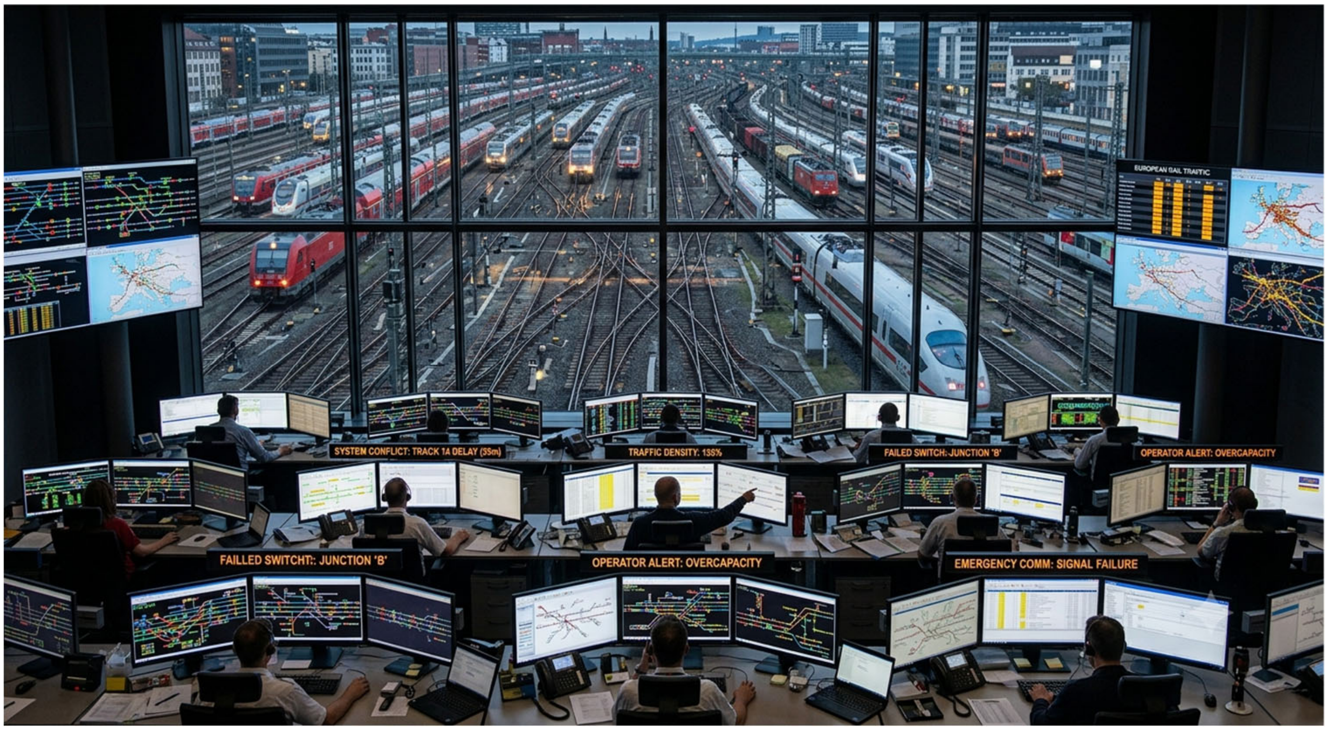

Real Time Intelligence

The Thinking Railway: How railways learns to react faster than problems can spread

Check out the poster series from the Real Time Intelligence dissemination event held on May 27, 2026.

The Digitalisation of the Railway System will contribute to an efficient, robust and intelligent System, with a harmonised architecture and interface which will lead to seamless cross-border traffic management.

FP1 MOTIONAL

Index

Summary

Trafikverket hosted the event "Real Time Intelligence - The Thinking Railway: How railways learns to react faster than problems can spread" in Borlänge on May 27. The event attracted about 30 persons on site and 80 persons online. The event showcased the result of 26 demonstrations performed during the project. Furthermore, 26 presentations and 26 pitch sessions were held in plenary, and 2 presentations were held in parallel sessions. Besides that, the attendees could visit the poster session, where posters from all demonstrations were showcased.

The four key sessions focused on the following areas:
Integration of TMSs including cross border operations where Jan Byström at Trafikverket held a technical speech whereas Christian Esposito from Hitachi presented the Improved resilience and disruption management and hosted the session. Camiel Simons at NS hosted the Linking TMS to ATO/CDAS for optimization-area and held a technical speech and finally, Nick Tahamtan Amirreza at ÖBB and Francisco Lozano at Enyse presented the Automated decisions and decision support for traffic management optimization.

It was a very inspirational event where information was shared, new connections were made and together we laid the foundation for our future research together.

Europe's Rail

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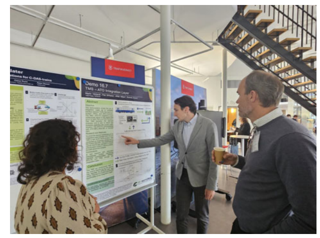
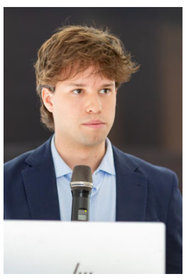
European Rail Network and Mobility Management

Photos from the event





FP1 MOTIONAL

Integration of Traffic Management Systems

FP1 MOTIONAL

Communication Platform interfaces towards TMS and TC

DEMO 12.1

Zbigniew Dyksy
ALSTOM

Håkan Palm

Edward Liszczyk

Abstract

Objective:
Development and validation of interfaces from the Communication Platform to the Timetable Management and Traffic Control systems.

Research and Methods:
Generic interfaces enabling communication between Timetable Management and Traffic Control systems for Communication Platform were implemented, together with dedicated adapters.
Production systems (TMS & TC), COM-P prototype used with Danish railway network real data.
Operation demonstrated with several use cases covering both normal and disrupted situations.

Results:
All intended business functions are correctly supported by the COM-P interfaces and correctly interpreted by the TMS and CTC systems. The tested functionalities behaved consistently with expectations for a relevant operational environment.

Conclusion

The results shows that integrations of both new and legacy systems via Integration Layer (COM-P) can be easier, more cost-effective, allowing for real-time data exchange, and improved management of data flows.

Additional Information

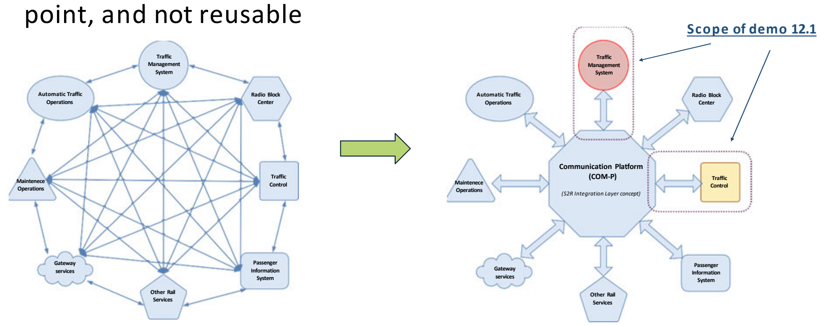
Alstom

1 Challenge

Railway system integrations are often custom, point-to-point, and not reusable

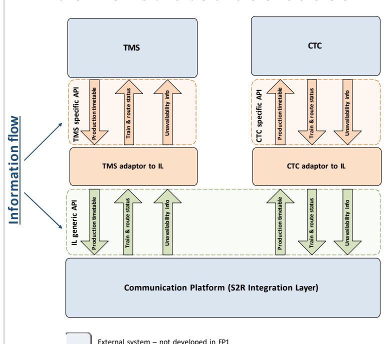
2 Objectives

Development of interfaces from COM-P to the TMS and TC



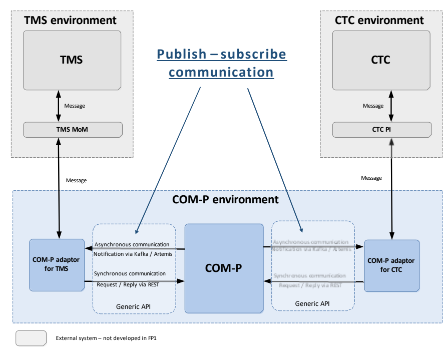
3 Use cases

Information flows between TMS, CTC and COM-P in demonstrated use cases



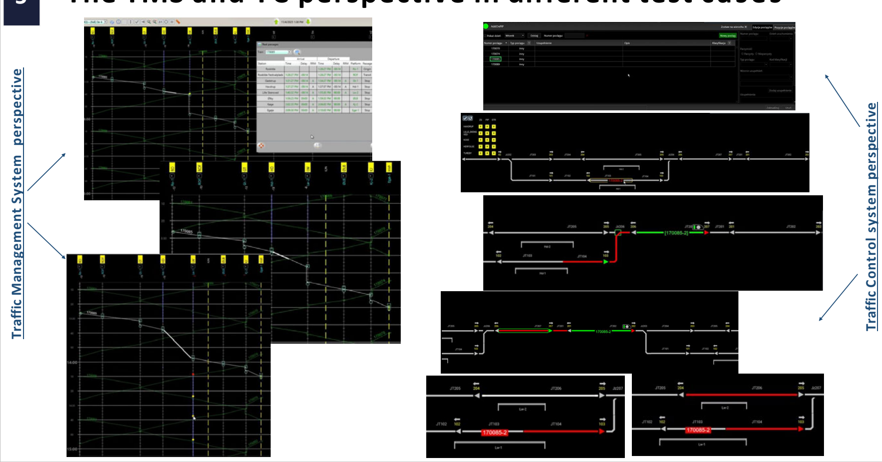
4 Communication over COM-P

Publish – subscribe communication mechanisms in COM-P API



Integration use cases: Operational Production Plan delivery, real time route setting info, real time train status information, unavailability of technical equipment

5 The TMS and TC perspective in different test cases



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Interfaces from the communication between TMS and C-DAS Trackside (TS)

Enrique Gómez González
INDRA

Abstract

Objective:
Effective coordination between Traffic Management Systems (TMS) and Connected Driver Advisory Systems (C-DAS) through standardised communication.

