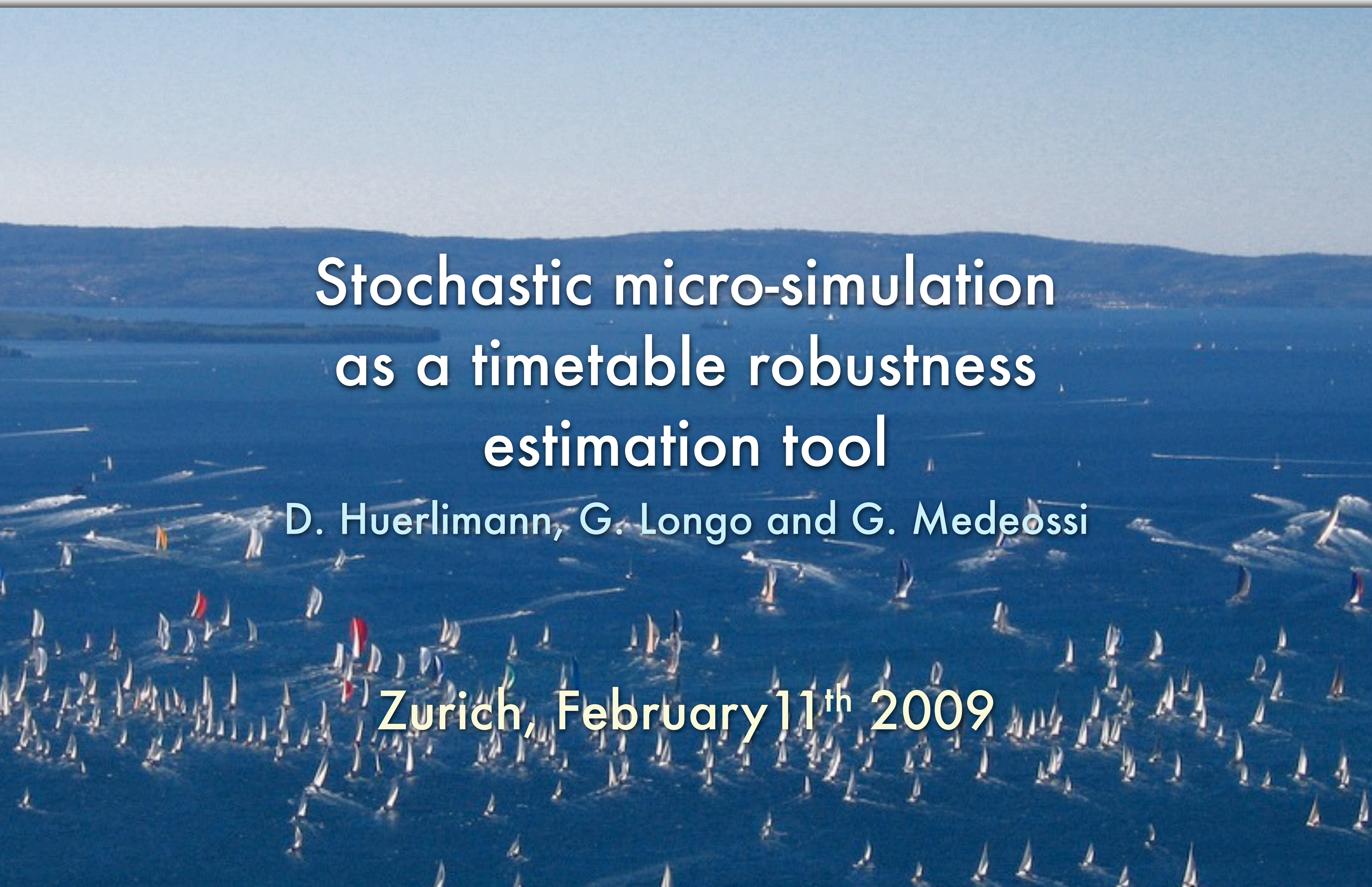
UNIVERSITY OF TRIESTE
Department of Civil and Environmental Engineering



Stochastic micro-simulation as a timetable robustness estimation tool

D. Huerlimann, G. Longo and G. Medeossi

Zurich, February11th 2009

Introduction

- Growing importance of precision in planning process
- Trade off capacity-punctuality

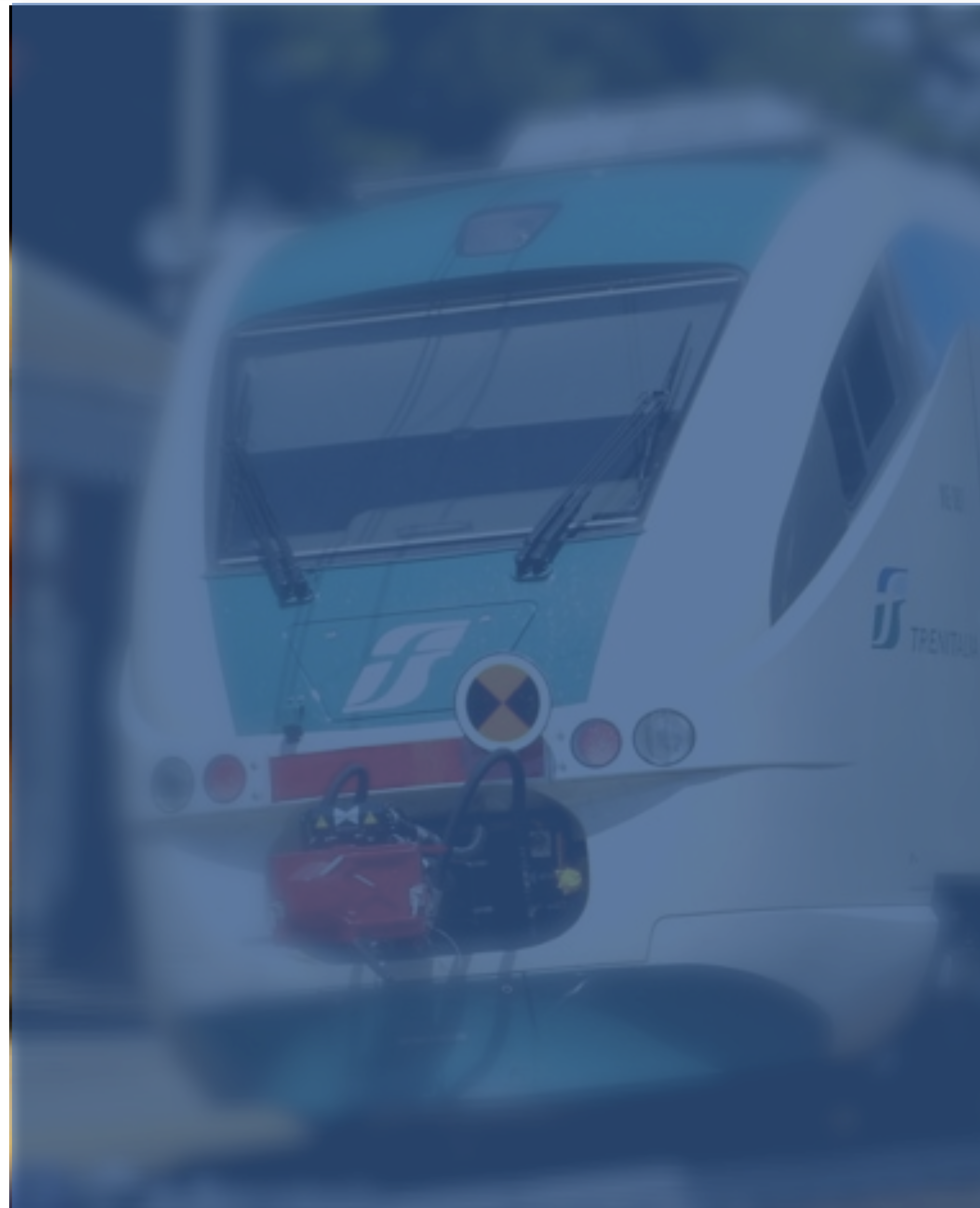
- Wide range of real-world collected data
- Micro-simulation can consider most stochastic phenomena

