Rail Optimization

TMS: A CLOSED-LOOP RE-SCHEDULING SYSTEM

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CASE STUDY DEN BOSCH

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  - Approach and results
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  - TMS effects

- Conclusions and Next
  - Train on the line.
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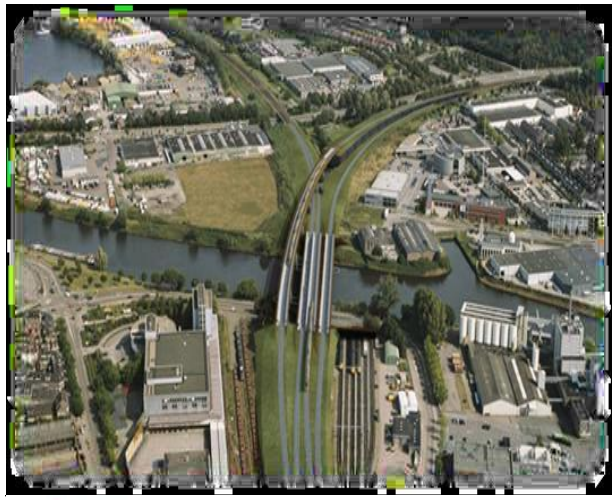
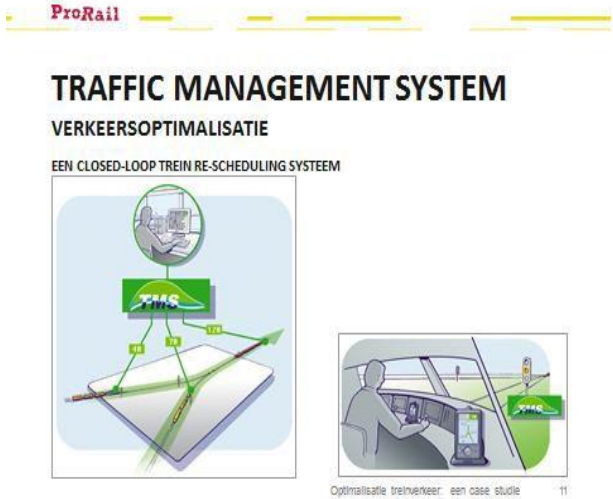




TIMETABLE AND INFRASTRUCTURE

Capacity development and distribution

Data transport demand ....

...design functionality infrastructure

travelers

goods

train paths

timetable

tracks

buttons, transfer

Given the infrastructure

...

...design lines

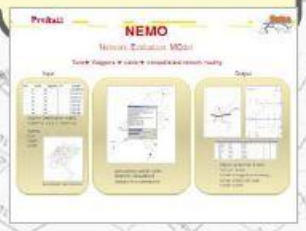
ONTWERPPROCES

VISUM

NEMO

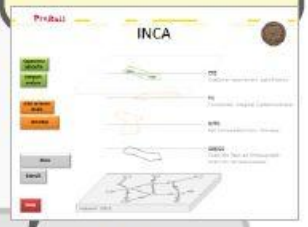
Vervoersbehoefte

- Reizigers
- Vracht



INFRA MONITOR

INCA



Infrastructuur

Verkeeersbehoefte Lijnvoeringen

- Frequenties
- Treintype
- Regelmaat
- Snelheid
- Aansluitingen….
- Onderhoud

Dienstregeling

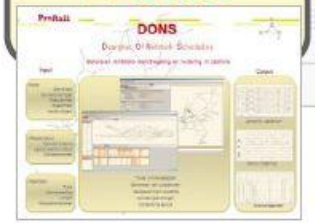
Kwaliteit Robuustheid

- Layout Netwerk
- (micro-macro)
- Beveiliging
- Energievoorziening
- Materieel
- [illegible]neel

Ontwerpnormen

- Rij- en halteertijden
- Opvolgtijden
- Buffers
- Conflicten
- ….