Research and Methods:
The demonstration was conducted in INDRA's virtual laboratory using the real timetable and network data of Estonian Railways. Redis and GraphQL provided data persistence and publish/subscription paradigm in the Integration Layer .

Results:
Use of different domains (INFRA, OPP, OE) from the SP TCCS data model.
Efficient transformation between TMS and TCCS data models with low latency implemented in the TMS-IL adapter.

Conclusion

TMS and C-DAS interfaces prove the reliability of message exchange providing a stronger foundation for interoperable, connected railway operations.

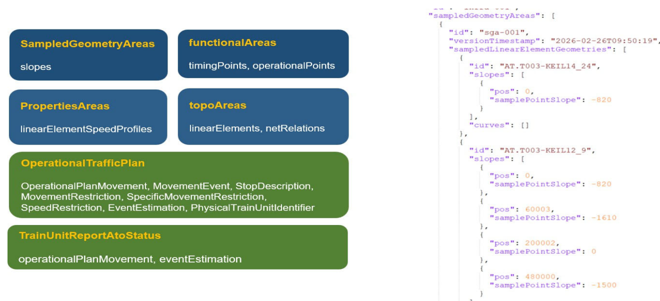
Additional Information

Demonstration 12.4
INDRA – Technology supplier
Estonian Railways – Topology and data supplier

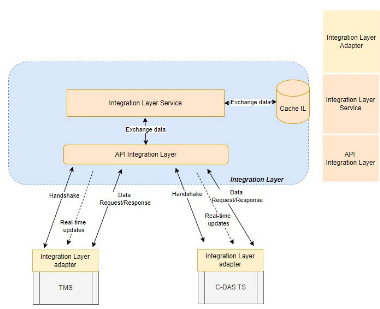
1 Estonian railway network

Tests executed using train paths corresponding to real timetable: Line 7 (Tallin – Paldiski).

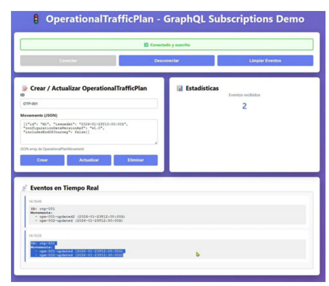
2 Use of System Pillar TCCS v1.1.1. data model



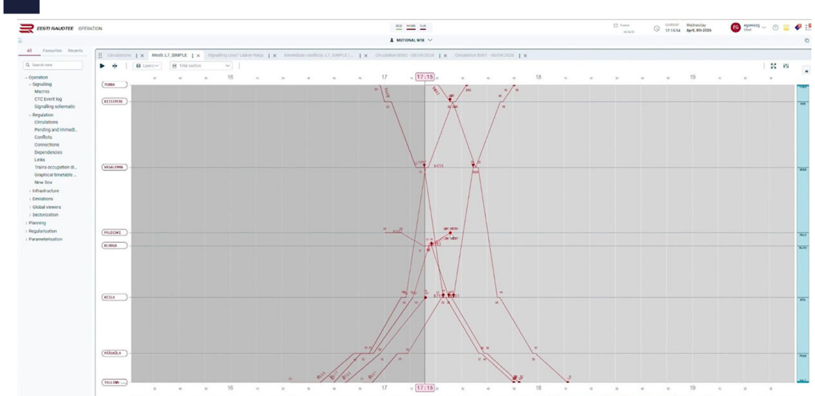
3 Subsystems in the demonstrator



4 Web-based facilities to test the IL capabilities



5 Update of train path forecast in graphical view



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INTELLIGENT TRAFFIC MANAGEMENT

TPS SUITE DEMO 12.7 & 14.3

Marika Potgieter Lars Deiterding Sandra Kempf
Hacon – Siemens Mobility Software

Abstract

Objective:

Our approach demonstrates a continuous, automated information pipeline from strategic timetable planning through to real-time operational execution.

Research and Methods:

The proof of concept was developed using two proprietary software platforms: TPS.plan, a CMS serving as the strategic planning hub, and TPS.live, a TMS focused on real-time operational execution.

Results:

The integrated system reduces reliance on manual communication and routine data transfers, minimising the risk of errors at the critical handover point between planning and execution. Operational restrictions and timetable updates are shared automatically and continuously across all connected systems, establishing a reliable and authoritative shared operational picture.

Conclusion

The results confirm that the CMS and TMS connected through digital interfaces can transform the speed and quality of operational decision-making. We demonstrates a credible and scalable pathway toward more resilient, responsive, and coordinated railway operations.

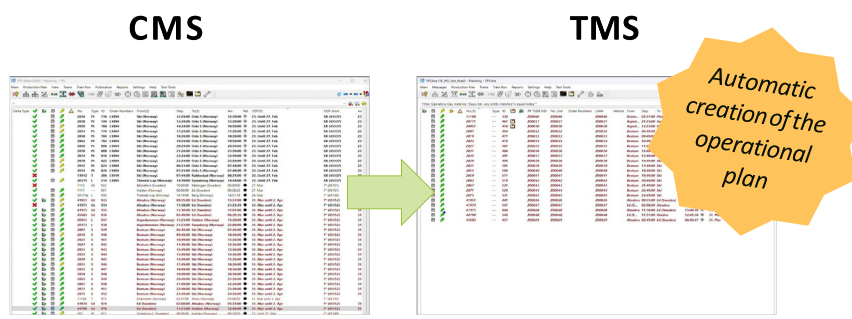
Additional Information

Hacon, Siemens Mobility

siemens.com/tps

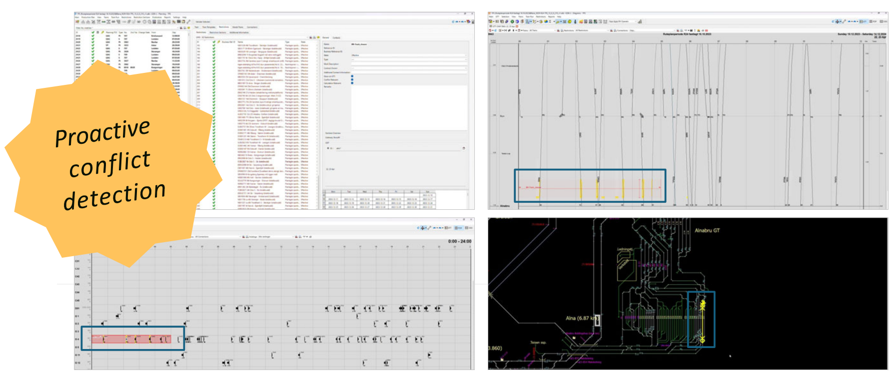
1 Automated Timetable Management

Automated timetable synchronisation between planning and operational systems using TSI telematics standard interfaces.



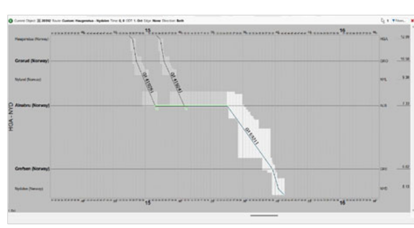
2 Shared Situational Awareness

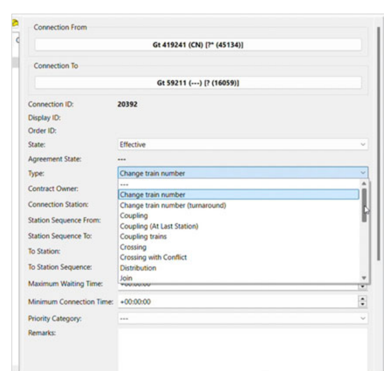
Automated export of operational restrictions to connected third-party systems including stations, depots, and yards.



3 Resource Links

Import and export of resource dependencies (such as crew and rolling stock links.)





4 Decision Support

Continuous, automatic recalculation of the operational timetable in response to real-time train movements and re-planning actions.

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Improved resilience and disruption management

FP1 MOTIONAL

Demo 14.1
Collaborative DSS for disruption management

Daniela Pietranera
Hitachi STS

Christian Esposito
CeRICT scarl

Abstract

Objective:
A Decision Support System (DSS) is essential for disruption management to ensure safety, minimize delays, and enable proactive, risk-informed infrastructure planning.

Research and Methods:
The validation study was conducted utilizing an end-to-end emulation platform designed to reproduce realistic railway infrastructure operations. The environment continuously provide real-world operational data recorded from a previous STS installation and suggest procedure to handle the emulated disruption event.

Results:
The demonstrator successfully executed all intended test scenarios and met its primary functional milestones. The operator received the proper information on the events and actions to be done to deal with them.

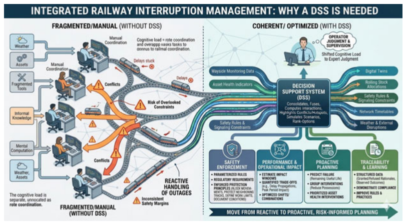
Conclusion

The role of a DSS in disruption management boils down to a fundamental shift: it moves the operator from a role of chaotic, manual calculation to one of high-level expert judgment and supervision.

