Simulation of the Iron Ore Line

[Optimal Networks for Train Integration Management across Europe]

Collaborative Project

7th Framework Programme

Uppsala University,

Borlänge, October 2014

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- The Iron Ore Line
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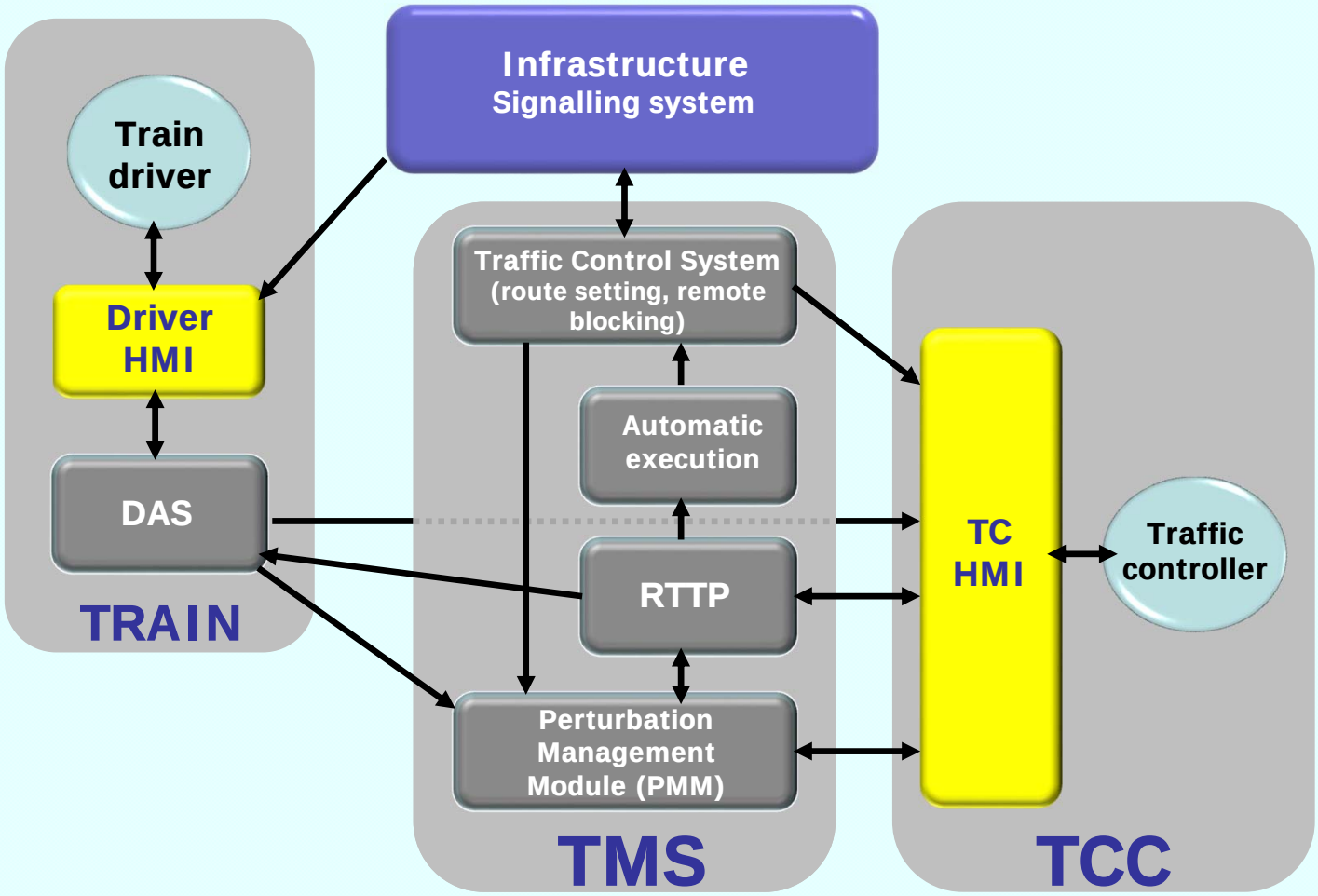
Objectives

- The objectives of the study are to:
  - Simulate normal traffic on the Iron Ore Line (IOL)
  - Evaluate the Hermes simulator for the IOL
  - Generate a number of relevant perturbation scenarios
  - Perform simulations for these scenarios
    - Using only the Hermes simulator
    - Using the perturbation management module (PMM) developed in WP4
  - Evaluate the performance of the PMM
    - Qualitatively
    - Quantitatively

The Iron Ore Line

- Kiruna (Sweden) to Narvik (Norway)
- Single track, 165 km long
- Heavy trains, 8600 tons, 750 m long
- Mixed traffic
- High capacity utilization

The ON-TIME PMM



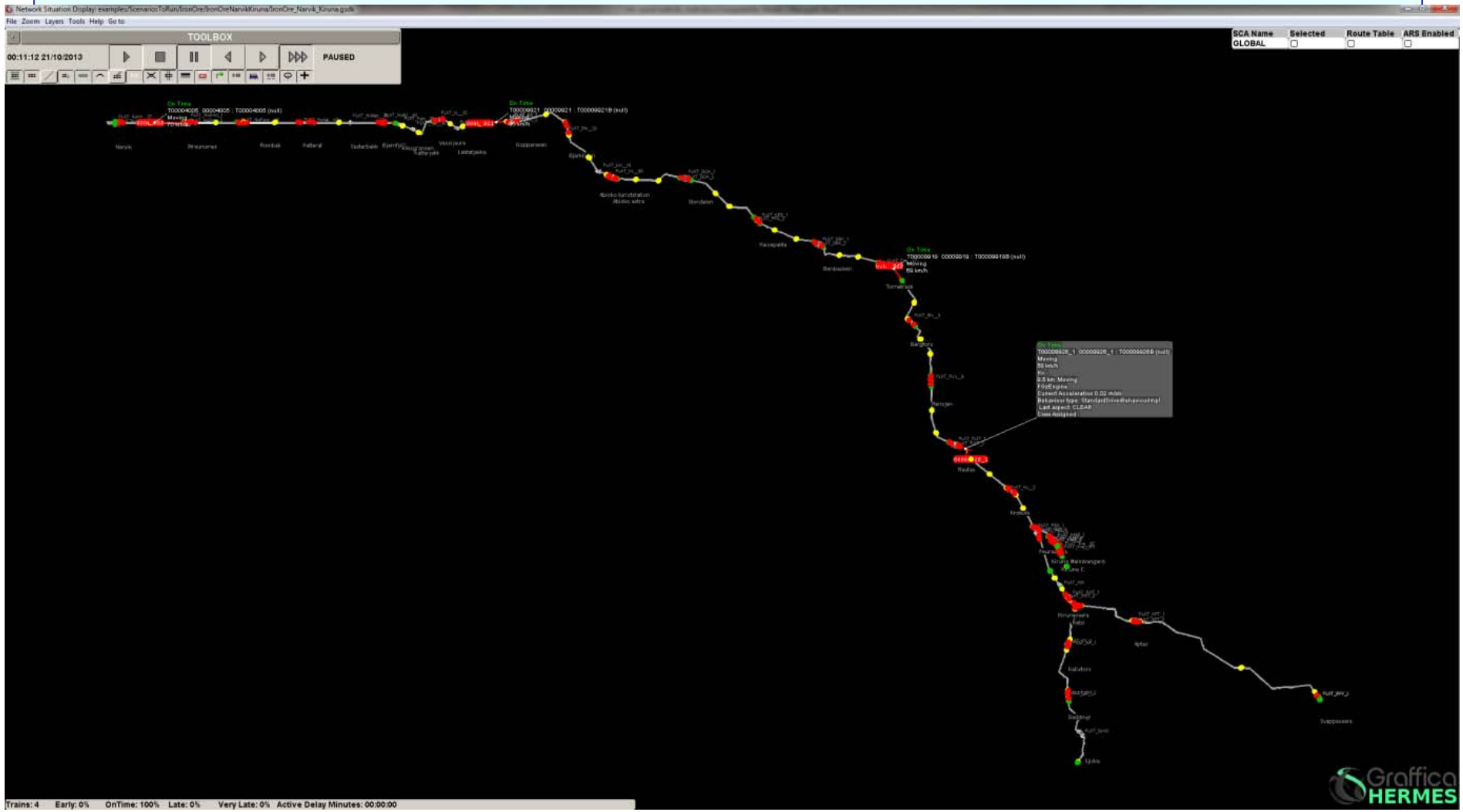
Scenarios

- The following scenarios have been specified
  0. Baseline simulation, no perturbations
  1. One Iron Ore Train delayed at departure
  2. Extra train added
  3. Long distance freight train delayed
  4. Speed restriction between stations
  5. Point out of order at one location
     - Meetings not possible

