IT15.rail

Zürcher Hochschule
für Angewandte Wissenschaften

School of
Engineering

IDP Institut für
Datenanalyse und
Prozessdesign

The OpenTrack Speed-Instruction API

Overview

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I. The objective of the OT speed-instruction API

II. Scenario Killwangen: Potential benefit of speed instructions (students essay)

III. RTSE I: time based OT speed-instruction API (implemented)

RTSE II: location based OT speed-instruction API (planned)

I. Adaptive Control (ADL ADaptive Lenkung)

*Homepage SBB: *Energieeffizienz*

http://www.sbb.ch/sbb-konzern/sbb-als-geschaeftspartnerin/angebote-fuer-evus/energie/energiesparen.html

Objective*:

- Train driver receives recommended speed instructions in cabine
- Improves prospective driving strategy, reduces unneccessary signal stops and braking maneuvers…
- **…and saves a huge amount of energy**.

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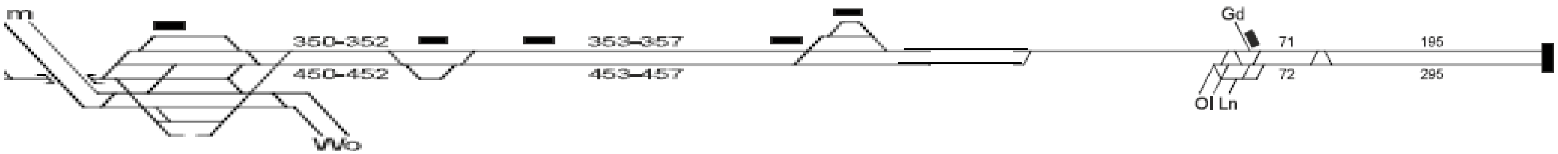
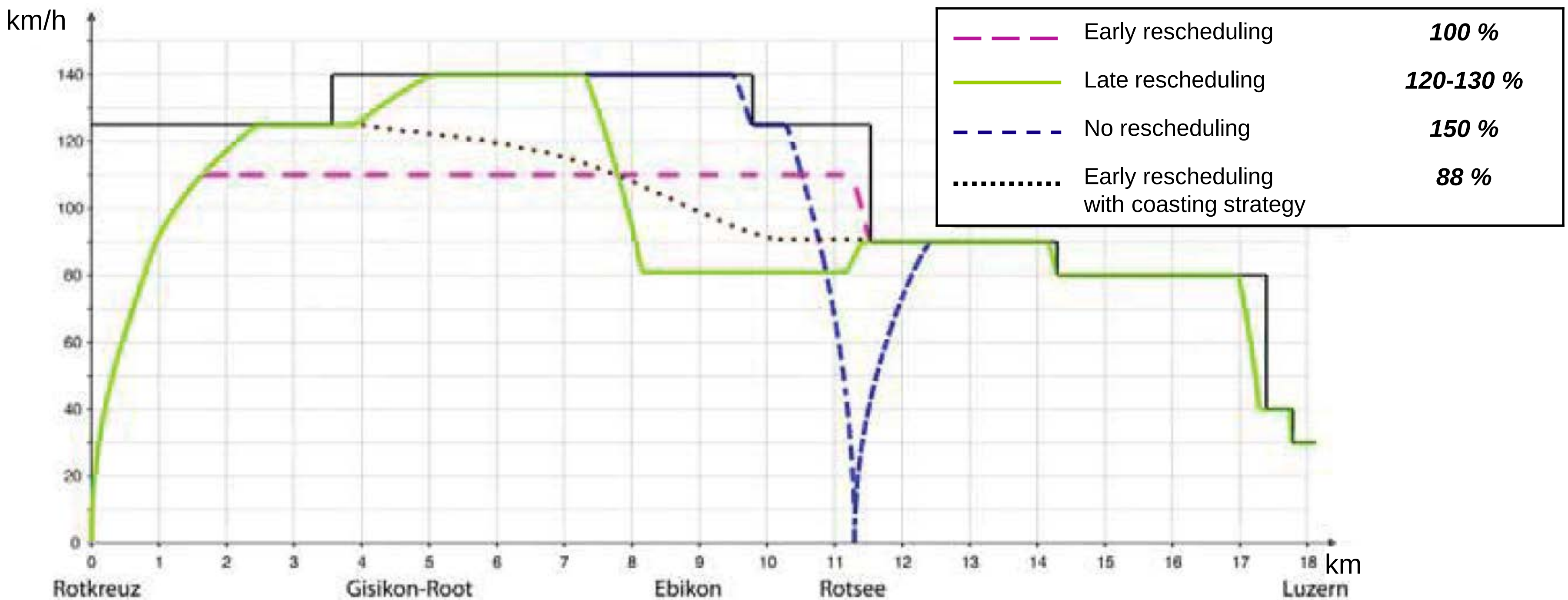
I. Influence of speed control on energy consumption





Casestudy with Interregio trains between Rotkreuz and Lucerne*

*M.Lüthi (2009): *Improving the Efficiency of Heavily Used Railway Networks through Integrated Real-Time Rescheduling,* Diss. IVT ETHZ

I. Influence of speed control on running time delay

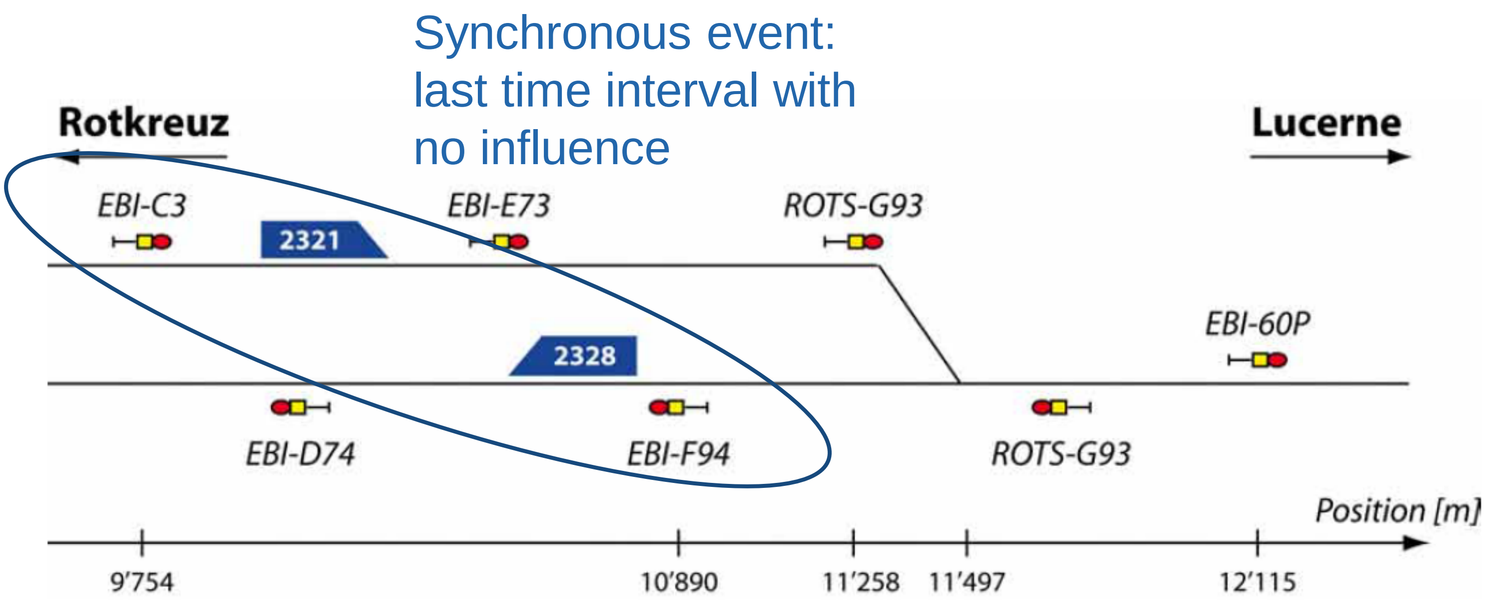


Figure 7.14: Detailed topology of the Rotsee single-line section

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I. Influence of speed control on running time delay

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Running time between EBI-C3 and EBI-60P

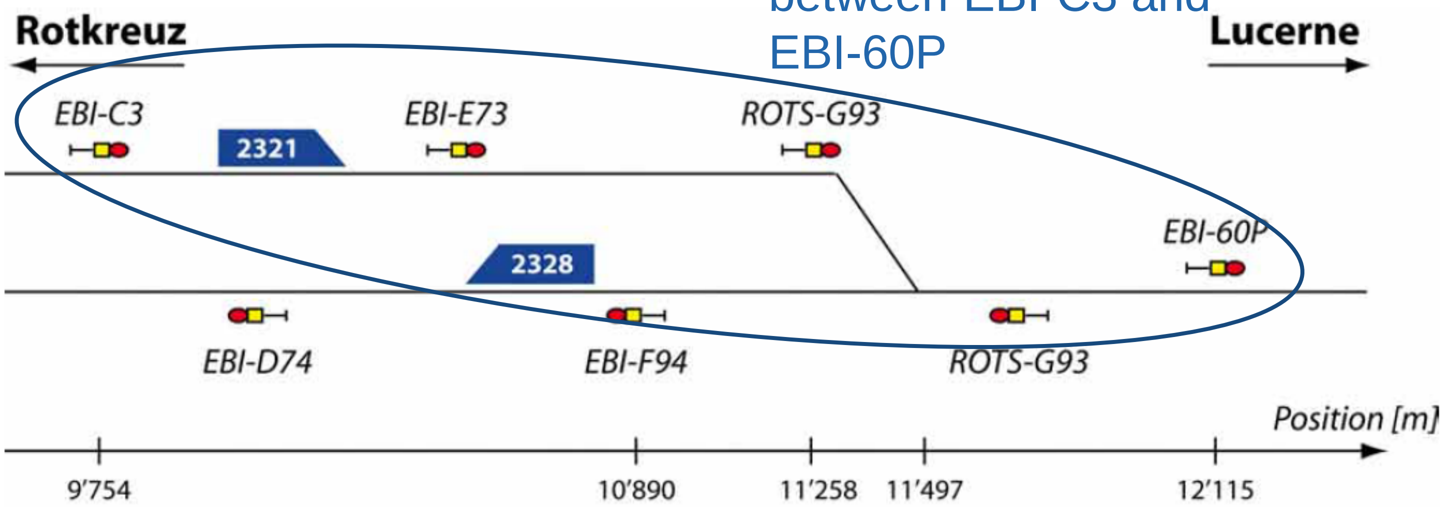

Figure 7.14: Detailed topology of the Rotsee single-line section

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I. Influence of speed control on running time delay