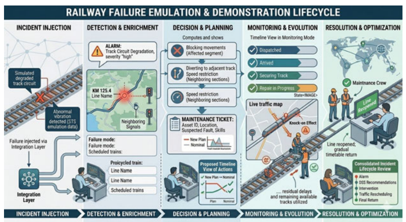
Additional Information

We receive from FP3-IAM4RAIL/(WP 3-4) representative data samples to feed our demo.

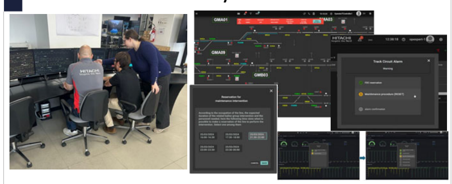
1 Manual Intervention Nightmare vs Automated Support



2 Demo Rational Idea



3 Demo Execution - Two days with End-Users at STS



The validation activities were carried out with a first day of training to familiarise selected end-users with the main functionalities of the tool and a second day of having operators respond to alarms of disruptions and emulating their management.

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Development of decision support for dispatchers: Demo 14.4

Gunilla Björklund Arne Cronvall Jan Andersson
VTI and Trafikverket

Abstract

Objective:
To demonstrate the capability of a set of specific instruments to measure mental workload during operational activities including subjective assessments and physiological variations.
To demonstrate how a new decision support system (DSS) affects the dispatcher's mental workload in operational work (order management in case of infrastructure problems), both during major and minor disruptions.

Research and Methods:
Human-in-the-loop simulation. Scenarios with large resp. minor disruption, both with and without the DSS. Each scenario took 2 hours. Four dispatchers who all completed two scenarios – one with and one without a DSS. We have assessed: Mental Workload, Experts evaluations, Acceptance (Van der Laan-scale) and, dispatchers' experiences and reflections.

Results:

- Reduced workload in order management
- Very high usability
- Better performances with the DSS

Conclusion

The DSS seems to deliver requested effects. We need to:

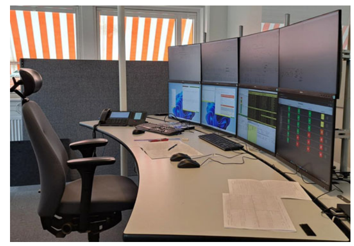
- Integrate with other systems
- Change the interface based on user experiences
- Develop interface for train drivers

Additional Information

The project was a result of a well functioning collaboration between four different organisations within Trafikverket.

1 Figure 1 describes the interface of the developed DSS.

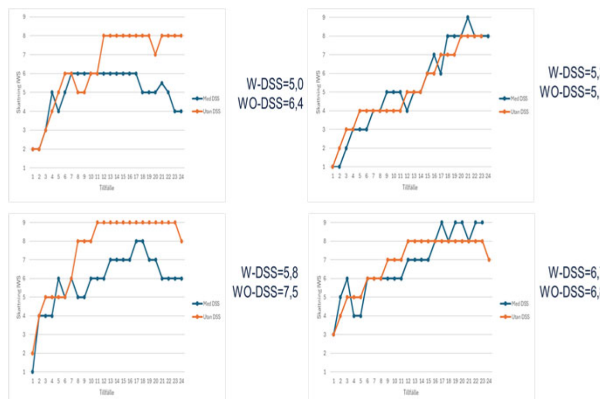
2 Figure 2 present the dispatcher's work station.



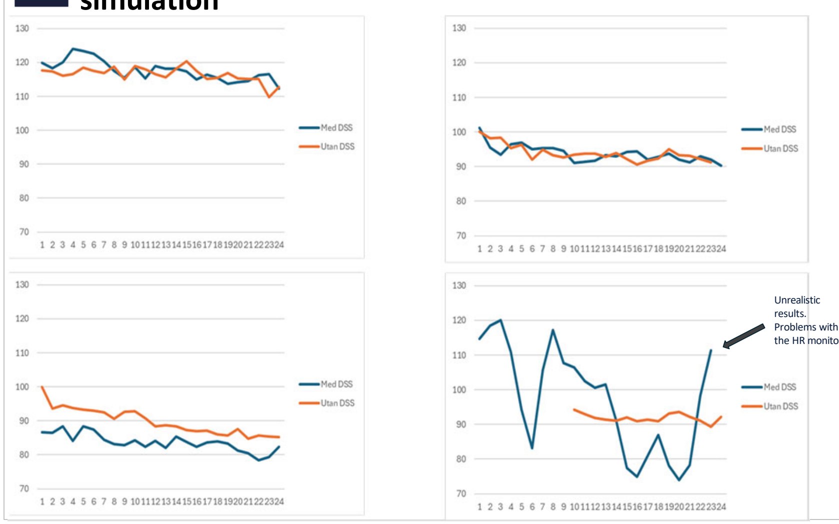
3 Figure 3 present the IWS scale.

1	Not Demanding
2	Minimal Effort
3	Some Spare Time
4	Moderate Effort
5	Moderate Pressure
6	Very busy
7	Extreme Effort
8	Struggling to keep up
9	Work too Demanding

4 Figure 4 presents dispatcher's IWS ratings during simulation



5 Figure 5 presents dispatchers Heart Rate during simulation



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Linking TMS to ATO/CDAS for optimised operations

FP1 MOTIONAL

Demo 16.1

TMS-ATO interaction with a TPE Generator

Rob Goverde[2] Ziyulong Wang[2] Emdzad Sehic[1]

[1]ProRail, [2]Delft University of Technology

Abstract

Objective:

How can the interaction between a Traffic Management System (TMS) and Automatic Train Operation (ATO) be optimized on dense railway traffic networks?

Research and Methods:

We developed a Train Path Envelope Generator that checks the Real-Time Traffic Plan from the TMS on blocking time overlaps between train paths considering a range of potential driving strategies per train. The TPE Generator may add extra Timing Points with time windows to avoid the overlaps. The TPEs are sent to the trains to guide the ATO-Onboard train trajectory generation. The approach has been implemented together with CAF ATO-Onboard components in the ProRail Human-in-the-Loop simulation environment.

Results:

The TPE Generator successfully generates conflict-free TPEs or sends conflict details to the TMS for rescheduling of the RTTP.

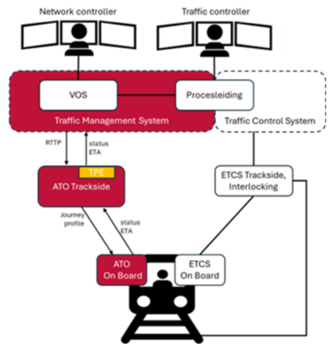
Conclusion

The demonstration showed that the TPE Generator supports more robust and responsive railway operations that improves punctual and energy-efficient train operation on ATO-equipped dense railway corridors.

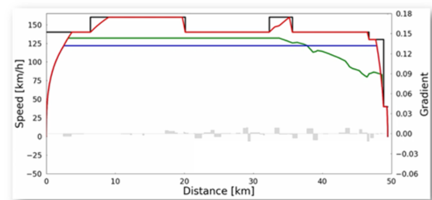
Additional Information

The partners participating in this demonstration were ProRail, TU Delft, NS, InControl, Sopra Steria and CAF.

1 The TPE Generator is implemented as an active ATO-Trackside, bridging the discrete RTTP and continuous train trajectories in the TMS–ATO interaction.

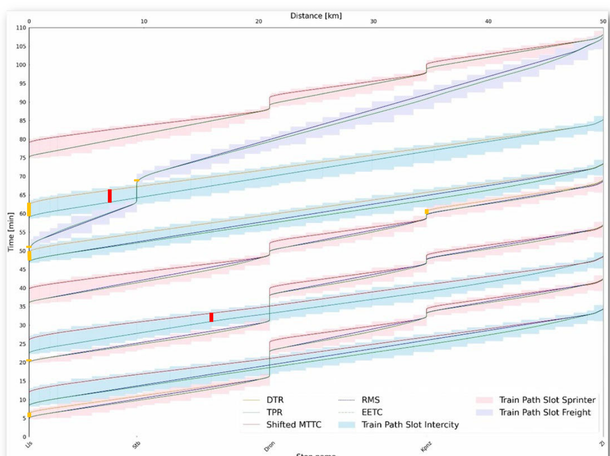


2 TPE generation considers multiple driving strategies per train aiming at robust train operation



- Minimum-time driving
- Reduced max speed (no coasting)
- Energy-efficient driving

3 The TPE Generator detects blocking time overlaps and reduces bandwidths where necessary by adding restrictive timing points and decreasing tolerances to prevent conflicts by speed control.

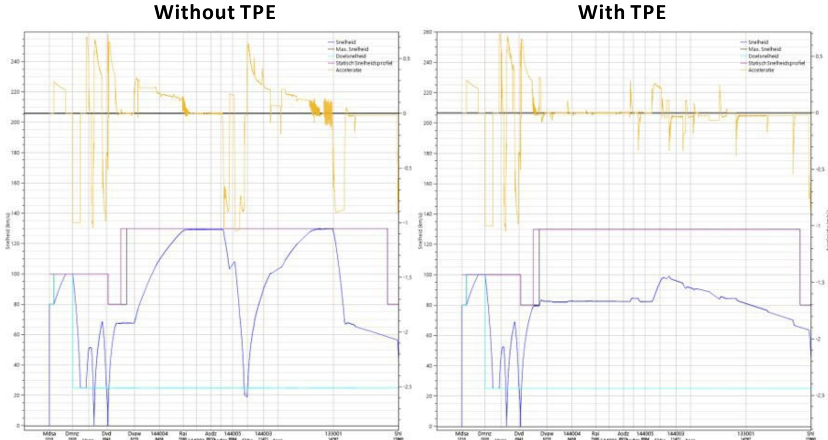


Control Timing Point

Reduced tolerance

4 Scenario of a dwell time extension by a traffic controller: the dynamic TPE generation enables anticipatory speed control by the ATO-Onboard before the critical block (right) that avoids repeated reactive braking due to conflicts (left).