DONS



ROBERTO

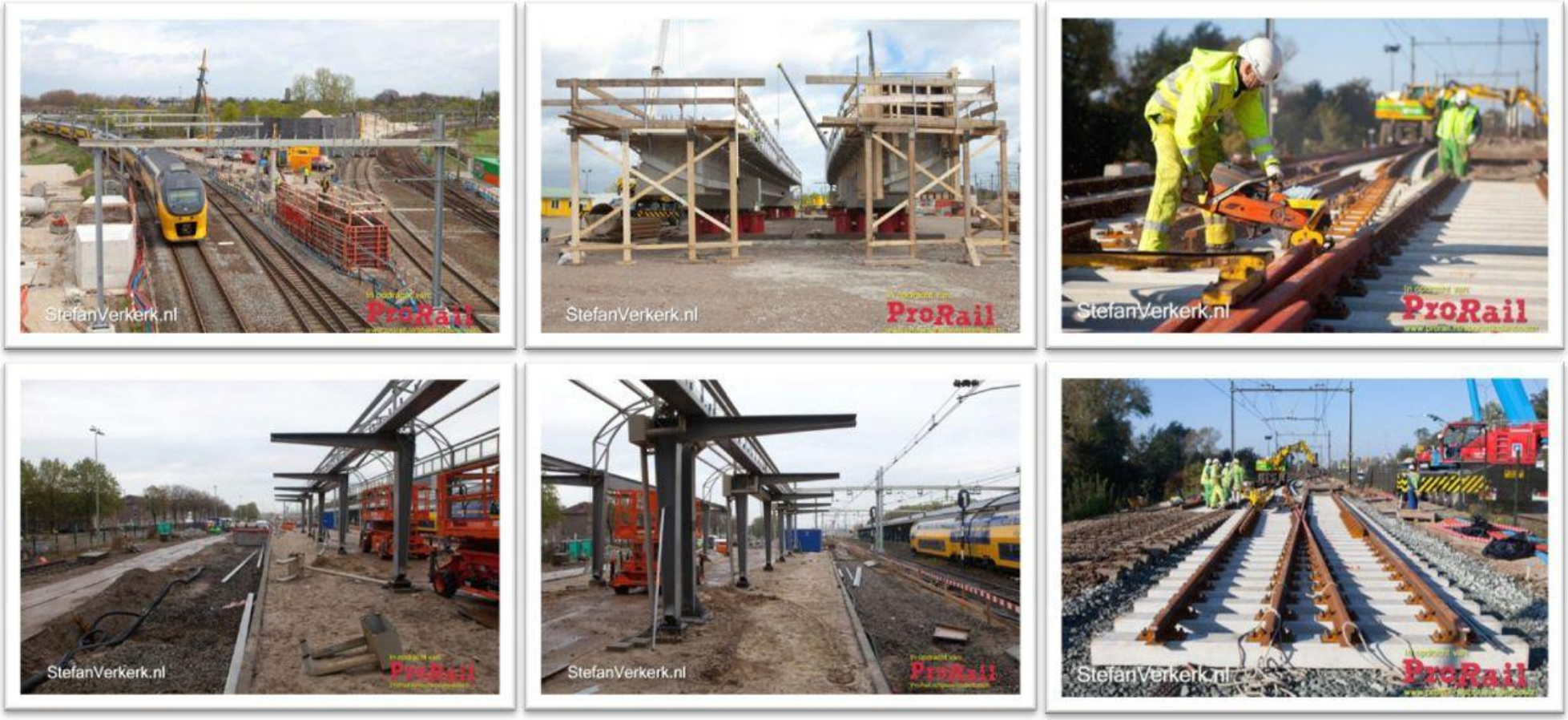
SIMONE

FRISO

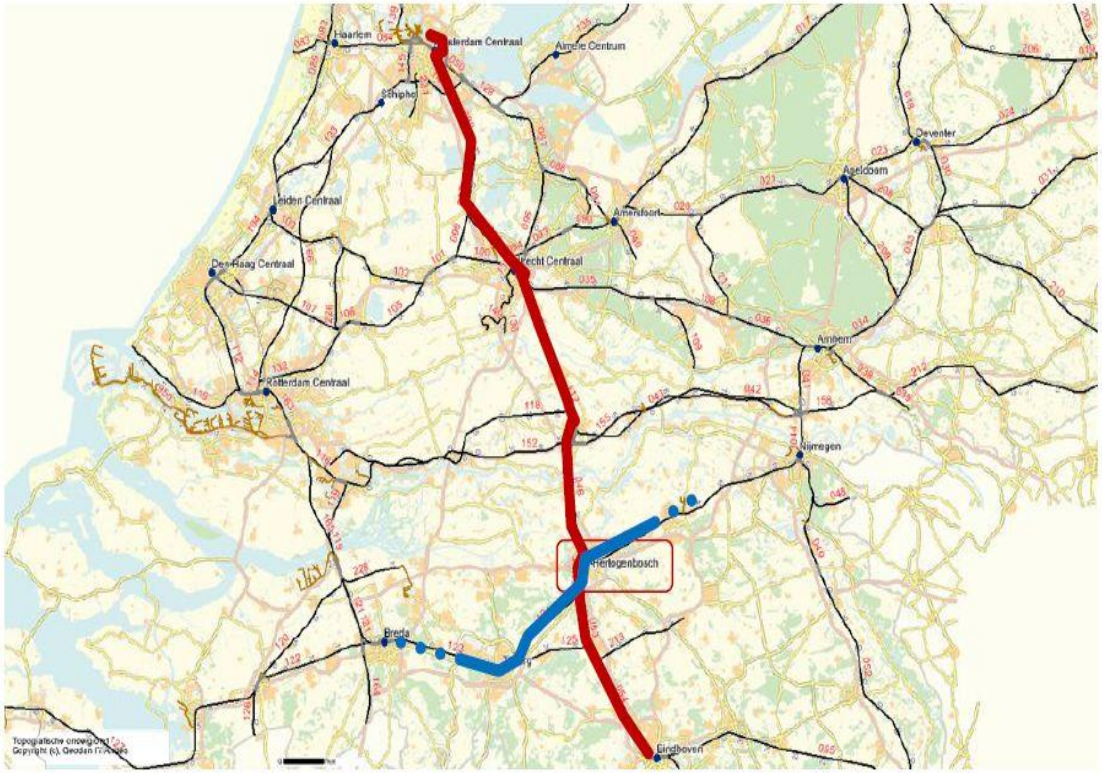
SITA

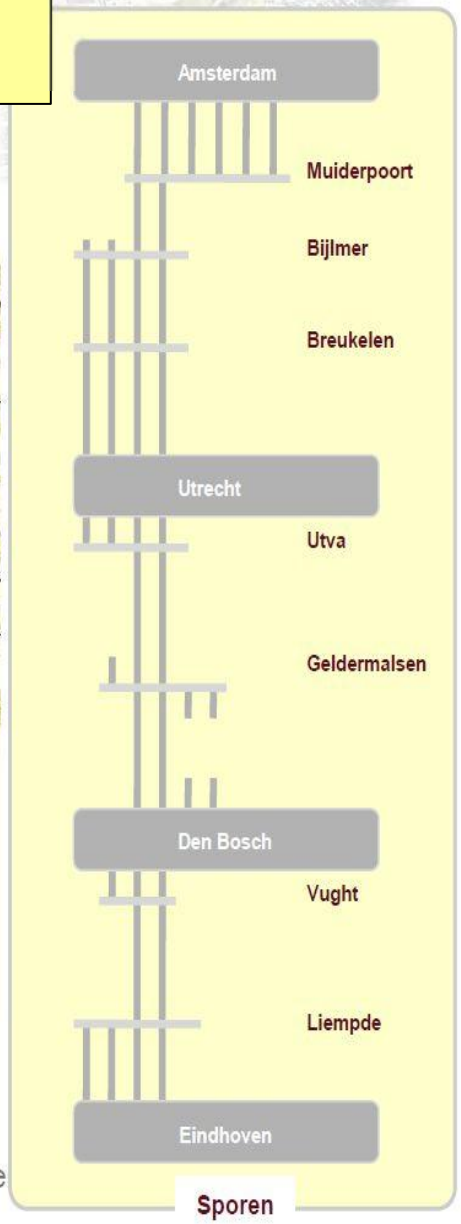
CASE STUDIE DEN BOSCH

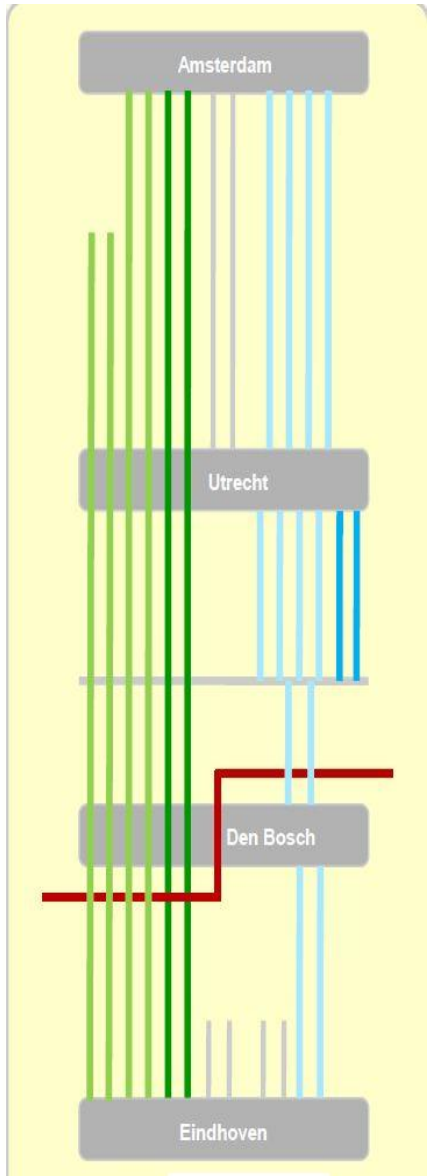