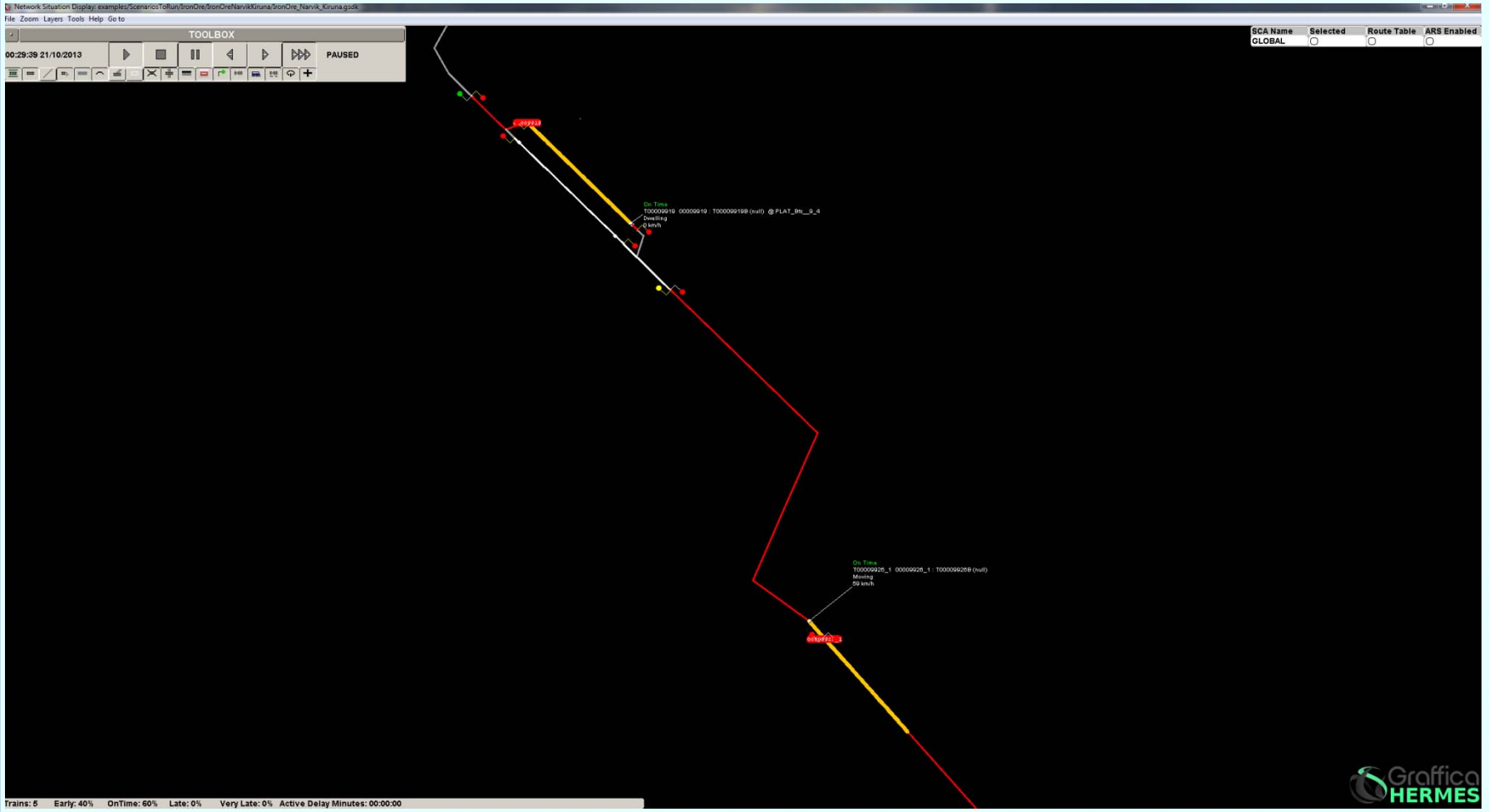
Output from simulations

- Hermes simulator output
- The Matlab tool, developed by UoB
  - Uses log-files generated by Hermes
  - Calculates quantitative measures for specified key performance indicators (i.e. journey time, resilience, punctuality, energy consumption, resource usage....).
  - Calculates and presents time-distance graphs for qualitative evaluation of PMM re-planning.

Hermes – Iron Ore Line

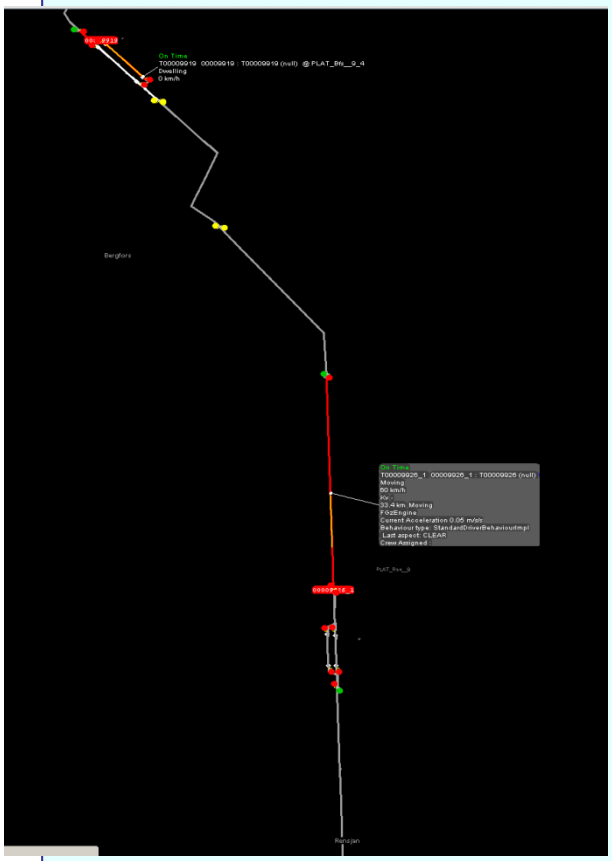


Meeting at station



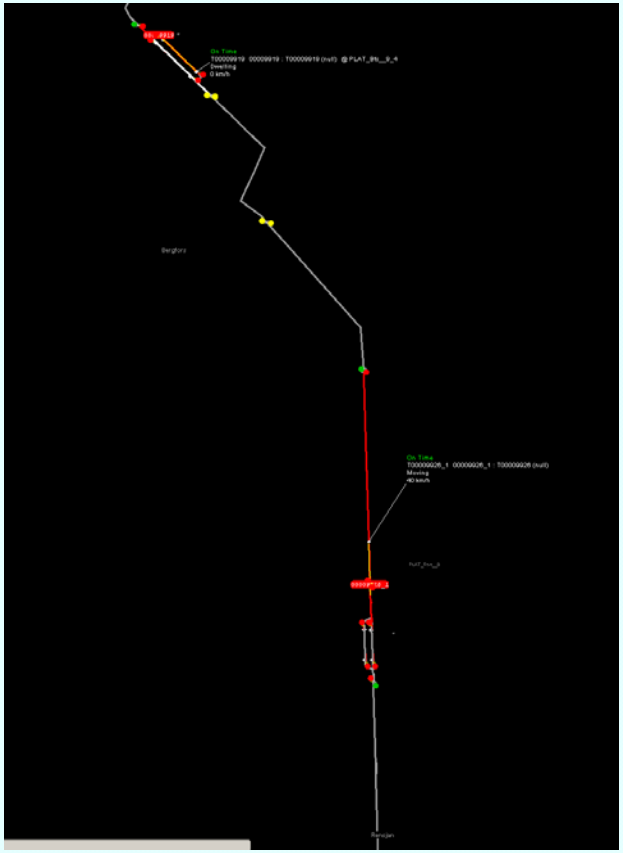
Train 9919 and Train 9926 meet at BFS - 12:29