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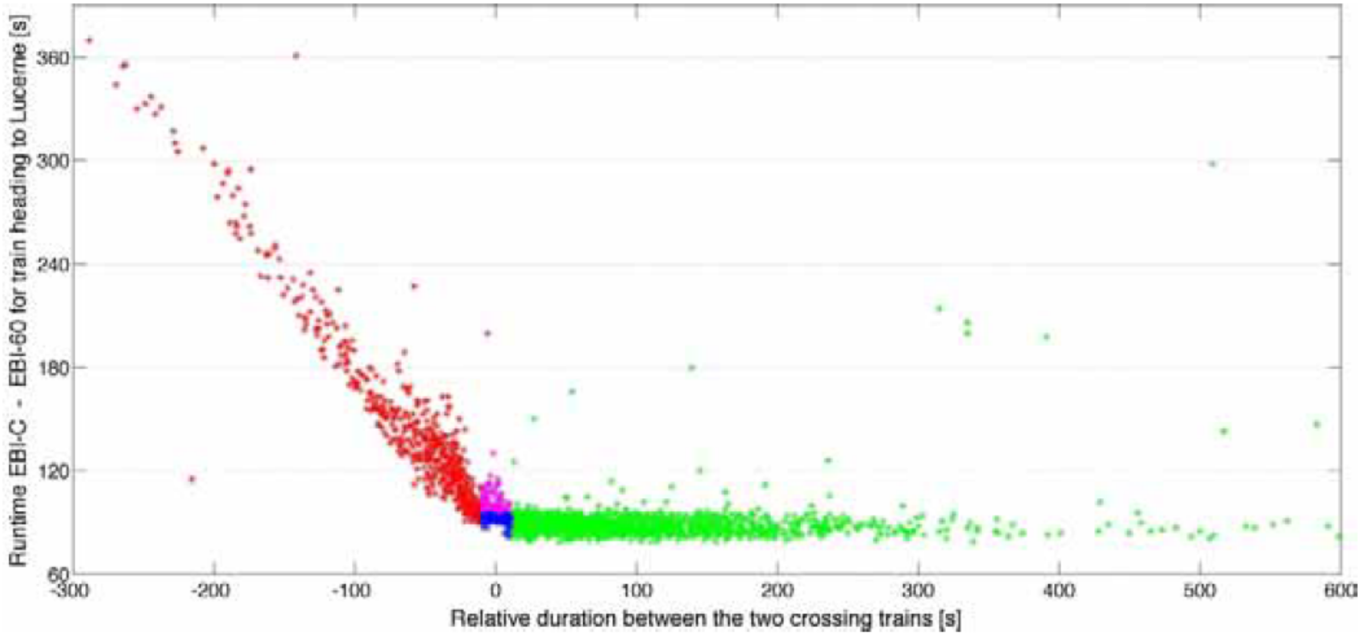

Figure 7.15: Running time of Interregio trains towards the single line section at Rotsee in dependence of the relative passing time with opposite train (green: major likelihood of no influence, blue: potential likelihood of an influence, magenta: possible likelihood of an influence; red: major likelihood of an influence)

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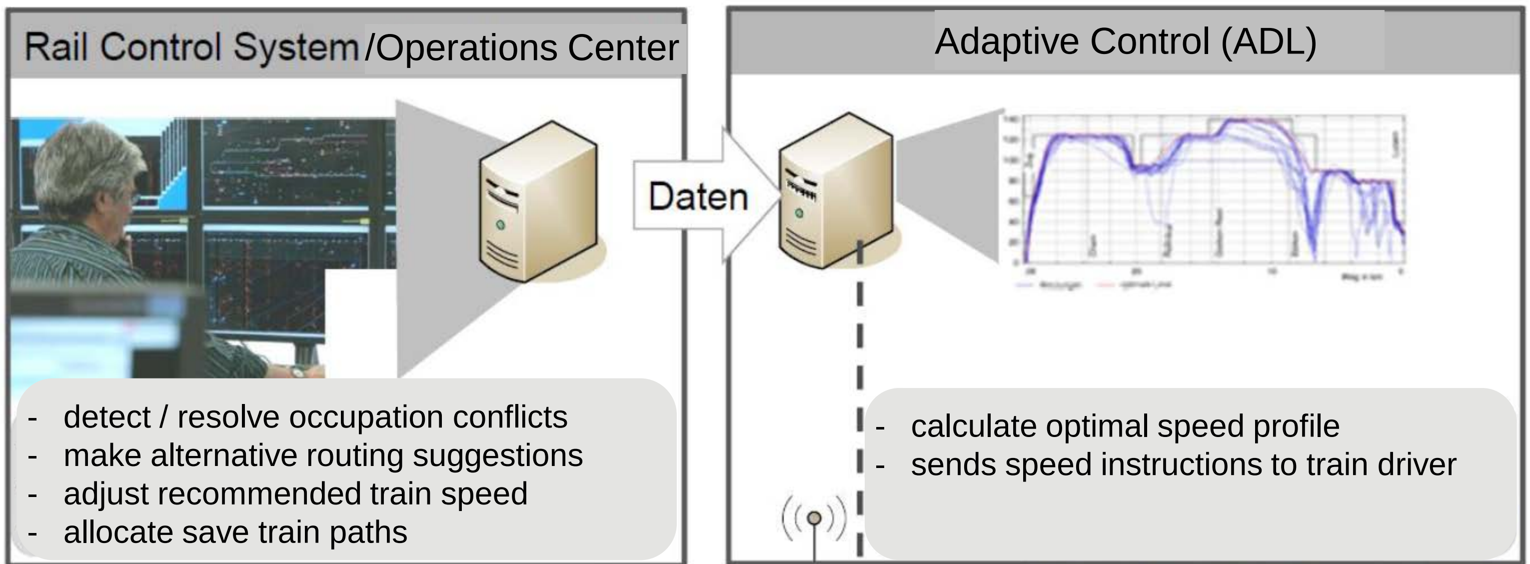
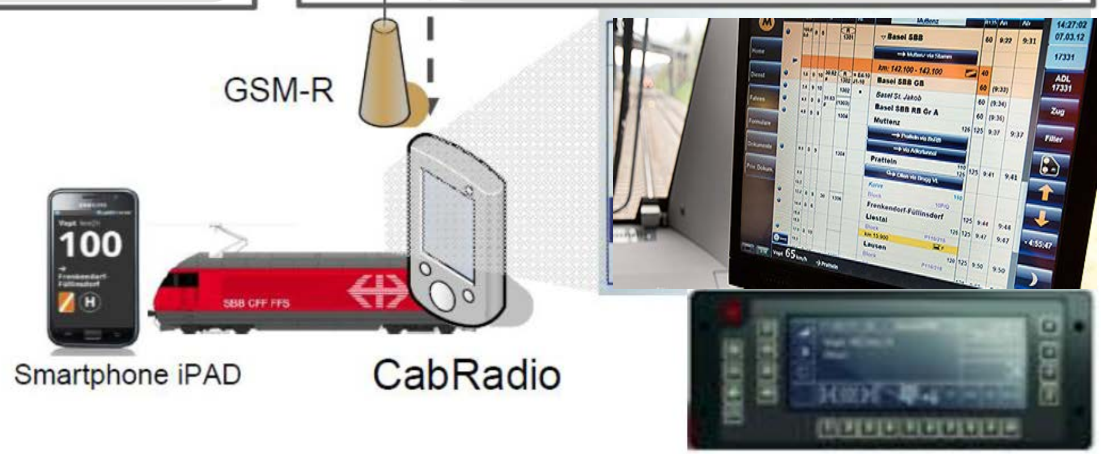
*M.Lüthi (2009): *Improving the Efficiency of Heavily Used Railway Networks through Integrated Real-Time Rescheduling,* Diss. IVT ETHZ

I. SBB: Produktion systems



ADL functions as connecting link between dispatching and train driver



Völcker, Marcus (2012): *Adaptive Lenkung bei den SBB.* http://www.it13rail.ch/downloads/presentations/7_Voelcker_ADL_IT13rail.pdf [download 22.11.2013]

II. Case Study Killwangen

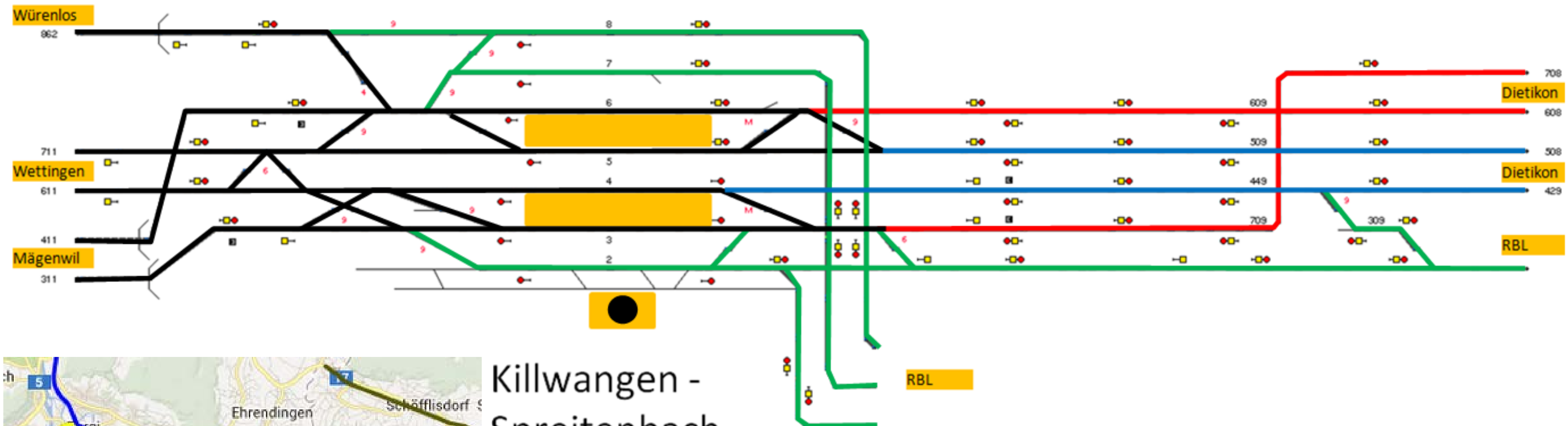
Killwangen-Spreitenbach: join of 2 main lines