↓

- Ex-ante timetable robustness evaluation
  - Point out critical points and suggest dispatching rules
- Evaluation of headway times

Outline

- Approach
- Timetable robustness measures
- New reliability indicator
- Model calibration
- Case study: Torino

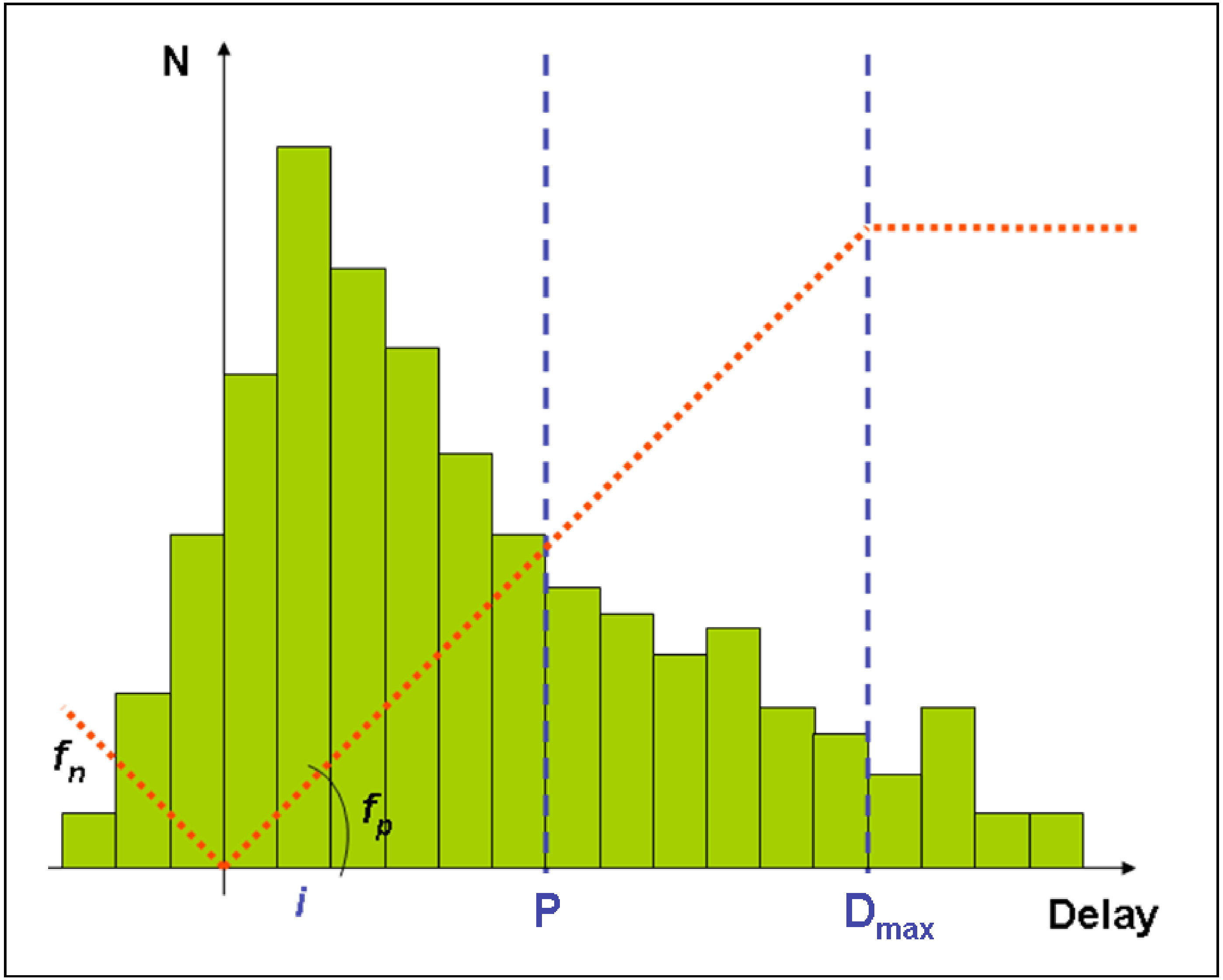


Approach

- Real Traffic Analysis
- Model Calibration
- Dense timetable (Fiche UIC 406)
    - real train mix
    - running times with no supplements
- Variable buffer times and supplements are inserted
- Multiple stochastic simulations
- Simulation output analysis

