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Optimised Real-time Yard and Network Management

D 4.2 Yard simulation software for WP6

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ABBREVIATIONS AND ACRONYMS

No abbreviations nor acronyms are used in this document.

1 SCOPE AND PURPOSE

This document describes main properties of adapted simulation software (the actual deliverable D4.2) that has been used to create simulation models of railway operation on two selected yards (case studies) in Česká Třebová (Czech Republic) and Trieste Campo Marzio (Italy). This software will further be utilised for the work on WP6 – Business Cases - Feasibility & Simulation Tests, as well as during further development and cooperation with optimisation module developed within the frame of WP5 – Process Optimisation.

The main purpose of the simulation software within OptiYard project is to:

- mimic the real railway operation of selected yards (laboratory yard as a replacement of the real yard),
- provide real-time information about the current status of the yard for the optimization module,
- adopt decisions taken/proposed by the optimisation module so that these are reflected in further state changes of the yard model and
- to provide means for WP6 to assess main performance parameters (KPI) of modelled yards, so that non-optimised and optimised operation and performance of the yards can be assessed.

2 SIMULATION TOOL FOR YARD SIMULATION

Simulation tool Villon (Simcon, 2012), provided by Simcon, is selected as the core of the simulation framework. This tool was utilised to create flexible simulation models of selected yards in Česká Třebová and Tieste Campo Marzio. Villon has further been adjusted and its functionality has been extended in order to support real-time data exchange with to-be-developed optimisation module. All required evaluation possibilities in order to fulfil WP6 tasks have been prepared as well.

Villon is a generic simulation tool, which allows microscopic modelling of various types of transportation logistics terminals containing railway and road infrastructures (e.g. marshalling yards, railway passenger stations, factories, train care centres, depots, airports, etc.). The simulation tool Villon is based on flexible agent-oriented simulation architecture ABAsim (detailed description of its properties can be found in (Kavička et al. 2007)), which enables trouble-free extension of its functionality as well as cooperation with other software modules (e.g. railway network module or optimization module).

Flexible definition of service technologies using customised activities and flowcharts enables creation of models of broad range of transportation logistics terminals not limited to rail transport mode only, but comprising also road and other transportation modes.

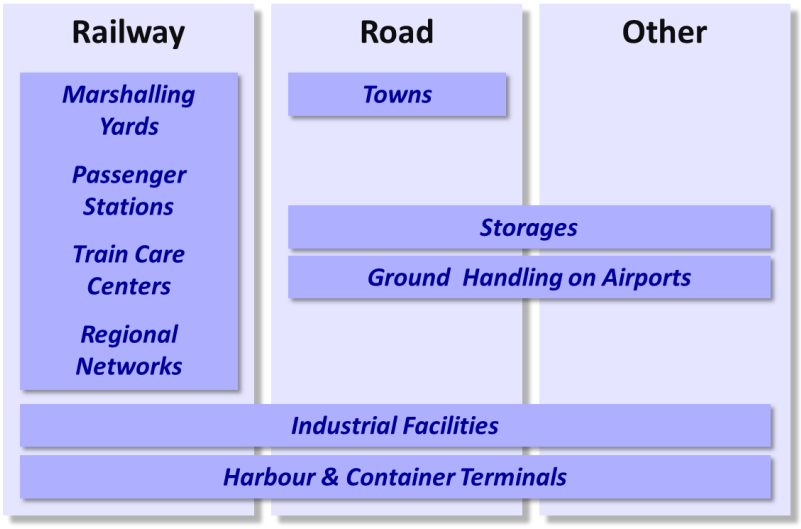


Figure 1: Application fields of simulation tool Villon

In Villon, modelled system (e.g. railway yard or container terminal) is considered a service (queueing) system, composed of three subsystems, with specific role in the system: resource subsystem, customer subsystem and control subsystem.

- **Resource subsystem** includes *Stable (fixed) resources* (set of tracks, signalling system, interlocking system) and *Mobile resources* (shunting or train locomotives and personnel). These resources are utilized during the service of systems' customers.
- **Customer subsystem** represents in the model the trains or parts of trains, which have to be served (e.g. technical inspection, shunting of a set of wagons, etc.). The arrival of customers into the terminal is modelled by input generator.
- **Control subsystem** consists of elements that model decision making activities and handling activities related to execution of defined service of each customer in the terminal. Currently, priority based algorithms are mostly employed when selecting resources that need to be assigned to a customer

(i.e. train). However, thanks to its flexible design, the simulation system is in such situations able to consult (via defined interface) possible future optimisation module and ask for an advice. This advice will then be introduced to the simulation model as a decision of the dispatcher of the yard and further development of the simulation model will dependent on it, hopefully leading to improved performance of the yard. Technological procedures of serving customers are defined by user-definable flowcharts. This enables the tool to model railway yards with varying operational procedures and thus guarantees the ability to cover OptiYard's needs in this aspect.

In order to model all functions as defined by functional specification, data defining the entities and operations of all subsystems have to be properly defined.

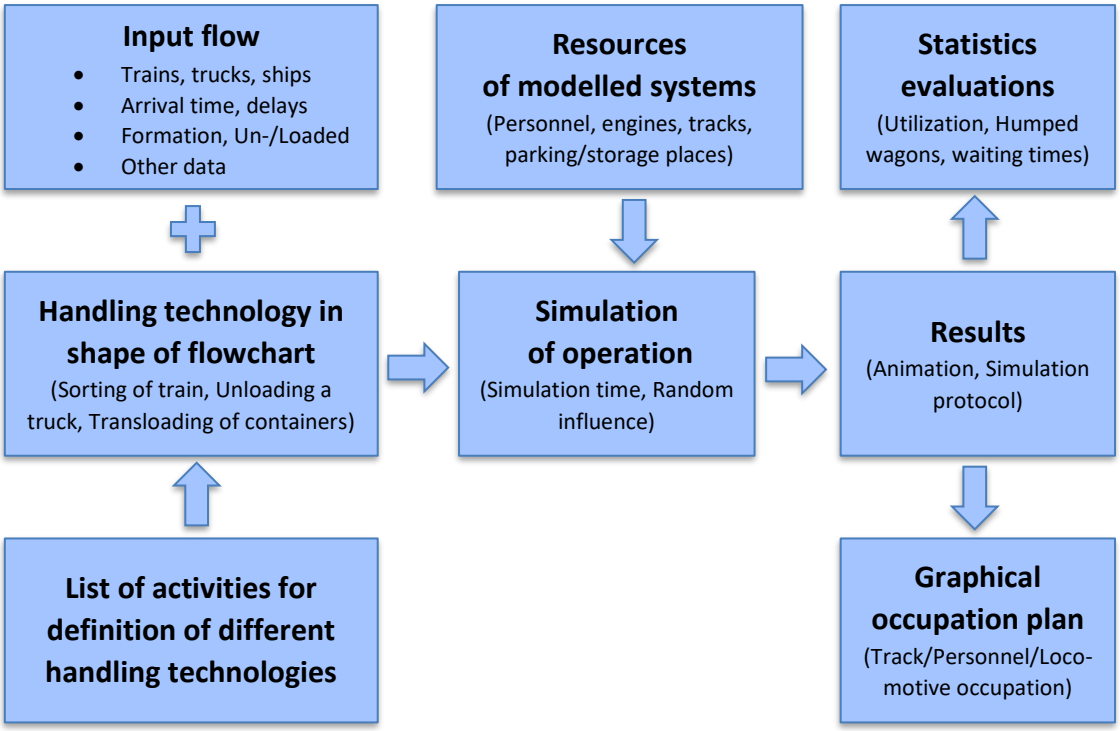


Figure 2: Main modules of simulation software Villon

The simulation software Villon meets the functional and technical specifications defined in OptiYard deliverable D3.2 [1] and it is therefore suitable for building of non-optimized yard models.

Following functionality of existing simulation tool Villon has been extended/enhanced during OptiYard project:

- Import of various input data from national information systems (for example: wagon list)
- Export of yard model data for optimization module in XML file format

The simulation environment in Villon is illustrated in Figure 3.

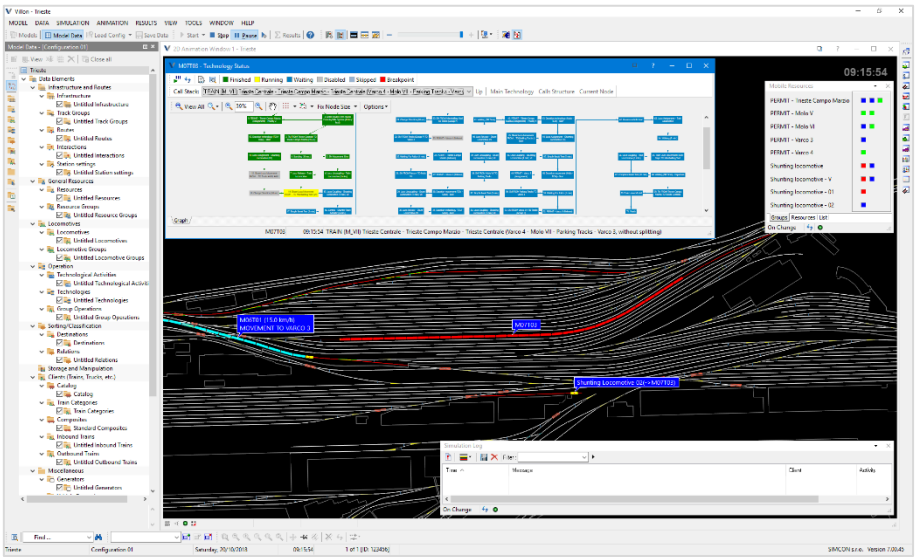


Figure 3: Yard model in simulation tool Villon

2.1 BUILDING A YARD SIMULATION MODEL

Depending on the type of yard model, specific data for model building are required. However, both simulation models share important data categories that needs to be defined, reflecting respective parts, processes and entities of the yard/terminal, namely:

- Track layout/Infrastructure model
- Working personnel
- Mobile technical resources
- Yard processes
- Train handling/sorting/forming schemes
- Input train flow

2.1.1 Creating the infrastructure model

The yard infrastructure model is usually based on data imported from in-scale CAD-drawings. The utilization of other railway specific standard formats describing the infrastructure is also possible.