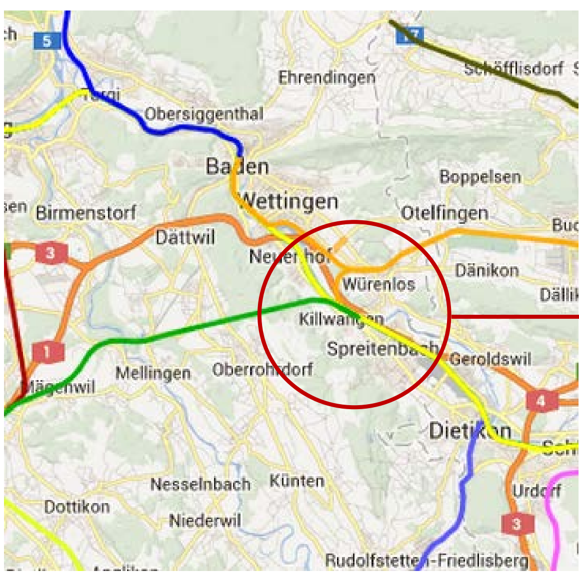
- Heitersberg line (Killwangen-Aarau), part of east-west transversal between Zurich und Berne
- Bözberg line, from Basel via Rheinfelden and Brugg to Zurich

overview of project perimeter (BAV 2013, adapted)

II. Topology

Topology of station KLW: colorcode for train type based track utilisation





Killwangen - Spreitenbach

Legend:

- intercity / interregio train
- commuter train
- cargo train
- all train categories

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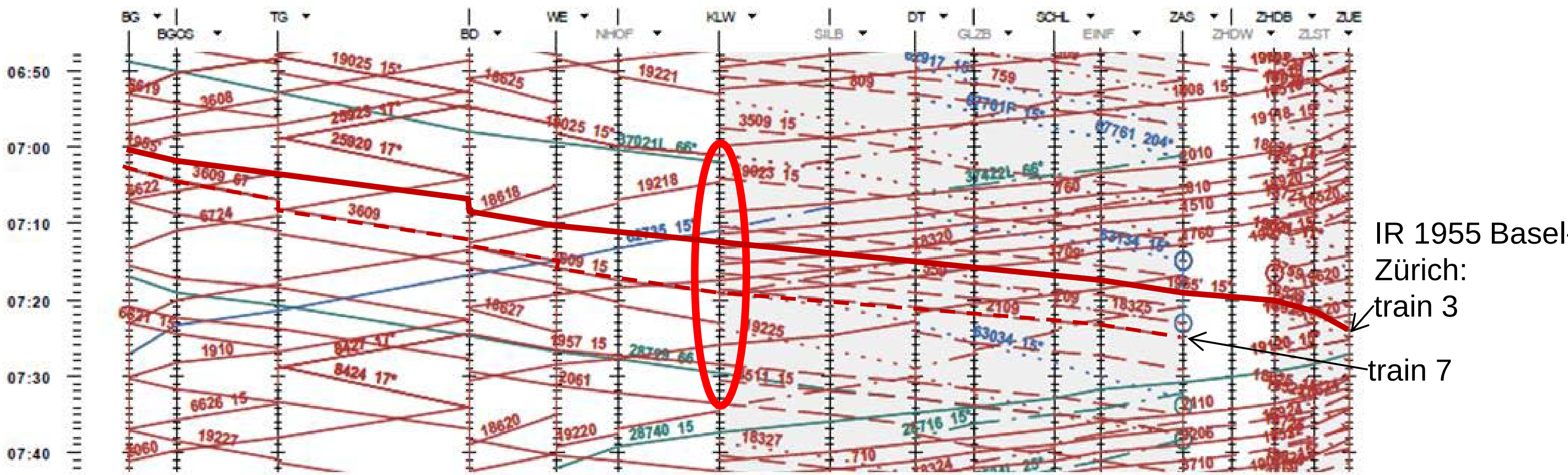
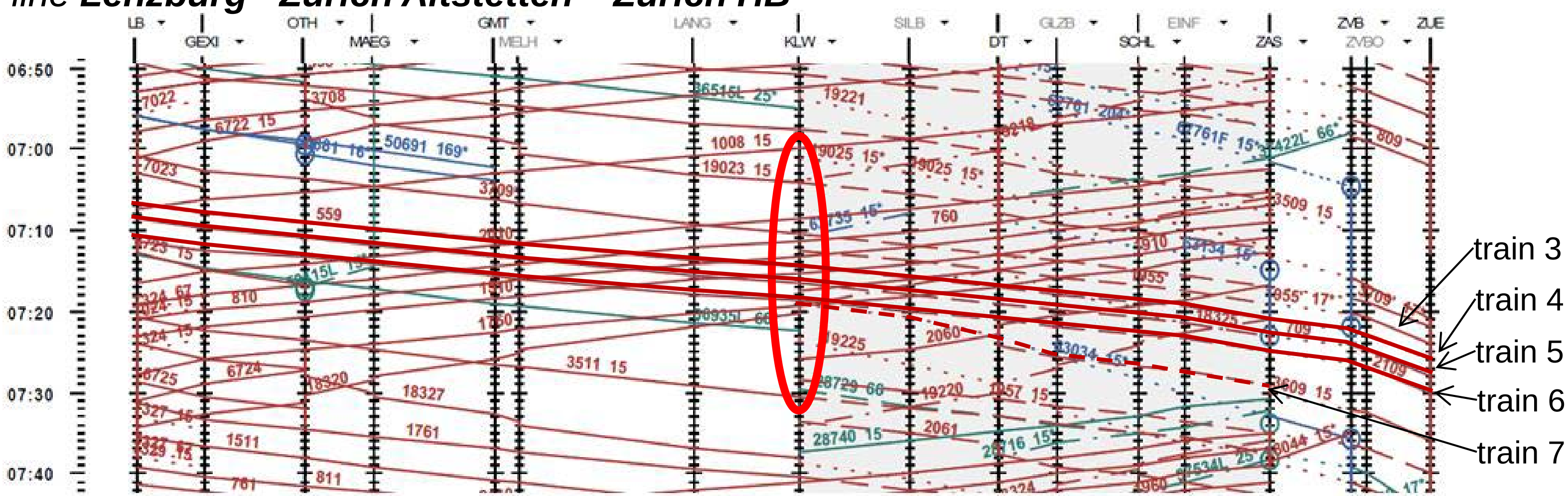
II. Line frequencies extracted from time table

line ***Brugg - Zürich Altstetten – Zürich HB*** *(from Fahrplanfelder 2012)*



line ***Lenzburg - Zürich Altstetten – Zürich HB***



Example

door failure at train 3

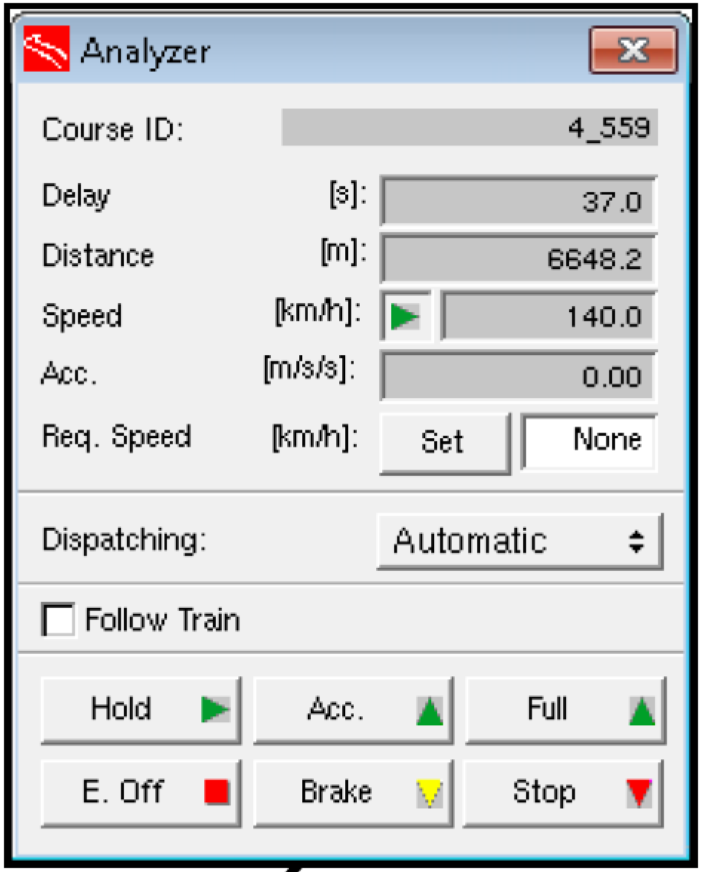
(IR 1955 Basel-Zürich, 2 min departure delay in Baden)

- **train 3** passes **KLW at 07:14 instead of 07:12**, (which corresponds to the planned passing time of train 4).