Without TPE **With TPE**



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Demo 16.2

Human factors research of TMS-ATO GoA2

Julia Lo[1], Emdzad Sehic[1], Sarah Kusumastuti[2], Simone Borsci[2], Tom Kolkman[2], Cor van ‘t Woudt[3]
[1]ProRail, [2]University of Twente, [3]NS

Abstract

Objective:
To assess the human factors implications of the TMS–ATO GoA2 feedback loop within a high-fidelity Human-In-The-Loop (HITL) simulation environment.

Research and Methods:
We investigated 7 teams (28 operators) in our high-fidelity HITL simulator with 1 train driver, 2 traffic controllers, and 1 network controller - to assess how TMS and ATO GoA2 affect workload, communication and collaboration.

Results:
The results indicate a higher workload for traffic operators, similar communication and collaboration between train driver – traffic controller, but a changed (more) communication and collaboration between traffic controller – network controller.

Conclusion

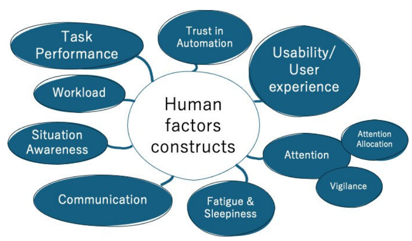
The simulation provided first insights in the human factors impact of TMS-ATO GoA2, mainly for traffic control and the interaction with train drivers. Iterative development is needed to align TRL and Human Readiness Levels (HRLs). Future steps involve alignment of operational roles in accordance to the European TMS system philosophy and further TMS development.

Additional Information

The partners participating in this demonstration were ProRail, UT, NS, and CAF.

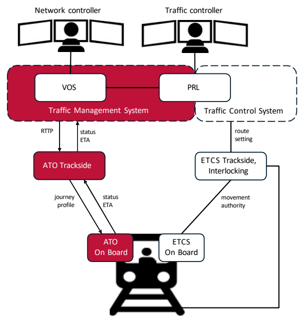
1 Rail human factors toolkit

Workload, communication and trust in automation were measured in the study.



2 TMS-ATO feedback loop

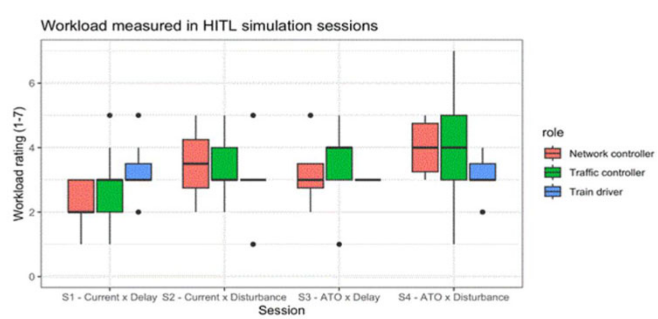
Involved human actors and system components.



3 Human-in-the-loop simulation rooms

The simulation rooms consist of three separate but interconnected workspaces: a room for traffic control operations (top-left), containing two train traffic control workstations and one network controller workstation, a simulation room for the train driver (bottom-left) and a simulation leader/facilitator room (top/bottom-right).

4 Mental workload



A key finding from the questionnaire and the debriefing is that the current TMS-ATO GoA2 operations lead to a higher workload for the traffic controllers and network controller, due to the mismatch in operational processes and limited decision support TMS functionalities.

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RTTP Updater

Better operations for C-DAS-trains

Martin Joborn* Oskar Rune Peter Olsson
RISE Research Institutes of Sweden, *martin.joborn@ri.se Trafikverket

Abstract

Objective:
Past trials of connected driver advisory systems (C-DAS) have highlighted the issue of coordinating C-DAS and non-C-DAS trains as an obstacle to realizing the benefits of C-DAS. *RTTP Updater* addresses this challenge for crossings on single-track railway sections.

Research and Methods:
RTTP Updater consists of a deep learning runtime estimation module, and a MILP-based optimization module that creates a proposed Real-Time Traffic Plan (p-RTTP), illustrated to the traffic controller in the TMS. Tests are performed on the Alvesta-Kalmar line, with a traffic controller using the system in real-time.

Results:
The calculation performance of *RTTP Updater* is high, both with respect to precision, solution quality and speed. Handling of p-RTTP in TMS is intuitive and can be automated. Trains following the p-RTTP achive the expected enhanced traffic flow.

Conclusion

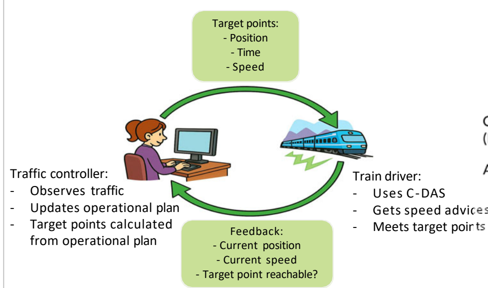
The system relives traffic controllers from tiresome minor updates and improves the quality of the plan. *RTTP Updater* enables the benefits of C-DAS – also when all trains does not have C-DAS.

Additional Information

Demonstration 16.3

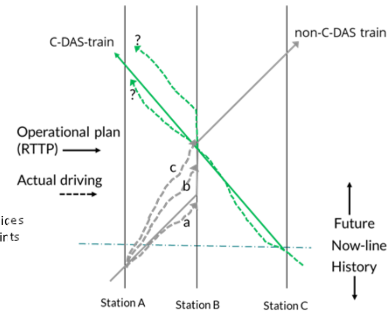
1 Better traffic flow with C-DAS

C-DAS coordinates traffic control with drivers, enabling capacity increase and energy optimization



2 Challenge

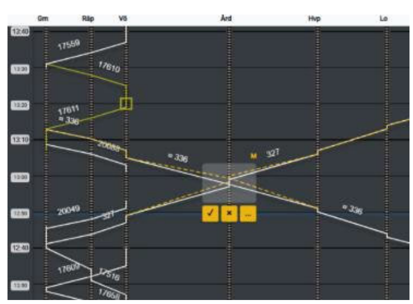
Unexpected stops for C-DAS-trains because of **non**-C-DAS-trains



Will non-C-DAS-train arrive B according to a, b, or c? Has big impact on other train's performance

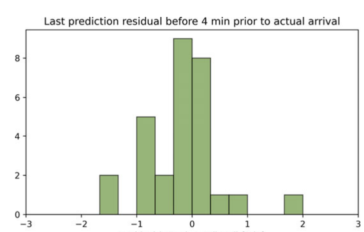
3 Finetuning the RTTP

RTTP Updater creates traffic flow by finetuning the operational plan (RTTP)



4 Runtime estimates

Short-term runtime estimates are an important part of the concept. Quality of estimates are sufficient for indented use and surpasses traffic controller's expectations.



5 Demonstration

RTTP Updater is validated with VR's Öresundståg on Växjö-Åryd-Hovmantorp line section in southern Sweden with a traffic controller using RTTP Updater in real-time.

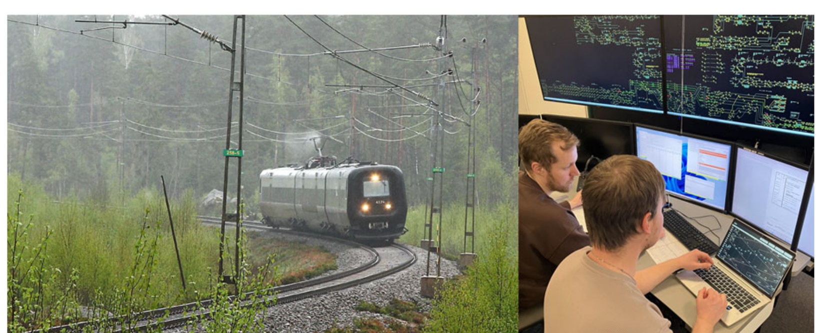


Photo: Magnus Backman

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Improvement of forecast calculation through TMS and C-DAS integration

Enrique Gómez González
INDRA

Abstract

Objective:
Effective coordination between Traffic Management Systems (TMS) and Connected Driver Advisory Systems (C-DAS) with accurate forecasting to optimize operations.

Research and Methods:
The demonstration was conducted in INDRA's virtual laboratory using the real timetable and network data of Estonian Railways. Different scenarios were simulated improving forecast calculation in the TMS based on C-DAS Status Reports.

Results:
There is a significant improvement in forecast calculation with C-DAS trains being the basis to solve conflicts. SP TCCS data model was implemented in the Integration Layer.

