contact lists, and escalation protocols.

9.2.4 On-Premises deployment requirements

#561 **State:** Preliminary **Severity:** **Responsibility:**

9.2.4.1 Local hosting requirement

#743 **State:** Reviewed internally **Severity:** must **Responsibility:**

The system must be deployed and operated entirely on-premises, within Israel Railways' local data centers. Deployment in public or private cloud environments is not permitted.

9.2.4.2 Infrastructure compatibility

#744 **State:** Reviewed internally **Severity:** must **Responsibility:**

The proposed solution must be fully compatible with Israel Railways' existing IT infrastructure, including server hardware, operating systems, virtualization platforms (e.g., VMware), and security protocols.

9.2.4.3 Data residency

#745 **State:** Reviewed internally **Severity:** must **Responsibility:**

All data, including backups and logs, must remain physically stored within Israel Railways' premises in Israel. No data shall be transmitted, stored, or processed outside the organization's local network

9.2.4.4 Installation and configuration

#746 **State:** Reviewed internally **Severity:** must **Responsibility:**

The vendor is responsible for the installation, configuration, and integration of the system on-site, in coordination with Israel Railways' IT department.

9.2.4.5 Security and access control

#747 **State:** Reviewed internally **Severity:** must **Responsibility:**

The solution must comply with all organizational security policies, including user access control, firewall configuration, and network segmentation as defined by Israel Railways.

9.2.4.6 No cloud dependencies

#748 **State:** Reviewed internally **Severity:** must **Responsibility:**

The system must function independently and must not rely on any external (cloud-based) services, APIs, or licensing servers for core functionalities.

9.2.5 External access via tablet devices for track possession dynamic map and management

#562 **State:** Preliminary **Severity:** **Responsibility:**

9.2.5.1 Tablet accessibility

#749 **State:** Reviewed internally **Severity:** must **Responsibility:**

The system must support secure access via modern tablet devices (iOS and Android), allowing external personnel (e.g., subcontractors, field staff) to view relevant scheduling data.

9.2.5.2 Web-based interface

#750 **State:** Reviewed internally **Severity:** must **Responsibility:**

The system shall include a responsive, browser-based interface optimized for tablet display and usability, without requiring installation of a native app.

9.2.5.3 Secure authentication

#751 **State:** Reviewed internally **Severity:** must **Responsibility:**

Access must be protected through secure authentication mechanisms, such as multi-factor authentication (MFA), SSO integration, or time-limited access tokens.

9.2.5.4 Offline mode

#752 **State:** Reviewed internally **Severity:** can **Responsibility:**

If possible, the system should offer offline viewing capabilities for certain datasets, allowing users to work in areas with limited or no internet connectivity.

9.2.5.5 Audit and monitoring

#753 **State:** Reviewed internally **Severity:** must **Responsibility:**

All access by external users must be logged and monitored for audit and compliance purposes, including timestamps, device IDs, and actions performed.

9.2.5.6 Licenss

#754 **State:** Reviewed internally **Severity:** must **Responsibility:**

The supplier shall provide system licenses as follow –

5 Administrator Licenses –

Licenses granting full administrative privileges, including system configuration, maintenance, user and permission management and overall platform administration.

35 Full/Editor –

Licenses providing full system functionality, including creation, update, editing, execution and data management

100 Basic User Licenses (for Track Possession model) – Licenses intended for user with limited permissions, allowing users to view existing information within the system and submit requests or forms only, without any capability to edit, modify or manage data.

All licenses shall remain valid for the entire duration of the contract period

The client shall have the option to expand the number of licenses in the future under the same commercial and technical terms.