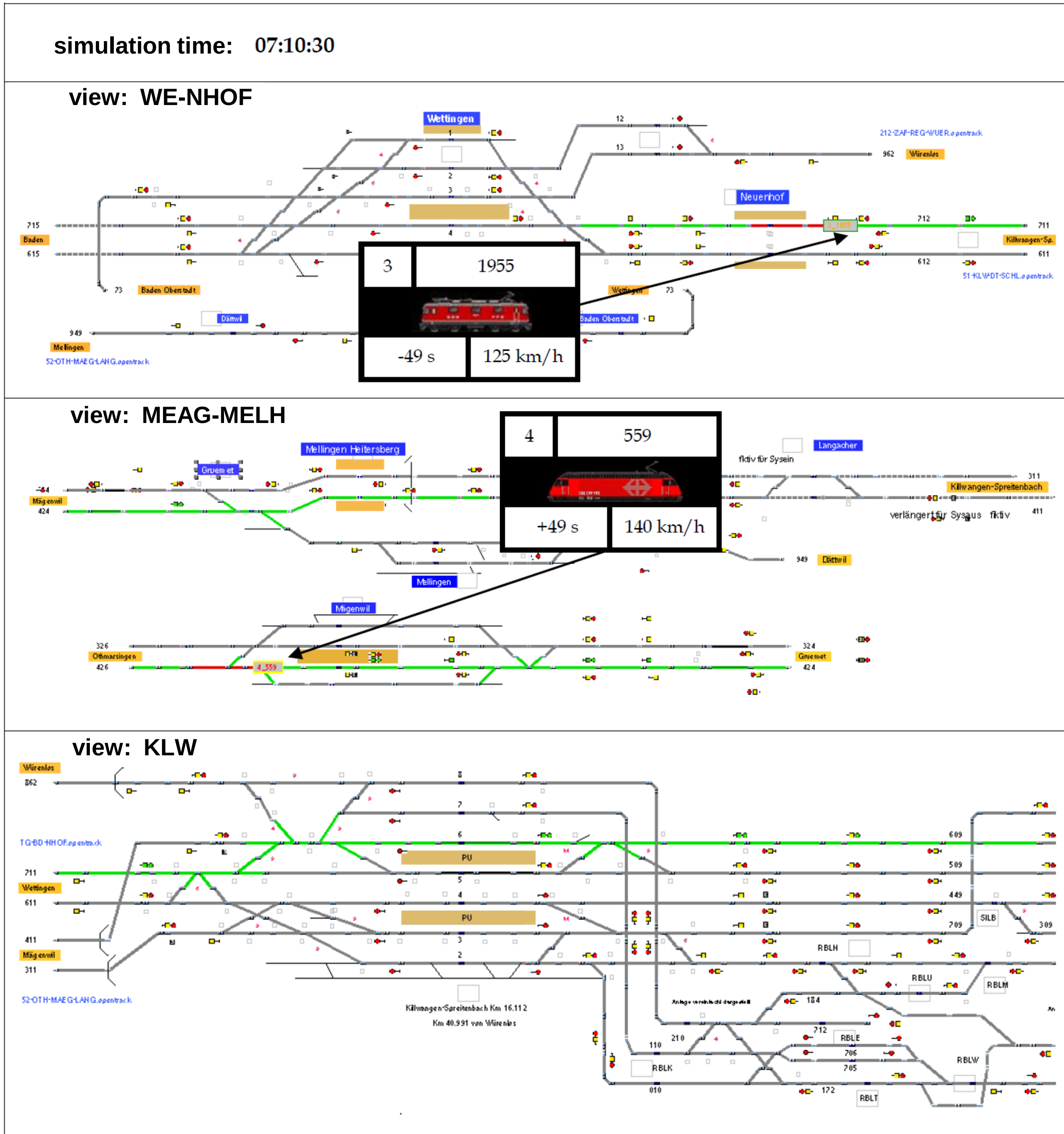
- Strong **influence on** the complete train set of scenario, three trains from the Lenzburg line (**train 4, 5 and 6**) cannot pass KLW as a „cluster of three" between 07:14 and 07:19 any more.

III. Speed instructions

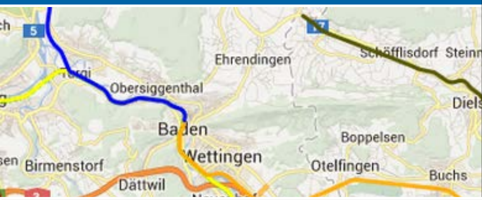
- The mask ‘Analyzer’ is used in order to execute speed controled simulations.
- The ‘Analyzer’ mask opens by selecting the respective train (siehe figure).
- In the field „Req. Speed“ you can enter the intended speed.
- This speed is respected only if it is below the technical speed of the respective edge (Otherwise the train drives with the technical track speed on the respective edge).

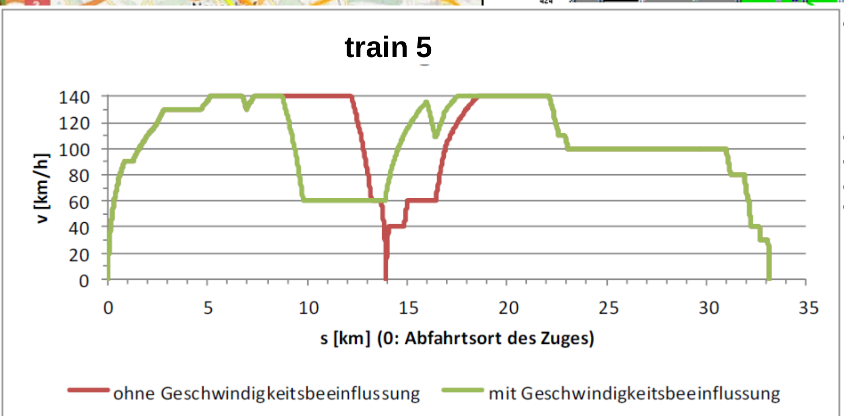


II. Operation state planned
07:10:30



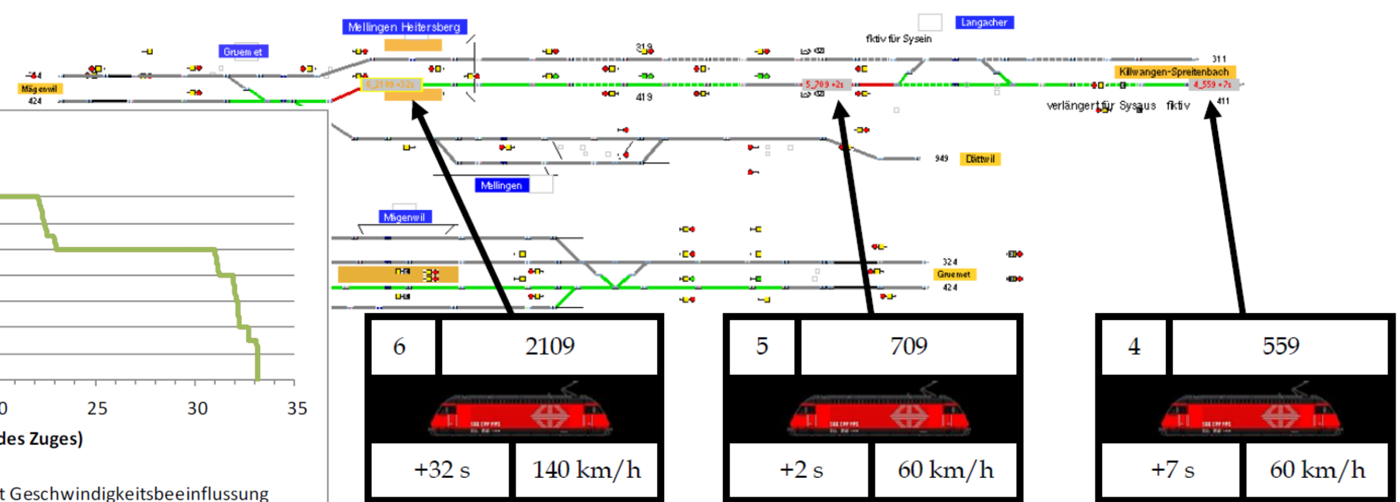
II. Operation state: 07:15:30 MAEG-KILW



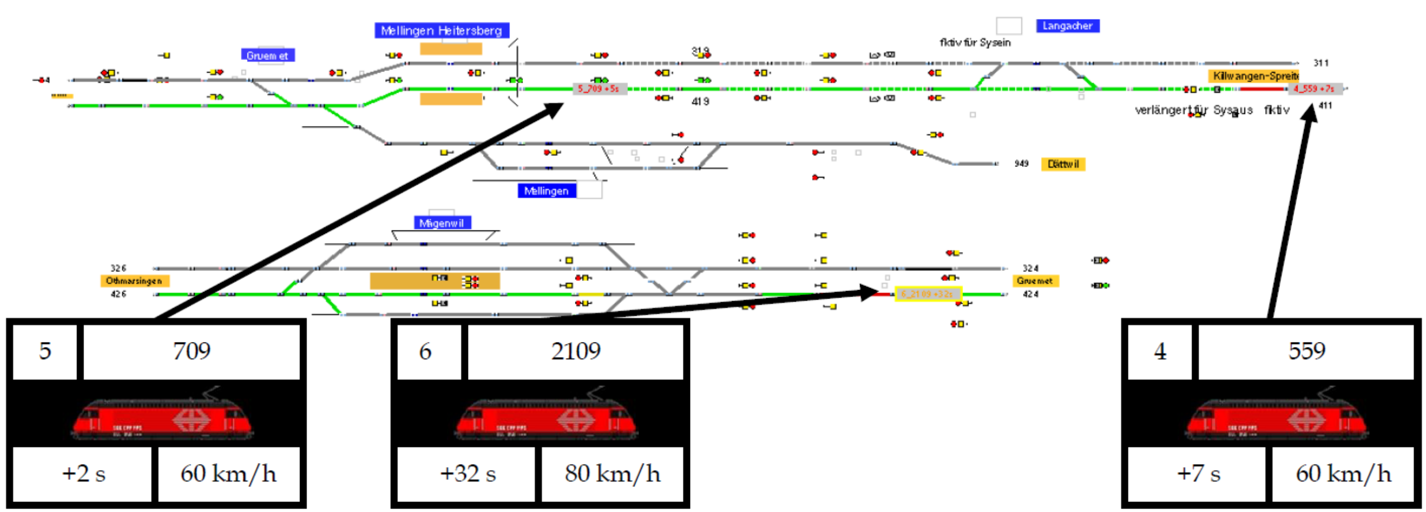


simulation time: 07:15:30 | **view:** MEAG-MELH

without speed control



with speed control



II. Connection matrix reference case

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Ankünfte (Zug # / SOLL)	IC 2110 07:30 Biel	IR 2261 07:31 Chiasso	IC 710 07:32 Genf	TGV 920 07:34 Paris	IR 2311 07:35 Luzern	IR 1960 07:36 Basel	IC 559 07:37 Chur	IC 2109 07:37 Konstanz	RE 3710 07:38 Aarau	IC 709 07:39 St. Gallen	RE3760 07:40 Schaffhausen	RE 3859 07:40 Schwanden	IC 1012 07:49 Bern	IR 2012 07:57 Bern	IC 30812 07:57 Brig	Anschlüsse Fahrplan	Effektive Anschlüsse
IC 560 07:23 Chur	7	8	9	-	12	13	-	14	15	16	17	17	26	34	34	7	
IC 710 07:23 St.Gallen	7	8	weiter	-	12	13	14	-	15	16	17	17	26	34	34	7	
train 3 07:24 IR 1955 Von Basel	-	7	-	-	11	-	13	13	14	15	16	16	25	-	-	6	
IC 2310 07:25 Luzern	-	-	7	-	-	11	12	12	13	14	15	15	24	32	32	8	
train 4 07:26 IC 559 Von Basel	-	-	-	-	9	-	weiter	11	12	13	14	14	23	-	-	7	
train 5 07:28 IC 709 Von Fribg	-	-	-	-	7	-	9	9	10	weiter	12	12	21	-	-	7	
train 6 07:28 IR 2109 Von Biel	-	-	-	-	-	-	7	weiter	8	9	10	10	19	-	-	6	
train 7 07:28 RE 3609 Von Olten	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
train 10 07:40 IR 1957 Von Basel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
train 11 07:45 RE 3511 Von Basel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	

