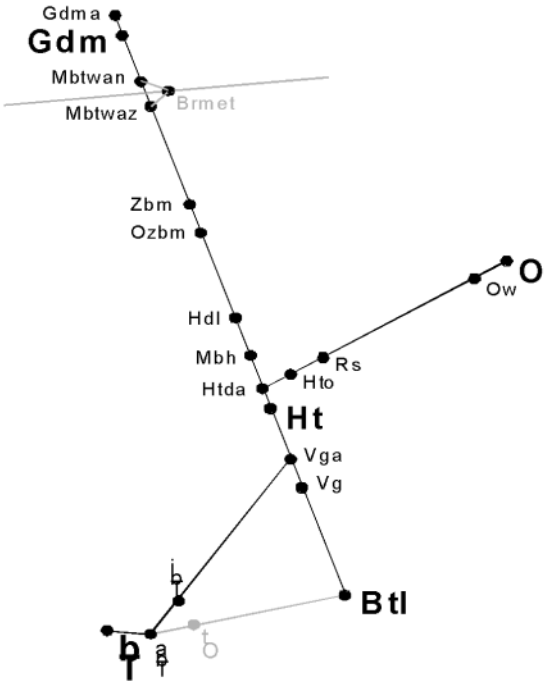
Simulatiestudie ‘s-Hertogenbosch 2010

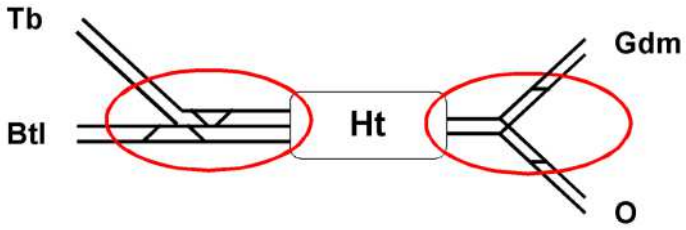
Douwe de Vries – October 2010

Study area

A simulation study has been executed for an area of reasonable size and complexity, where an actual control challenge exists. TMS results have been compared statistically to a number of other strategies (FCFS, VaVo).
The study area is delimited by and including Tilburg and Boxtel on one end and by and including Geldermalsen and Oss on the other end.

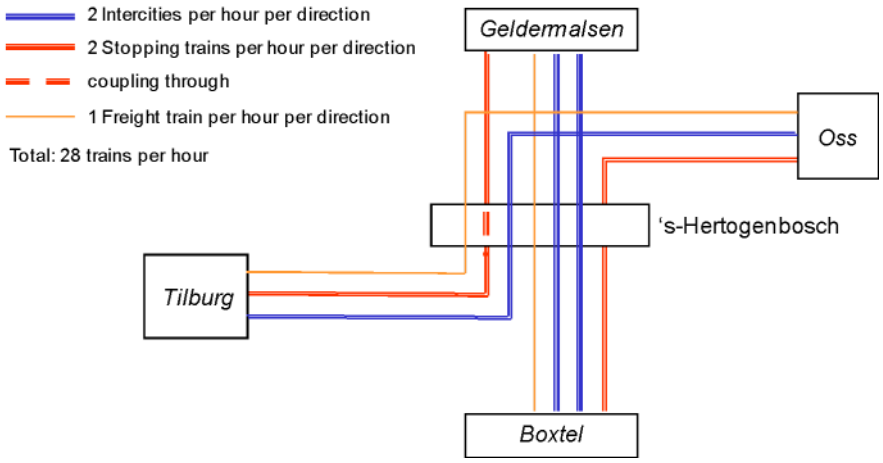


The main conflict area’s are at Vught Aansluiting (Vga) and at Diezebrug Aansluiting (Htda) and also in ‘s-Hertogenbosch (Ht) itself. Additionally, headway conflicts frequently occur on the open tracks (e.g. between intercities and stopping trains or freight trains).



Timetable

The timetable contains 28 trains per hour.



Simulation settings

The simulation allows for the use of:

- Alternative routes.
- Phased route setting (headway of 2 steps has been used).
- ATB signal improvement.
- Setting rules (instelvoorschriften).