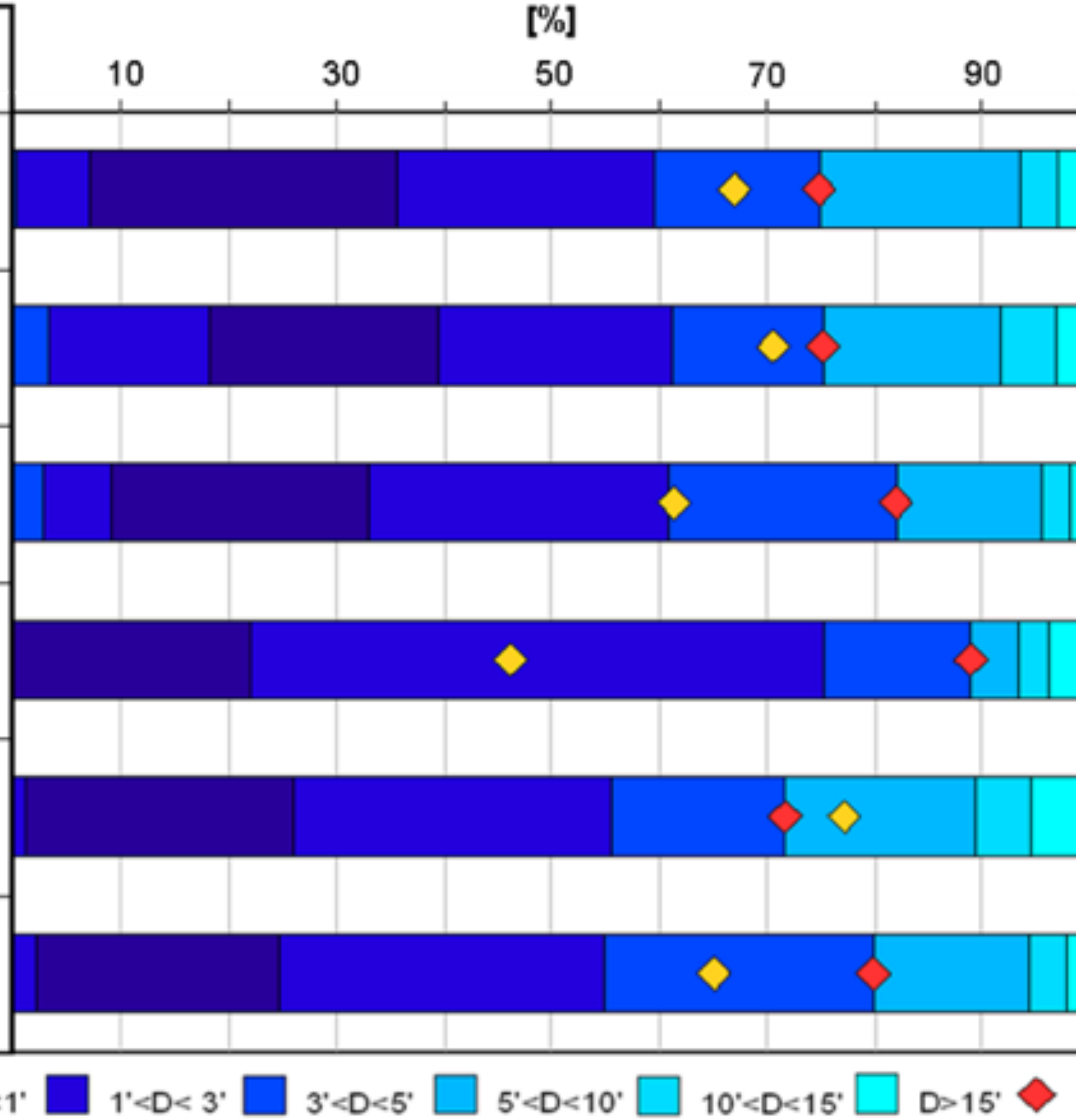
New reliability indicator

Frequency of Delay Index (*F*)

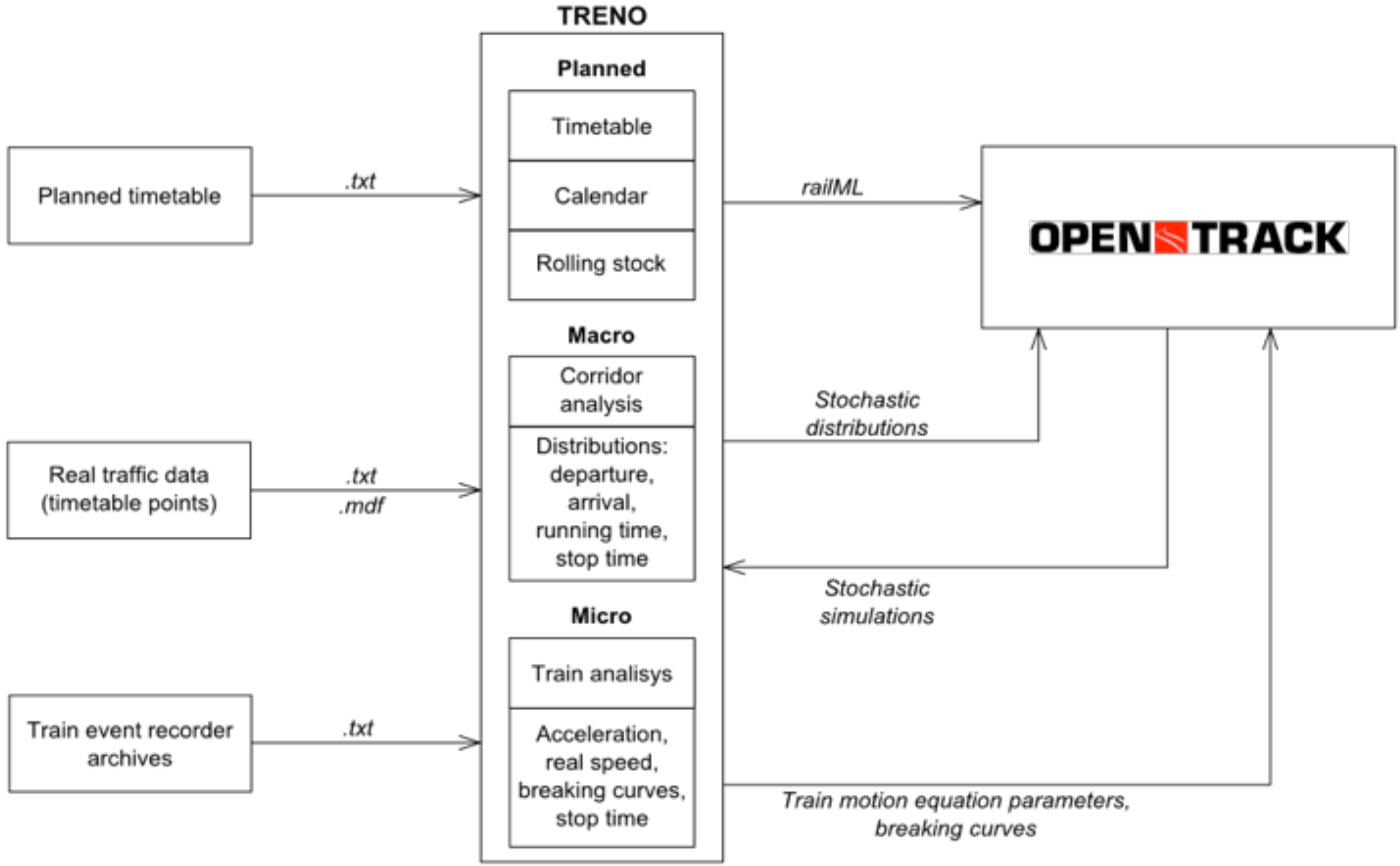


New reliability indicator

Train Family	Station	Arr/Dep	P	F
20000s	Trofarello	Arr	74.9	67.0
2150s	Torino Porta Nuova	Arr	75.2	70.6
10050s	Collegno	Arr	82.0	61.4
10051s	Torino Porta Nuova	Arr	88.9	46.1
10050s	Torino Porta Nuova	Dep	71.7	77.2
4000s	Chivasso	Dep	79.9	65.1



