



CLOSED-LOOP SIMULATION OF A RAILWAY NETWORK WITH POSITIVE TRAIN CONTROL

Rumo North Operation | Capacity & Operations Research



ABOUT US



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Transport and Logistics Engineer with 6+ years of experience in transport planning.

Working since 2025 at Rumo conducting capacity analysis for long term strategic assessments



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Specialist — Simulation

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Control and Automation Engineer and Applied Mathematician with over nine years of experience in simulation and programming

Since 2022, been working at Paratech Informatica, developing models in AnyLogic to study industrial processes, trains, and railroads.



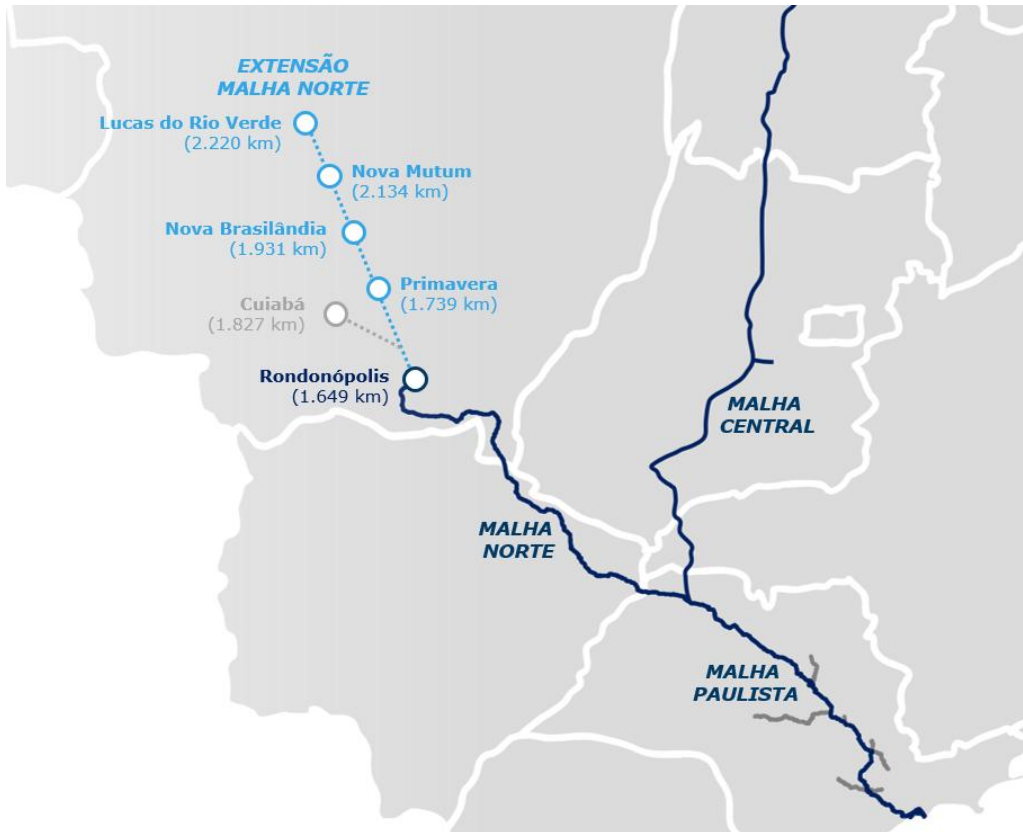
Rumo — Capacity & Operations Research (C&PO)



Closed-Loop Simulation of a Railway Network with Positive Train Control

RUMO NORTH OPERATION

... the rail corridor that moves the Brazilian Midwest



North Operation and its extension towards Lucas do Rio Verde (MT)



Network

Move **more than 1,500km** linking Rondonópolis (MT) to the Rumo network towards the Port of Santos, with the extension under 4 states of Brazil.



Cargo

Agricultural output of the Midwest — **grain, sugar, cellulose and biofuels** — moved over long distances in a shared, single-track dominated network.