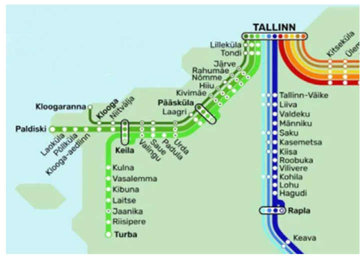
Conclusion

TMS and C-DAS interaction provides clear benefits in terms of real-time awareness in scenarios between Tallin and Paldiski

Additional Information

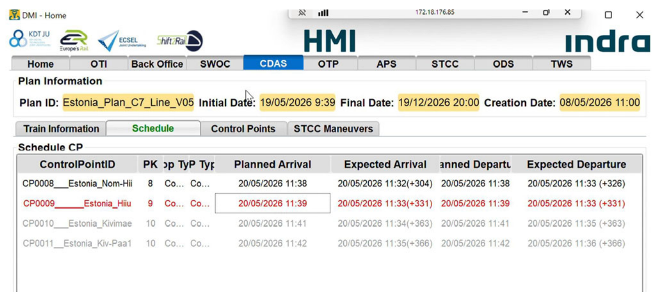
Demonstration 16.4
INDRA – Technology supplier
Estonian Railways – Topology and data supplier

1 Estonian railway network

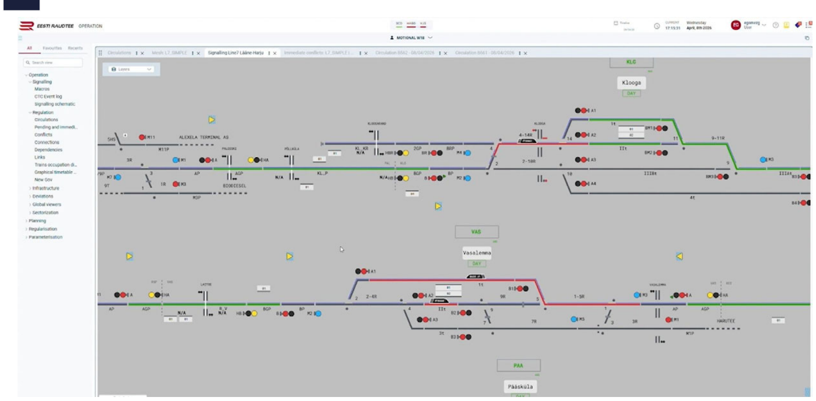


Tests executed using train paths corresponding to real timetable: Line 7 (Tallin – Paldiski).

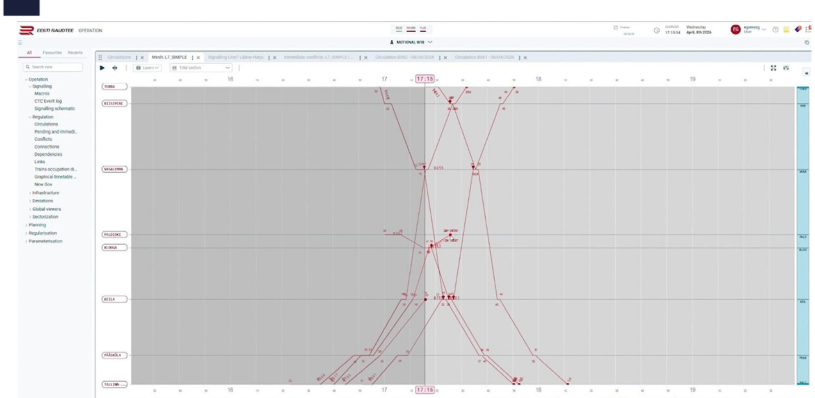
2 C-DAS HMI informs about the *"estimated time to arrival"*



3 Synoptic view with C-DAS simulated trains



4 Update of train path forecast in graphical view



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Development of a simulation tool for C-DAS with TMS connection

Pablo Ciáurriz Unai Díez de Ulzurrun
CEIT - BRTA

Abstract

Objective:
Development and validation of a modular C-DAS simulation platform with TMS connectivity, developing interfaces to enable real-time data exchange between subsystems.

Research and Methods:
The methodology is based on a modular railVOS|SIM framework applied to a real railway scenario, integrating TMS data via an Integration Layer and simulating operations through distributed On-Board modules. It combines trajectory computation, continuous Train Status Report exchange and real-time monitoring within a scalable, dockerised architecture.

Results:
RTTP was successfully retrieved from the TMS and simulated, with continuous Train Status Report transmission every 15s.
Bidirectional communication between system components was maintained and real-time monitoring of train movements was achieved.

Conclusion

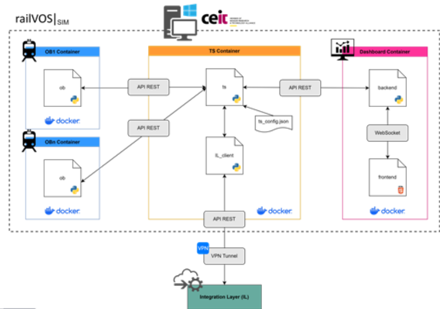
The results confirm the successful integration of TMS and C-DAS within a modular simulation platform, enabling reliable data exchange and real-time train monitoring in a realistic use case scenario.

Additional Information

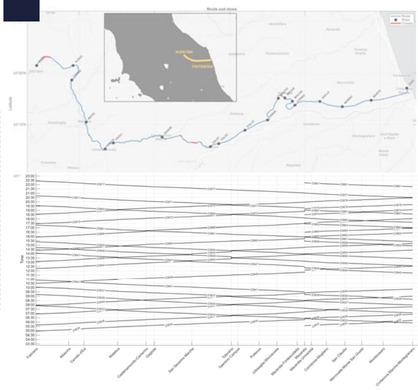
MERMEC and **STS** have collaborated with this demonstration providing the use case scenario data and the access to the IL respectively.

1 Simulator architecture

Architecture used for the simulation platform railVOS|SIM

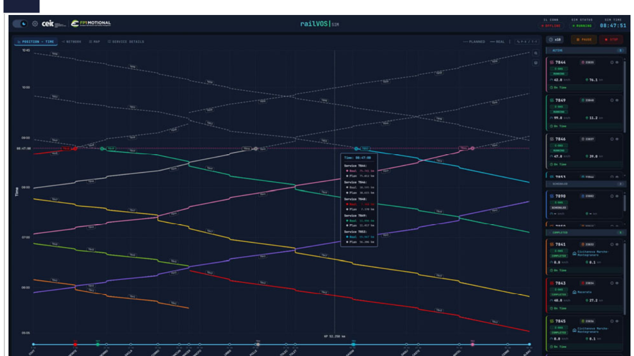


2 Albacina-Civitanova line



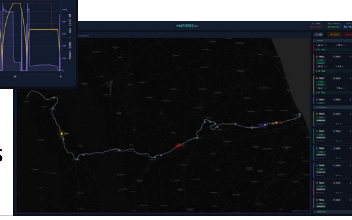
3 System Execution and Data Exchange

4 railVOS|SIM Simulation platform



railVOS|SIM dashboard showing the movement of the different trains running during the simulation

Service details with operational info, calculated and real speed profiles, acceleration, power consumption, etc.



Real-time GPS location of trains

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Demo 16.7
TMS – ATO Integration Layer

Martin Václavík[1], Petr Stříteský[1], Alfréd Hebert[1], Roberto Divano[2]
[1]AZD Praha, [2]HITACHI

Abstract

Objective:

This demonstration shows the use of Integration Layer as a universal interface between Traffic Management System (TMS) and ATO-Trackside. The TMS – ATO-TS Integration Layer continuously reacts to the events that occur on both TMS and ATO-TS sides. The TMS provides the planned timetable and is able to adjust this timetable regarding the current traffic situation. The ATO-TS communicates with ATO-OB/C_DAS-OB of involved train.

Research and Methods:

To prove the desired capabilities of the Integration Layer between ATO-TS and TMS a real world demonstration was conducted on Kopidlnka railway line in the Czech Republic. The experimental vehicle EDITA was operated in Grade of Automation (GoA) 3, without a driver, but with personnel onboard.

Conclusions:

A test scenario with simulated disturbances verified functioning real-time communication between ATO-TS and TMS through the Integration Layer.

Conclusion

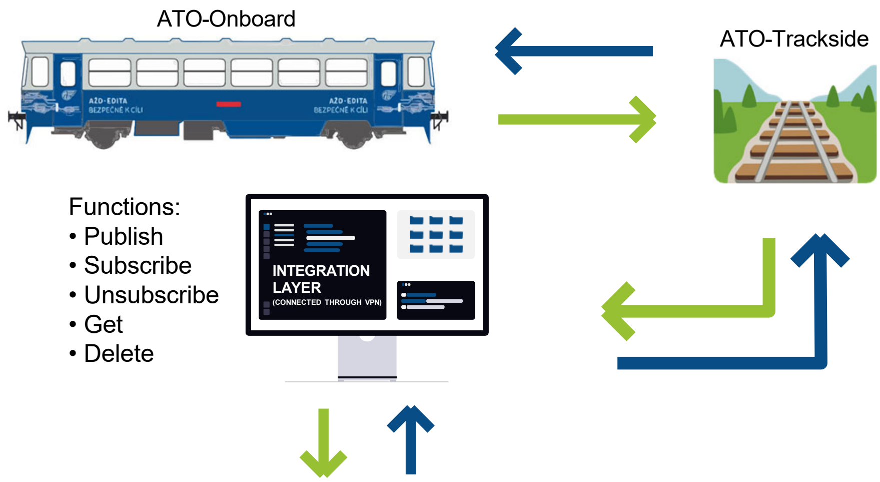
The TMS can continuously react to the events happening on the railway line reported by ATO-TS and vice versa. The communication proves the functionality of the Integration Layer.

Additional Information

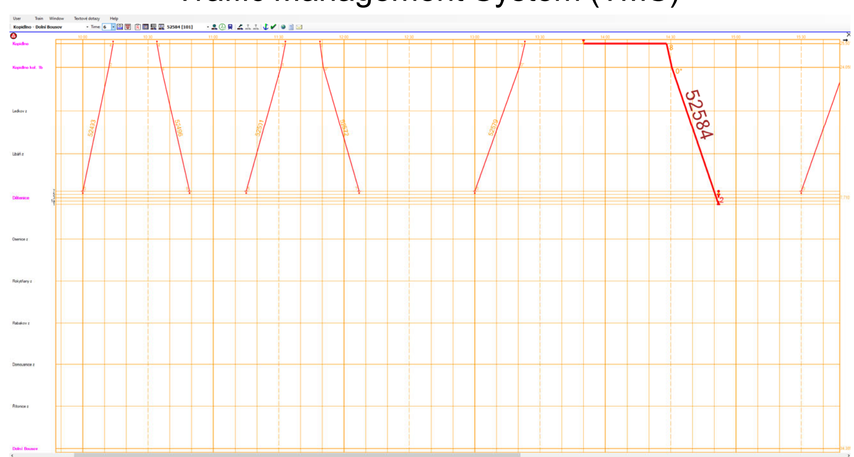
The test track, vehicle and TMS was provided by AZD. The Integration Layer was developed by HITACHI.