Hermes - Speed Restrictions



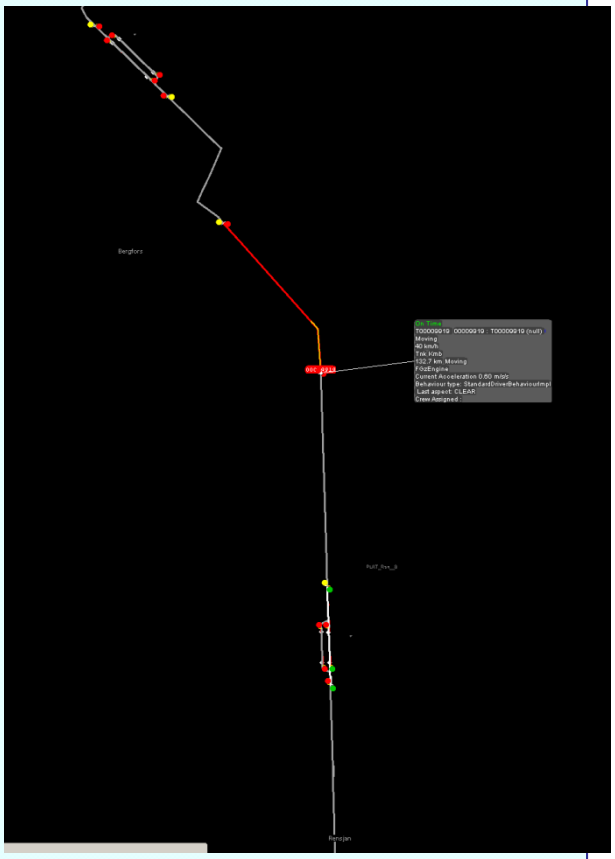
Baseline Scenario

Train 9926 drives at a speed of 60km/h between the stations RSN and BFS



Speed Restriction

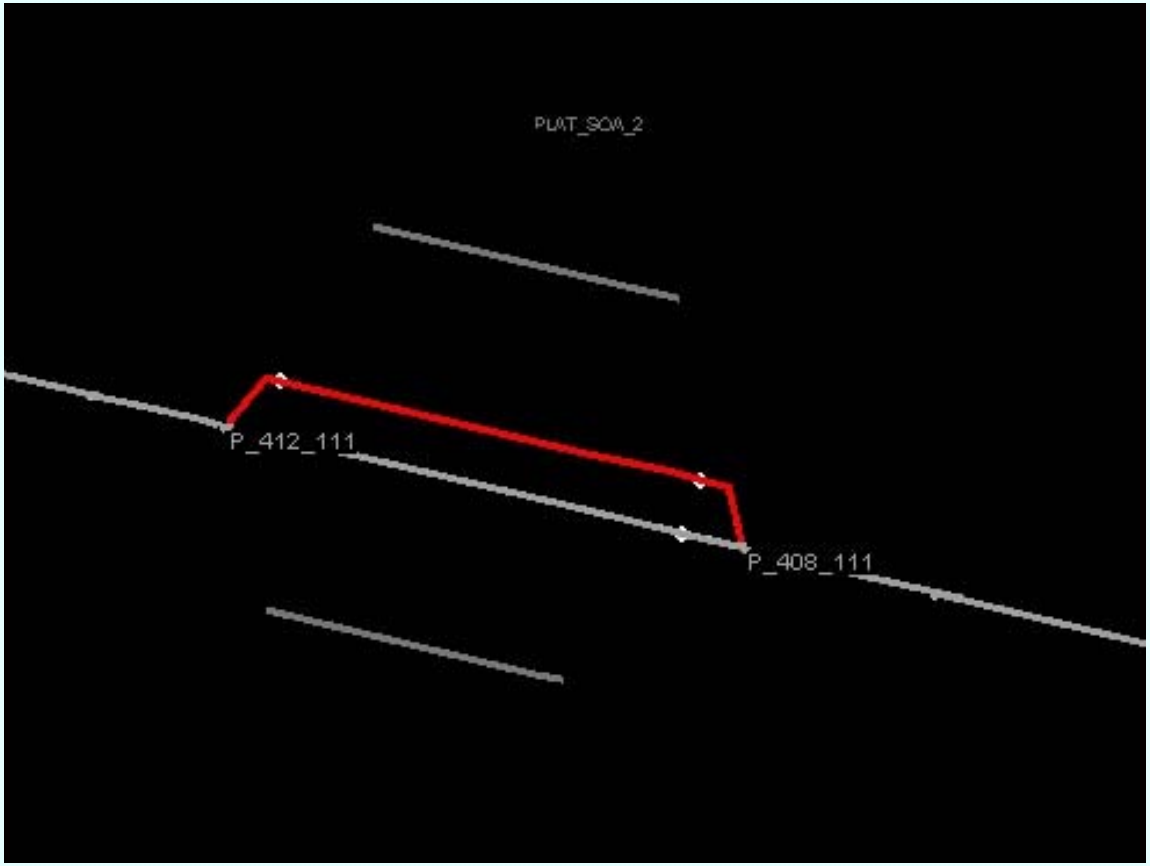
Train 9926 drives at a speed of 40km/h between the stations RSN and BFS



Speed Restriction:

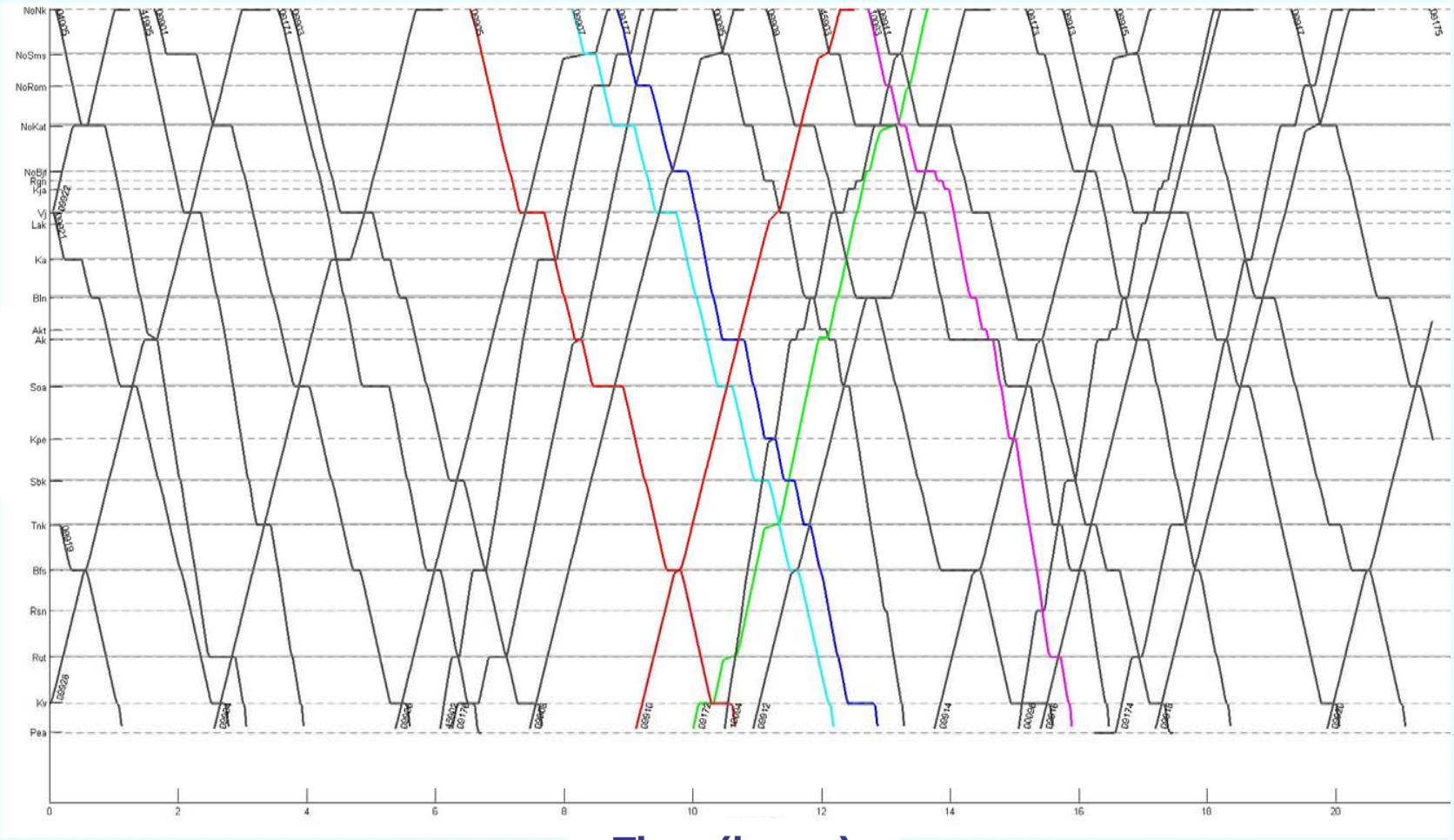
Train 9919 drives at a speed of 40km/h between the stations RSN and BFS