AANPASSEN CAPACITEIT SPOREN EN PERRONS



Future service line

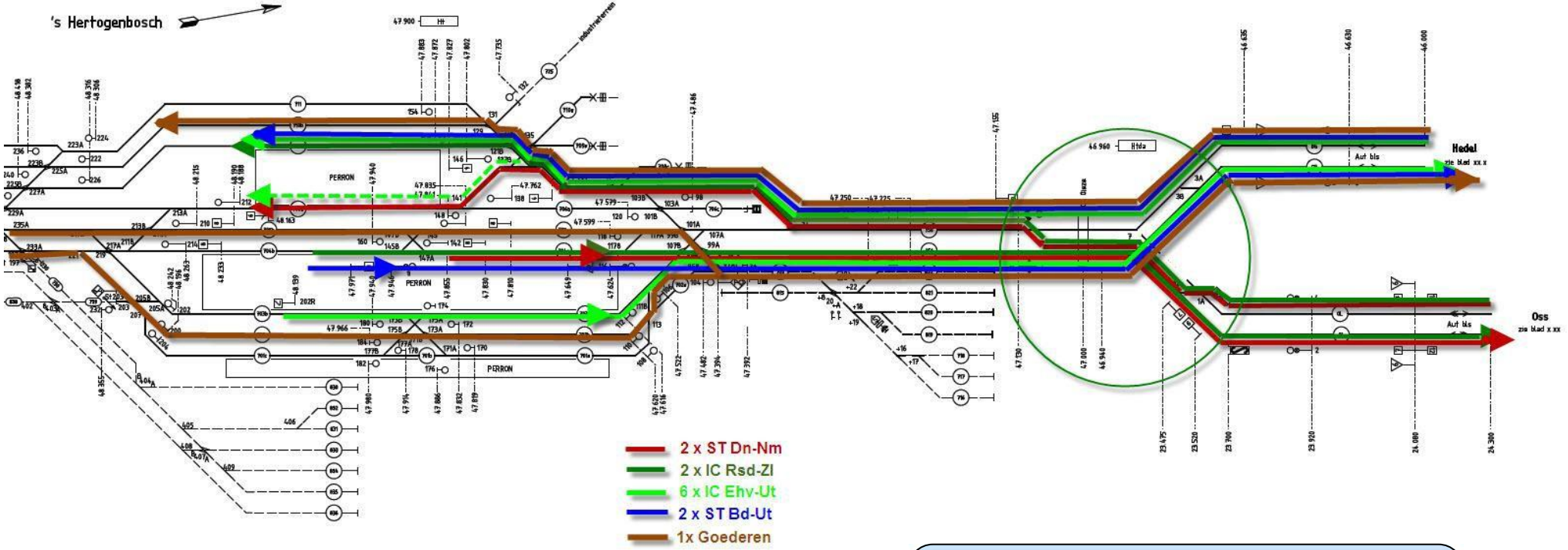






CASE STUDY DEN BOSCH

TRAIN ROUTES



Disruptions in operation:
How do we send more trains over less infrastructure?