1 Demonstration setup

A graphical overview of demonstration setup on Kopidlnka line



Traffic Management System (TMS)

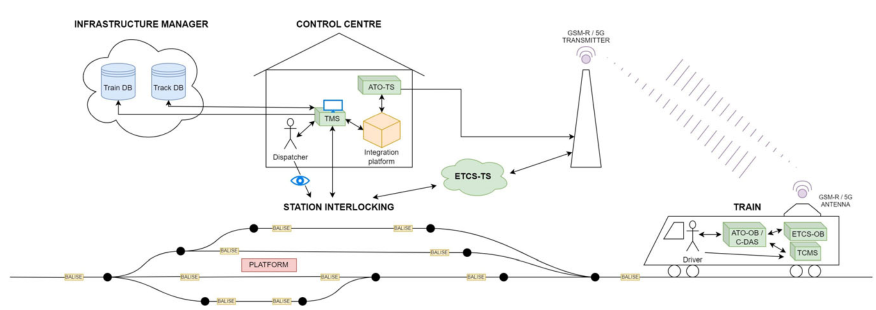


Journey Profile, Journey Profile Update from the TMS

Real Time Information, Status Report to the TMS

2 Functional Architecture of ATO-TMS Integration

A functional architecture with involved actors



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Traffic Regulator

Isabel Meseguer Hijós
CAF

Abstract

Objective:
Ensuring that minor disruptions that occur during operations can be resolved without the need for rescheduling.

Research and Methods:

Depending on the time of day or the area through which the route passes, requirements vary, so services must be adjusted to take into account headway or the timetable in order to meet the needs of network users and cause them as little disruption as possible

Results:

As a result, we have developed a controller to which a hybrid control algorithm has been added, enabling us to successfully resolve the issues we had identified.

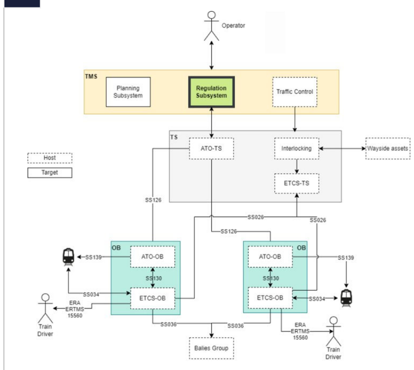
Conclusion

A regulator validated at TRL 5 has been developed, enabling us to resolve any disturbances that arise without the need for replanning.

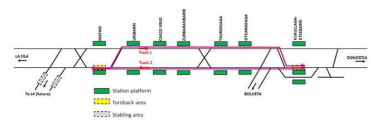
Additional Information

Demo 16.8
CAF ➔ Technology supplier

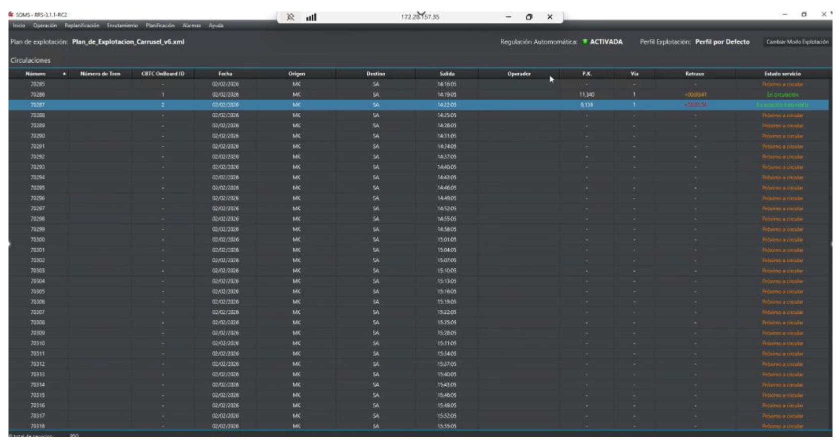
1 Laboratory setup



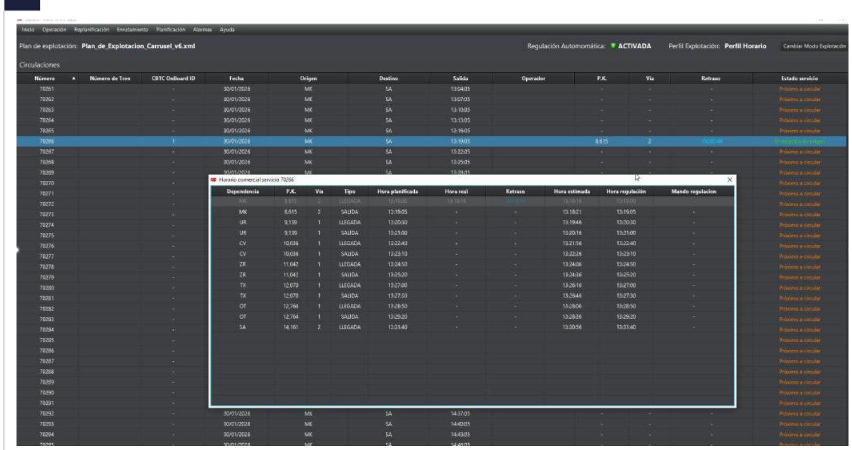
2 Line topology



3 Headway regulation



4 Timetable regulation



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Automated decisions and decisions support for traffic management optimisation

FP1 MOTIONAL

Real Time Conflict Identification & Resolution (18.2.1)

Tahamtan Amirreza
ÖBB Infra

Anastasiia Öttl
Software Competence Center Hagenberg (SCCH)

Abstract

Objective:
Improve railway traffic management through automatic conflict handling and optimized decision-making. Support dispatchers in managing larger and more complex railway networks by shifting their role from active control to passive supervision.

Research and Methods:
Railway traffic operations were modeled in a TMS simulation environment to represent dispatcher workflows and network interactions. Automated routing and conflict resolution were implemented using A*, Safe Interval Path Planning (SIPP), Large Neighborhood Search (LNS), and heuristic optimization methods. Scenario-based testing was conducted to analyze system behavior under varying traffic and operational conditions.

Results:
Conflict-resolution scenarios involving up to 79 trains were solved in under 10 seconds. The required response time of 120 seconds was consistently met.

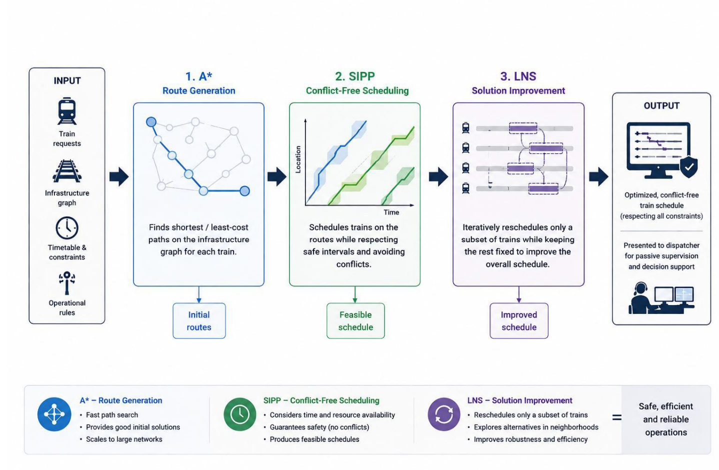
Conclusion

The solution supports safe automated conflict handling and enables dispatchers to shift from active control to passive supervision.

Additional Information

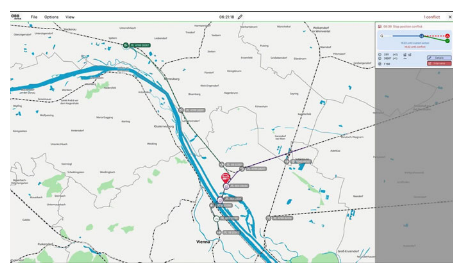
ÖBB Infra: Railway infrastructure and operational domain expertise
SCCH: Algorithm & prototype development

1 Algorithm Framework

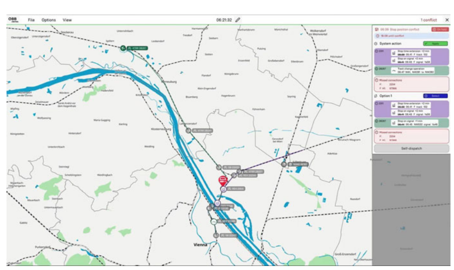


2 Conflict Detection

Detected conflicts are shown on the map with a location pin. Selecting a conflict displays details and a countdown to automatic resolution, with the option for dispatcher intervention.



3 Conflict Resolution



In manual mode, the automation is paused. The dispatcher can review solution alternatives and their details. Switching between solutions updates the action markers on the map. Selection follows a two-click process: select and confirm.

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Algorithms for Automatic Conflict Detection and Resolution using AI Demo 18.2.2

Specific application to Depots&Terminal St.