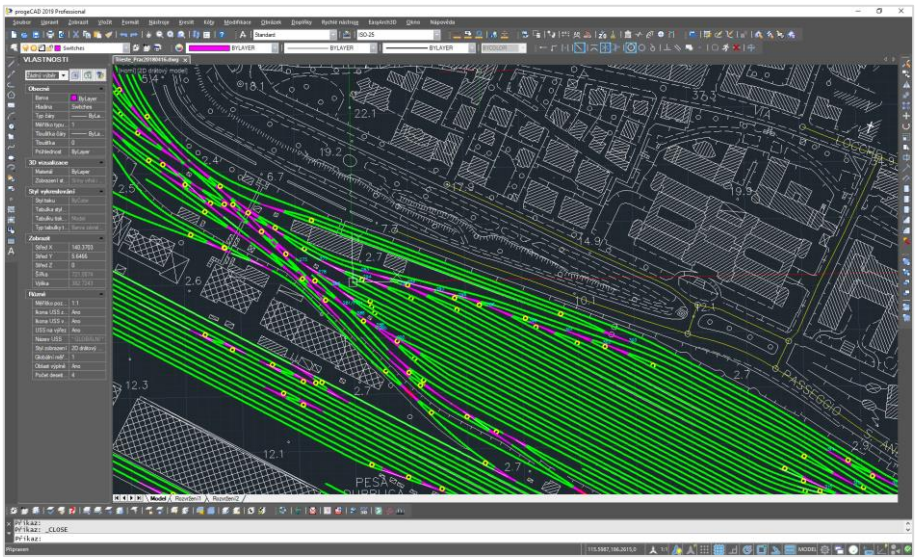


Figure 4: Example of CAD-drawing ready for infrastructure import

To add missing infrastructure data (e.g.signals) or to make simple modifications to modelled infrastructure a build-in infrastructure editor is at hand.

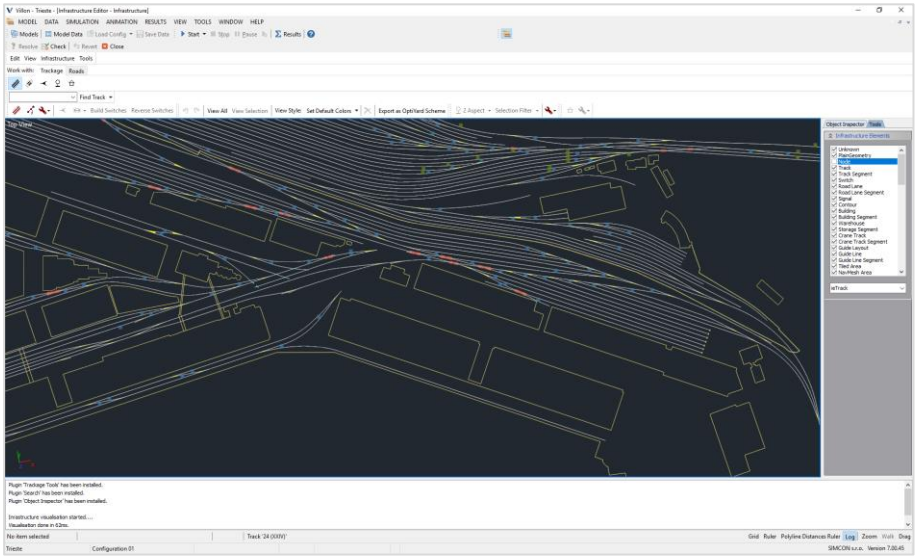


Figure 5: Post-processing of infrastructure data in Villon

Besides the data defining the physical shape of the infrastructure, the logical level of infrastructure has to be prepared. The logical level distinguishes specialized track groups in the reception sidings, hump zone and retarders, sorting sidings, auxiliary hump zone, departure sidings, storage tracks for empty wagons etc. This is utilized to define the subsets of tracks that are available for assignment, for example only few tracks can be used as reception tracks for incoming trains.

2.1.2 Definition of workers (personnel)

In simulation tool Villon the working personnel belonging to yard is understood as mobile resources – resources, which are changing their location in time. The focus is put on employees servicing the trains and shunting units outside in the trackage, e.g. the action is clearly bound to a certain train or shunting unit

standing on a track or moving through the yard. The personnel is specialized in different professions (similar to other resource types, the profession is defined by assignment to groups) – each profession represents an ability of a resource to execute defined task (full/simple break test, train loco uncoupling, etc.). The schedule, representing the availability for work, can be set as well.

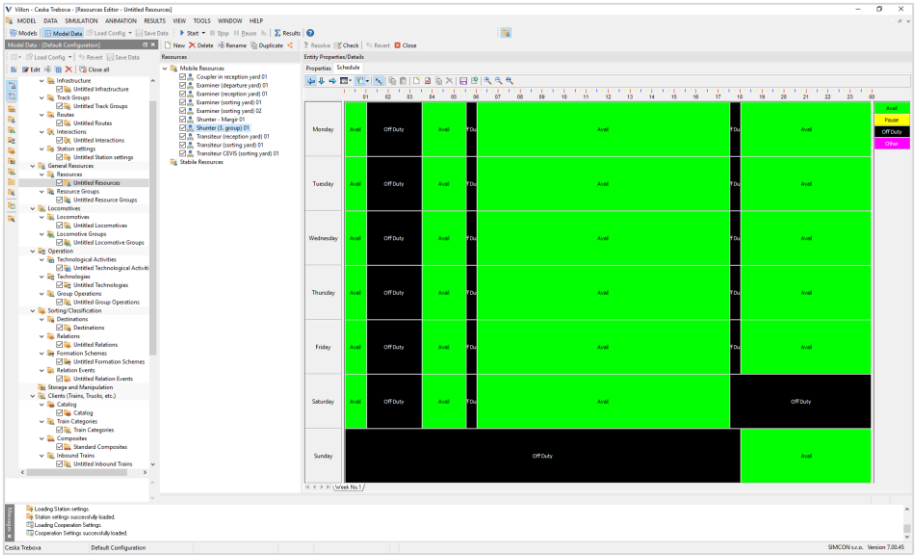


Figure 6: Editor for working personnel

2.1.3 Defining mobile technical resources

In railway yard or container terminal, shunting locomotives represent typical mobile technical resource. The main role of the shunting locomotives is to transfer sets of wagons in yard between track groups.

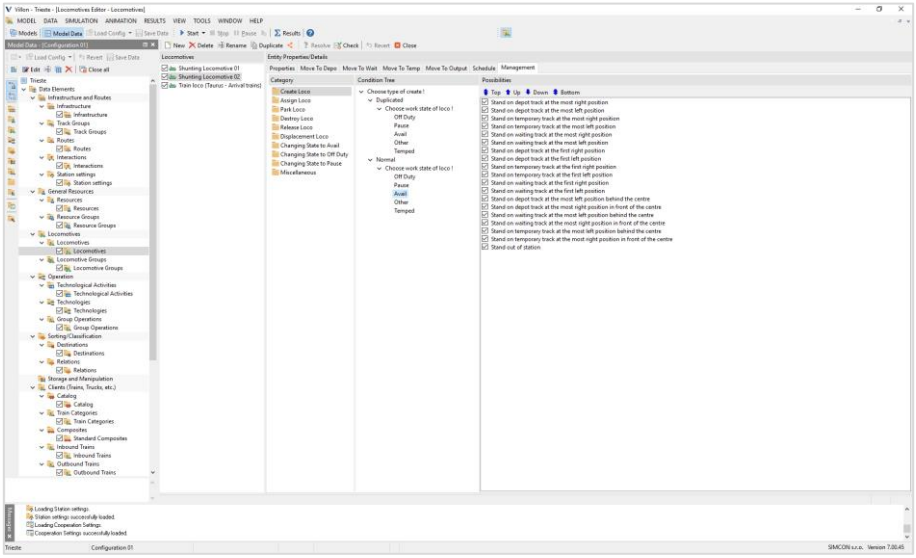


Figure 7: Editor for locomotives used in modelled yard

Usually, following types of locomotives (distinguished by the role in railway yard or container terminal) are modelled in Villon:

- Hump locomotive – responsible for sorting of incoming trains over the hump

- Formation locomotive – responsible for formation of new outgoing trains in classification yard
- Pushing locomotive – responsible for wagon compression on sorting track after humping or before train formation
- Shunting locomotive – executing shunting operations in entire yard

In case of modelling train locomotives, the approach is different. This mainly because these locomotives do not belong to the resources of railway yard or container terminal. The train locomotives are resources of railway network, which has to properly manage them over whole railway network. From the point of view of yard or container terminal, the train locomotive is considered as a customer that is to be served (uncoupling, coupling, transfer to/from locomotive shed or directly to another train).