18 trains per hour = average follow-up of 200 sec in planning

TRAFFIC MANAGEMENT SYSTEM

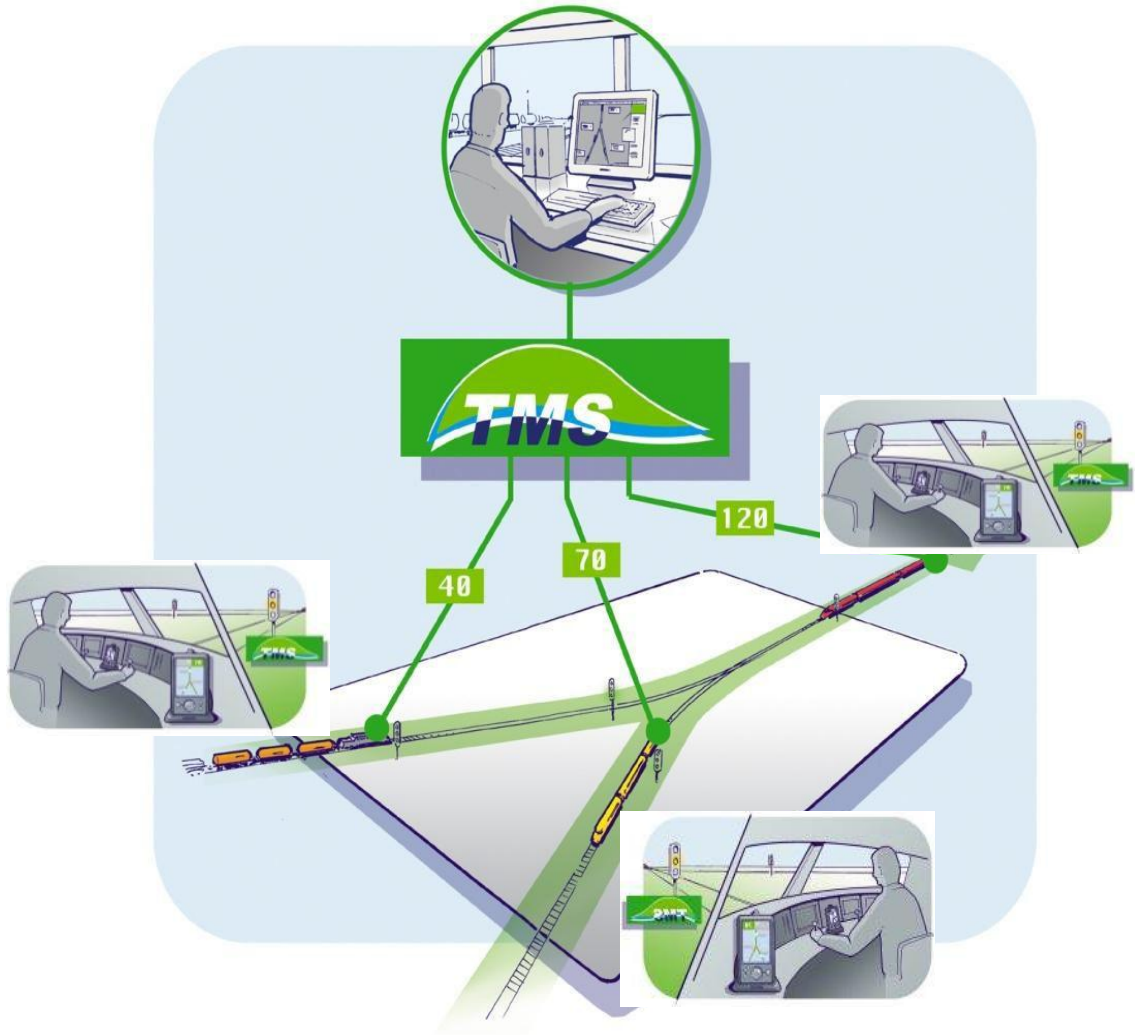
HISTORY

Development started in EU project COMBINE
- **Variable and sliding blocks**
- **Adjusted for fixed blocks (NS'54)**

Practice Pilot "Green Wave
- **TMS opinions used in surgery**
- **Growing confidence mcn, trdl, vkl**

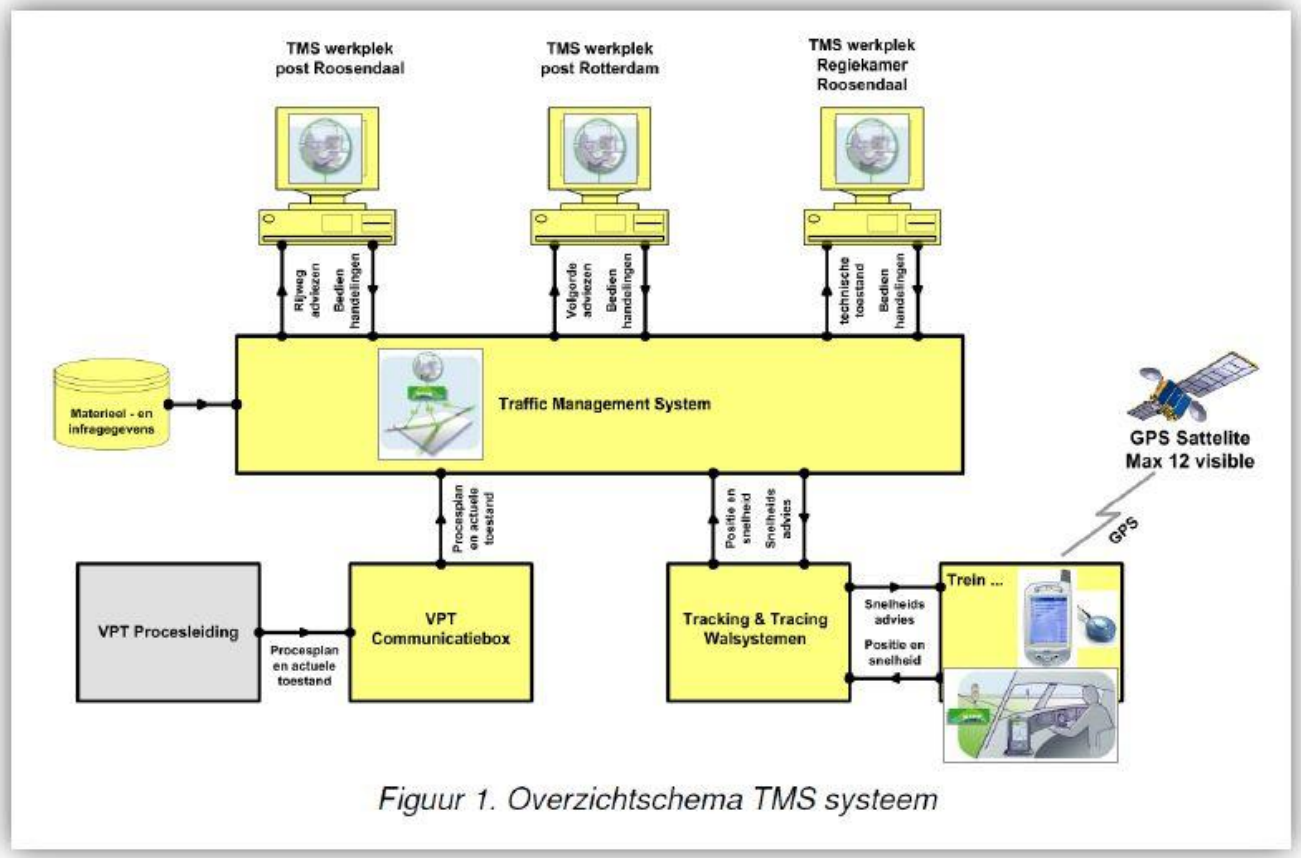
Effects:
- **Increase punctuality level (3-6%)**
- **Reduced energy consumption (10%)**
- **Fewer unplanned stops**