Jaime Durán Daniel Bonet Francisco Lozano

ENYSE

Abstract

Objective:

To provide a solution being able to detect conflicts and using AI provides solution for such conflicts. The solution is presented to the Network Controller who has to validate at this stage the suitability of such solution

Research and Methods:

Conflict Detection based on predictive algorithms

AI-based Conflict resolution using two LLMs: Solver and Critic. Critic has the aim of challenging any results obtained by the Solver.

Results:

The following elements have been developed (WP17 + WP18):

- Algorithms for conflict detection,
- AI-based based algorithms for conflict resolution,
- Planning module that can be integrated in TMS solutions,
- Data preparation tool,
- Simulation and testing environment
- A huge number of scenarios to train the AI

Proposal of solution needs to be validated by user (Semi-automatic)

Conclusion

The AI algorithm is capable of providing solution(s) prioritized by the minimum impact (i.e. shorter delay) in less than one minute to be validated by user. Depots and Terminal stations still under tests.

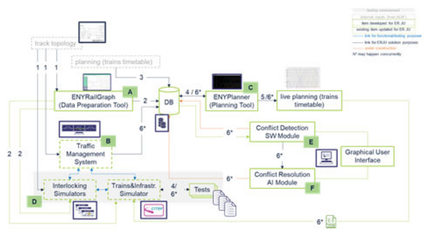
Additional Information

ENYSE – Technology supplier

ADIF – Topology and data supplier

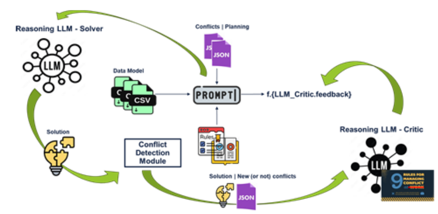
1 Functional Architecture

Complete process including data preparation/configuration for on-line testing

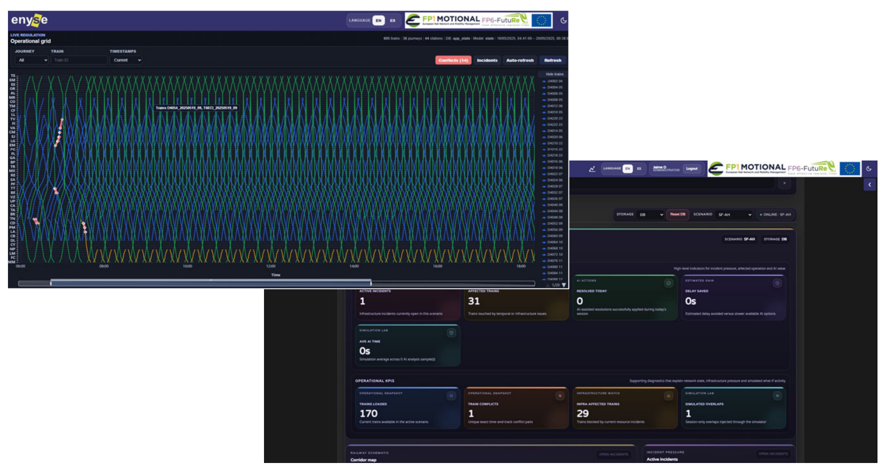


2 Conflict Detection and Resolution process

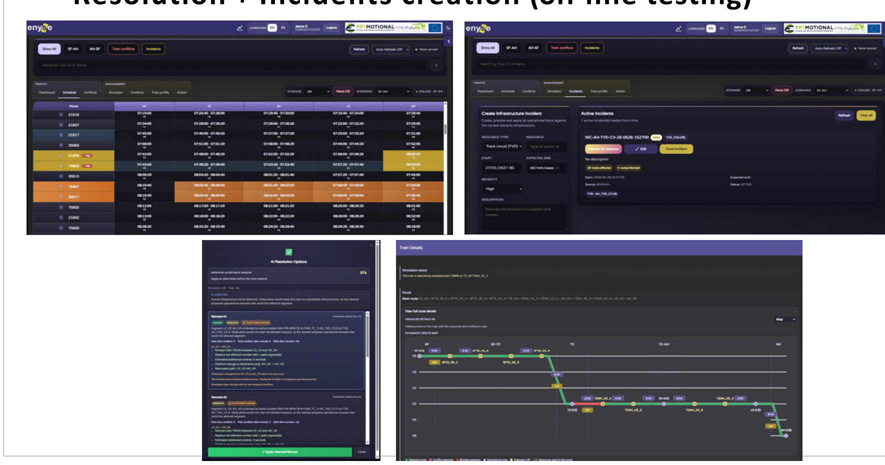
Iterative process for detection and AI-based resolution process. Currently in semi-automatic mode.



3 Graphical User Interface – Planning window + Dashboard



4 Graphical User Interface – Conflict detection & Resolution + Incidents creation (off-line testing)



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Dispatching Optimizer

TPS SUITE — DEMO 18.3

Paolo Ventura Klaas Eggert Lasr Deiterding Paolo Luigi Rinaldi

Abstract

Objective:
We present an optimized decision-support tool for train dispatching. It solves the complex challenge of producing, in real time, optimized and conflict-free solutions in numerous instances where dispatchers are required to adjust the current timetable due to train delays, temporary restrictions, requests for the insertion of a new train, or the introduction of a new control rule.

Research and Methods:
The AMP algorithm, integrated into the Traffic Management System TPS.live, uses a Master/Worker iterative scheme together with a smart and exact implementation of a Rolling Horizon procedure, called *Roll&Branch&Bound*.

Results:
Within a maximum computational time of 20 seconds, AMP generates optimized conflict-free plans for the next two hours for highly congested timetables.

Conclusion

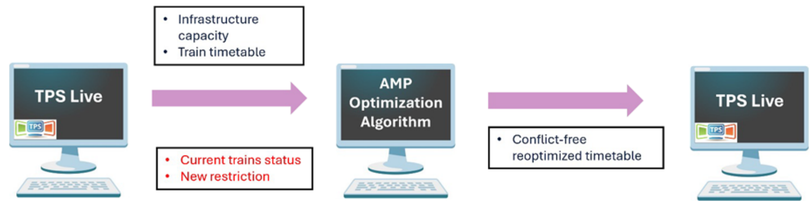
The integration of AMP into TPS.live represents an efficient and reliable tool to support dispatchers in their every-day work. It delivers faster response times, optimized infrastructure use, and highly robust traffic management under real operational conditions.

Additional Information

Siemens Mobility COC for Optimization Hacon

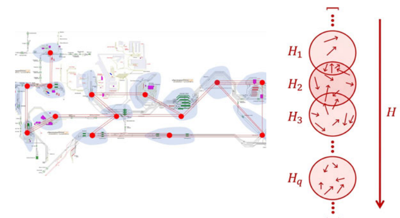
siemens.com/tps

1 AMP & TPS.live

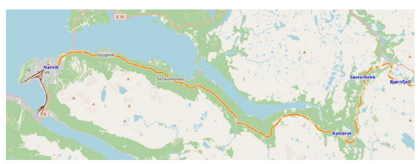


2 The AMP algorithm

It efficiently implements a Line-Station spacial decomposition within a new Rolling-Horizon scheme.

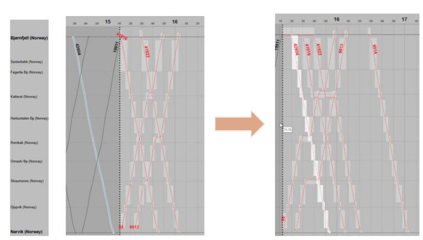


3 The infrastructure



Norwegian railway between Narvik and Bjornfjel

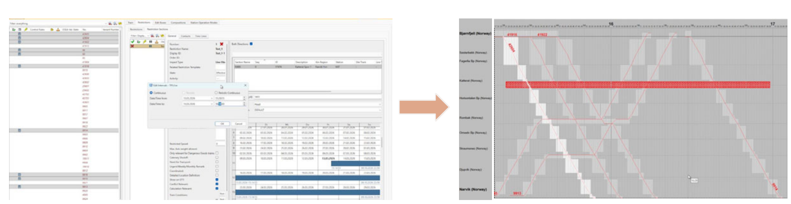
4 Delayed train



The departure of train 42604 from Bjornfjell is delayed from 14:30 to 15:20. A new plan is calculated for all trains in the network from 15:30 to 17:30.

5 Temporary restriction

Then, a temporary restriction is introduced on a platform in Katterat station from 15:20 to 17.00



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Decision Support for improved traffic operation

Enrique Gómez González
INDRA

Abstract

Objective:
Reduce the dispatcher's workload in situations involving a high volume of conflicts in the near future by ACR (Automatic Conflict Resolution).

Research and Methods:
The demo was conducted in INDRA's virtual laboratory using Estonian Railways network data and a real timetable. The operational changes introduced by the dispatcher generated conflicts that were automatically detected and resolved by the ACR. Various parameters provided flexibility to the ACR depending on the chosen infrastructure and operational model.

Results:
The system successfully resolves conflicts automatically until a stable state is reached. At that point, the system reverts to manual resolution, as this is considered more effective because it offers a wider range of resolution methods based on the dispatcher's experience.

Conclusion

The demonstration confirms that the ACR is a tool that effectively reduces the dispatcher workload.