Modelling of other mobile technical resources within container terminals, like cranes, reach-stackers or forklift is possible as well.

2.1.4 Defining of yard processes

The simulation software Villon contains set of predefined template activities, which cover whole spectrum of actions found in operation of transportation terminals. Each activity has distinct set of parameters and resources that are required for its execution.

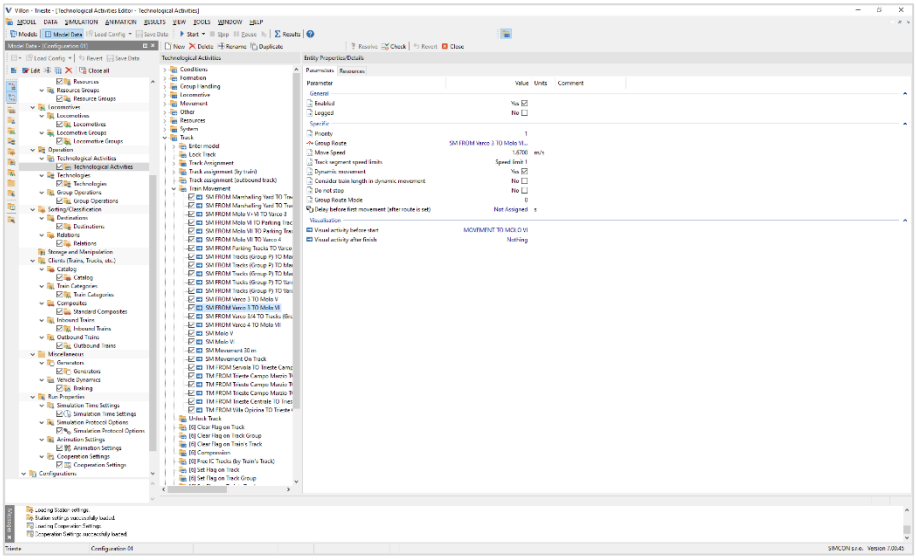


Figure 8: Activity editor in Villon

Customized activities for creation of handling technologies with duration parameters and planned resources employment are prepared in an Activities editor. For example, different types of technical inspections can be prepared (with one worker, with two workers, with fixed duration, with duration depending on train length). Parametrisation of activity “Loco coupling” on Figure 8 shows that duration of this activity is fixed – 180 sec. To complete this activity, one shunter and one locomotive have to be present by the train.

2.1.5 Definition of train handling/sorting/forming schemes

Handling technologies are composed of prepared customised activities and are defined in specialised graphical editor. They define (in the form of flowcharts) the succession and mutual dependences of activities.

Each customer in the system (trains/trucks/ships/etc.) gets a technology assigned and executed. The handling technology can be prepared for a group of customers (the execution will however differ according to actual customer and parameters defined) or just single customer. In order to modify the service of a customer (train), user can modify parameters or resources of activities, change mutual dependency of activities (change the flowchart shape) or even exchange whole technology at once (simply by assigning another technology from the list of defined technologies to the customer).

The variety of handling technologies depends on infrastructure layouts, level of details, scope of the model, and so on. Some samples of train handling technologies (flowcharts) from created models are presented in Annex B.

Described formalization of train handling in simulation tool Villon provides high flexibility at implementation phase and enables its application not only to marshalling yards and terminals, but also to other types of yards.

The modelling functionality of sorting process over a hump is available in simulation tool Villon. This feature can be used in a marshalling yard for both, primary and secondary sorting. The wagon sorting in simulation tool respects predefined sorting scheme, which could be changed in time or based on an event (initialization of outgoing train for example). It is expected that the coexisting optimization module will also initiate a sorting scheme change as part of decision-making process.

The formation of outbound group trains is another feature required during modelling of yard operation. Villon offers building of the outbound group trains from wagon groups, accumulated in distinct sorting tracks according to specified order. The utilization of personnel and shunting locomotives is part of this process. The same feature will be used in case, when the trains have to be split in shorter wagon groups for delivery to short tracks within a terminal or harbour and when these wagon groups have to be coupled again together later.

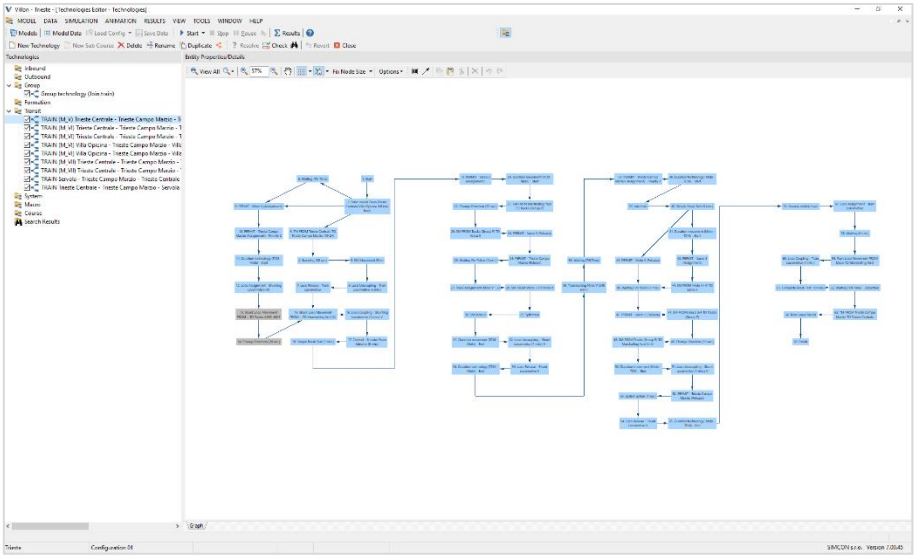


Figure 9: Editor for defining the handling technology for customer in Villon

2.1.6 Defining the input flow

The input flow represents all incoming trains (customers) into the yard. Two basic types of incoming trains are considered: incoming train with sorting and transit trains (part of train will be uncoupled and sorted, rest

of the train leaves the marshalling yard). The movements of all pieces of rolling stock (with the exception of cuts on the hump) exploit real driving dynamics.

All required data have to be defined in input flow editor. Depending on the quality of source data an import of such data is possible too.

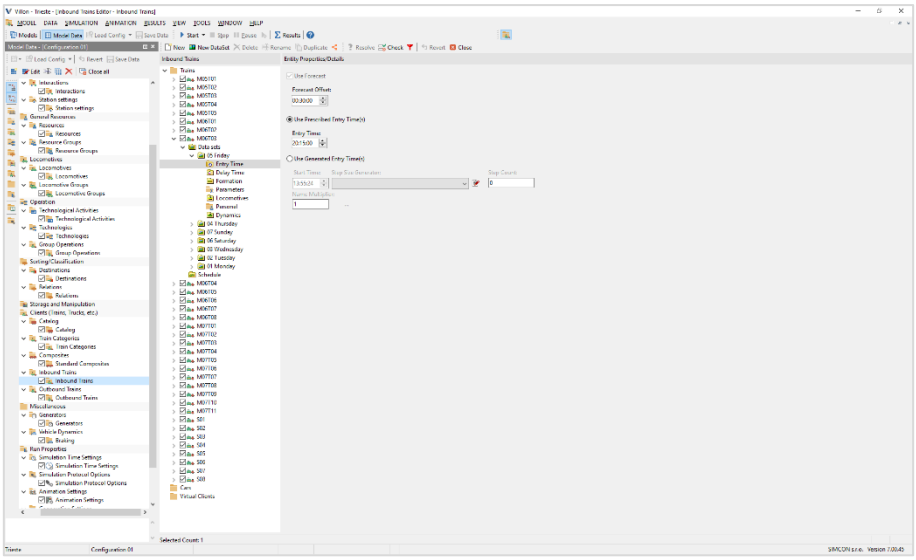


Figure 10: Editor for input flow in Villon

2.2 SIMULATION OF OPERATION

The simulation environment in Villon supports standard controls of simulation run execution, i.e. Start, Stop, Pause, furthermore the selection of simulation speed is possible. The presentation of simulation run execution is using on-line animation and visualisation to allow the validation and evaluation process of simulation runs.