Legende:

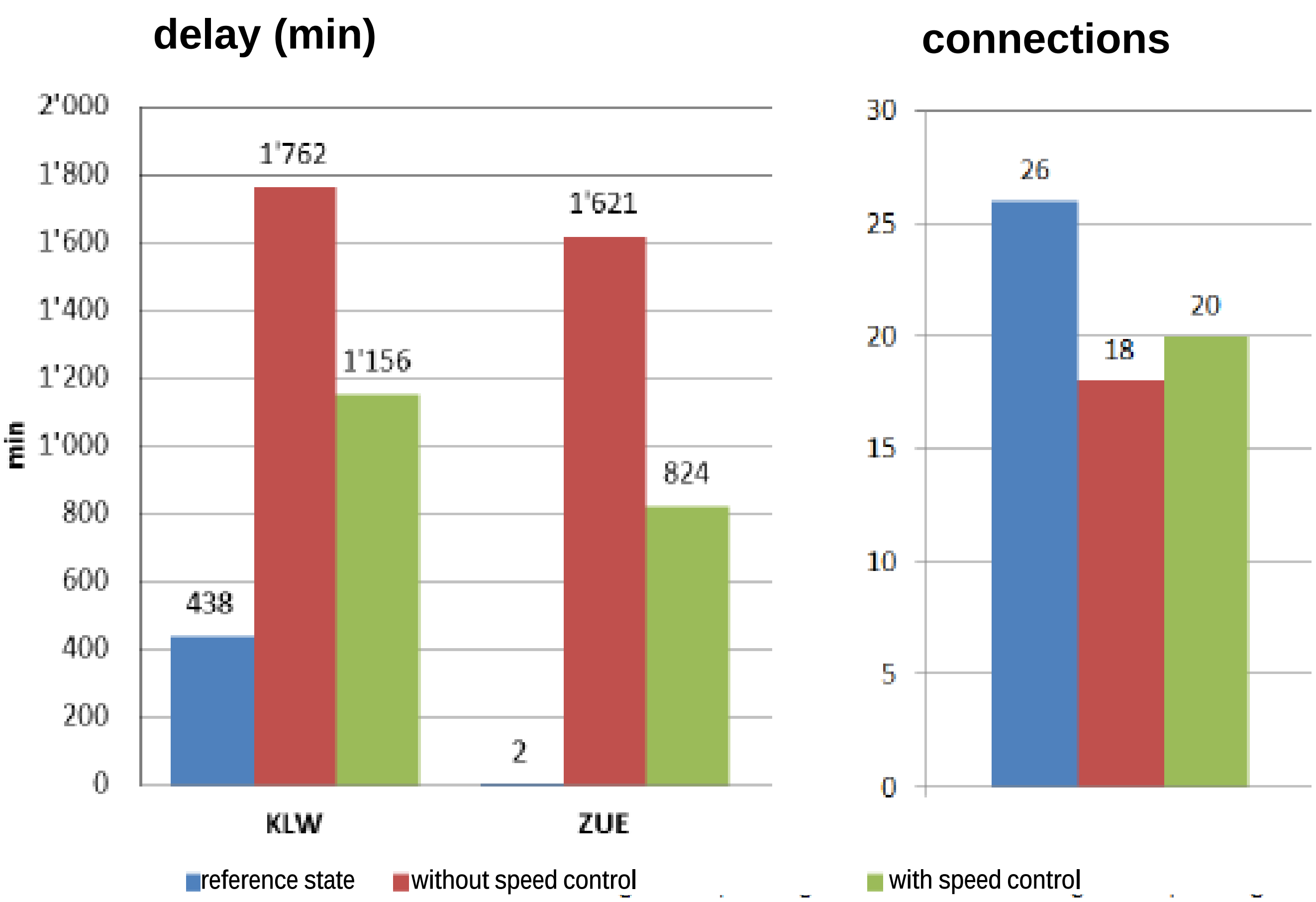
- weiter: Der Zug verkehrt nach Ankunft im ZHB weiter nach
- Anschluss 8-10 Minuten
- Anschluss grösser als 15 Minuten
- Anschlussbrüche
- Anschluss 7 Minuten (Minimumumsteigezeit ZHB)
- Anschluss 11-15 Minuten
- Züge aus der Simulation

Was wird als Anschluss betrachtet?

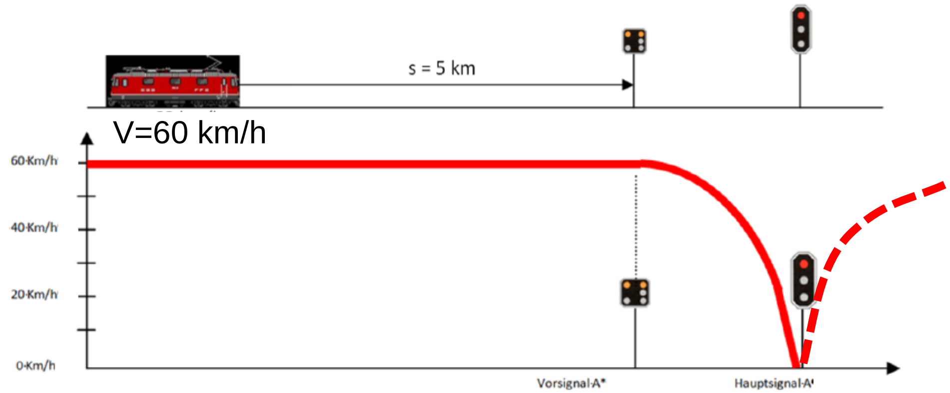
In unserer Betrachtung gilt: Grundsätzlich werden keine Anschlussbeziehungen in die Richtung publiziert, aus welcher der Zug kommt. Bei S-Bahnen und dem Internationaler Verkehr (TGV,EC,EN) werden keine Anschlüsse hergestellt.

II. results scenario door failure train 3

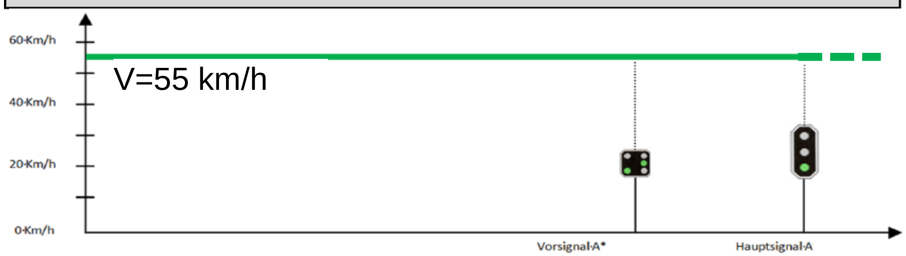
aggregated delay and connections in Zurich



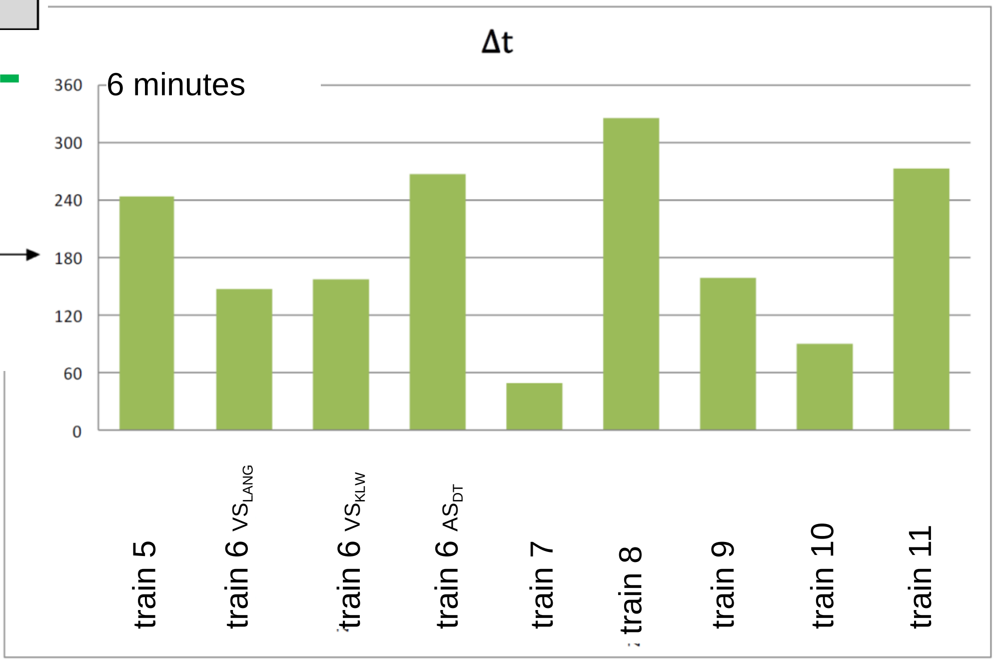
II. Lead time Δt for all speed adaptations (ADL-communication)