Side Track Disrupted



Side track at SOA is disrupted

Time-distance graph



Simulations

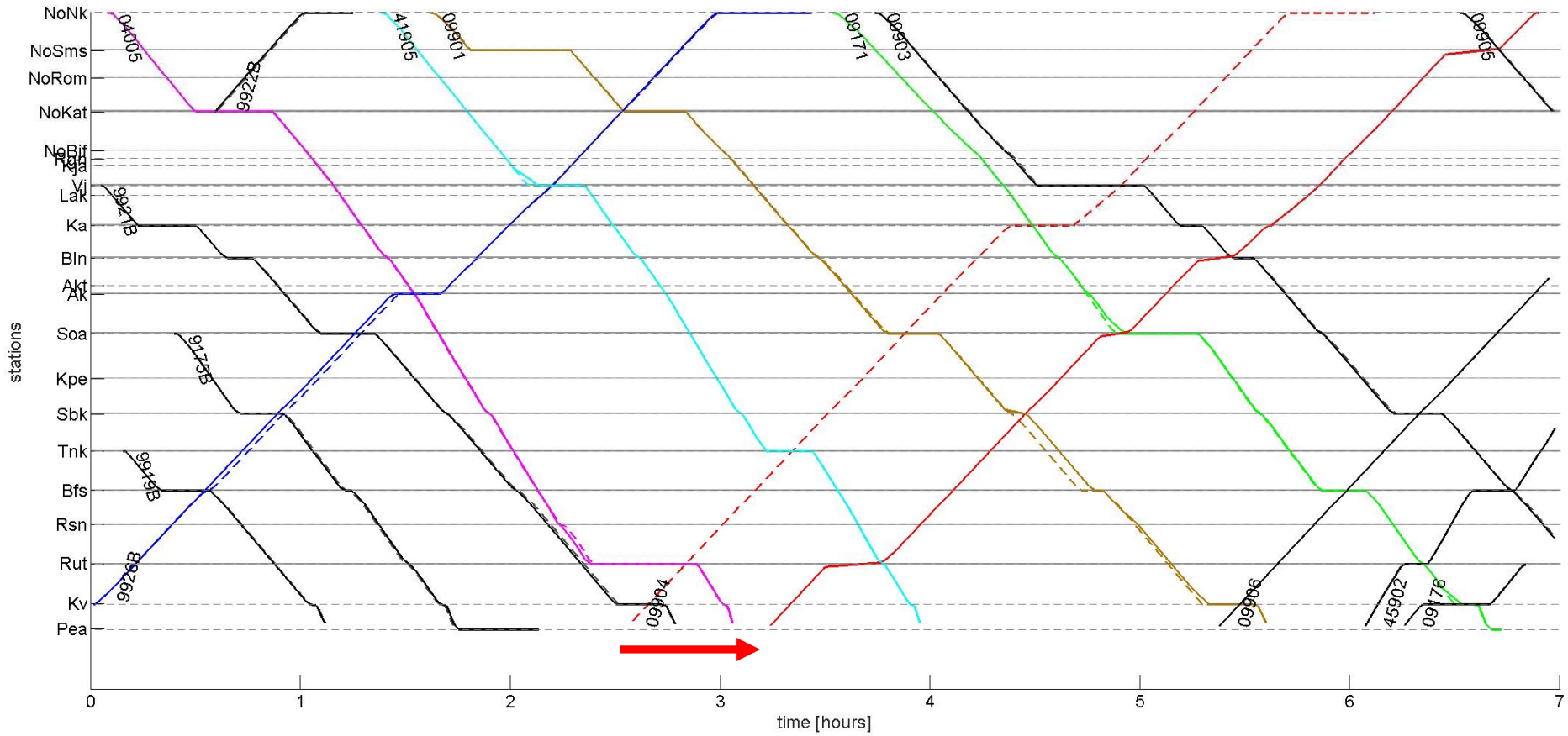
- Simulations performed
  - Baseline simulations, with original timetable, no perturbations, to validate the model
  - Simulations with perturbations for the different scenarios, no PMM
    - Scenario 1: One iron ore train delayed
    - Scenario 2: Speed restrictions between two stations
  - Simulations with perturbations for the different scenarios, with PMM
    - ROMA algorithms
    - RECIFE algorithms

Conclusions

- The Hermes simulator can simulate the IOL, with some limitations.
- The PMM algorithms can perform operational re-planning in the tested scenarios.
- To be fully relevant for the IOL, additional requirements must be fulfilled. Some limitations today are:
  - Headways are sometimes too small
  - Unnecessary stops for meetings are not eliminated
  - Priorities between trains are not specified
  - The interactive connection to human control is not developed
  - The integration of the PMM into the HMI of the traffic controller is not developed