Following detailed presentation of status of simulation model is available:

- Status of all model components/elements (infrastructure, vehicles, resources, etc.)
- Animated output of modelled activities in 2D or 3D presentation
- Execution status of serving procedures
- Simulation log

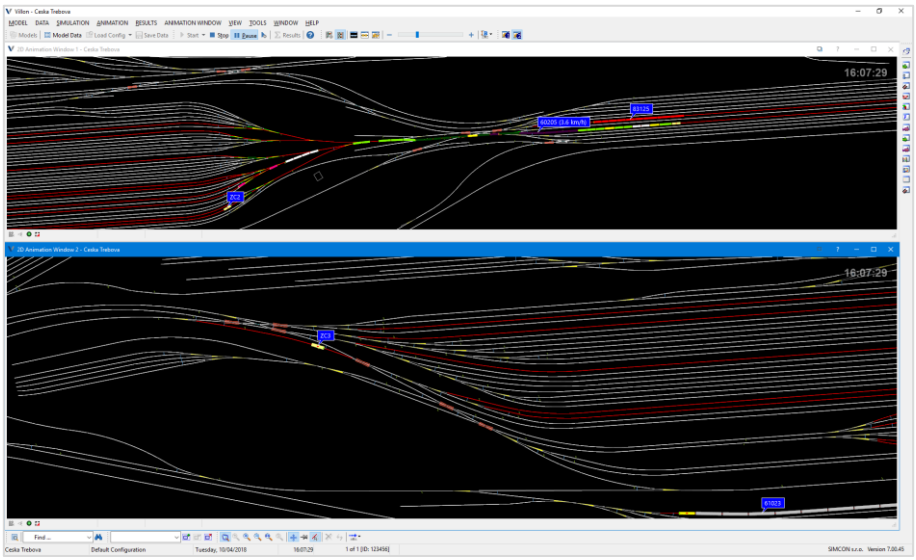


Figure 11: Animation of modelled processes during simulation

2.3 POST-SIMULATION EVALUATIONS

After the simulation run, extensive set of post simulation evaluations is at hand – these are based on detailed simulation protocol recorded during simulation run. Besides graphical presentation of simulation results using time dependent reports on utilization of resources, waiting times, etc.; statistical evaluations are also provided – in the form of tables, graphs and charts (including resource utilisation statistics and many others). Villon also offers the chance to export all collected information to the XLS/CSV/JPG/PNG file for further processing using spreadsheet, text or graphical editor.

At the present, the set of available evaluations is considered to be sufficient to support the work in WP6 of OptiYard project. In case that the works on WP6 will require some additional evaluations that are currently not present in the software, the software can be enhanced in reasonable time by Simcon, to support timely finishing of WP6 tasks.

Post-simulation evaluations are accessible via Results centre. In order to obtain the evaluations, detailed protocol (trace) must be recorded during simulation run. Comparison of two or more recorded simulation protocols is also available.

Desired evaluation can be reached through following steps:

1. Selection of one or more simulation protocols
2. Selection of specific evaluation and its scope
    a) Selection from saved evaluations or
    b) Selection of specific evaluation + selection of entities for evaluation
3. Selection of presentation form (alphanumerical statistics, graphs, time-dependent diagram s, colour-coded infrastructure layout)
4. Selection of evaluation time range

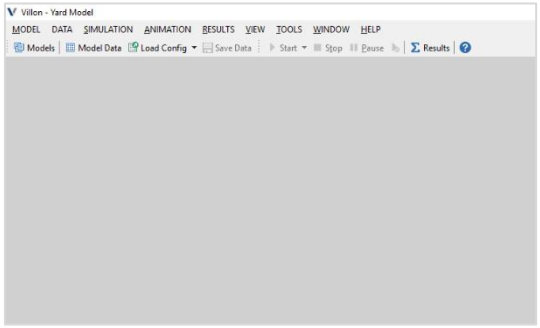


Figure 12: Villon software

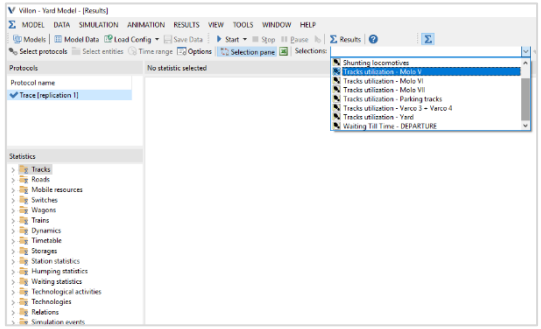


Figure 13: Saved evaluations

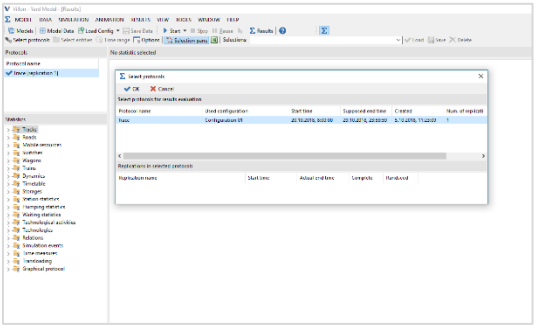


Figure 14: Selection of simulation protocol

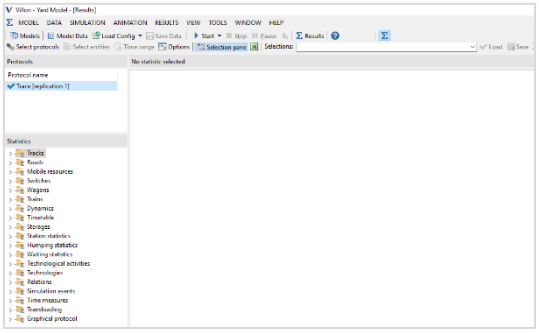


Figure 15: Scope of evaluation

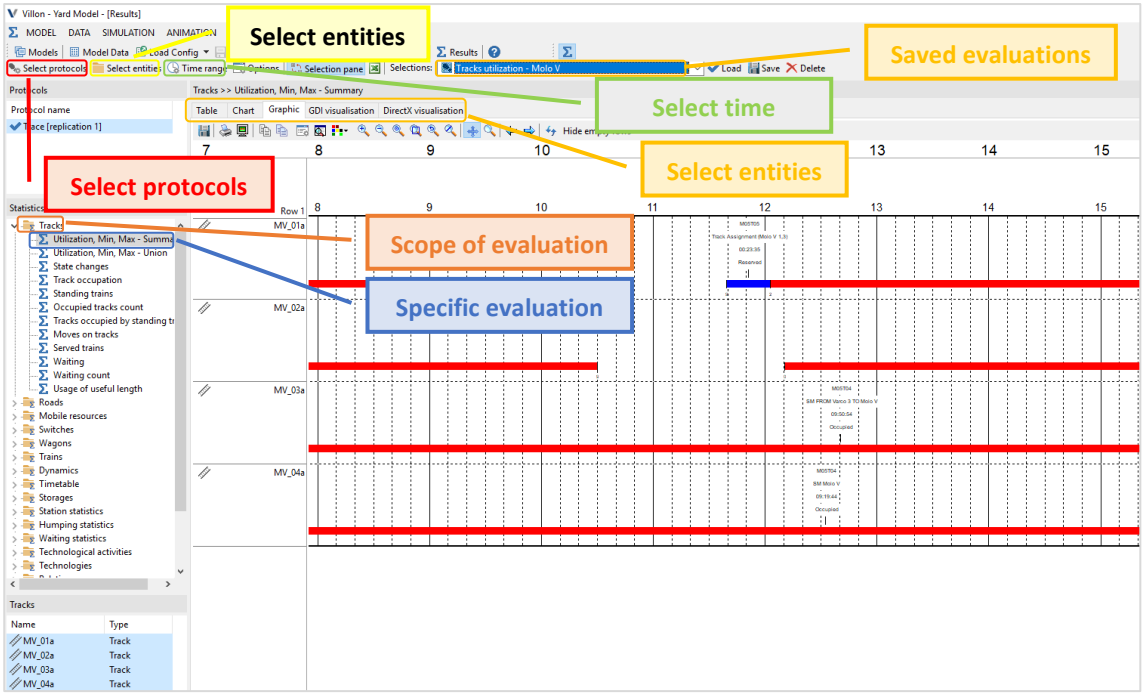
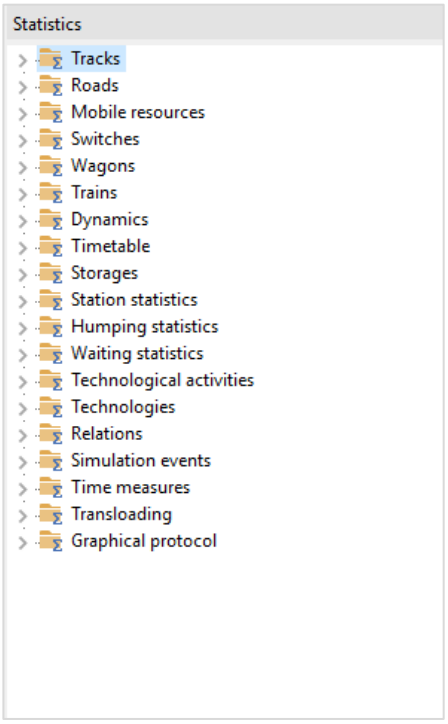


Figure 16: Example of track occupation

The evaluation possibilities in Villon are organized into logical groups:

- Tracks
- Roads
- Mobile resources
- Switches
- Wagons
- Trains
- Dynamics
- Timetable
- Storages
- Station statistics
- Humping statistics
- Waiting statistics
- Technological activities
- Technologies
- Relations
- Simulation events
- Time measures
- Transloading
- and Graphical protocol



Depending on model type, not all evaluations are available. For example, a simulation without model component "Road Transportation" does not provide the evaluation "Utilization of road infrastructure".

A brief explanation of each specific evaluation that was prepared and is available for the work on WP6 tasks is given in Annex C.

2.4 EXPORT OF DATA FROM SIMULATION TOOL FOR OPTIMIZATION MODULE

In order to support tasks of WP5 – Process Optimisation, the simulation software Villon has been enhanced to provide export of data to XML formats, as specified during works on WP5. The detailed description of data scheme and formats will be part of future deliverables, so they are not presented here.