Required time to distant signal:	5.0 min
Remaining time until Signal A switches to 'green':	5.5 min



Required time to distant signal:	5.5 min
Remaining time until Signal A switches to 'green':	5.5 min



III. RAIL TRANSPORT SERVICE ENVIRONMENT (RTSE) *PROJECT PARTNERSHIP*

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement für Wirtschaft, Bildung und Forschung WBF
Kommission für Technologie und Innovation KTI
Förderagentur für Innovation

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Data analysis and Process-optimisation

ZHAW, School of Engineering

- Jürgen Spielberger (InIT)
- Claudio Gomez (IDP)
- Bernhard Seybold (IDP, TrafIT)
- Albert Steiner (IDP)
- Raimond Wüst (IDP)

IBM Research

Automatised conflict resolution based on process model

Smarter Rail

Emch+Berger

Consulting traffic engineering

BdK-Projekt

SBB CFF FFS

Rail operatios

Practical requirements

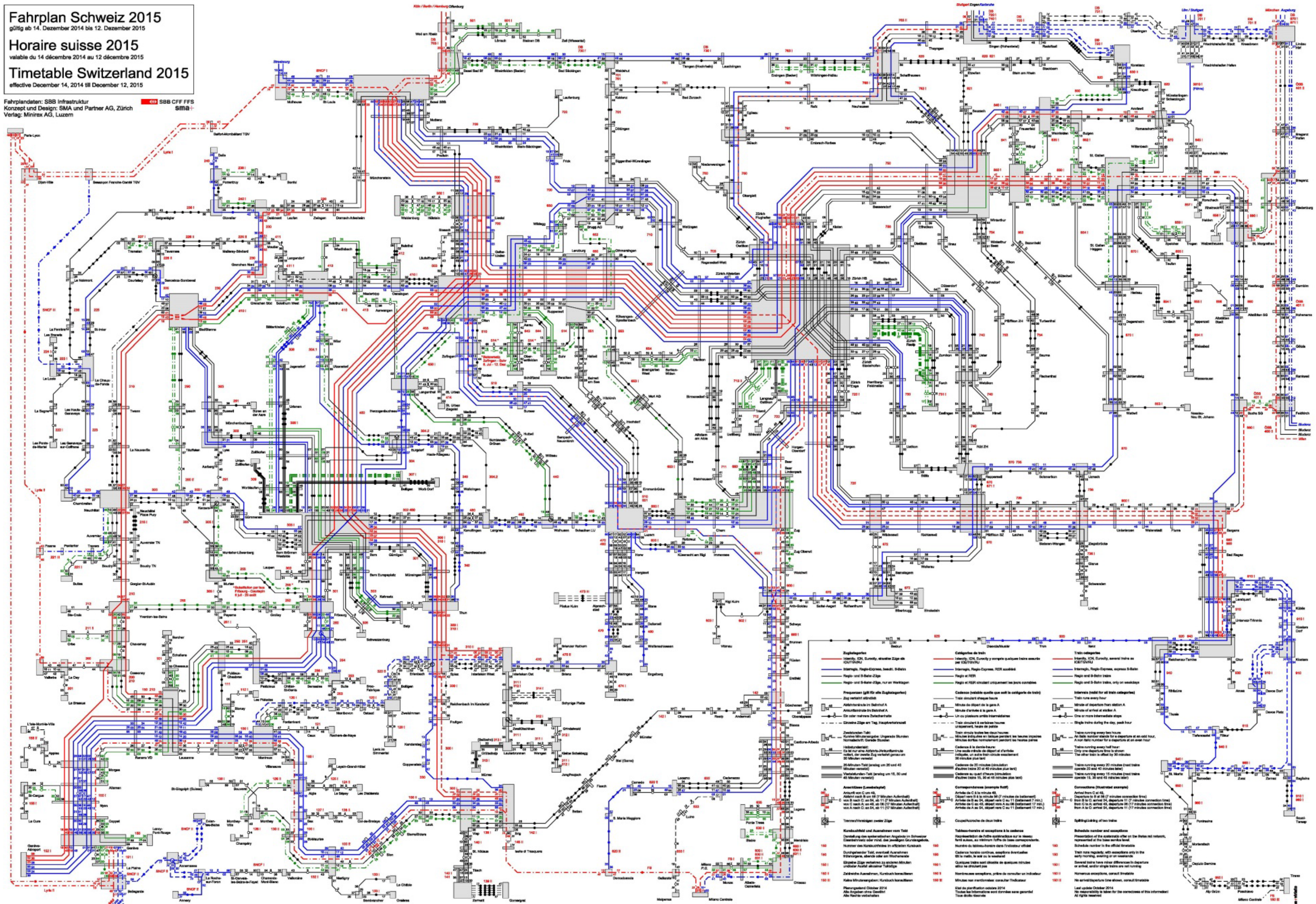
OPEN TRACK

realistic train simulation broad distribution

industry partner

- Marco Laumanns (IBM Research GmbH)
- Daniel Hürlimann (OpenTrack Railway Technology)
- Ivan Levkov (Emch + Berger AG)
- Peter Grossenbacher (SBB Infrastruktur Betrieb)

III. RTSE: focus on network-connectivity effect



Motivation: problems in service delivery

- Limited usability of public transport due to communication problems
- Decreasing service reliability due to operational volatility and technical disturbances
- Considerable total delay times due to local dispatching decisions

III. Layer Multi-Component Closed Loop Control Framework *System overview*

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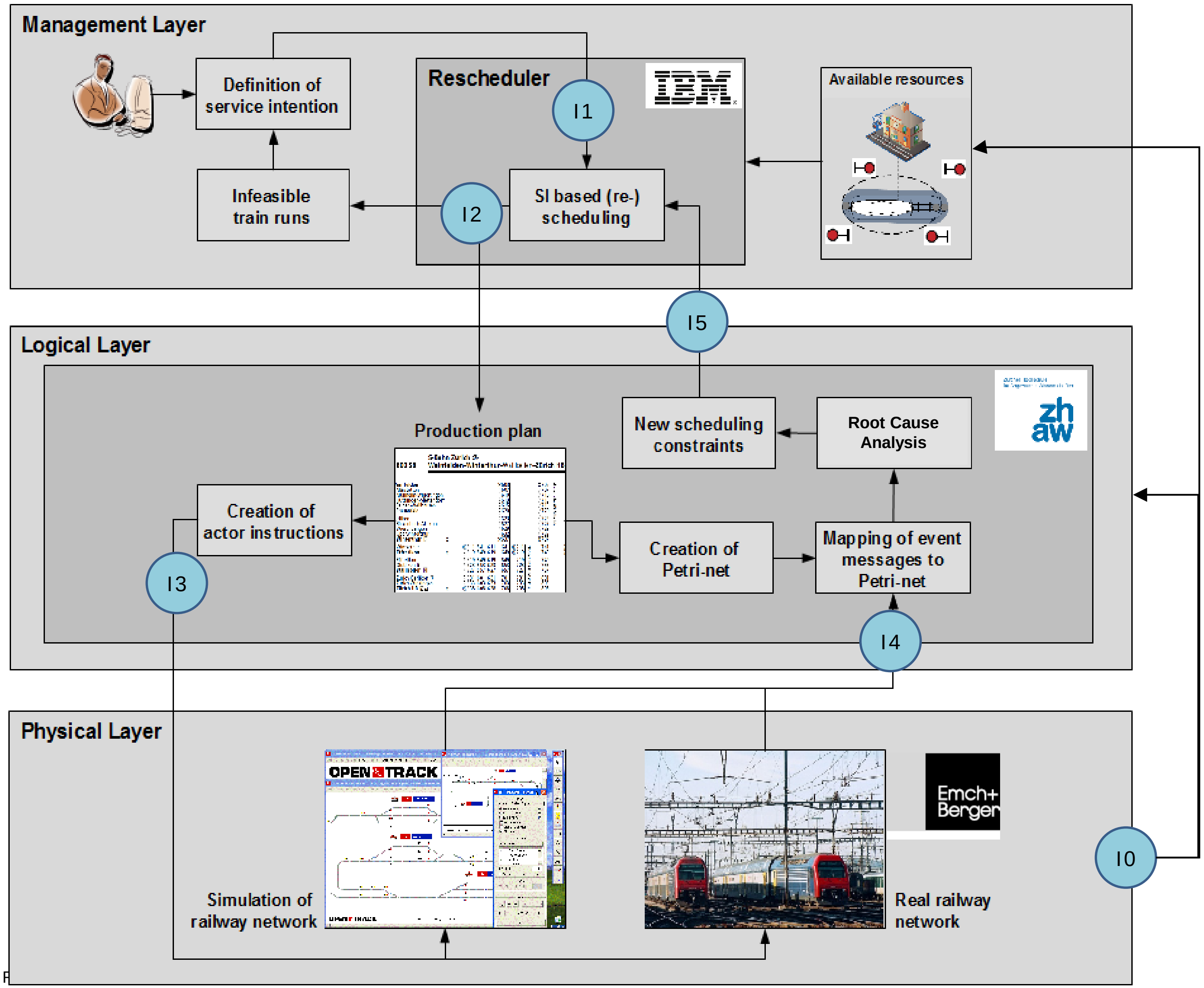
- **(I0)** common data
- **(I1)** service intention
- **(I2)** production plan and unfeasible train runs (if any)

- **(I2)** production plan
- **(I5)** new scheduling constraints related to the available resources

- **(I3)** timetable and actor instructions for real-time process configuration of the railway network.
- **(I4)** position and process state messages