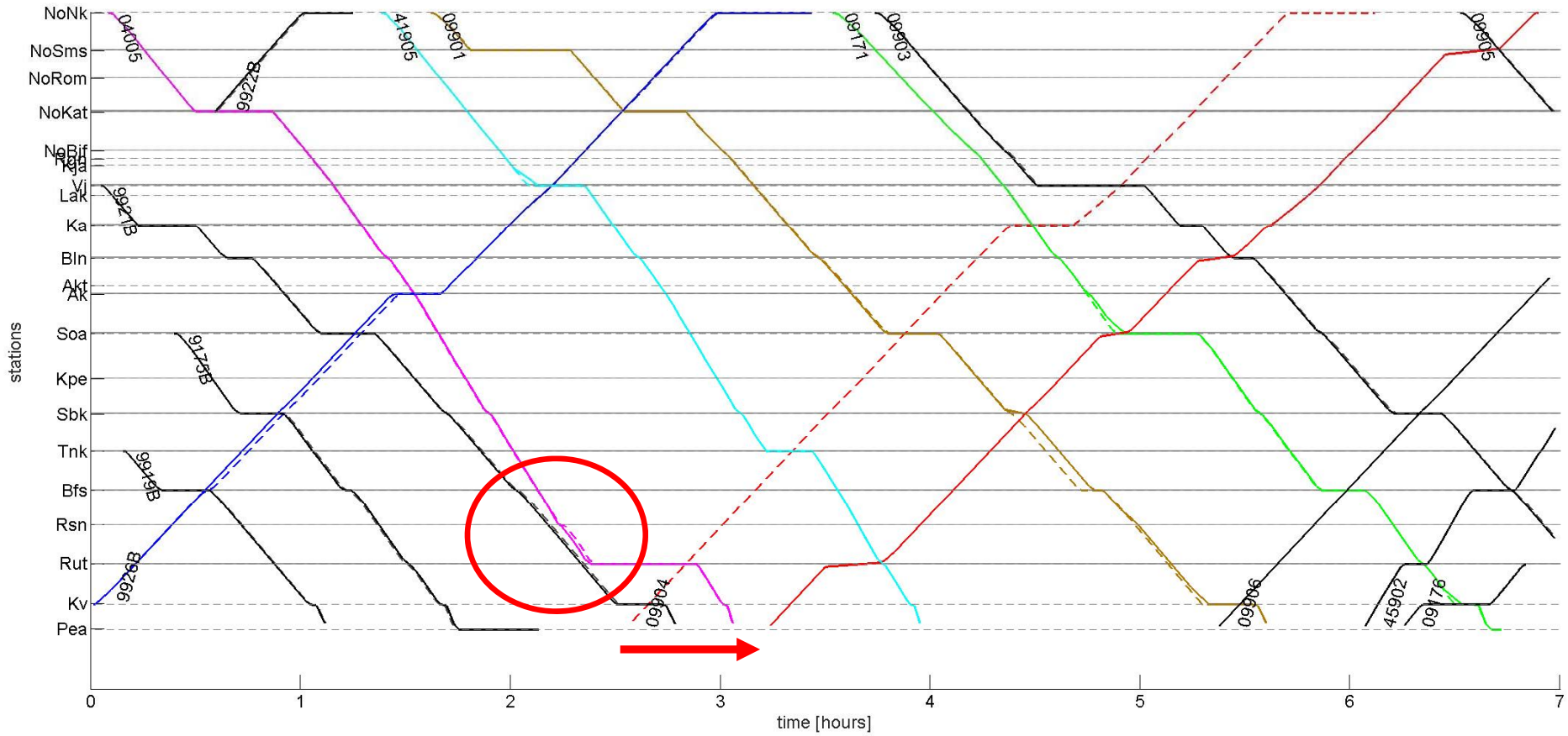
Scenario 1 - ROMA

A delayed iron ore train



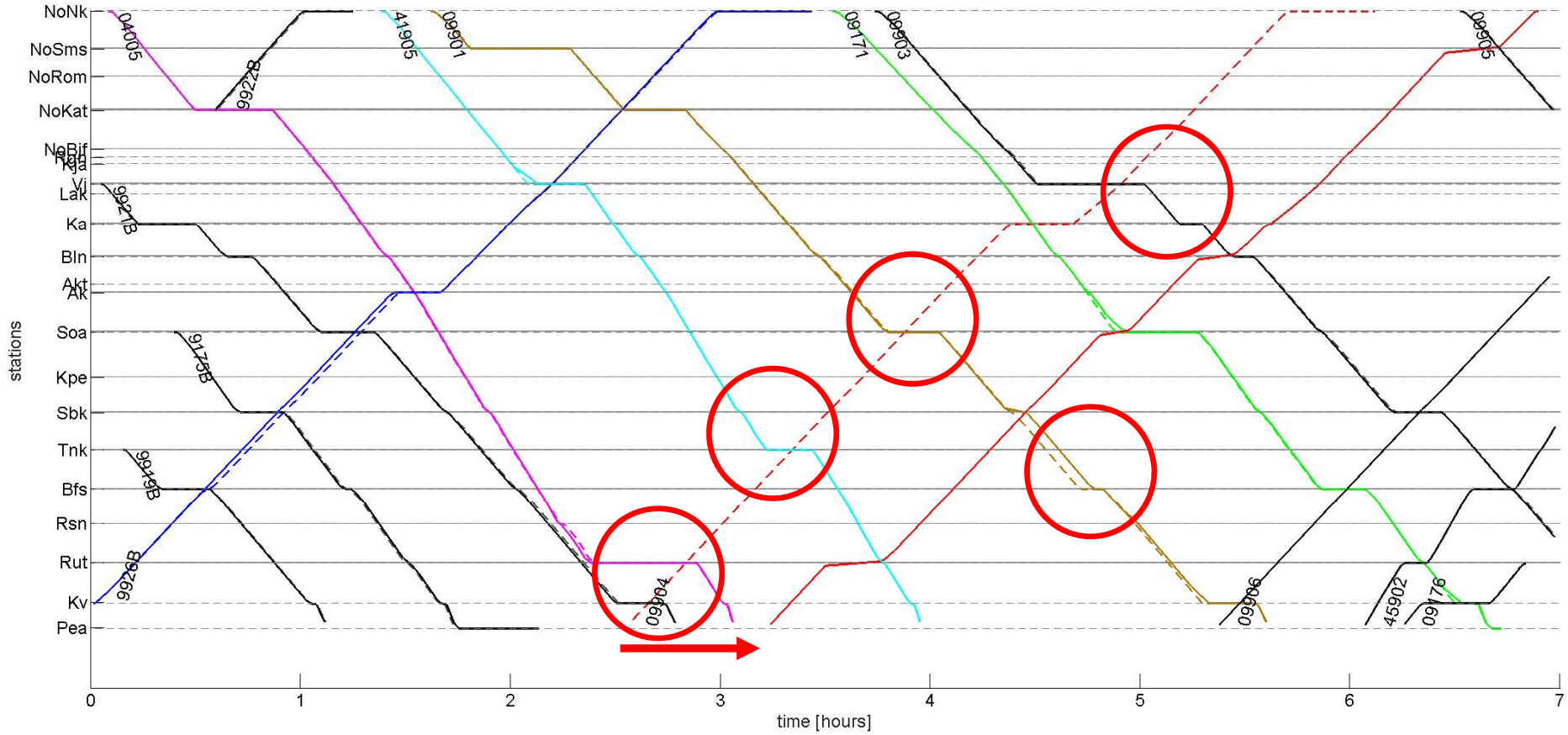
Scenario 1 - ROMA

Short headways