Entry delays in the simulation are generated from distributions based on measured data (peak hours 2007). Since no internal disturbances are used, twice the measured entry delays have been applied.

Simulation results have been gathered over 15 hours (3 runs of 6 hours where the first hour is discarded as warm-up time). Note that this is rather limited. However, it does provide a first impression. Also, the TMS performs better (on average tardiness) not only over all replications, but also in each single replication separately.

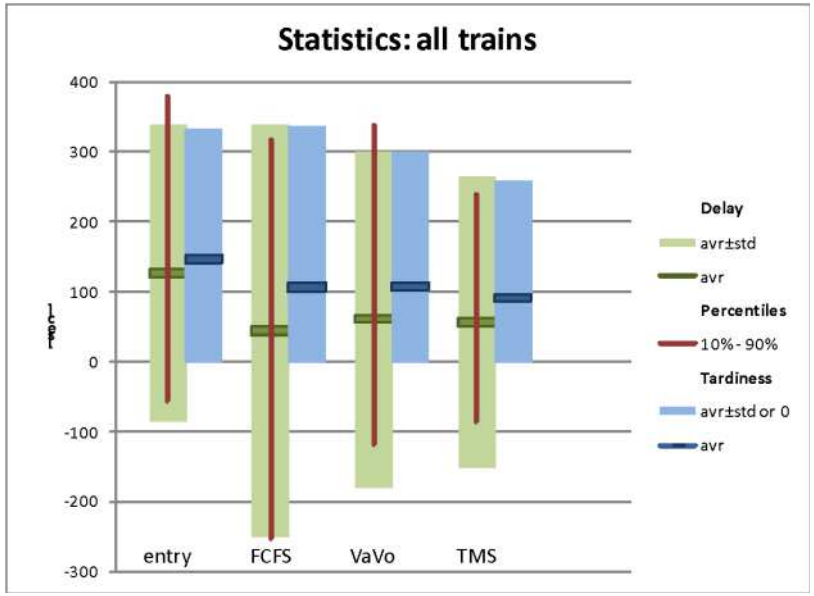
Results

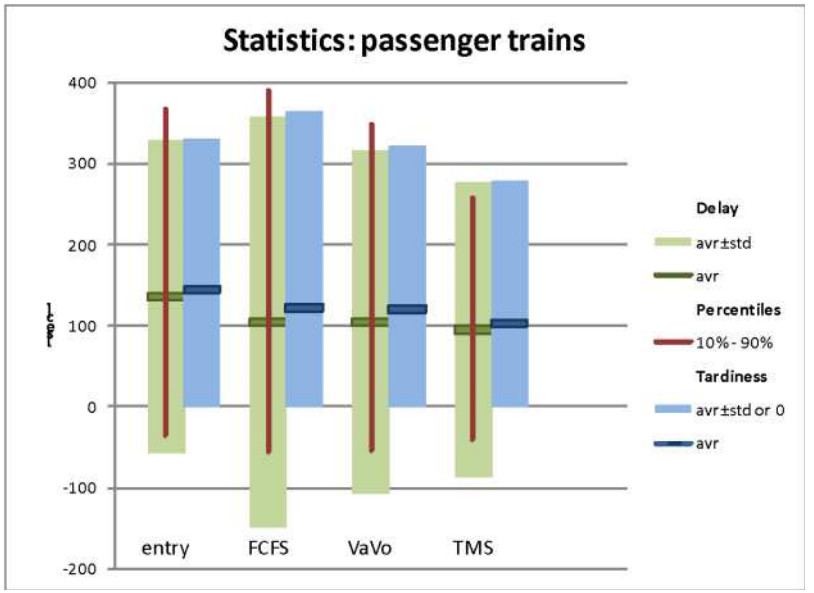
Punctuality at exit and bandwidths at exit are depicted below. Note that the tardiness of a train is a measure its for delay where negative delays are put to zero first, so it is max(0,delay).