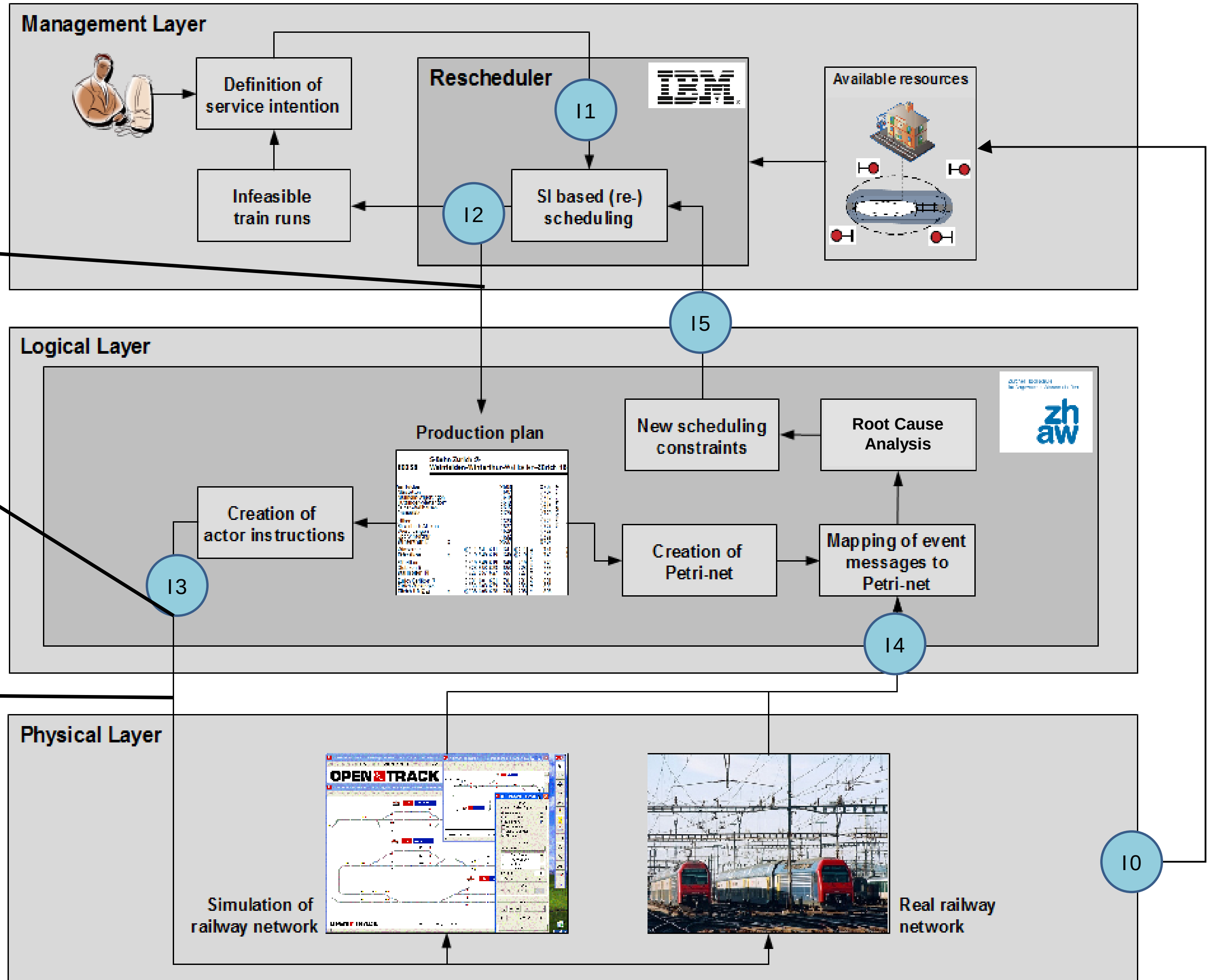


III. RTSE Information flow

guard instructions: connections, departures, arrivals, platforms, etc.

driver instructions: trip times, departure times, speed recomendations

operator instructions: route changes, route reservations, route cancellations. train sequences etc.

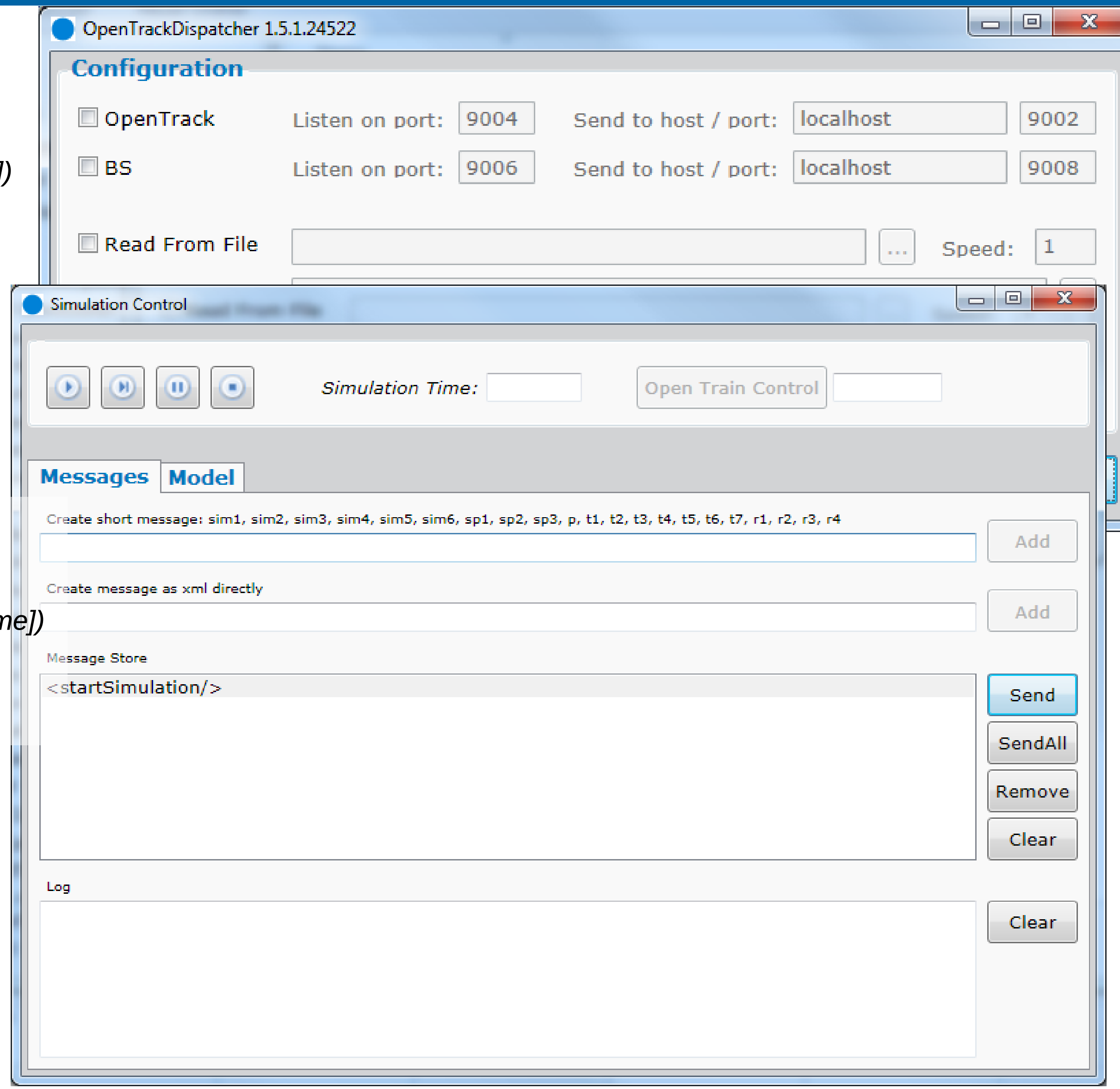


III. OpenTrackDispatcher

timetable messages
trainArrival (trainID, stationID, time, [delay])
trainDeparture (trainID, stationID, time, [delay])
trainPass (trainID, stationID, time, [delay])

route messages
routeReserved (routeID, trainID, time)
routeReleased (routeID, trainID, time)
infraPartReserved (infraPartID, trainID, time)
infraPartEntry (infraPartID, trainID, time)
infraPartExit (infraPartID, trainID, time)
infraPartReleased (infraPartID, trainID, time)

train messages
setRequestedSpeed (trainID, speed, [time])
resetRequestedSpeed (trainID, [time])
setEngineSwitch (trainID, switchOnOffFlag, [time])
setPerformance (trainID,
performanceFactorOnTime,
performanceFactorDe-layed, [time])



Model Calibration

test scenario

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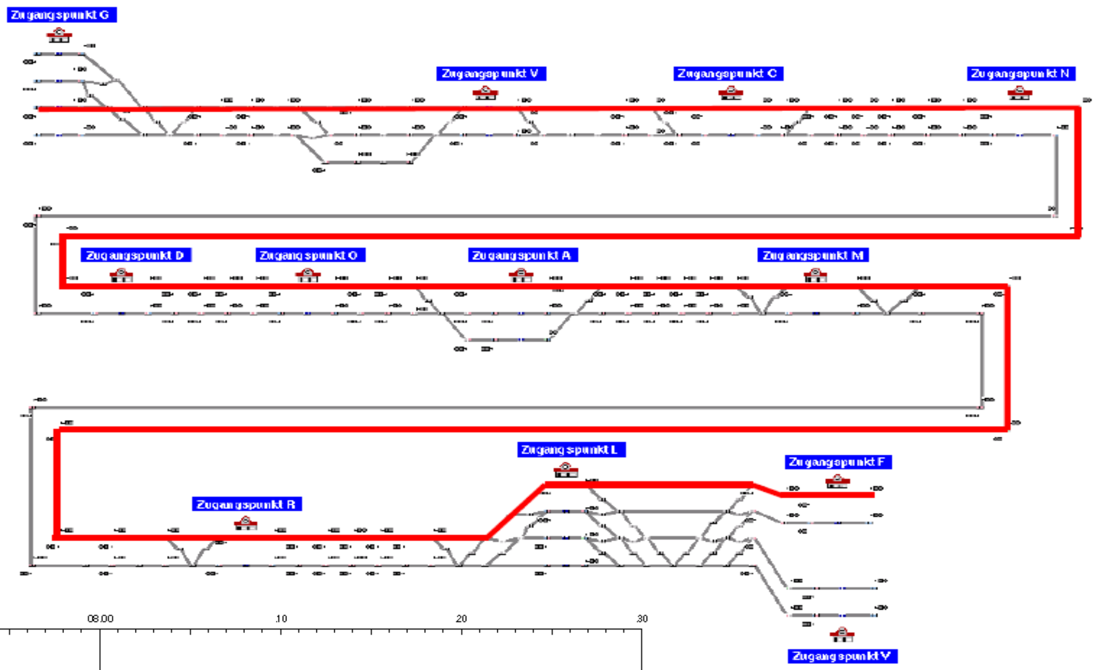