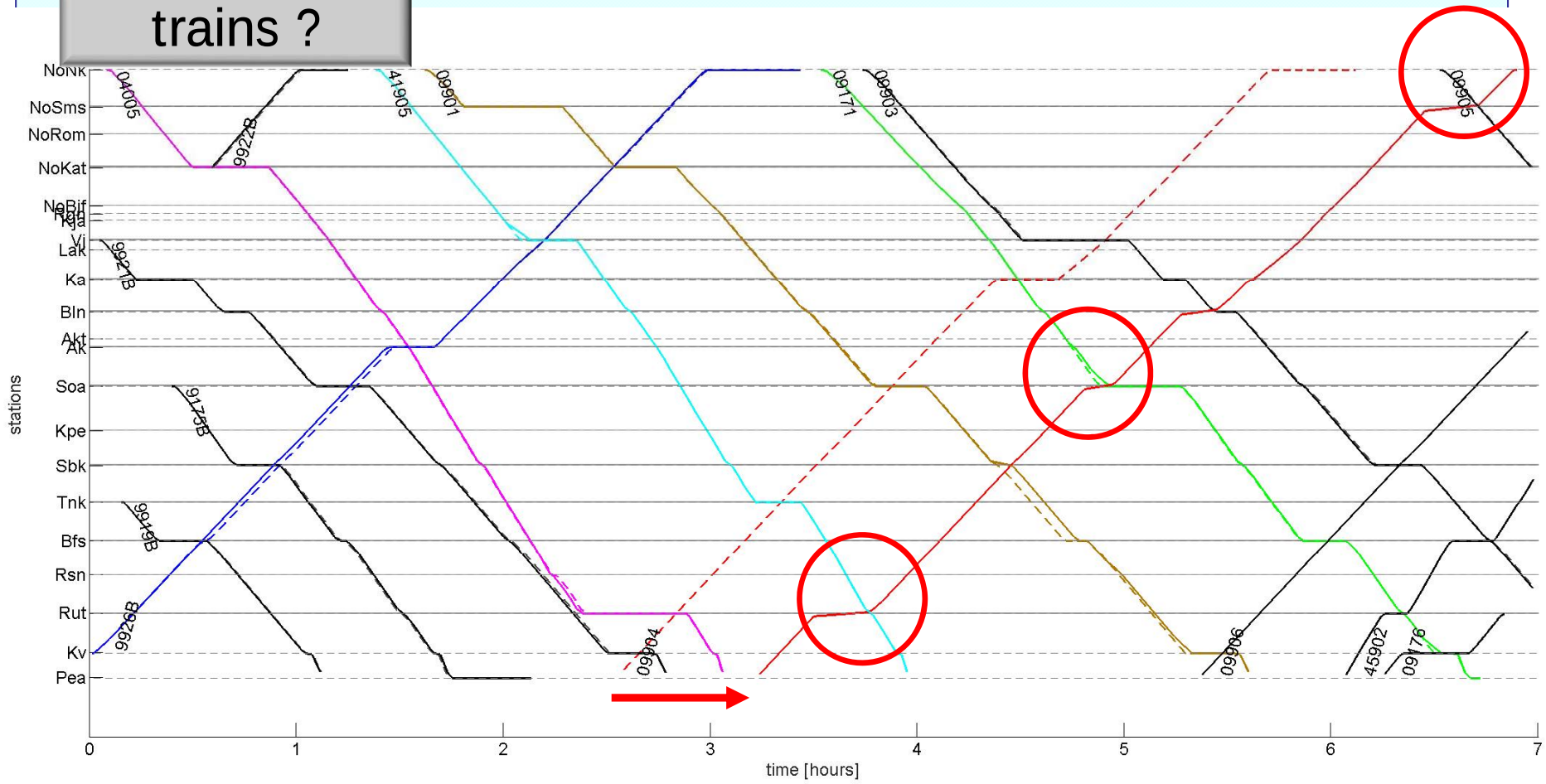
Scenario 1 - ROMA

Unnecessary stops not eliminated

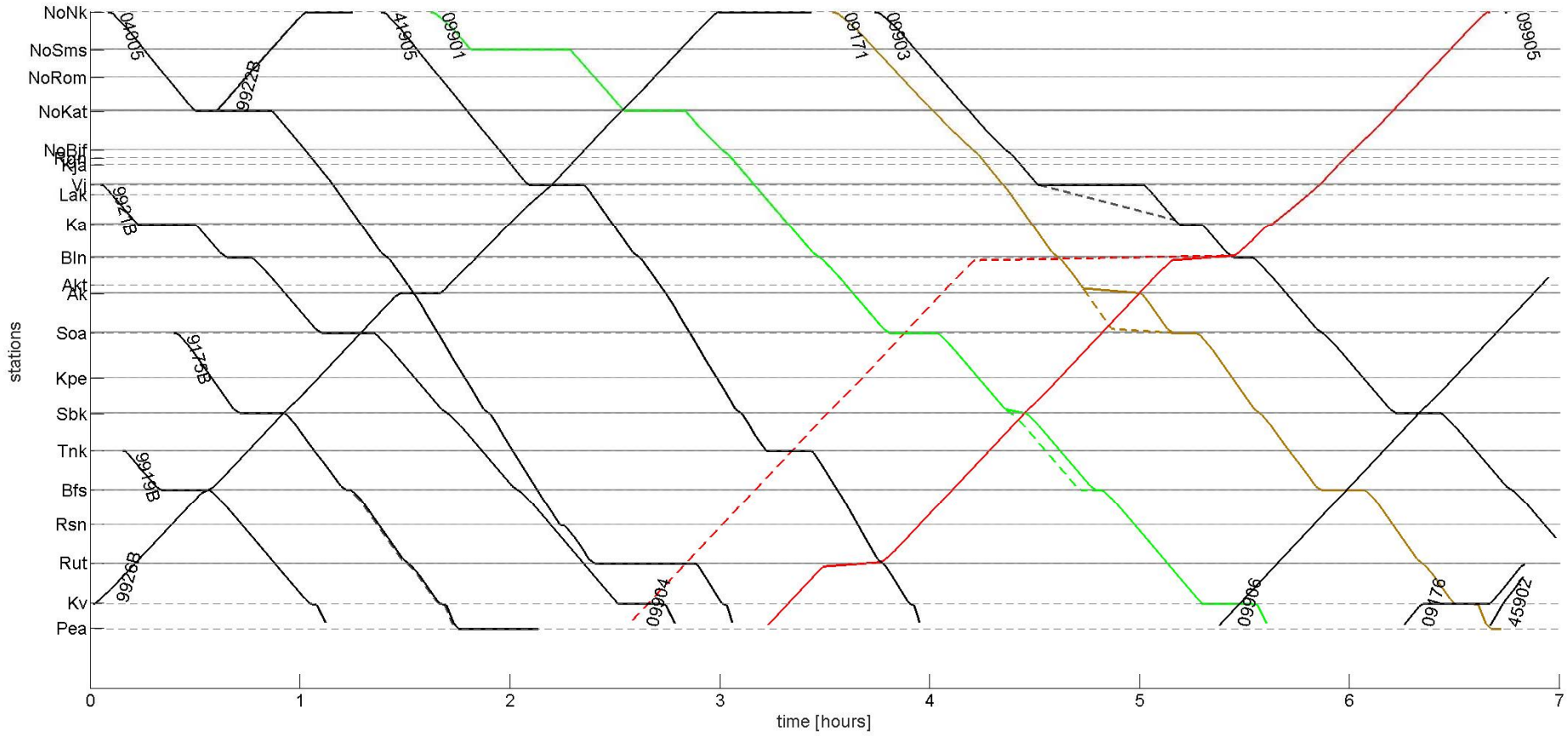


Scenario 1 - ROMA

Priorities between trains ?