Demand

Rumo North Operations has just set a monthly record of **7 BTKU**

~1,500 train circulations per month reproduced in the simulated network

RUMO'S CAPACITY CHALLENGES

... where the corridor is under pressure — and why the answer is not obvious

Capacity at Rumo is not one problem. It is several at the same time, and they interact: what one of them gives back, another one takes. That is why we measure capacity with a simulator instead of a spreadsheet.



Demand grows faster than track

Volume records keep coming, while duplications and new sidings take years of capital to deliver.



Single line, shared corridor

Most of the network is single track. Every meet between two trains turns directly into waiting time.



Seasonal peaks

The harvest concentrates demand. The corridor has to absorb the peak, not the annual average.



Maintenance competes with trains

Track and rolling-stock windows need the same asset the circulation needs.



Terminals and yards at both ends

Loading, unloading and yard length can cap the corridor before the line itself does.



More from the network we have

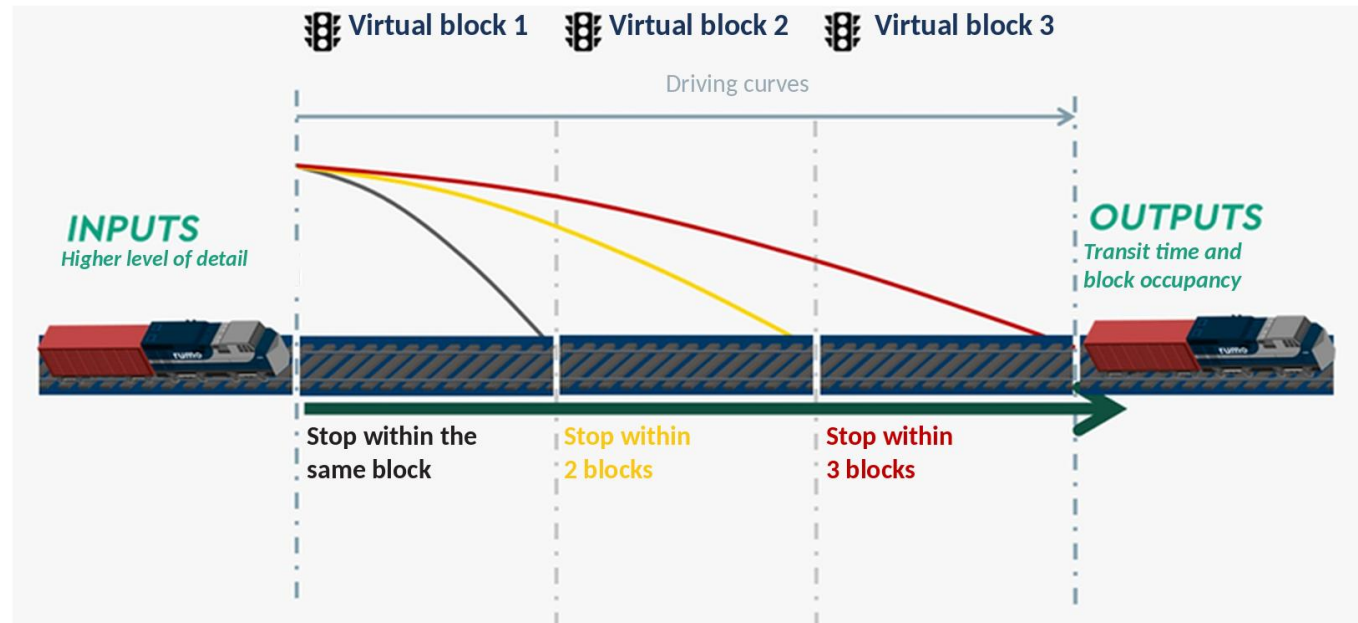
Better circulation rules can add capacity with no new track — the lever we test today.

Every one of these is a capacity question. The simulator is where we answer them — and today we follow the green one: Positive Train Control.

SCENARIO: POSITIVE TRAIN CONTROL

... how a control technology becomes a rule inside the model

PTC supervises the position of every train continuously and validates its movement authority in real time. In the simulator this becomes a single rule: how much of the track ahead is free decides how the train is driven.