Lessons learned
- **Quality GSM / GPS data**
- **Plan Consistency in change (VL)**
- **Transfer TMS advice to PRL**



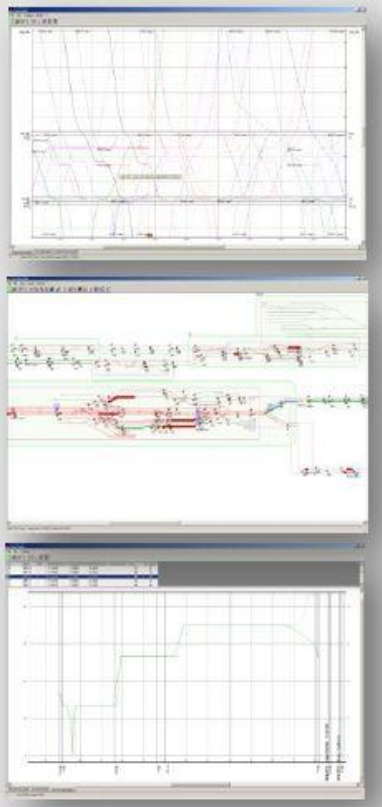
‘GROENE GOLF’

REAL LIFE PILOT



Figuur 1. Overzichtschema TMS systeem

GUI infra en plan status



TRAFFIC MANAGEMENT SYSTEM

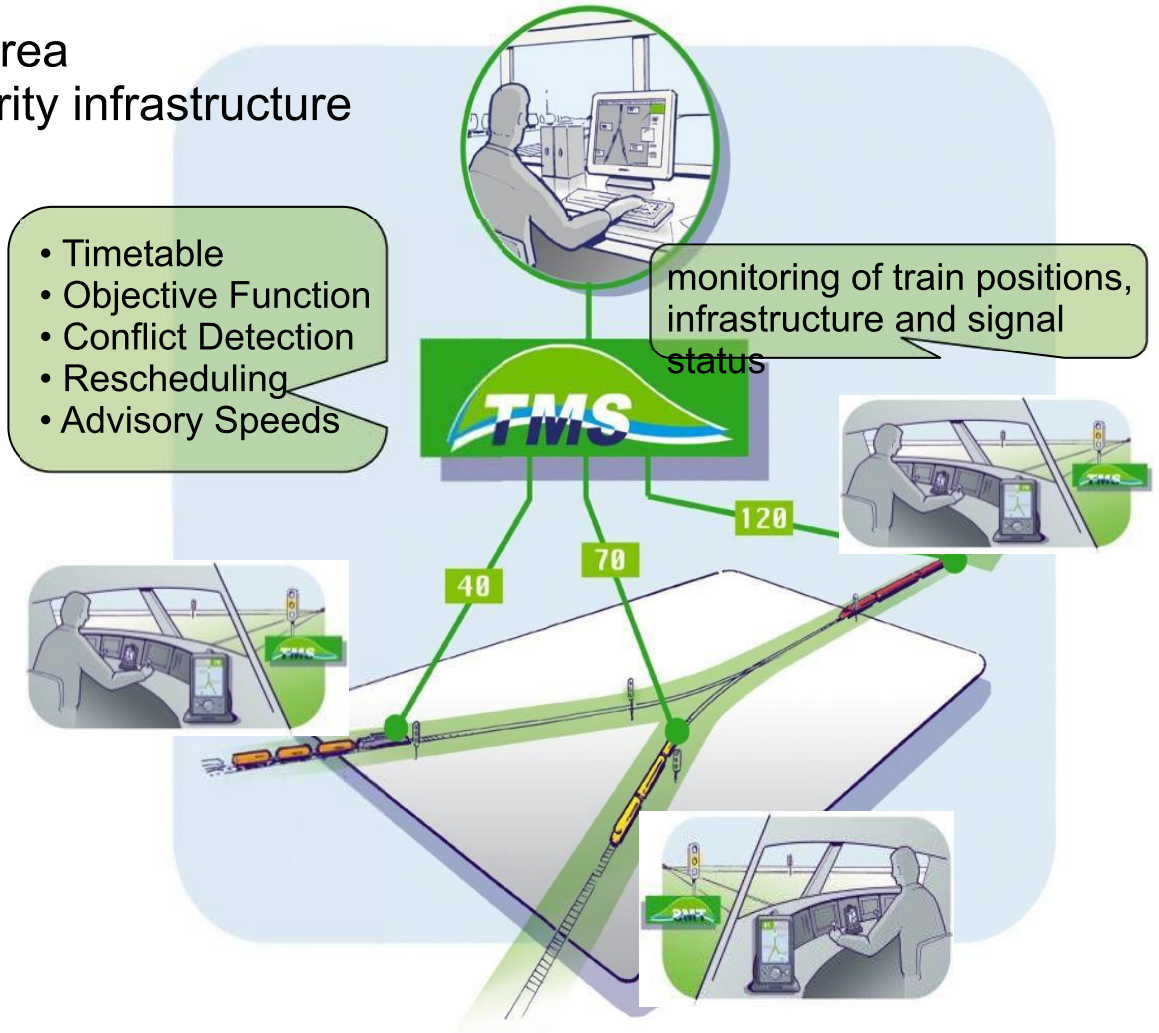
HOW DOES IT WORK?