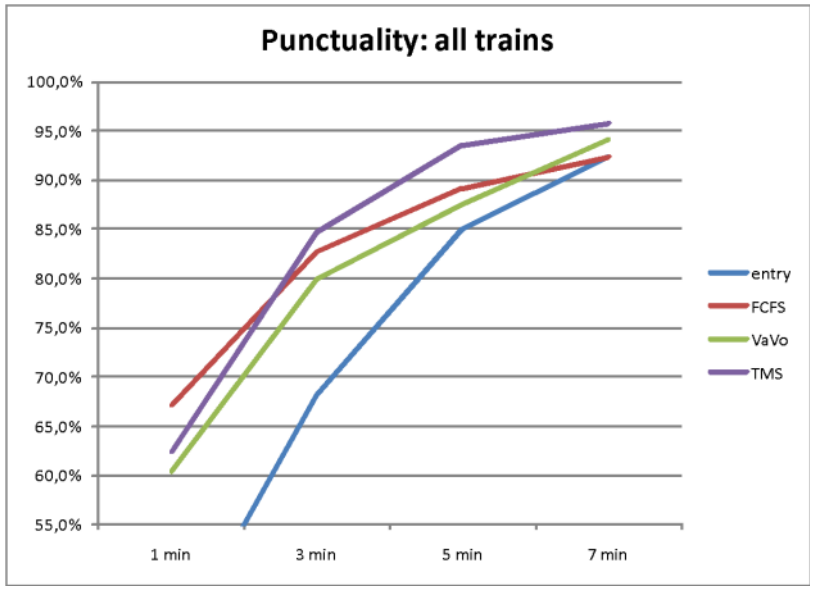
It can be seen that TMS performs better than FCFS and VaVo:

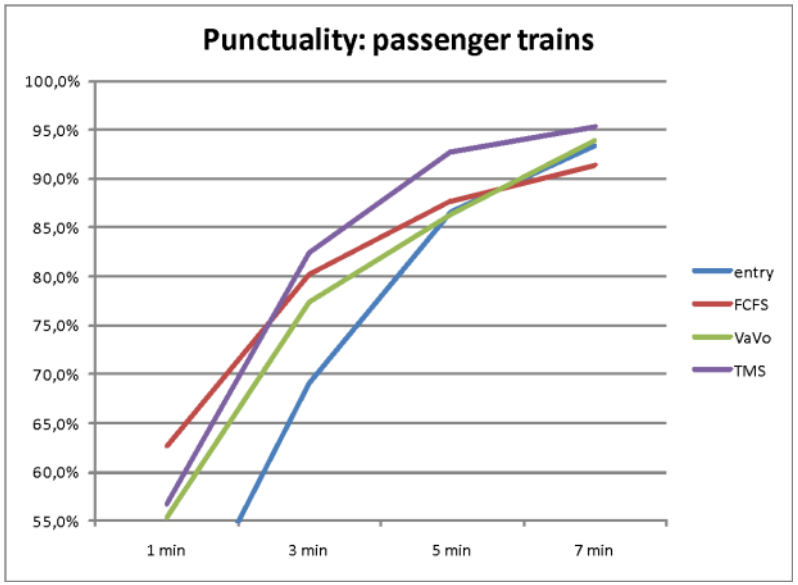
- TMS achieves a lower average tardiness: TMS 91 sec, VaVo and FCFS 107 sec, an improvement of 15%.
- TMS achieves lower bandwidths: 29% less than VaVo and 43% less than FCFS considering the 10-90 percentiles bandwidth. This means much smaller deviations from planned timetable paths.
- TMS achieves higher punctuality when considering the 3-5-7 min punctualities. Punctuality for 3 min is: TMS 84,6%, VaVo 79,8% and FCFS 82,7%.