3 CONCLUSIONS

This deliverable 4.2 from WP4 describes the enhanced and adapted simulation tool, which meets the functional and technical specification defined in OptiYard deliverable D3.2 [1] and was used for building the non-optimized simulation models of yards Česká Třebová (Czech Republic) and Trieste Campo Marzio (Italy). It will be be used in the subsequent OptiYard activities of WP5 "process optimisation" and WP6 "business cases, feasibility and simulation tests".

The simulation software itself is the main part of this deliverable. The possible ways to obtain the software including models of both case study yards are stated in Annex A.

4 REFERENCES

[1] Licciardello R. et al. "OptiYard Deliverable D3.1 - Definition of suitable simulation environment for real-time yard and network management in OptiYard", 31/01/2018.

[2] Liu R. et al., "OptiYard Deliverable D3.2 Functional and Technical Specification for the OptiYard Simulation Environment", 26/06/2018.

[3] Licciardello R. et al., "OptiYard Deliverable D4.1 Yard and network simulation model ", 26/06/2018.

[4] Kavička, A., Klima, V., Adamko, N., 2007: Simulations of Transportation Logistic Systems utilizing Agent-Based Architecture. International Journal of Simulation Modelling 6 (1): 13-24

[5] Simcon. 2018. Villon simulation tool. Simcon. Accessible on internet: < http://www.simcon.sk/en/tools/villon>

Annex A **VILLON SIMULATION SOFTWARE**

Developed simulation models of Trieste Campo Marzio and Česká Třebová yards are provided as a downloadable setup file that can be accessed on following address:
http://www.simcon.sk/downloads/OptiYard/VillonOptiYard20181129_Setup.exe

This software and accompanying models represent the main part of the deliverable D4.2 of OptiYard project WP4.

Annex B **EXAMPLES OF HANDLING PROCESSES IN THE YARDS**

Examples of trains handling in marshalling and harbour yard

- *Example of handling for inbound trains in marshalling yard*
- *Example of handling for outbound trains in marshalling yard*
- *Example of handling for freight trains in harbour yard*
- *Example of handling for transit freight trains in harbour yard*