Continuous monitoring all trains in the area
• Current train position, status and security infrastructure

Optimize performance
• Predicting conflict
• Sequence of views at intersections
• Adjust plan times
• Use alternate routes [optional]
• Calculate the optimum speed profile

Route Booking management
• Route mapping
• Set times
• Update status

Communication to driver and traffic and Traffic management



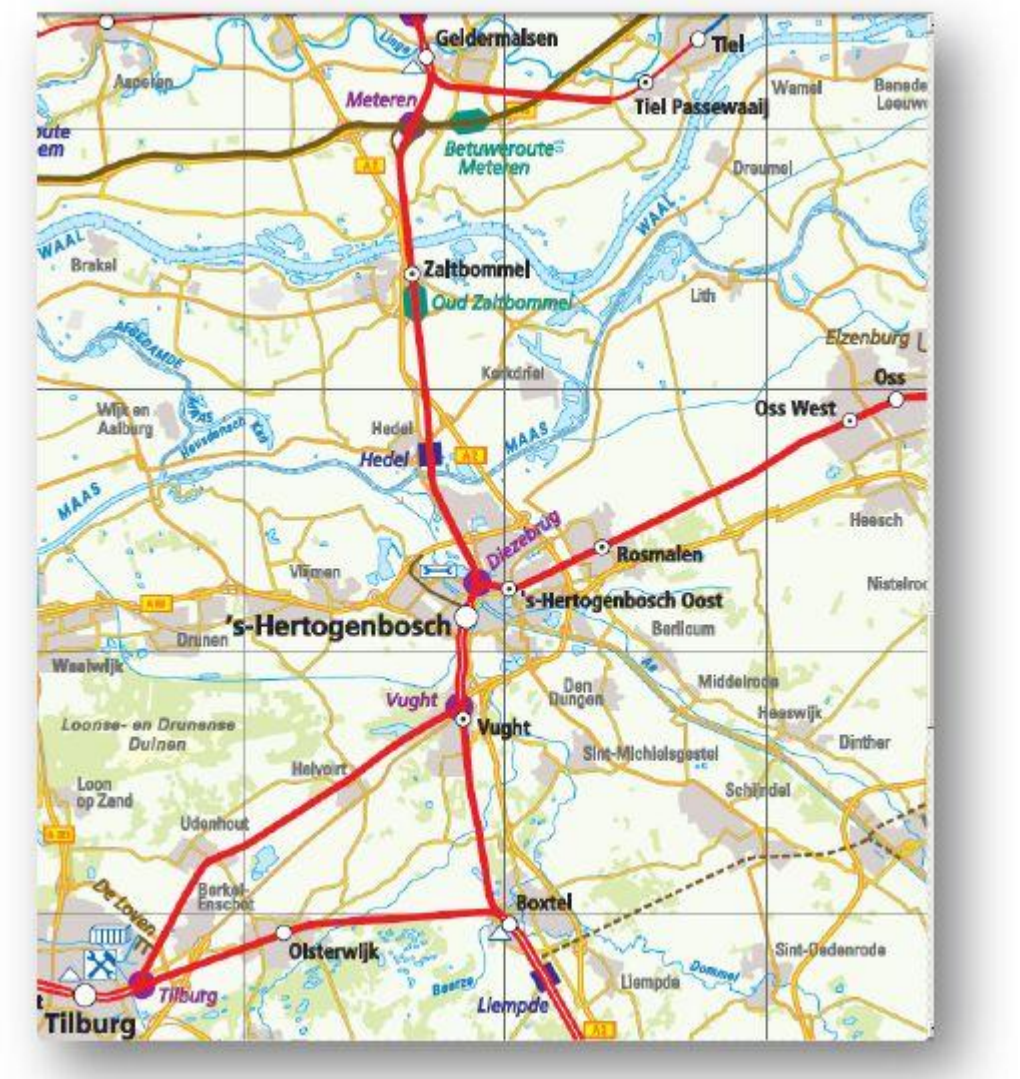
TRAFFIC MANAGEMENT SYSTEM

DEVELOPMENTS
- Custom ambition and goals
- Identify candidate sites for application
- More focus on potential use as decision support
- Research TMS settings and algorithms

(accuracy and objective functions)
- Adapted for simulation studies
- Improved optimization algorithms
- Automatic generation of simulation models
- Apply in stochastic simulations
- Connect to High Level Architecture (re-usability, scalability)
- "New" effect: safety