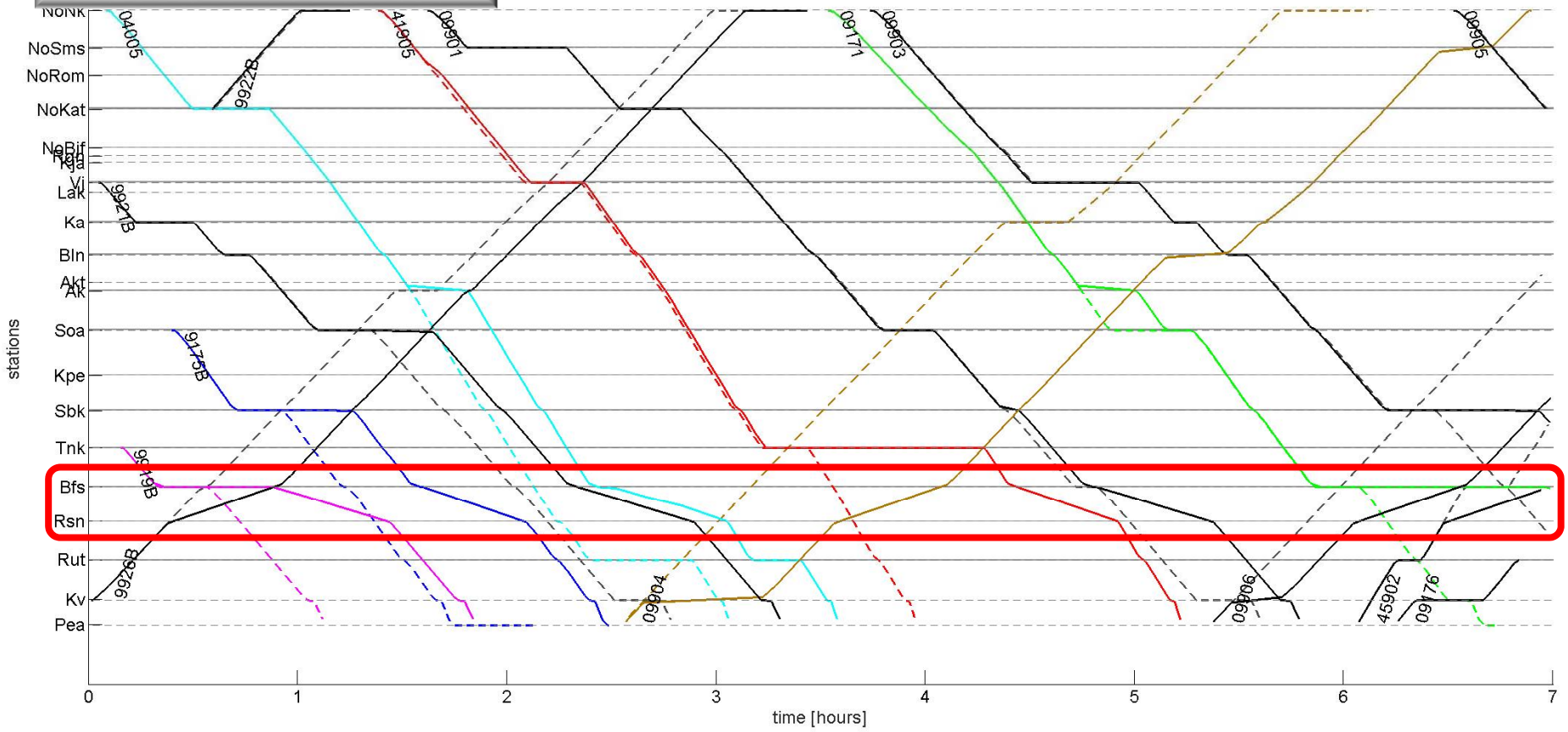


Scenario 1 - RECIFE



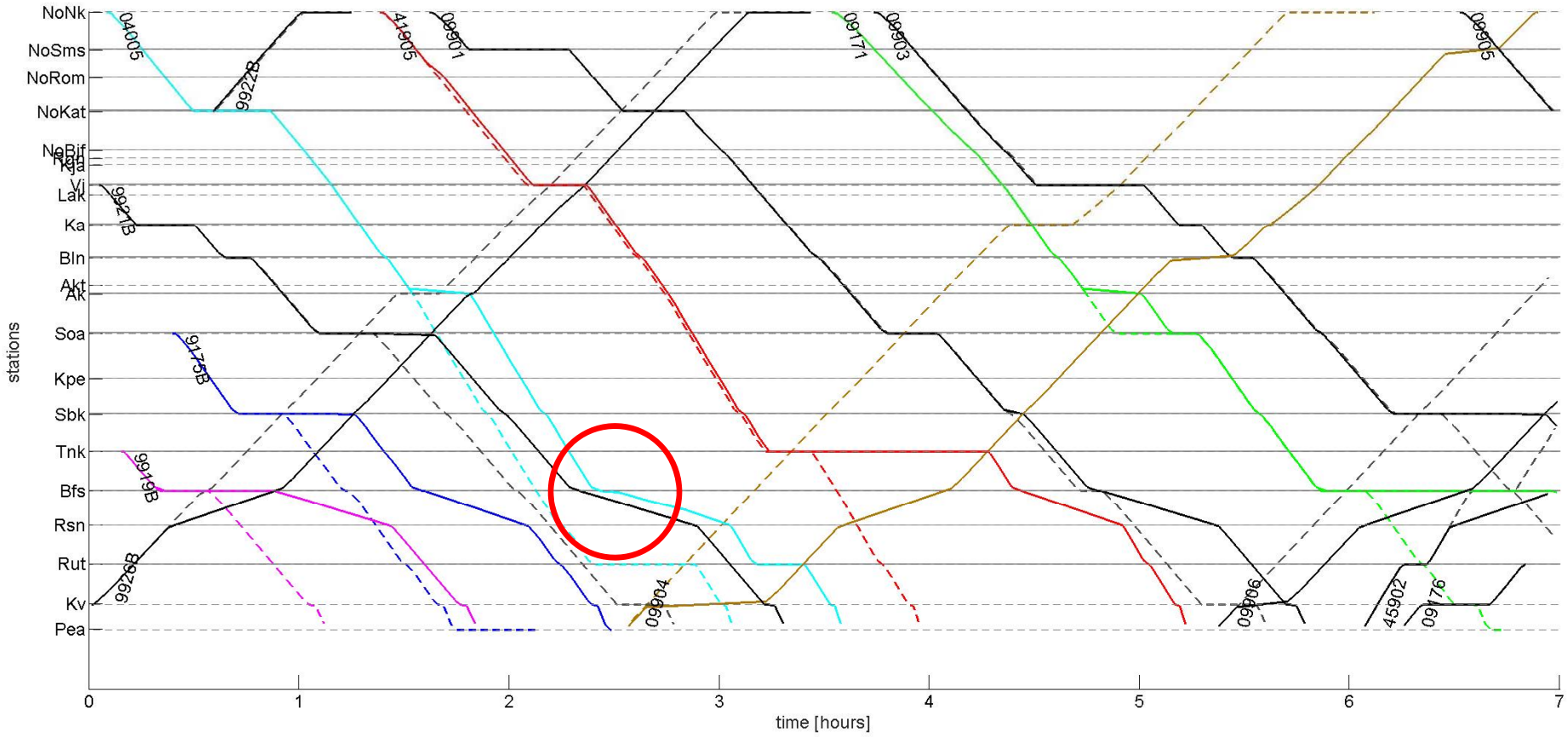
Scenario 2 - ROMA

Speed restrictions
Rsn-Bfs
(20 km/h)



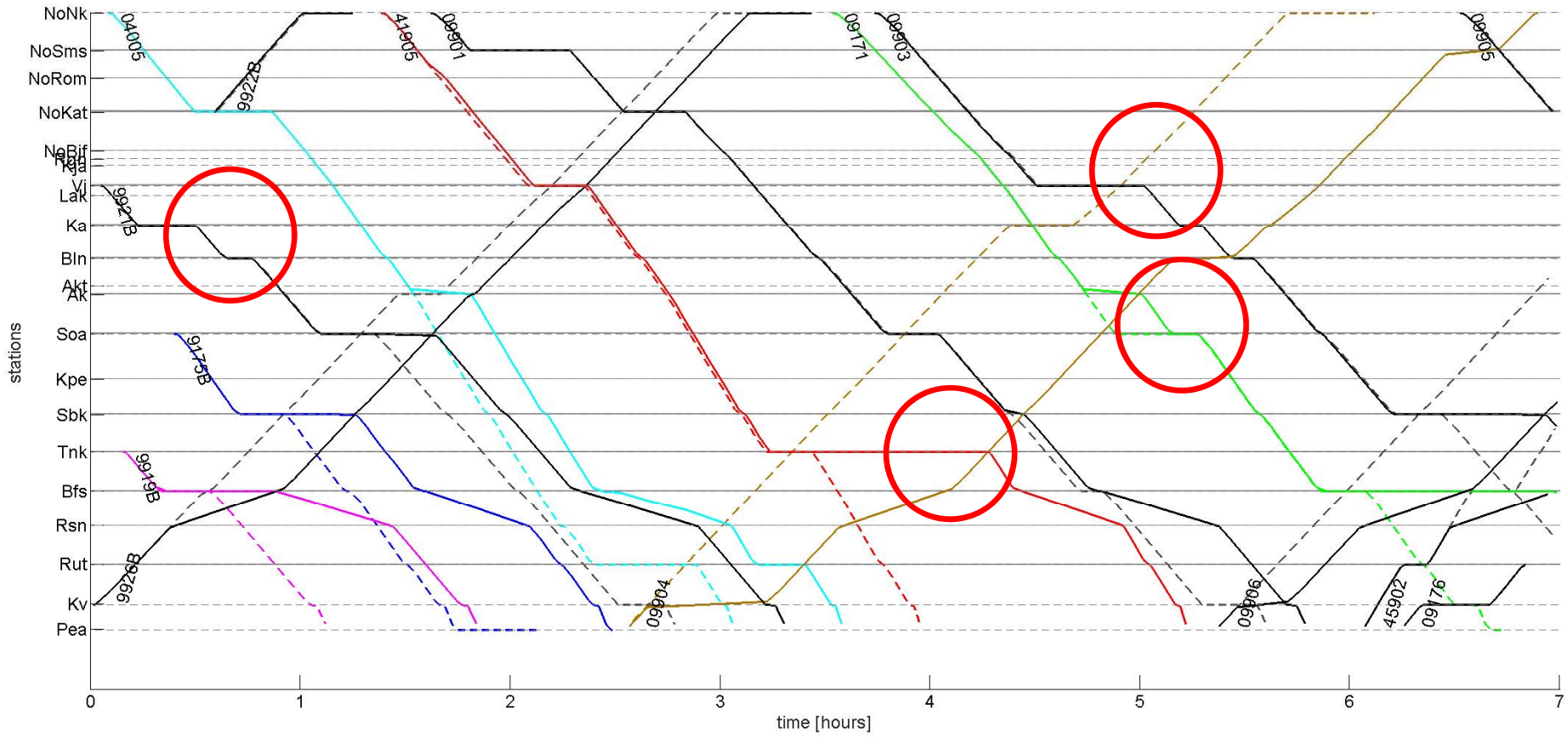
Scenario 2 - ROMA

Short headways?