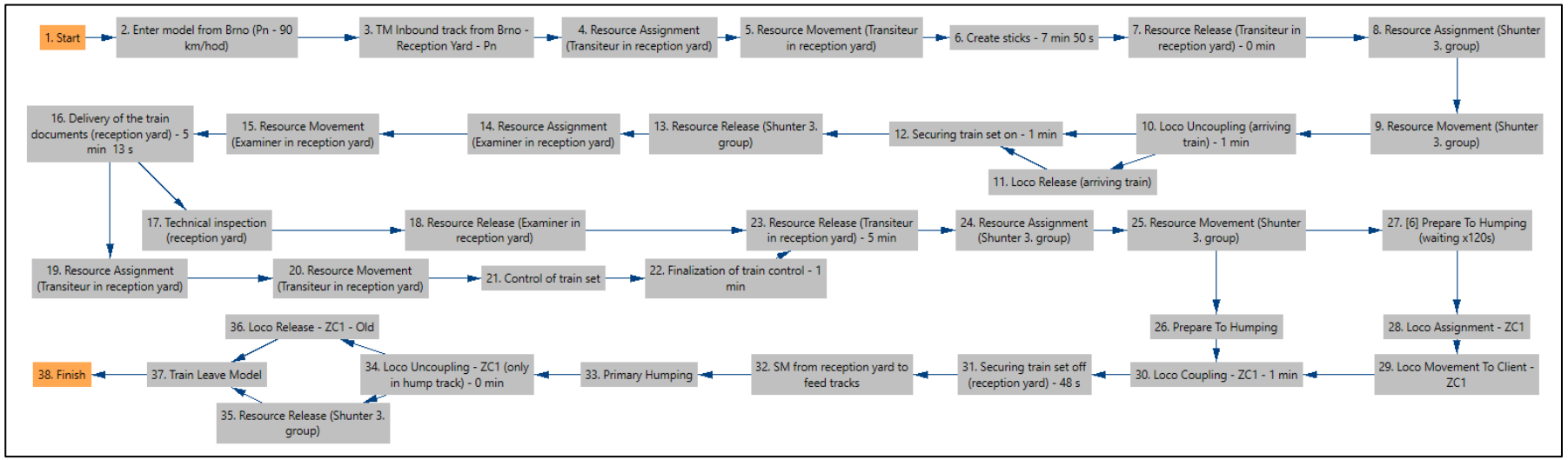


Figure 17: Example of handling for inbound trains in marshalling yard

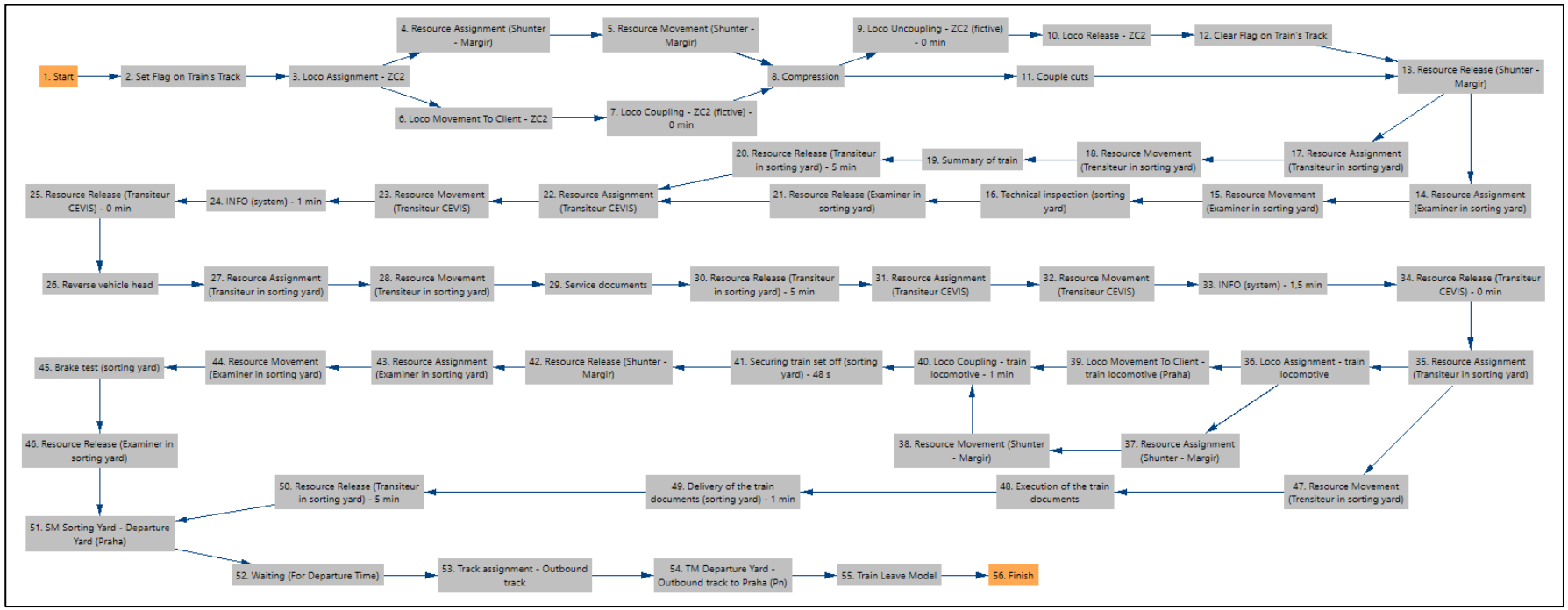


Figure 18: Example of handling for outbound trains in marshalling yard

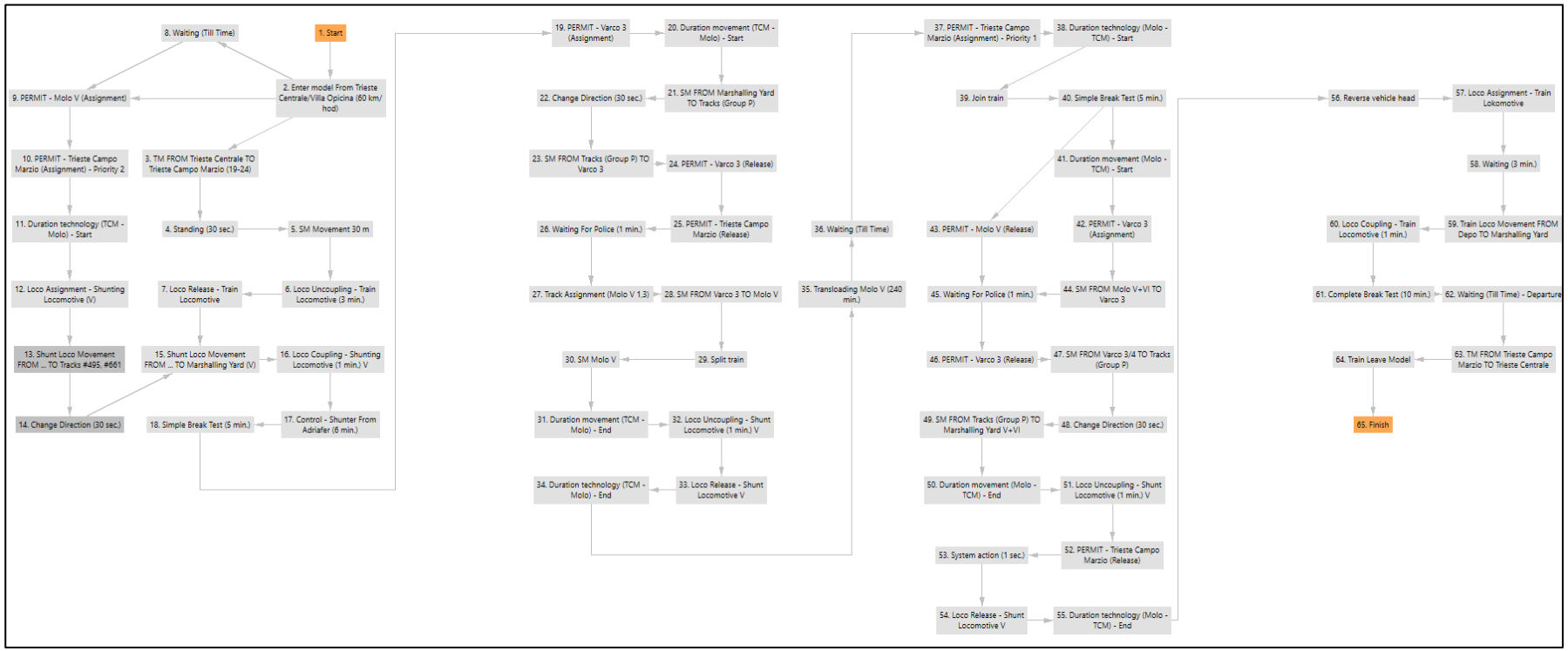


Figure 19: Example of handling for freight trains in harbour yard

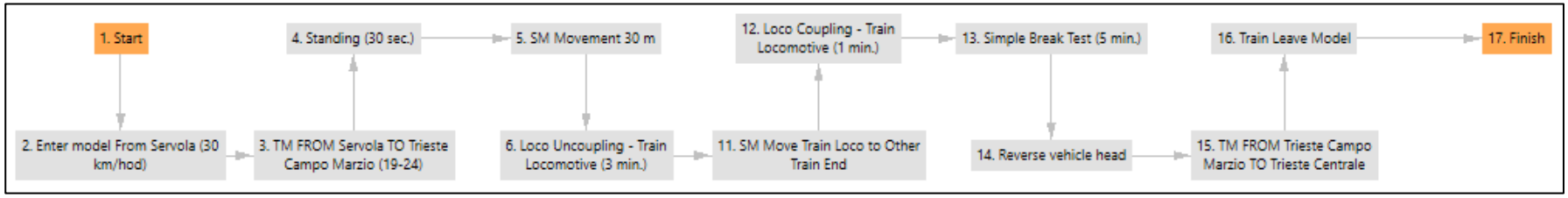


Figure 20: Example of handling for transit freight trains in harbour yard

Annex C BRIEF EXPLANATION OF AVAILABLE EVALUATIONS

C.1. EVALUATION - TRACKS

Following evaluations for tracks are available:

1. Utilization - state „occupied“
2. Utilization - state „occupied“ + „reserved“
3. Number of state changes
4. List of track occupations
5. List of standing trains per track
6. Count of occupied tracks + Percentage of occupied useful track length
7. Count of tracks occupied by standing tracks + Percentage of useful track length occupied by standing trains
8. Moves on tracks
9. List of served trains – standing trains + drive-through trains
10. Waiting times for track (track reservation or route setting)
11. Count of trains waiting for a track
12. Usage of useful length per track (train length versus useful track length)

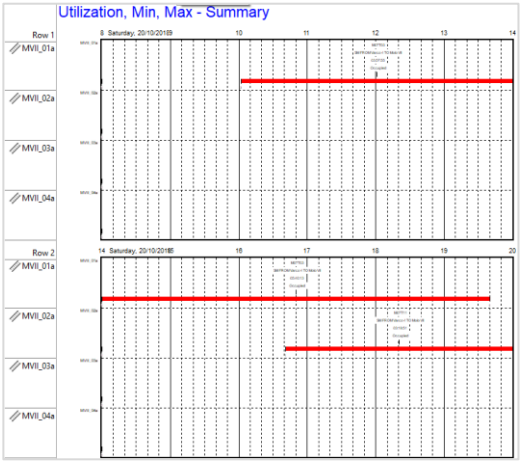


Figure 22: Track occupation. – time-dep. diagram

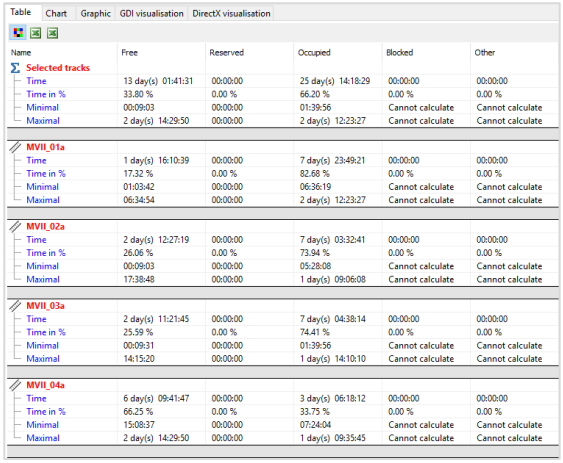


Figure 21: Track occupation – table form

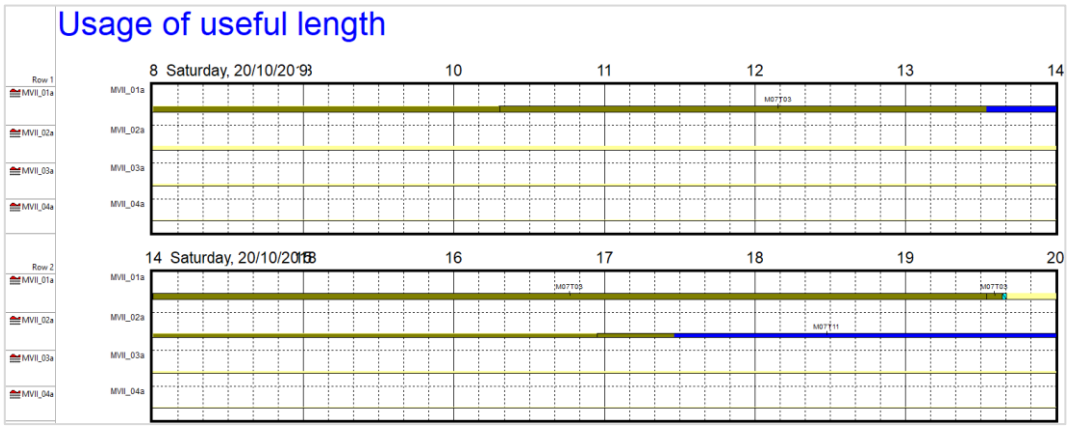


Figure 23: Track occupation – usage of useful track length

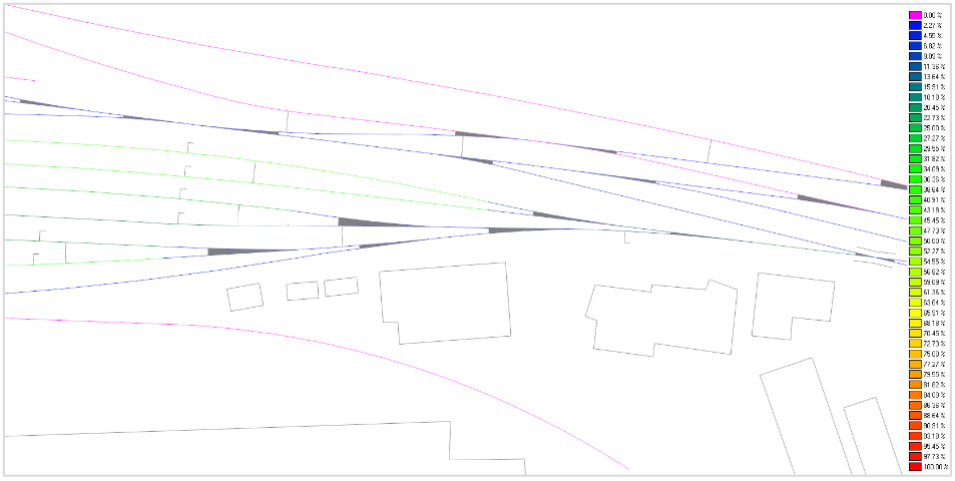


Figure 24: Utilization of track – presented on colour coded infrastructure layout

C.2. EVALUATION – MOBILE RESOURCES

Following evaluations for mobile resources are available:

1. Utilization - different states (moving, delay, work, etc.)
2. Travelled distance of mobile resources during their duty (useful for locomotives or other ve hicles)
3. Number of mobile resources in specific state (number of persons in “work” state)
4. List of served trains by selected mobile resource
5. Infrastructure occupation by selected mobile resource (for locomotives)
6. Waiting times for mobile resource
7. Count of trains waiting for mobile resource
8. Personnel available at specific location - modelled area was divided in more locations