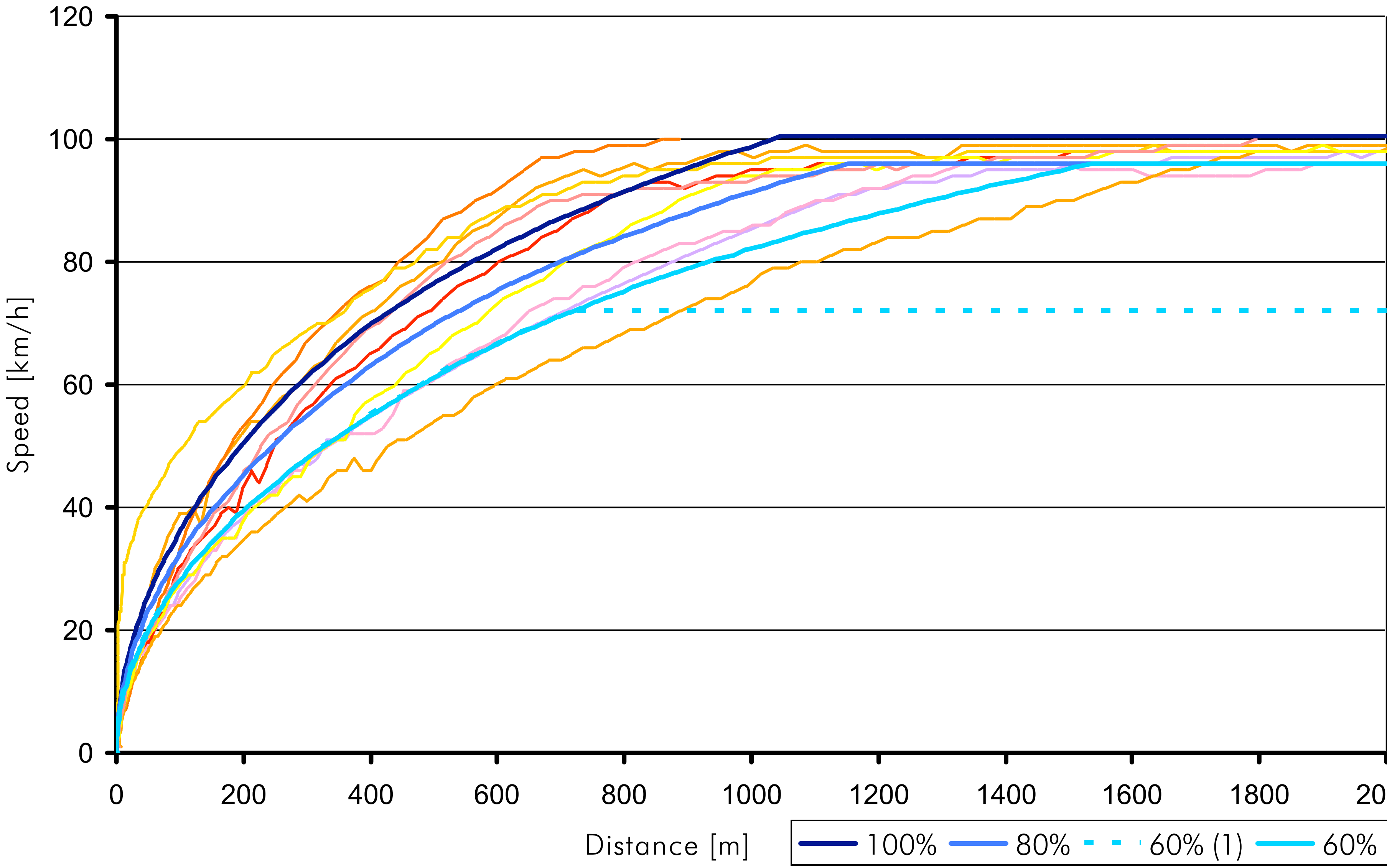
Data flow


TRENO
Planned
Timetable
Calendar
Rolling stock
Macro
Corridor analysis
Distributions: departure, arrival, running time, stop time
Micro
Train analisys
Acceleration, real speed, breaking curves, stop time
Planned timetable
.txt
Real traffic data (timetable points)
.txt
.mdf
Train event recorder archives
.txt
railML
OPEN TRACK
Stochastic distributions
Stochastic simulations
Train motion equation parameters, breaking curves