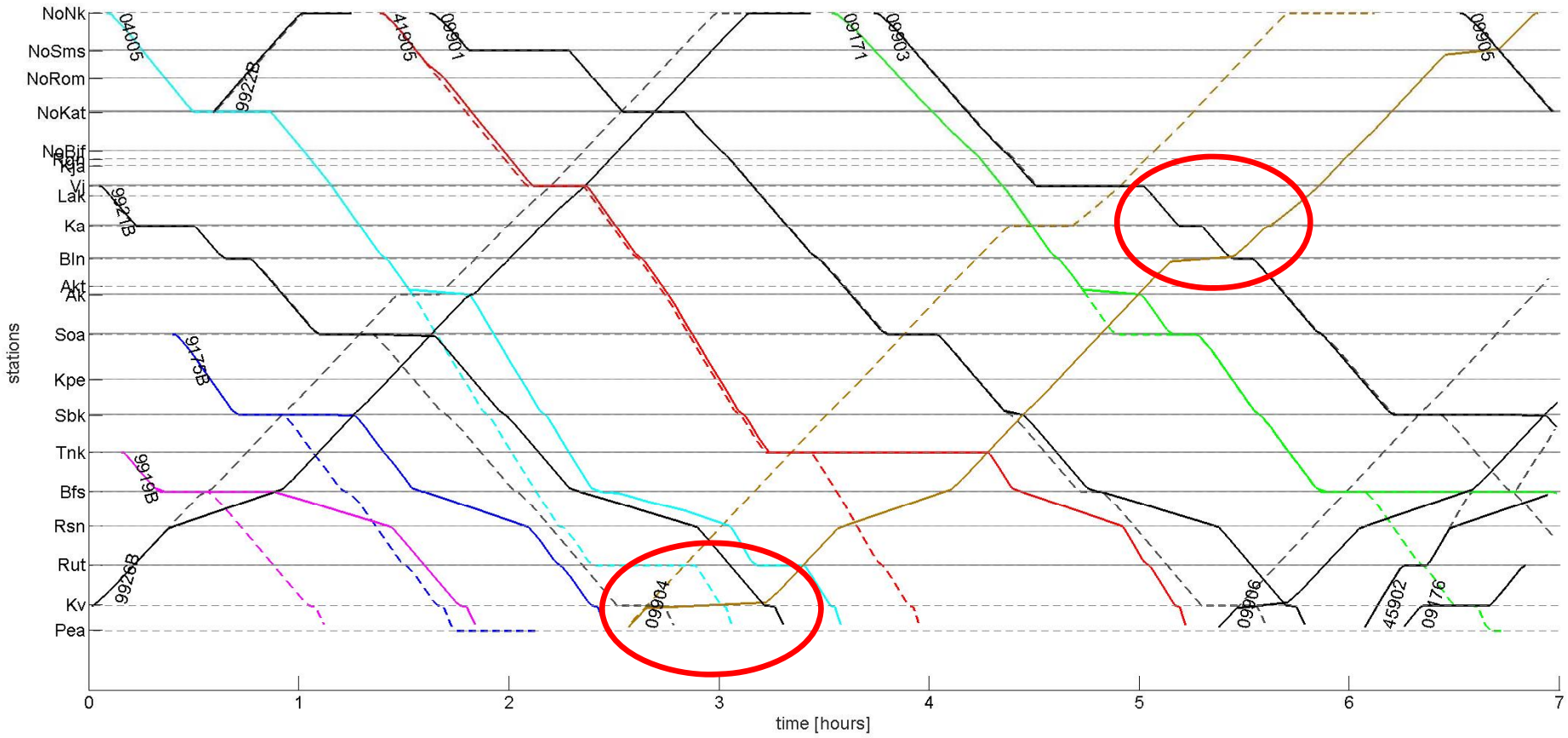
Scenario 2 - ROMA

Unnecessary stops

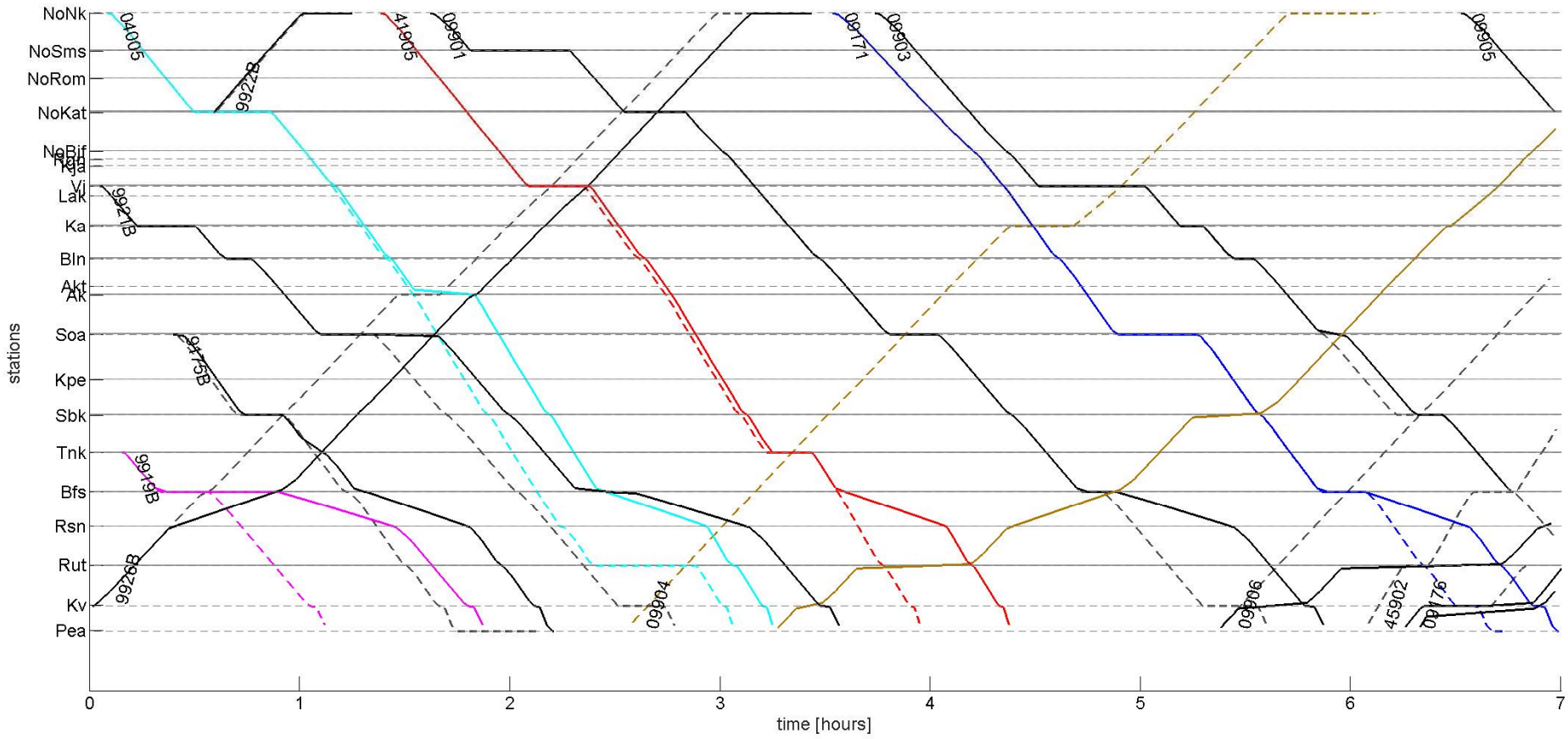


Scenario 2 - ROMA

Priorities between trains?



Scenario 2 - RECIFE



Final Conclusions

- Further evaluation of the simulations are needed
- The quality of the RTTP generated by the PMM will be further evaluated
- Additional elements must be included in the model and in the PMM, e.g.:
  - Different types of stops/meetings (fixed, dynamic..)
  - Priorities
- Interactivity must be developed, together with HMI for the traffic controllers