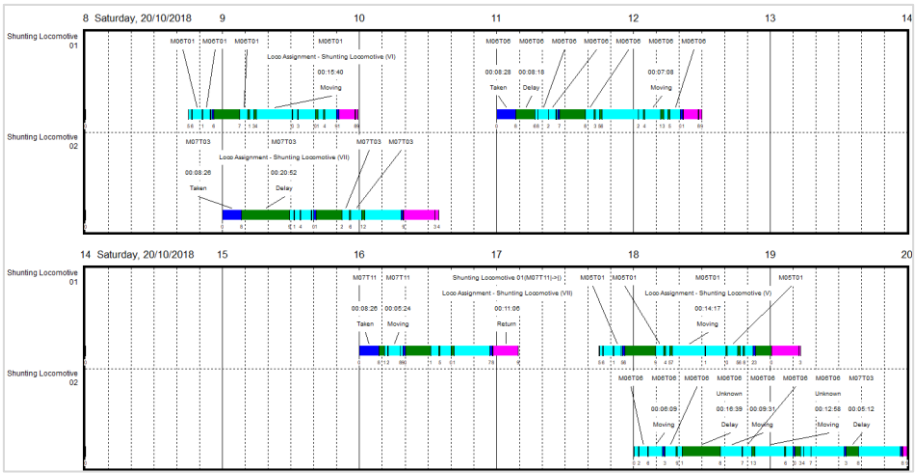


Figure 25: Work of two shunting locomotives (states: avail, assigned, moving, work, delay, release)

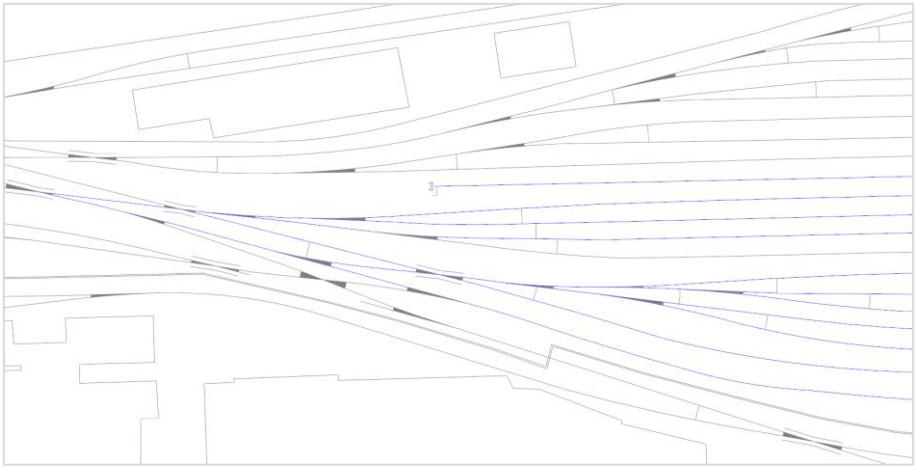


Figure 26: Infrastructure occupation by shunting locomotive

C.3. EVALUATION – SWITCHES

Following evaluations for switches/points are available:

1. Occupation time of selected switches
2. Count of switch occupations and settings to other position
3. Times, at which the switches were set to other position

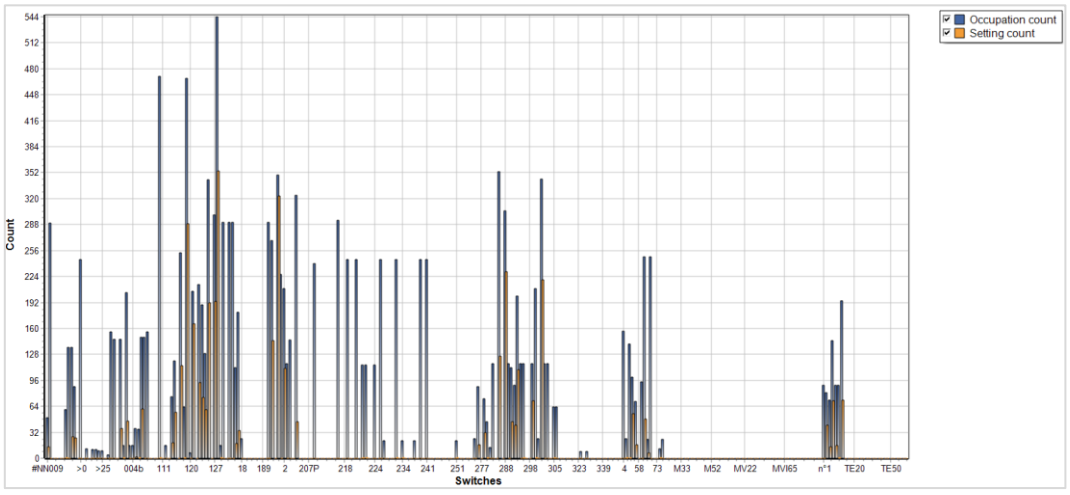


Figure 27: Count of switch occupation and settings to other position

C.4. EVALUATION – WAGONS

Following evaluations for wagons are available:

1. Trace wagon – list of occupied tracks on timeline
2. Time spent in station (from model entry till model exit)
3. Time spent in specific track group (e.g. reception sidings)
4. Activities executed on selected wagon
5. Change of wagon weight – evaluation of loading and unloading procedures
6. Infrastructure occupation by selected wagon – presented on infrastructure layout

C.5. EVALUATION – TRAINS

Following evaluations for trains are available:

1. List of inbound trains that have entered the model
2. List of inbound trains that have entered the model including the wagon list
3. Time difference between supposed and real end of inbound train service
4. List of outbound trains that have left the model
5. List of outbound trains that have left the model including the wagon list
6. Time difference between supposed and real end of outbound train service
7. Travelled distance of train
8. Count of moving trains at same time
9. Train trace – list of occupied tracks on timeline
10. Infrastructure occupation by selected train – presented on infrastructure layout
11. Infrastructure occupation by selected train complemented by movement activity
12. Graphical timetable for selected network part

C.6. VALUATION – DYNAMICS

Following evaluations for train dynamics are available:

1. Plot of train movement dynamics – travelled distance/speed
2. Plot of train movement dynamics – time/speed

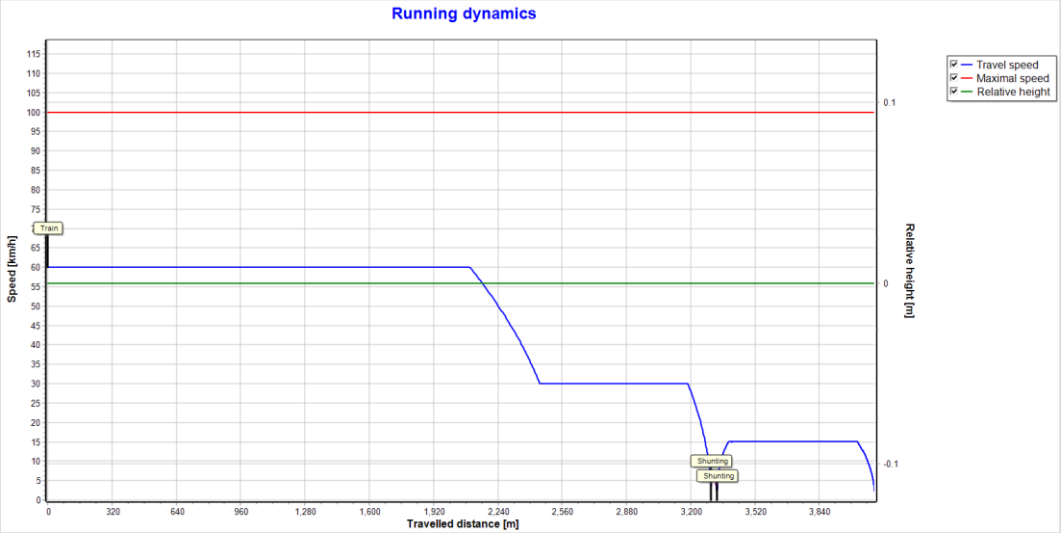


Figure 28: train movement dynamics – travelled distance/speed diagram

C.7. EVALUATION – TIMETABLE

Following evaluations for timetable are available:

1. Train delays related to selected tracks
2. Development of train delays over selected network part – tendency (increasing/decreasing)
3. Train delays related to selected group of tracks

C.8. EVALUATION – STATION STATISTICS

Following evaluations for station are available:

1. List of train arrival/departures on selected tracks
2. List of train arrival/departures on selected group of tracks
3. Number of trains that entered/left the simulation model
4. Number of wagons that entered/left the simulation model

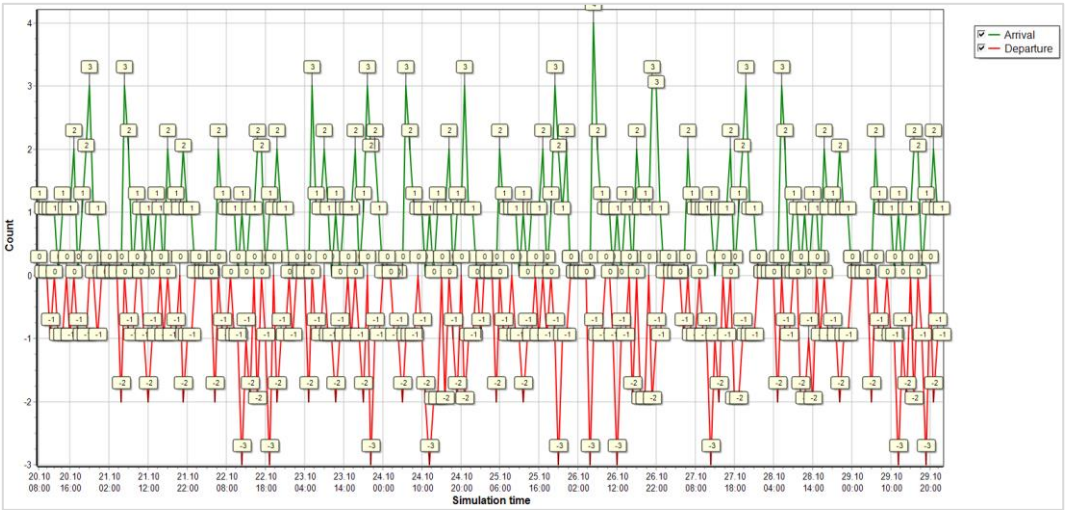


Figure 29: Number of trains that entered/left the model in specific time intervals