1

Query

On entering each virtual block the train measures the distance to the preceding vehicle.

2

Count

The number of free blocks ahead of the consist is computed.

3

Draw

A stochastic draw conditioned on that count selects the driving and braking curve.

4

Effect

More free blocks, less restrictive curve — lower transit time and shorter block occupancy.

WHY A SIMULATION MODEL

... what an analytical estimate could not deliver



Randomness

... handles a range of inputs

Driving strategies, arrival patterns and maintenance windows drawn from distributions rather than average values.



System behaviour

... captures interactions

Queueing at meets, yard occupation and knock-on delays emerge from the interaction between trains and blocks.



Scenario comparison

... one change at a time

Infrastructure, demand and fleet are held constant, so the difference between two runs belongs to the change under test.



Risk-free decision

... evidence before investment

A siding, a technology or a demand scenario is measured in the model before any money is committed.

What does the North Operation actually support today — and what changes it?

Today's case: how much transit time can PTC recover, keeping infrastructure, demand, O-D matrix and fleet unchanged?

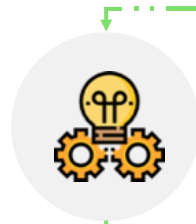
PROJECT DELIVERIES

... using best practices to achieve the goal



CONCEPTUAL MODEL

Documentation of the approach to the problem
Assumptions, objectives, inputs and outputs