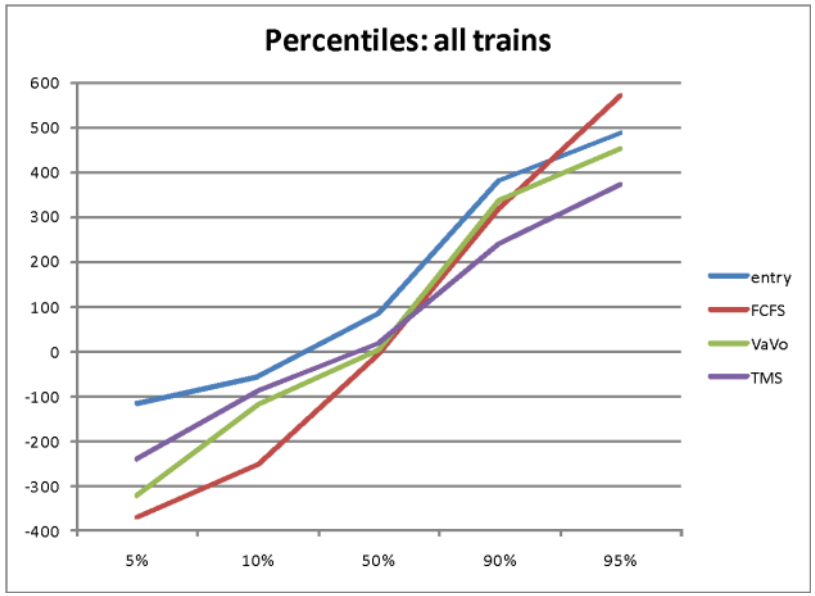
When considering only passenger trains the improvements become even more pronounced. Note that FCFS actually increases the 10-90 percentiles bandwidth by 11% when comparing entry with exit, that VaVo keeps it exactly the same, while TMS decreases it by 26%.

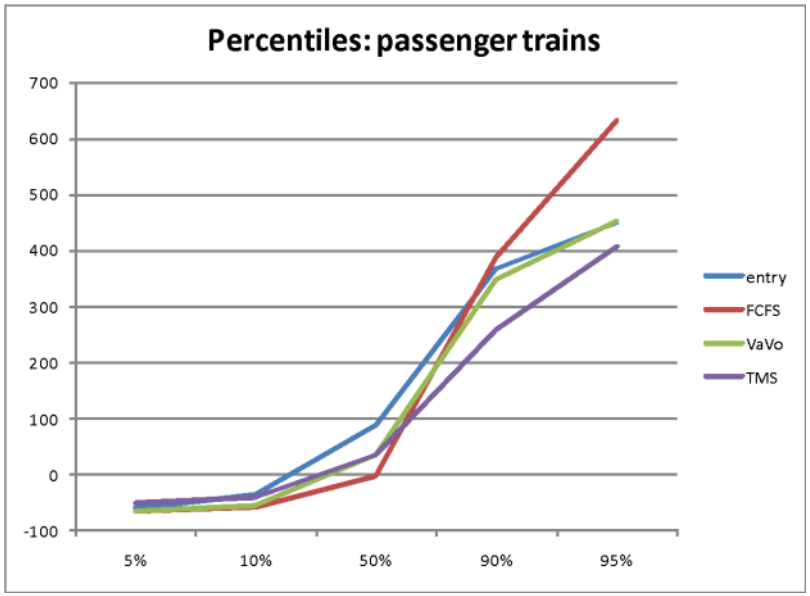

Statistics: all trains
400
300
200
100
0
-100
-200
-300
entry
FCFS
VaVo
TMS
Delay
avr±std
avr
Percentiles
10% - 90%
Tardiness
avr±std or 0
avr


Statistics: passenger trains
400
300
200
100
0
-100
-200
entry
FCFS
VaVo
TMS
Delay
avr±std
avr
Percentiles
10% - 90%
Tardiness
avr±std or 0
avr


Punctuality: all trains
100,0%
95,0%
90,0%
85,0%
80,0%
75,0%
70,0%
65,0%
60,0%
55,0%
1 min
3 min
5 min
7 min
entry
FCFS
VaVo
TMS


Punctuality: passenger trains
100,0%
95,0%
90,0%
85,0%
80,0%
75,0%
70,0%
65,0%
60,0%
55,0%
1 min
3 min
5 min
7 min
entry
FCFS
VaVo
TMS


Percentiles: all trains
600
500
400
300
200
100
0
-100
-200
-300
-400
5%
10%
50%
90%
95%
entry
FCFS
VaVo
TMS


Percentiles: passenger trains
700
600
500
400
300
200
100
0
-100
5%
10%
50%
90%
95%
entry
FCFS
VaVo
TMS