C.9. EVALUATION – SORTING STATISTICS

Following evaluations for sorting in marshalling yard are available:

1. Wagon count sorted over the hump or during the flat humping in marshalling yard
2. Train count sorted over hump or during the flat humping in marshalling yard
3. List of wagons sorted over hump or during the flat humping in marshalling yard

C.10. EVALUATION – WAITING STATISTICS

Following evaluations of waiting times are available:

1. Waiting times for tracks (reason: unable to reserve track or set a route to destination track)
2. Waiting times for mobile resources (reason-unable to reserve personnel/locomotive)

Summary statistic	Value						
Total time	1 day(s) 21:37:57						
Total count of waitings	120						
Average time	00:22:48						
Minimal	00:00:01						
Maximal	01:16:16						
Client	Group	Resource	Reason	From	To	Duration	Location
M07T03	Shunting locomotive	Shunting Locomotive 02	No Resource Available	20/10/2018 19:00:00	20/10/2018 19:10:53	00:10:53	
M05T02	Shunting locomotive	Shunting Locomotive 02	No Resource Available	20/10/2018 21:45:00	20/10/2018 21:50:51	00:05:51	
M07T01	Shunting locomotive	Shunting Locomotive 01	No Resource Available	20/10/2018 22:45:00	20/10/2018 23:00:55	00:15:55	
M07T11	Shunting locomotive	Shunting Locomotive 02	No Resource Available	20/10/2018 23:00:00	20/10/2018 23:06:00	00:06:00	
M05T04	Shunting locomotive	Shunting Locomotive 01	No Resource Available	21/10/2018 06:45:00	21/10/2018 06:59:31	00:14:31	
M05T03	Shunting locomotive	Shunting Locomotive 01	No Resource Available	21/10/2018 10:00:00	21/10/2018 10:12:24	00:12:24	
M05T02	Shunting locomotive	Shunting Locomotive 02	No Resource Available	21/10/2018 21:45:00	21/10/2018 22:06:39	00:21:39	
M07T08	Shunting locomotive	Shunting Locomotive 01	No Resource Available	22/10/2018 08:00:00	22/10/2018 08:00:04	00:00:04	
M06T08	Shunting locomotive	Shunting Locomotive 01	No Resource Available	22/10/2018 09:00:00	22/10/2018 09:01:44	00:01:44	
M05T03	Shunting locomotive	Shunting Locomotive 02	No Resource Available	22/10/2018 10:00:00	22/10/2018 10:00:26	00:00:26	
M07T02	Shunting locomotive	Shunting Locomotive 01	No Resource Available	22/10/2018 12:00:00	22/10/2018 12:28:04	00:28:04	
M06T06	Shunting locomotive	Shunting Locomotive 01	No Resource Available	22/10/2018 16:45:00	22/10/2018 17:11:48	00:26:48	
M05T04	Shunting locomotive	Shunting Locomotive 02	No Resource Available	22/10/2018 17:00:00	22/10/2018 17:13:30	00:13:30	
M06T01	Shunting locomotive	Shunting Locomotive 01	No Resource Available	22/10/2018 18:10:00	22/10/2018 18:11:50	00:01:50	

Figure 30: List of waiting times for shunting locomotives

C.11. EVALUATION – TECHNOLOGICAL ACTIVITIES

Following evaluations of technological activities are available:

1. List of all executions for selected activity

Activity / Train	Start	End	Duration	Last train	Technology	Technology Start	Techn. node ID
Simple Break Test (5 min.)							
M06T01	20.10.2018, 9:02:14	20.10.2018, 9:07:14	00:05:00	M06T01		20/10/2018 08:00:00	58
M07T03	20.10.2018, 9:47:01	20.10.2018, 9:52:01	00:05:00	M07T03		20/10/2018 09:00:00	58
S02	20.10.2018, 11:17:37	20.10.2018, 11:22:37	00:05:00	S02		20/10/2018 10:55:00	279
M06T06	20.10.2018, 11:33:44	20.10.2018, 11:38:44	00:05:00	M06T06		20/10/2018 11:00:00	58
S03	20.10.2018, 12:51:36	20.10.2018, 12:56:36	00:05:00	S03		20/10/2018 12:30:00	279
S05	20.10.2018, 14:31:36	20.10.2018, 14:36:36	00:05:00	S05		20/10/2018 14:10:00	279
S04	20.10.2018, 16:17:12	20.10.2018, 16:22:12	00:05:00	S04		20/10/2018 15:55:00	279
M07T11	20.10.2018, 16:26:05	20.10.2018, 16:31:05	00:05:00	M07T11		20/10/2018 16:00:00	58
M05T01	20.10.2018, 18:02:14	20.10.2018, 18:07:14	00:05:00	M05T01		20/10/2018 17:00:00	58
S06	20.10.2018, 18:16:57	20.10.2018, 18:21:57	00:05:00	S06		20/10/2018 17:55:00	279
M06T06	20.10.2018, 18:22:24	20.10.2018, 18:27:24	00:05:00	M06T06		20/10/2018 11:00:00	49
M07T03	20.10.2018, 19:33:16	20.10.2018, 19:38:16	00:05:00	M07T03		20/10/2018 09:00:00	147
S07	20.10.2018, 19:35:15	20.10.2018, 19:40:15	00:05:00	S07		20/10/2018 19:10:00	279
M06T03	20.10.2018, 20:30:37	20.10.2018, 20:35:37	00:05:00	M06T03		20/10/2018 20:05:00	58
M07T05	20.10.2018, 21:15:24	20.10.2018, 21:20:24	00:05:00	M07T05		20/10/2018 20:00:00	58
M07T08	20.10.2018, 22:00:16	20.10.2018, 22:05:16	00:05:00	M07T08		20/10/2018 21:10:00	58
M05T02	20.10.2018, 22:17:19	20.10.2018, 22:22:19	00:05:00	M05T02		20/10/2018 21:20:00	58
M07T01	20.10.2018, 23:18:52	20.10.2018, 23:23:52	00:05:00	M07T01		20/10/2018 21:00:00	58
S08	20.10.2018, 23:24:50	20.10.2018, 23:29:50	00:05:00	S08		20/10/2018 22:55:00	279

Figure 31: Activity "Simple Break Test" – list of all executions

C.12. EVALUATION – TECHNOLOGIES

Following evaluations of handling technologies are available:

1. Train handling grouped by technology
2. Train handling grouped by train and time

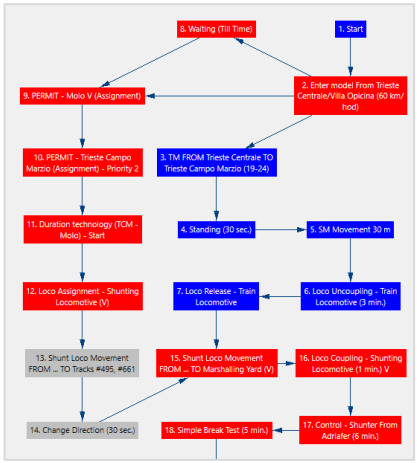


Figure 32: Executed technology–flowchart

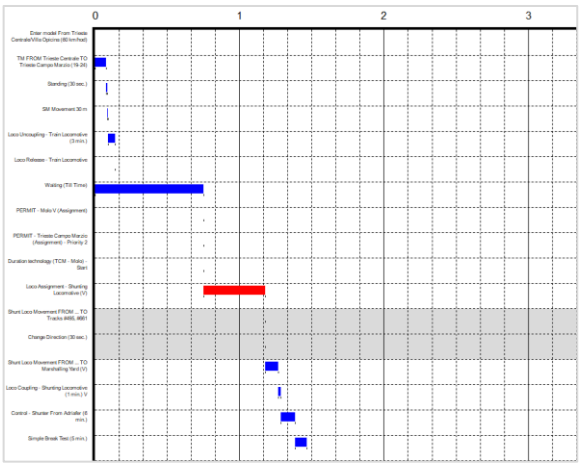


Figure 33: Executed technology–activities on timeline

C.13. EVALUATION – RELATIONS

Following evaluations of relations in marshalling yards are available:

1. Assignment of relations (set of wagon destinations for outbound trains) to tracks in sorting sidings of marshalling yard

C.14. EVALUATION – SIMULATION EVENTS

Following evaluations of simulation events are available:
List of important events during simulation run (start of movement, train delay, unable to assign personnel to train, etc.)

C.15. EVALUATION – TIME MEASURES

Following evaluations of time measures are available:

1. Average/Min/Max time between two time measures points set in technology
2. Detailed list of time intervals between two time measures points set in technology

C.16. EVALUATION – GRAPHICAL PROTOCOL

Additionally, a custom mix of evaluations that are presented in one graphical time-dependent diagram is available.