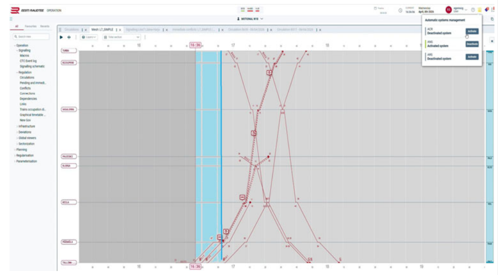
Additional Information

Demonstration 18.7
INDRA – Technology supplier
Estonian Railways – Topology and data supplier

1 Estonian railway network

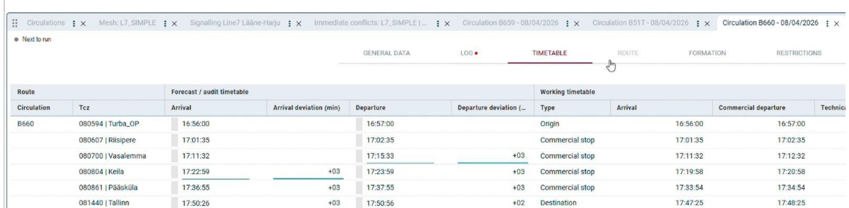
Tests executed using train paths corresponding to real timetable: Line 7 (Tallin – Paldiski)

2 Enabling ACR when needed



Enabling automatic conflict resolution during periods of high frequency of railway conflicts is key for an efficient operation.

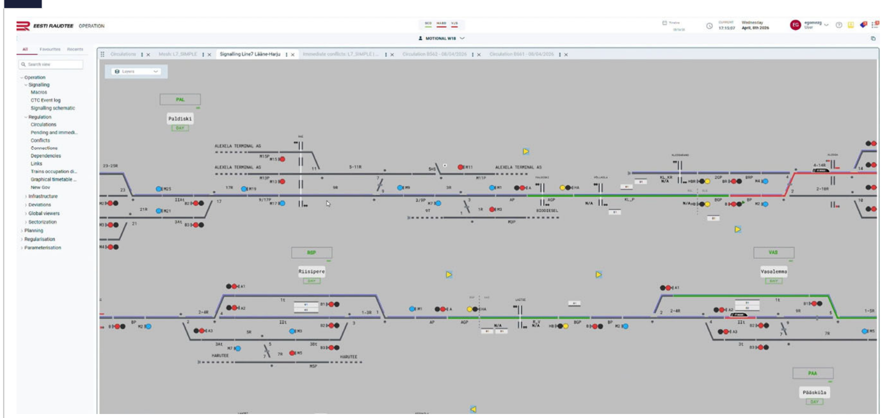
ACR in action



Route		Forecast / audit timetable				Working timetable		
Circulation	Tcz	Arrival	Arrival deviation (min)	Departure	Departure deviation (...	Type	Arrival	Commercial departure
B660	080594 | Turba_OP	16:56:00		16:57:00		Origin	16:56:00	16:57:00
	080607 | Riisipere	17:01:35		17:02:35		Commercial stop	17:01:35	17:02:35
	080700 | Vasalemma	17:11:32		17:15:33	+03	Commercial stop	17:11:32	17:12:32
	080804 | Keila	17:22:59	+03	17:23:59	+03	Commercial stop	17:19:58	17:20:58
	080861 | Pääsküla	17:36:55	+03	17:37:55	+03	Commercial stop	17:33:54	17:34:54
	081440 | Tallinn	17:50:26	+03	17:50:56	+02	Destination	17:47:25	17:48:25

As the algorithm runs, the number of forecasted conflicts are progressively reduced by application of conflict resolution methods.

4 Schematic view representing Estonian railway network



Once a stable state is reached, the simulated trains fulfil the replanning operations applied without causing any unexpected delays.

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Demo 18.2.8

Automated decision and support for traffic management optimisation

Federico Santamaria Angelo Naselli Mirko Ghersi
Mermec STE

Abstract

Objective:
The objective was to develop a Conflict Detection and Resolution (CD/CR) module and to make its operation fully automatic. The module forecasts train motion, detects conflicts and computes resolutions, assisting traffic control operators in the management of railway lines. It works in two modes — semi-automatic and fully automatic — both intended to reduce the operator's manual burden.

Research and Methods:
In semi-automatic mode, conflicts and candidate resolutions are presented to the operator for approval, with the automatic function taking over only in emergencies; in fully automatic mode, detection and resolution run without human intervention. The managed micro-infrastructure was described through the System Pillar Infrastructure Model. Resolution is framed as a graph-based optimization that explores alternative plans and ranks them by cost, with different strategies selectable by the operator.

Results:
Reached TRL5, evaluated by RFI, the Italian Infrastructure Manager. The workflow was rated intuitive, and operational constraints were consistently respected.

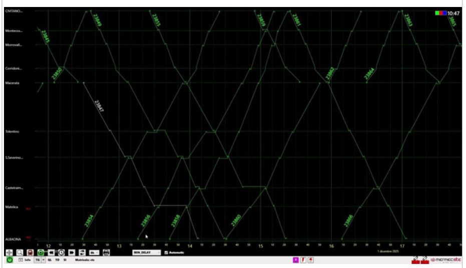
Conclusion

Automatic conflict resolution proved feasible on real infrastructure and was accepted by expert operators — less workload, more efficient network use, and a basis for the next phase: cross-border, cooperative resolution.

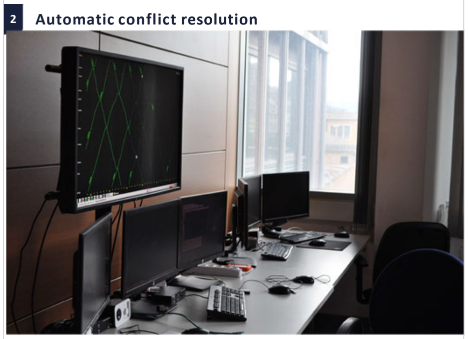
Additional Information

For this demo we collaborated with the associated company Mermec Engineering

1 Conflict free operational plan



2 Automatic conflict resolution



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Evaluation of optimization algorithms for local TM

P. Pellegrini, J. Rodriguez, B. Pascariu, G. Marlière, B. Sharma
SNCF - Université Gustave Eiffel

Abstract

Objective:
When traffic is dense, the resolution of a single conflict may have impacts on trains that seem not directly involved. We have proposed an optimization-based decision-making approach to dealing with complex situations, and a demonstrator to assess its performance in TRL5.

Research and Methods:
The algorithm exploits state-of-the-art optimization techniques to manage traffic considering a very high level of detail in the representation of train movements and infrastructure capability. It exploits local rerouting whenever relevant to resolve conflicts, in addition to rescheduling.

Results:
Optimization brings a reduction of 50 to 60% on average in two complex case studies, compared to applying the original plan. The improvement remains remarkable even when input data are imprecise.

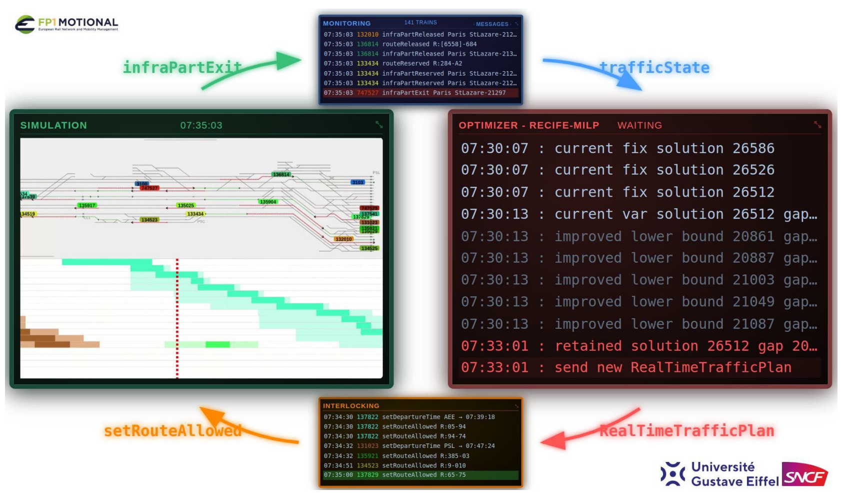
Conclusion

Automated traffic management is possible even in complex areas with dense or mixed traffic, and it can bring significant delay reductions.

Additional Information

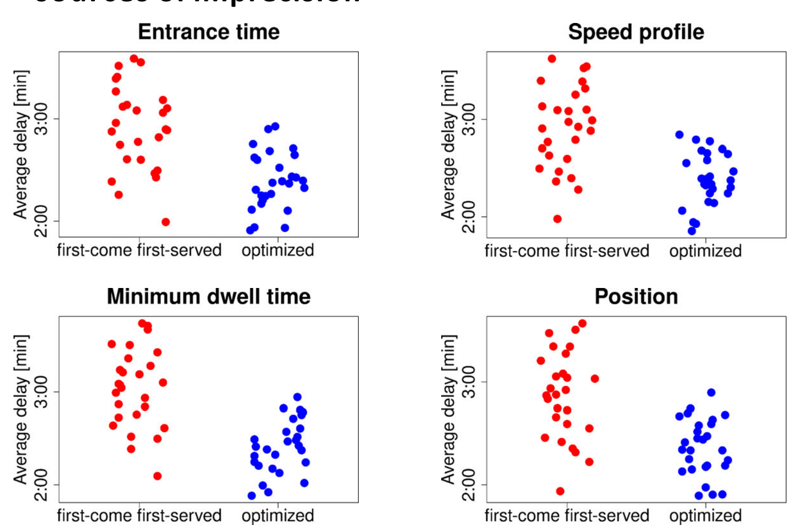
SNCF and SNCF Réseau actively participated to the definition of the study specifications and to its validation.

1 Demonstrator of fully-automated, optimization-based traffic management



The field, here represented by the OpenTrack simulator, interacts with the optimization algorithm in a closed loop system. Optimization is periodically updated based on the most recent traffic situation and prediction available.

2 Comparison of average delay when data has various sources of imprecision



Results obtained for 3-hour traffic in St. Lazare station, in Paris, France: 27 platforms, around 100 trains per hour.

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