RECENT DEVELOPMENTS
- Train Relations
- Passenger and material connections
- Continuous signal enhancement
- Phased route setting
- Alternative routes and stop locations
- Improving train behavior
- Ramps, consider, stop by, G braking mode trains
- Deadlock prevention trace
- Efficient and safe headway management: at least two blocks to prevent / harmonica limiting effects in combination with speed control
- Algorithms

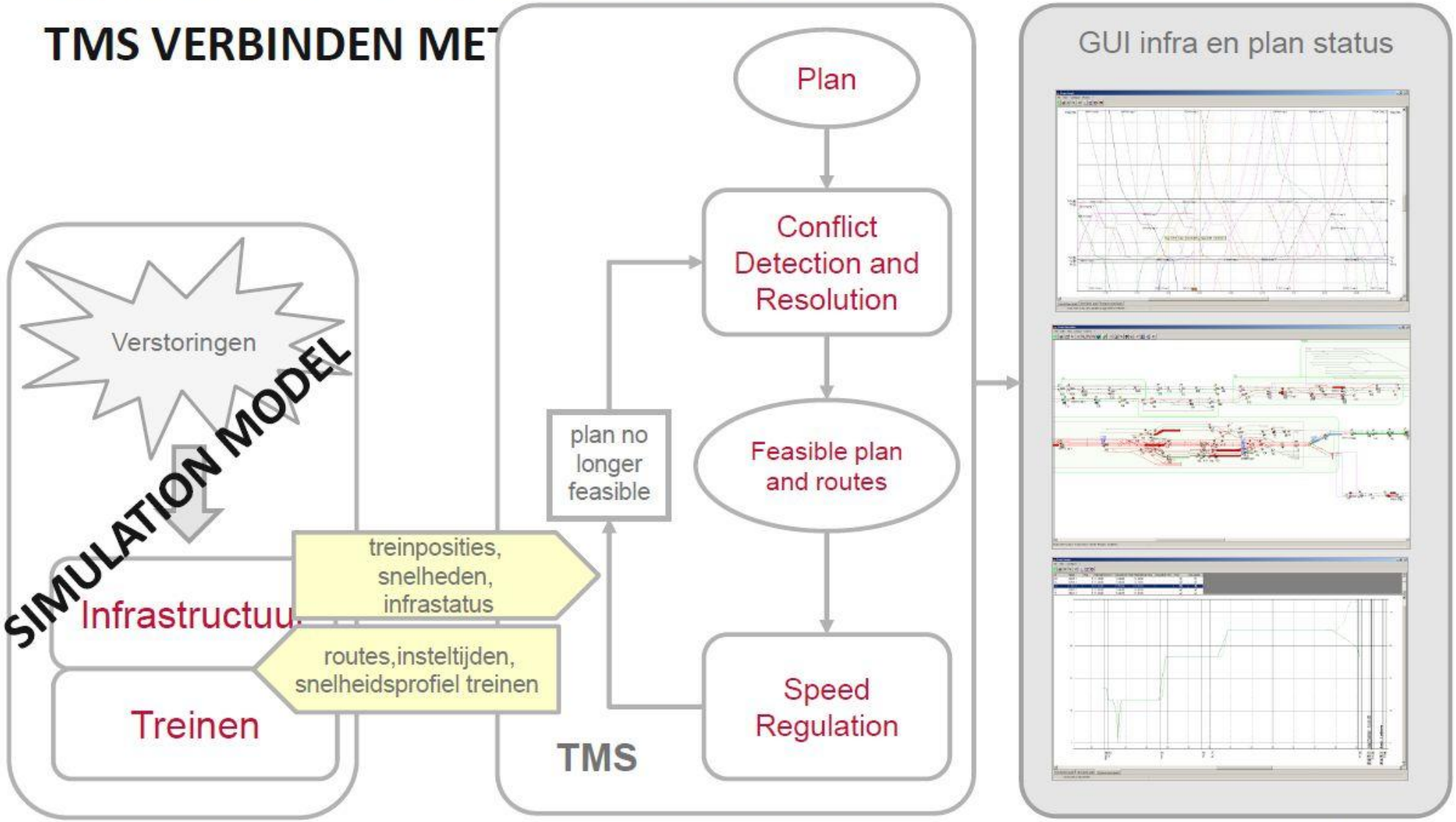
CASE STUDY DEN BOSCH : METHODOLOGY AND RESULTS