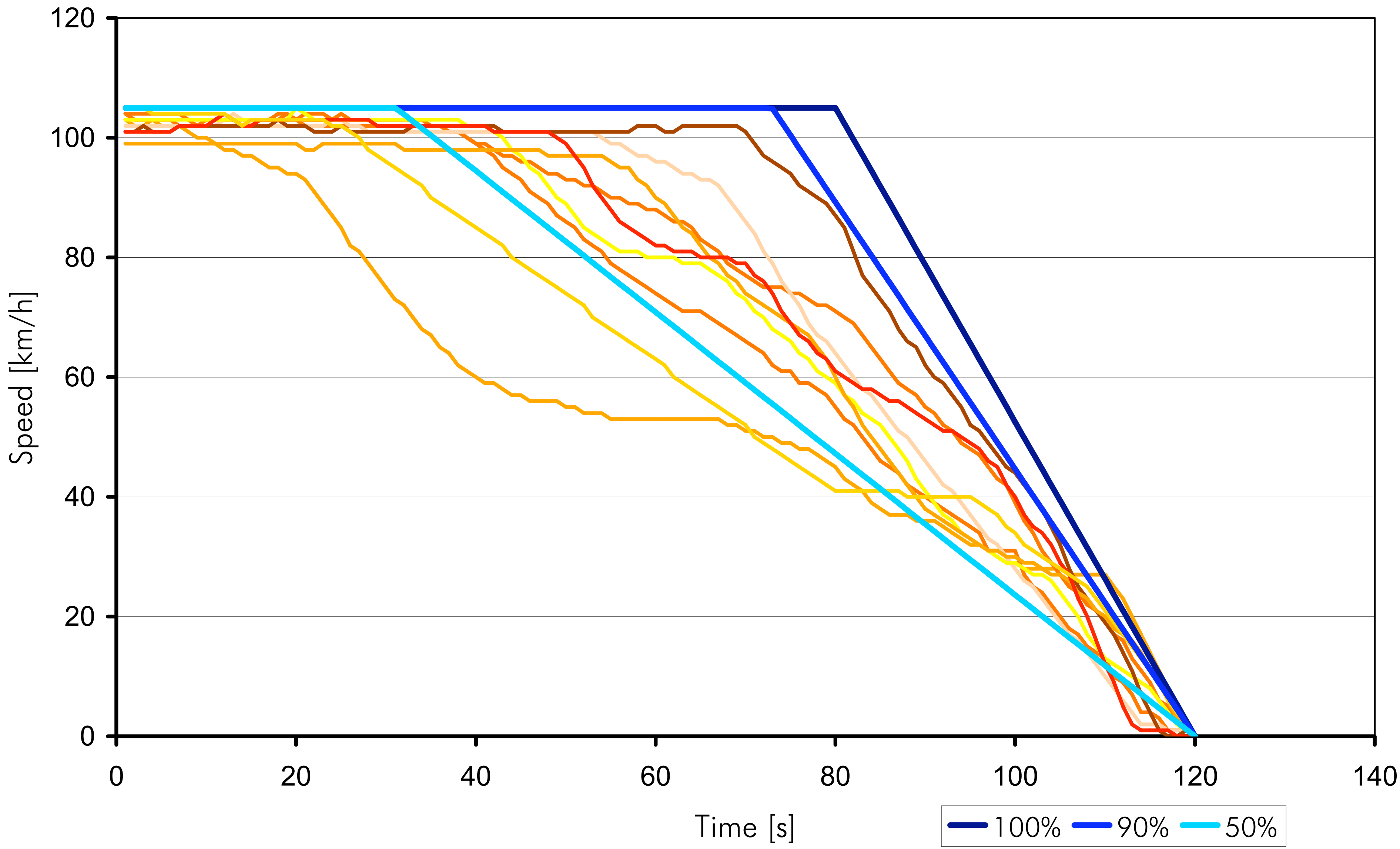
"Micro" Analyzer

Acceleration	Acceleration Percentage Gradients Tractive Effort/Speed Curve	Distributions Running Time Calculator On Time / Delay
Full Speed	Real Speed ATP	Distributions On Time / Delay
Braking	Braking Behavior Gradients Planned BWP	Distributions On Time / Delay
Stop Time		Distributions On Time / Delay