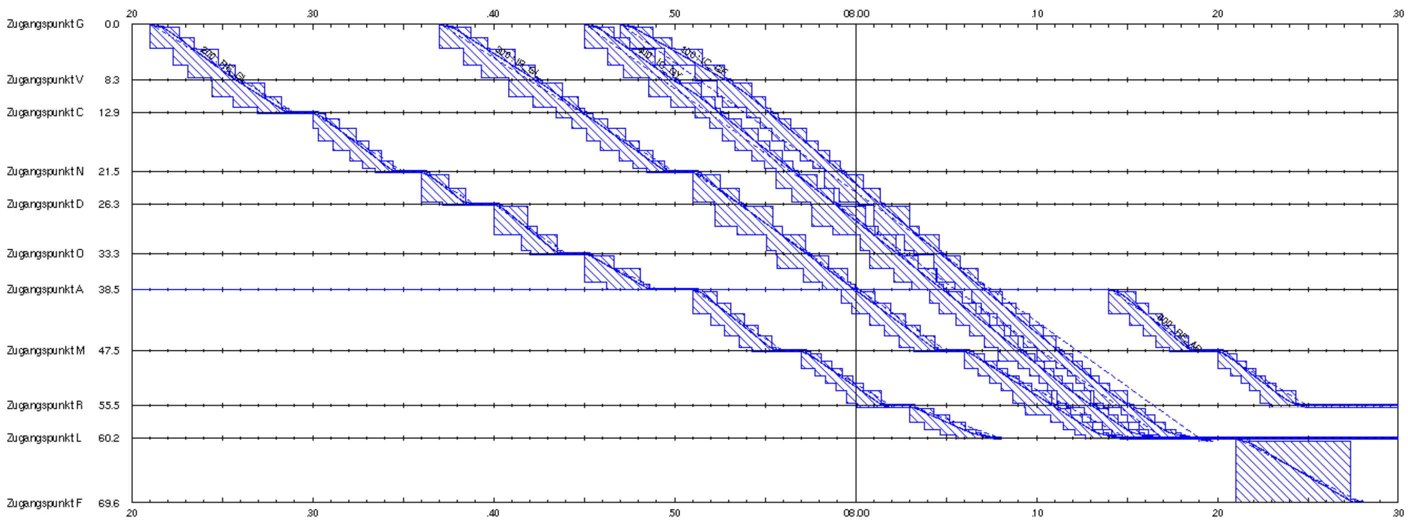

RTSE Overall Process Integration

Time Deviations of Process Events

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Display Event Queue

train... ▲	eventType	ressourceID	operatingTi...	planne...	delayTi...
1	ROUTE_OCCUPY	KTI_Szenario2-14326-R:[14326]_WN_2-[14337]_[1...	28196	28182	-14
1	ROUTE_LEAVE	KTI_Szenario2-14313-R:[14313]_[14313]-[14326]_...	28198	28136	-62
1	ROUTE_RELEASE	KTI_Szenario2-14313-R:[14313]_[14313]-[14326]_...	28204	28136	-68
1	ROUTE_RESERVE	KTI_Szenario2-14337-R:[14337]_[14337]-[14349]_...	28251	28251	0
1	ROUTE_OCCUPY	KTI_Szenario2-14337-R:[14337]_[14337]-[14349]_...	28267	28251	-16
1	ROUTE_LEAVE	KTI_Szenario2-14326-R:[14326]_WN_2-[14337]_[1...	28270	28182	-88
1	ROUTE_RELEASE	KTI_Szenario2-14326-R:[14326]_WN_2-[14337]_[1...	28276	28182	-94
1	ROUTE_RESERVE	KTI_Szenario2-14349-R:[14349]_WN_3-ZP_V_WN_4	28307	28307	0
1	ROUTE_RESERVE	KTI_Szenario2-14371-R:ZP_V_WN_4-[14393]_[143...	28325	28325	0
1	ROUTE_OCCUPY	KTI_Szenario2-14349-R:[14349]_WN_3-ZP_V_WN_4	28325	28307	-18
1	ROUTE_LEAVE	KTI_Szenario2-14337-R:[14337]_[14337]-[14349]_...	28327	28251	-76
1	ROUTE_RELEASE	KTI_Szenario2-14337-R:[14337]_[14337]-[14349]_...	28333	28251	-82
1	TRAIN_PASS	ZP_V	28338	28329	-9
1	ROUTE_OCCUPY	KTI_Szenario2-14371-R:ZP_V_WN_4-[14393]_[143...	28342	28325	-17
1	ROUTE_LEAVE	KTI_Szenario2-14349-R:[14349]_WN_3-ZP_V_WN_4	28345	28307	-38
1	ROUTE_RELEASE	KTI_Szenario2-14349-R:[14349]_WN_3-ZP_V_WN_4	28351	28307	-44
1	ROUTE_RESERVE	KTI_Szenario2-14393-R:[14393]_[14393]-[14398]_...	28397	28397	0
1	ROUTE_OCCUPY	KTI_Szenario2-14393-R:[14393]_[14393]-[14398]_...	28415	28397	-18
1	ROUTE_LEAVE	KTI_Szenario2-14371-R:ZP_V_WN_4-[14393]_[143...	28417	28325	-92
1	ROUTE_RELEASE	KTI_Szenario2-14371-R:ZP_V_WN_4-[14393]_[143...	28423	28325	-98
1	ROUTE_RESERVE	KTI_Szenario2-14398-R:[14398]_WN_5-ZP_C_[144...	28438	28438	0
1	ROUTE_OCCUPY	KTI_Szenario2-14398-R:[14398]_WN_5-ZP_C_[144...	28458	28438	-20
1	ROUTE_LEAVE	KTI_Szenario2-14393-R:[14393]_[14393]-[14398]_...	28460	28397	-63
1	ROUTE_RESERVE	KTI_Szenario2-14423-R:ZP_C_[14423]-[14428]_W...	28461	28461	0
1	ROUTE_RELEASE	KTI_Szenario2-14393-R:[14393]_[14393]-[14398]_...	28466	28397	-69
1	ROUTE_RESERVE	KTI_Szenario2-14428-R:[14428]_WN_6-[14440]_[1...	28477	28477	0
1	TRAIN_PASS	ZP_C	28479	28468	-11

update

ping

1148 Events in der Queue

III. Model Calibration: Time Deviation of Events

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aw
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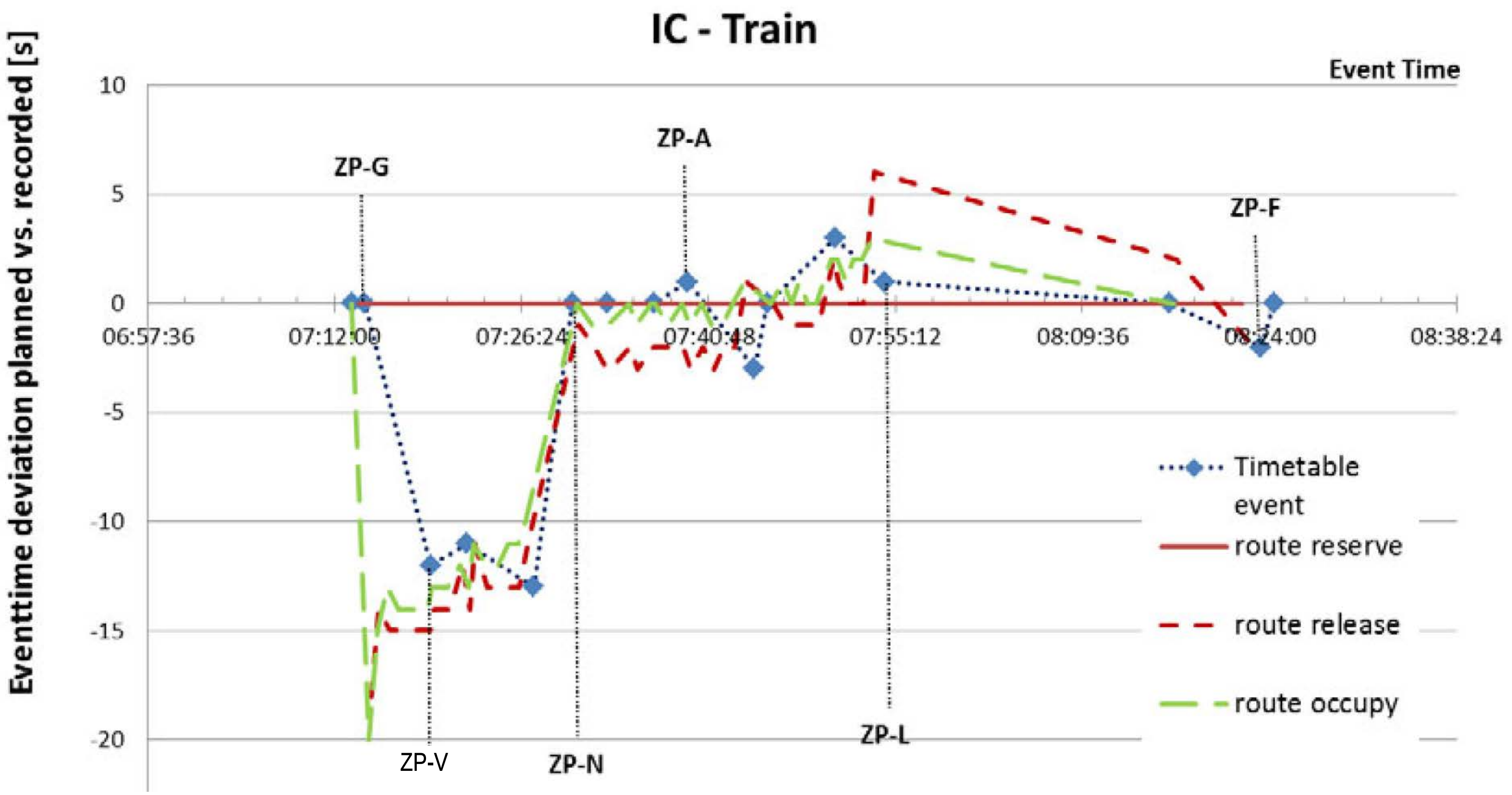

Proposal: implement location based speed instructions

QUESTIONS?