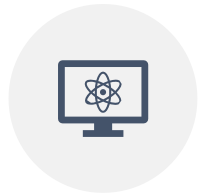
MODELING

Translating the conceptual model into AnyLogic



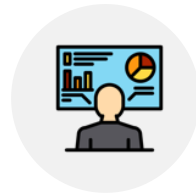
VALIDATION

Comparison between the model output and real data



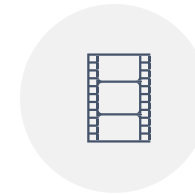
SCENARIOS

Set of scenarios of interest and its results



FINAL REPORT

Description of studied scenarios, its outputs and conclusion



VIDEO/ANIMATION

Animation of the model



KNOW-HOW TRANSFER

Training the user on how to use the model

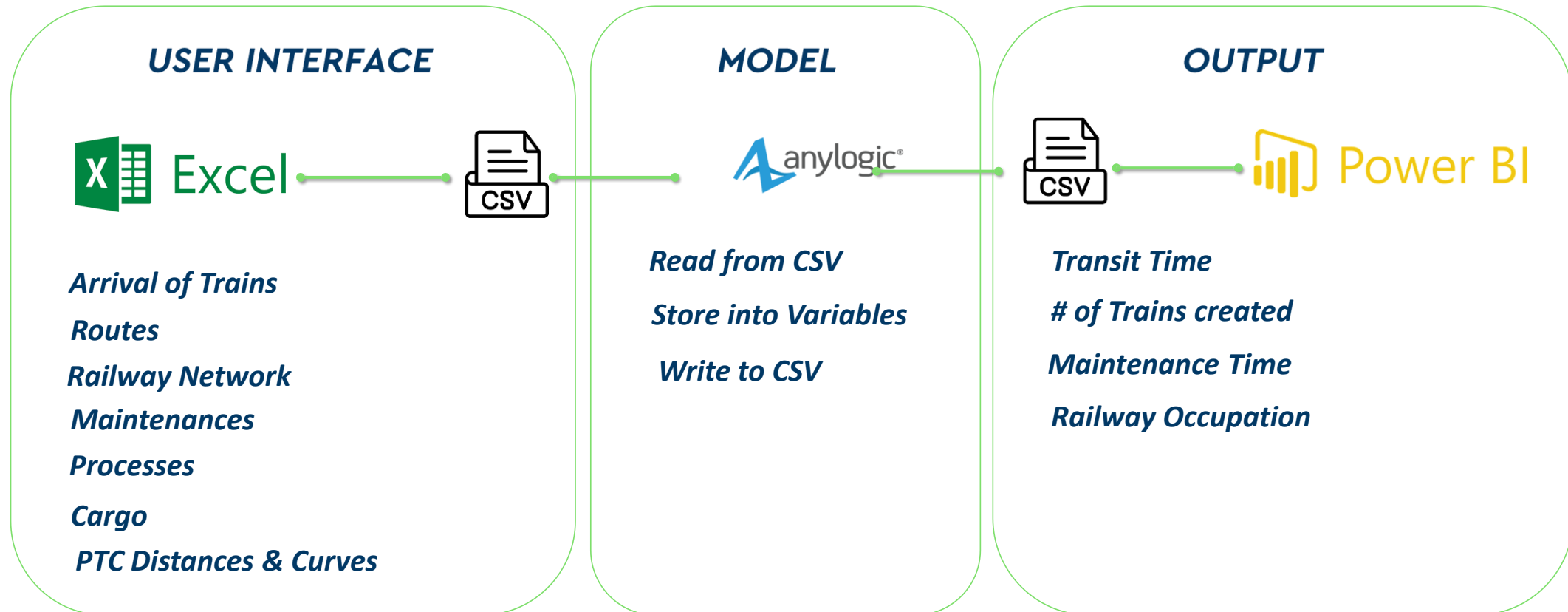


ANYLOGIC TRAINING

Training the team in using AnyLogic

DATA INTEGRATION

... moving Input data into a Generic Railway Model



MODEL ANIMATION

... animation displays a portion of the simulated network



Animation view

Blue and green
train symbols

Distinguish the
travel directions

Supports inspection
of movement and
block occupancy

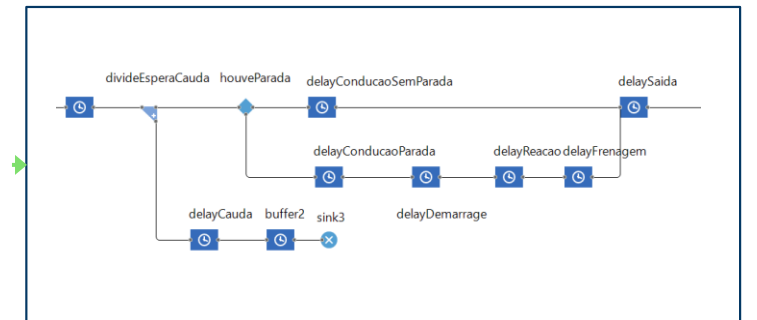
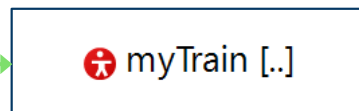
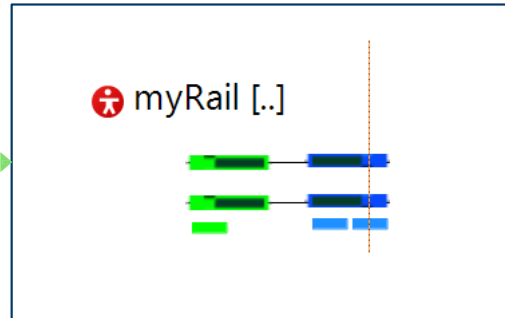
Show Maintenances
happening in Railway

CHALLENGES

... making the model capable of representing any Railway



Excel



VALIDATION

... model reliability and scenarios

Validation and Results Framework



Validate against past performance

Compare the model results
with **historical data**
for the entire railway network



PTC Impact

Run the model **with and without
PTC curves** to see how the system
implementation affects the railway



Train time analysis

Verify how **each part of the
transit time** is affected by PTC
Implementation



Directional comparison

Export and import movements
analyzed separately

CONCLUSION

... and future of the model

Conclusion



Better Decision Making

Providing stakeholders
data to enhance
decision making



Results Reliability

Model Validated using
real world data and can be
used to test new scenarios
for the future



PTC Impact

PTC application
shown to reduce
one hour of total transit time
in each direction



Model integration

Integrate the model
to new
Rumo Networks

Model enhancement



Thank you!

*Also,
we would like to thank
all the other team members
for their support
along the development
of the presented model*

September 2026