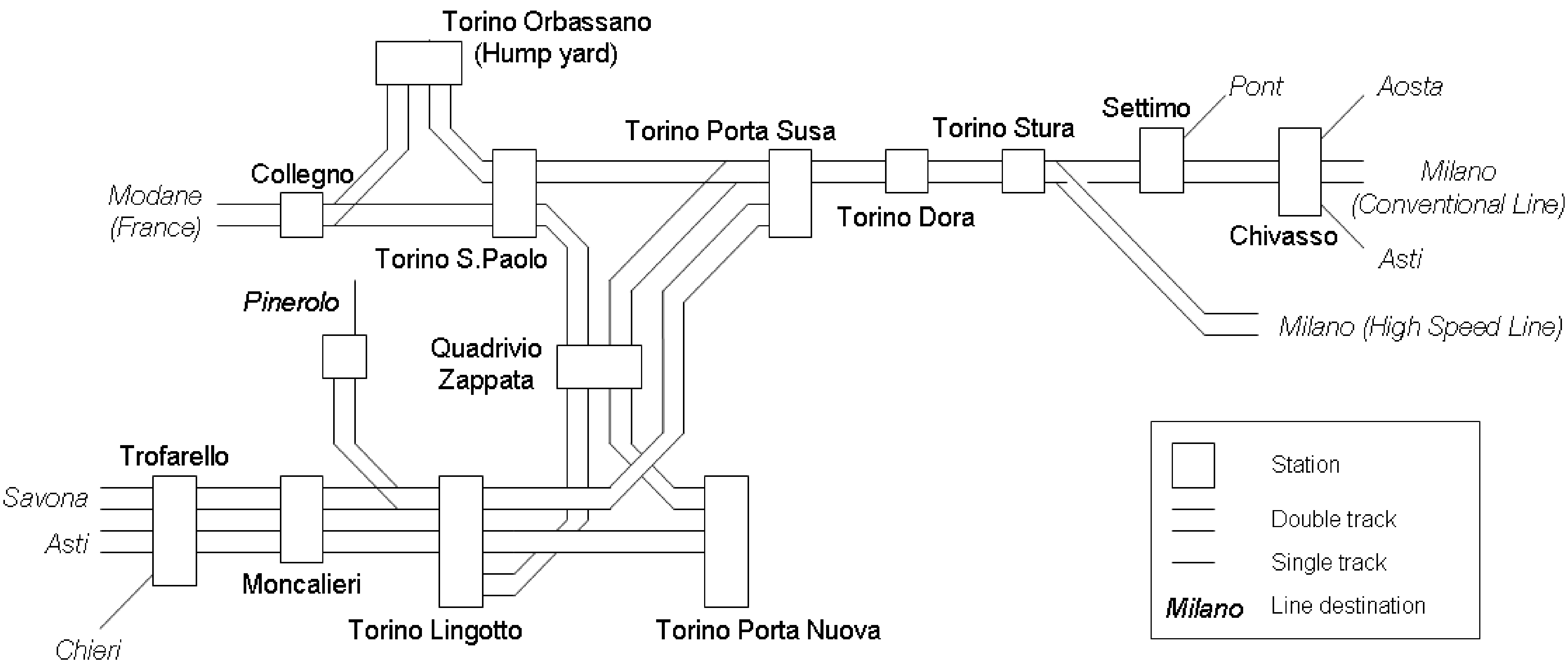
Acceleration Analysis



Braking Analysis

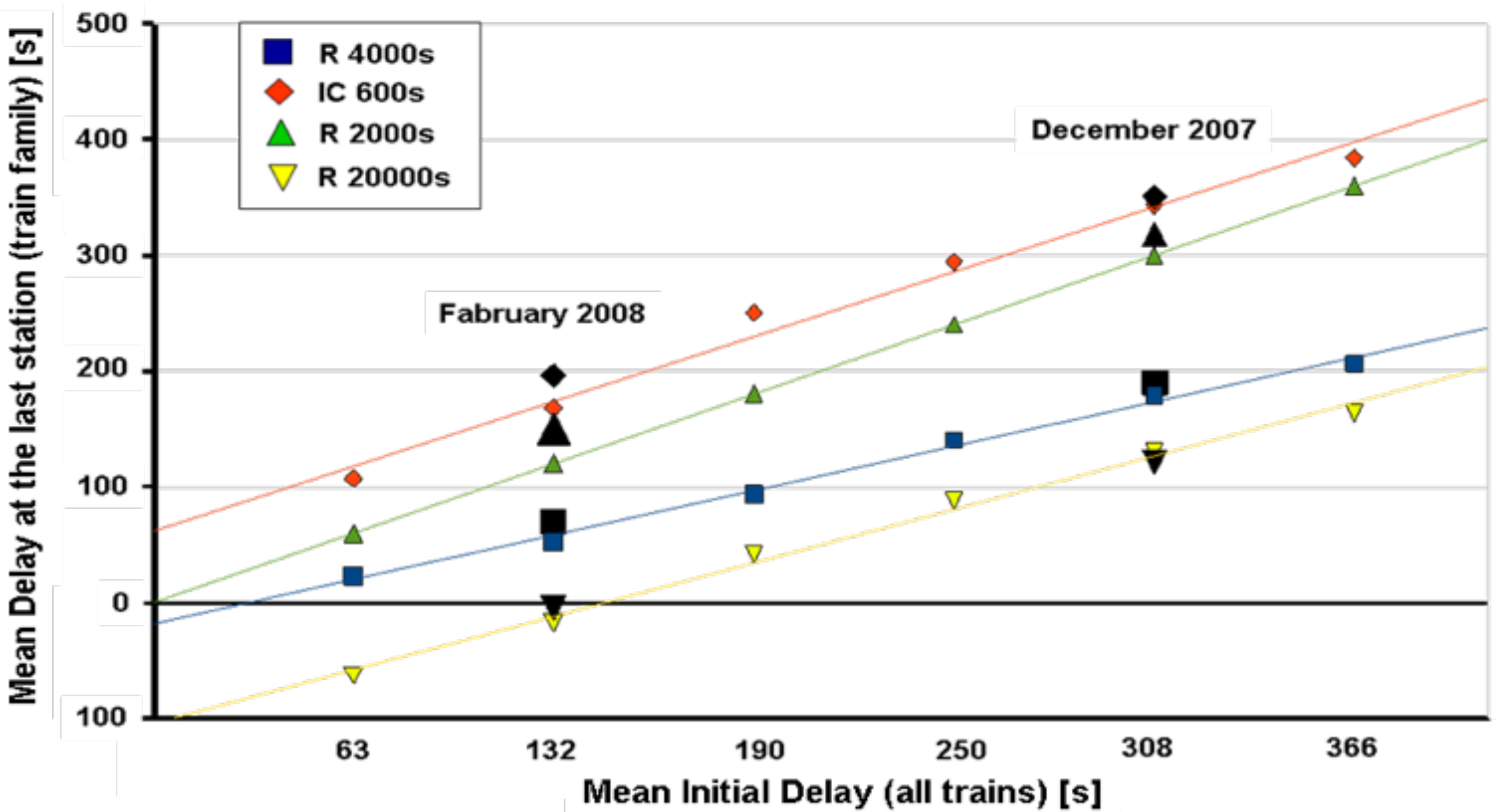


Case Study: Torino Node

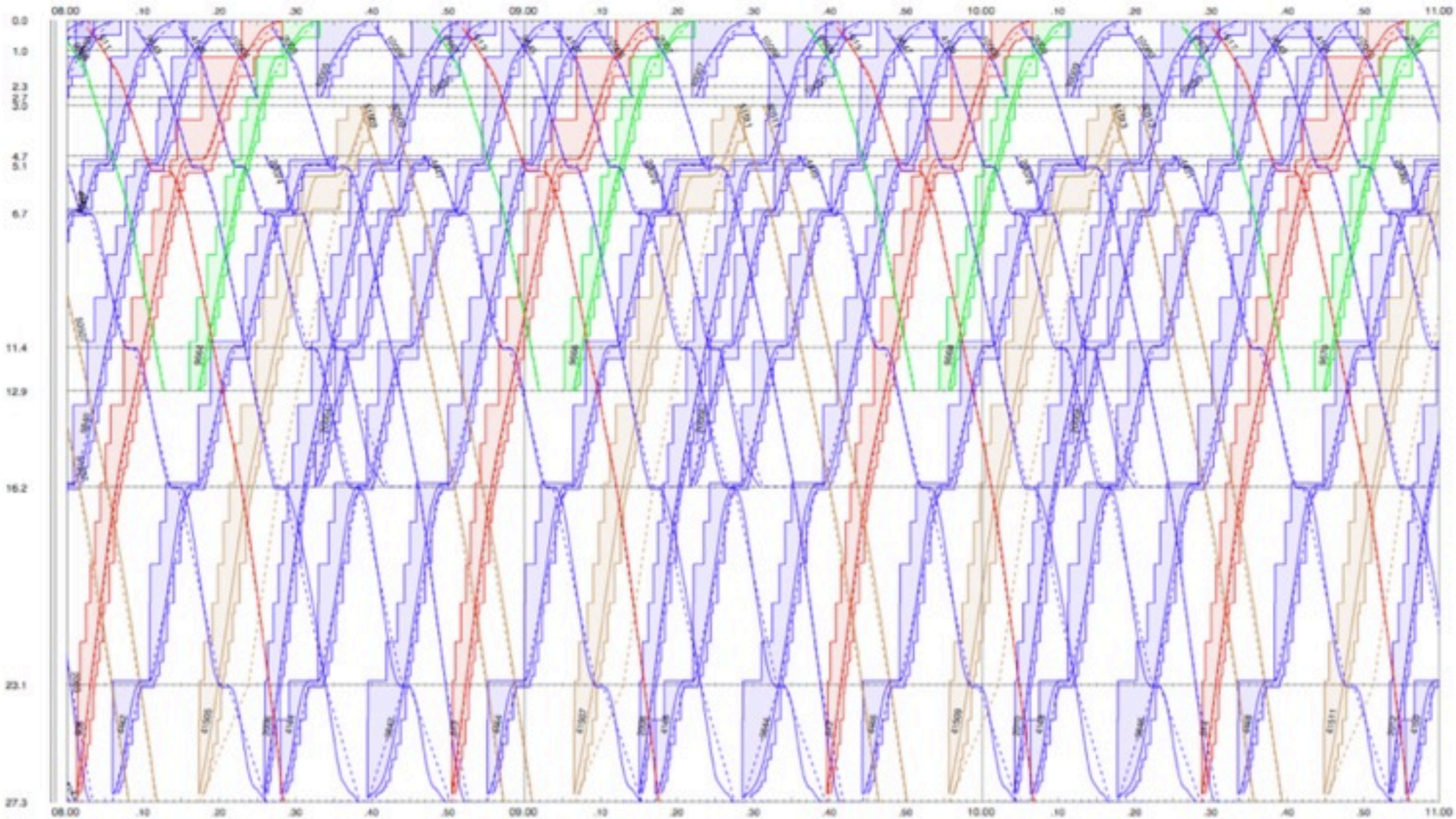


- 180 km line, different interlocking systems
- Various train mix
- Frequent perturbations due to node saturation or delayed trains from Milan