About 100 km (2 * 50) around Den Bosch

CASE STUDIE AANPAK

TMS VERBINDEN ME



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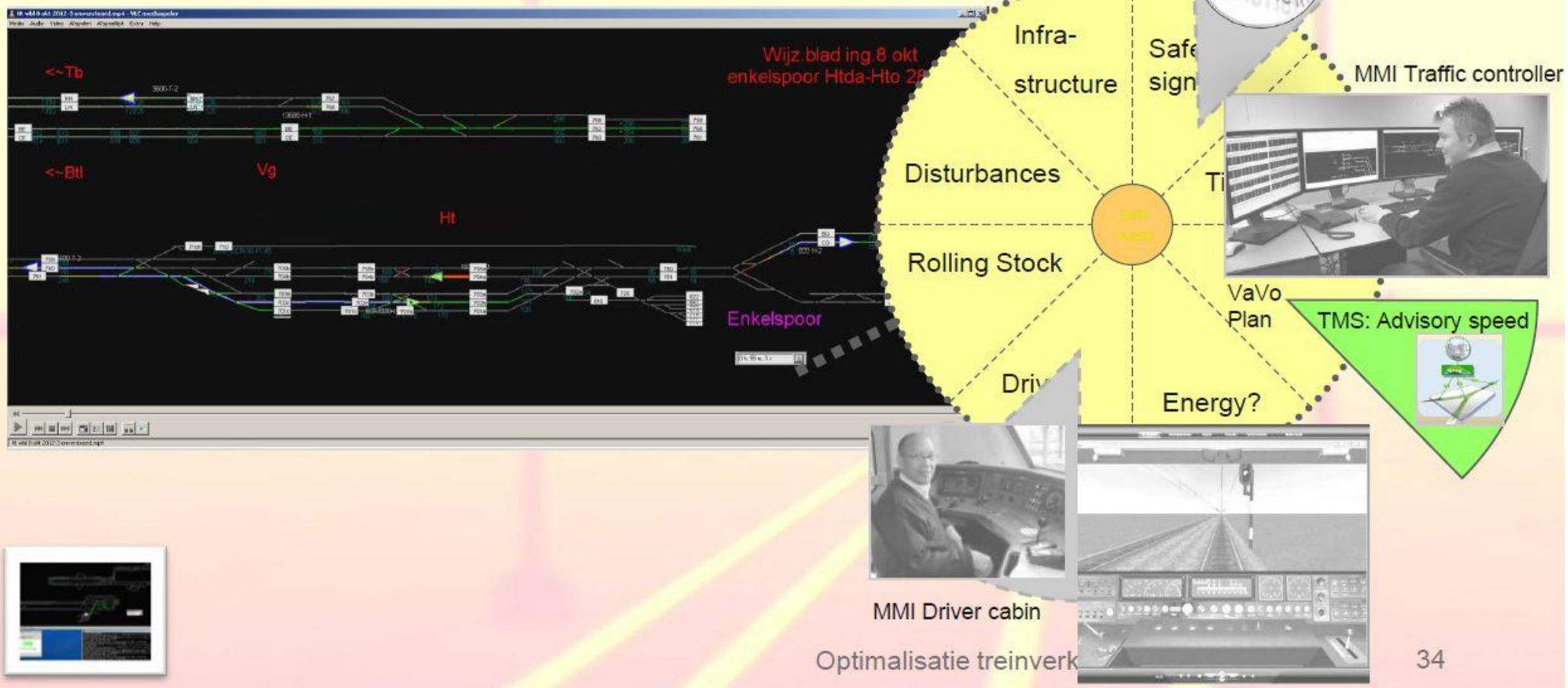
SIMULATIEMODEL



CASE STUDIE DEN BOSCH

RESULTATEN

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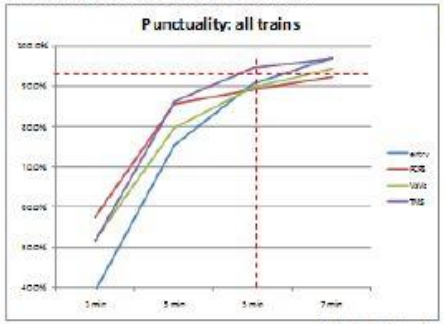
EXPERIMENTEN EN RESULTATEN



Punctualiteitscontract NSR 2010: 93% < 5 min

TMS presteert beter bij dit verstoringsniveau

Beheerste uitvoering: "uitgaand/ingaand" >= 1

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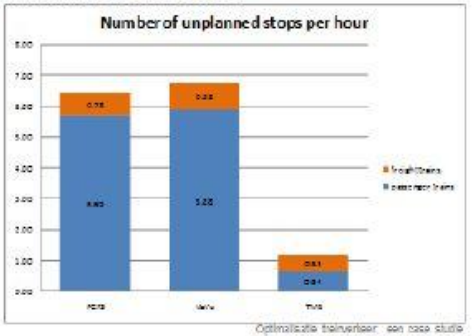
EXPERIMENTEN EN RESULTATEN



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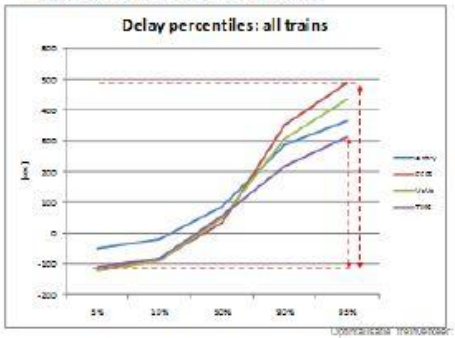
CASE STUDIE DEN BOSCH

EXPERIMENTEN EN RESULTATEN



TMS presteert beter bij dit verstoringsniveau

Kleiner bereik, minder grillige ritten

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CASE STUDIE DEN BOSCH

EXPERIMENTEN EN RESULTATEN

CASE STUDY DEN BOSCH
CONCLUSIONS

TMS results in fewer delays, fewer unplanned stops and less spread

Even more impact possible on fewer limitations in capacity and use of alternative routes

All trains	Improvements at exit with respect to entry			Improvements TMS w.r.t. FCFS and VaVo at exit	
	FCFS	VaVo	TMS	FCFS	VaVo
average tardiness	22%	16%	27%	7%	13%
std delay	-38%	-32%	-9%	21%	17%
5 min punctuality	-2%	-1%	4%	6%	6%
90% delay percentile	-23%	-7%	24%	38%	29%
10%-90% bandwidth	-43%	-30%	2%	31%	24%
number of unplanned stops	-	-	-	81%	82%

Table 2: Relative improvements.

WHAT DO WE DO NOW?
RAILWAY GAMING SUITE + CONTINUED

Developing TMS
- Connect with TMS (new) operating systems for practical pilot
- New control variant: only advisory speed
- New objective functions: energy, red-signal approaches ....

Train on the Line
- Step 1: Potential Studies and Implement real-time advisory speeds for driver
- Step 2: possible extension to decision support for traffic and Traffic management

Simulation and gaming application for:
- Increase situational awareness
- Bringing knowledge, acceptance and testing by operator / dispatcher
- Development and testing of control variants, objective functions, position (in) accuracy, MMI's development ....