Torino Node: Results

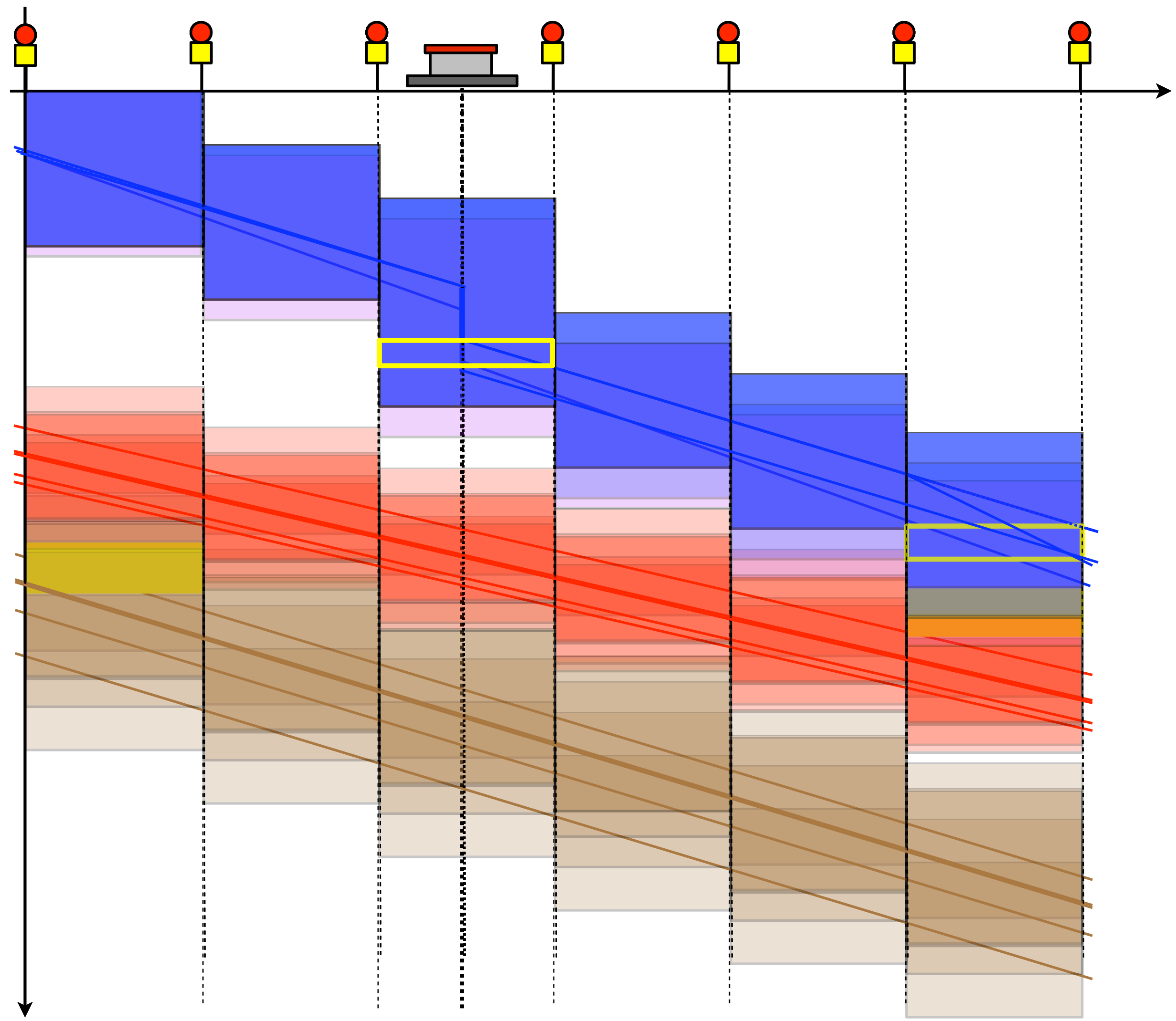


Dense Timetable



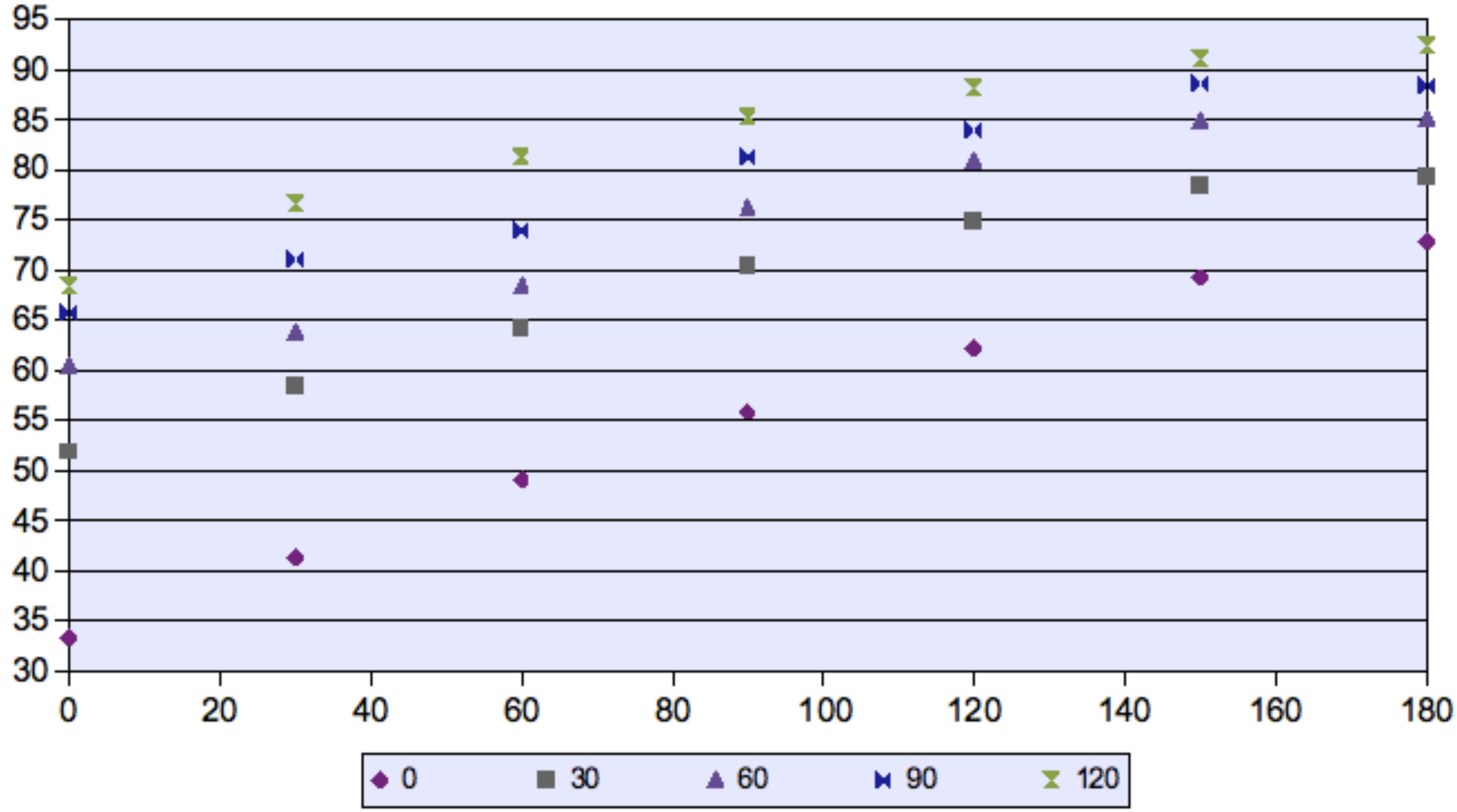
Compensation of stochastic phenomena

- Buffer times
- Supplements
  - distributed
  - concentrated
  - stop time

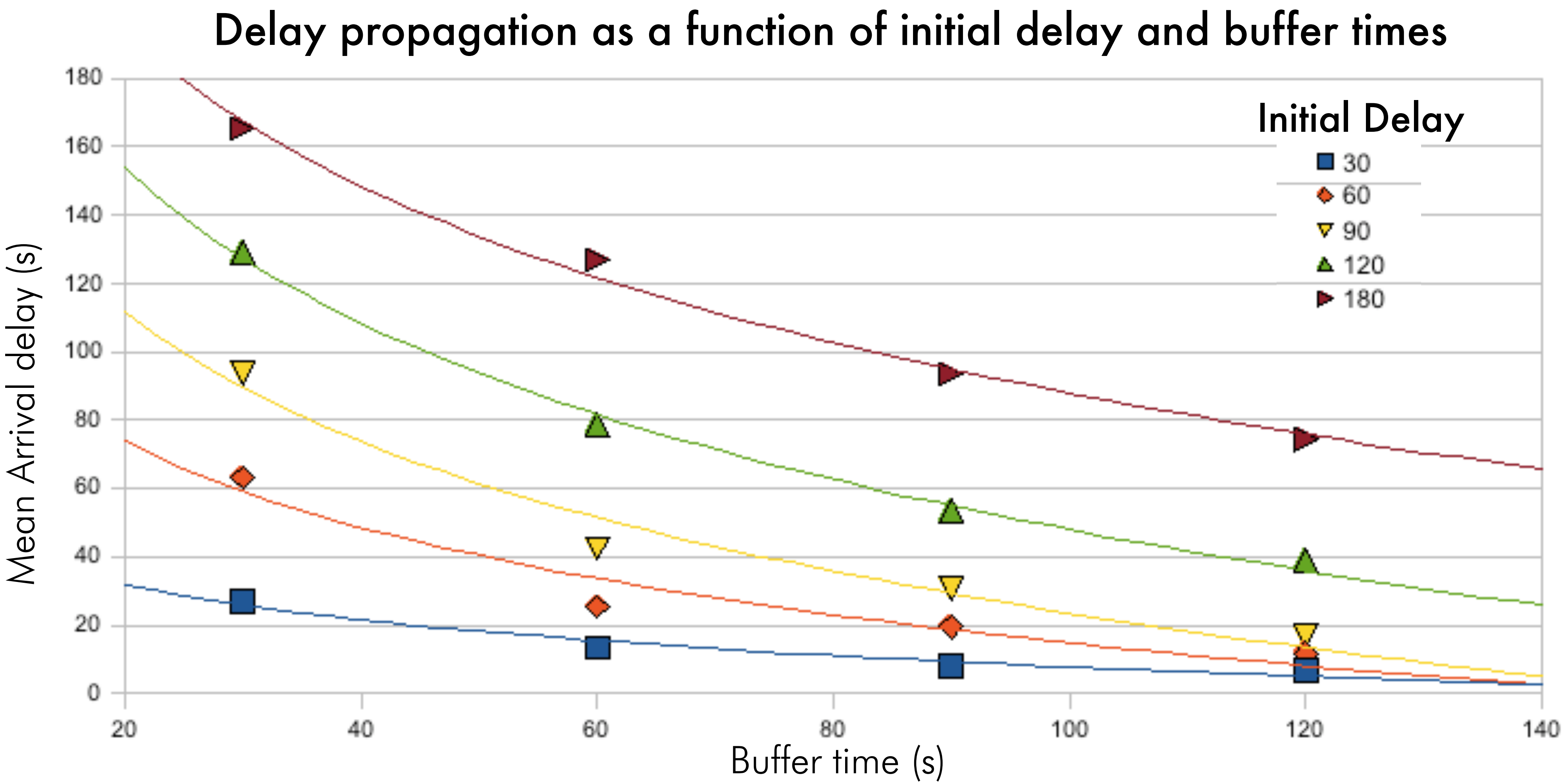


Buffer times and running time supplements

Arrival % with less than 3′ delay as a function of buffer times and supplements



Buffer time and initial delay



Conclusions and outlook

- Very precise traffic representation
- Combination of “micro” and “macro” data
- Relationship between various parameters
- Search for a capacity - stability equilibrium

- Various block and ATP Systems
- Fit of resulting curves to obtain rules
- Other case studies

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thank you for your attention!

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