Høyhastighetstog i Norge
Vurdering av noen kapasitetsmessige forhold.

28.Oktober 2008

Ove Skovdahl
Railconsult AS

Background

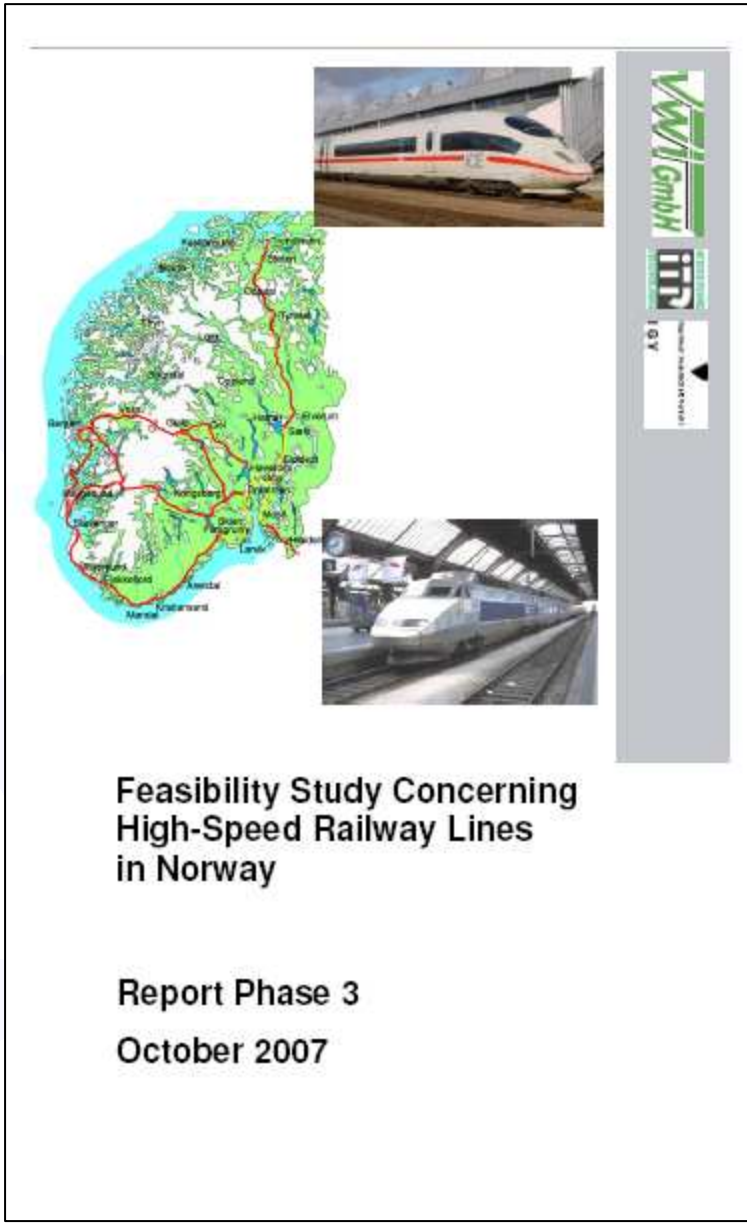
- VWI 2007 High Speed Report
- JBV summary of comments to this report.

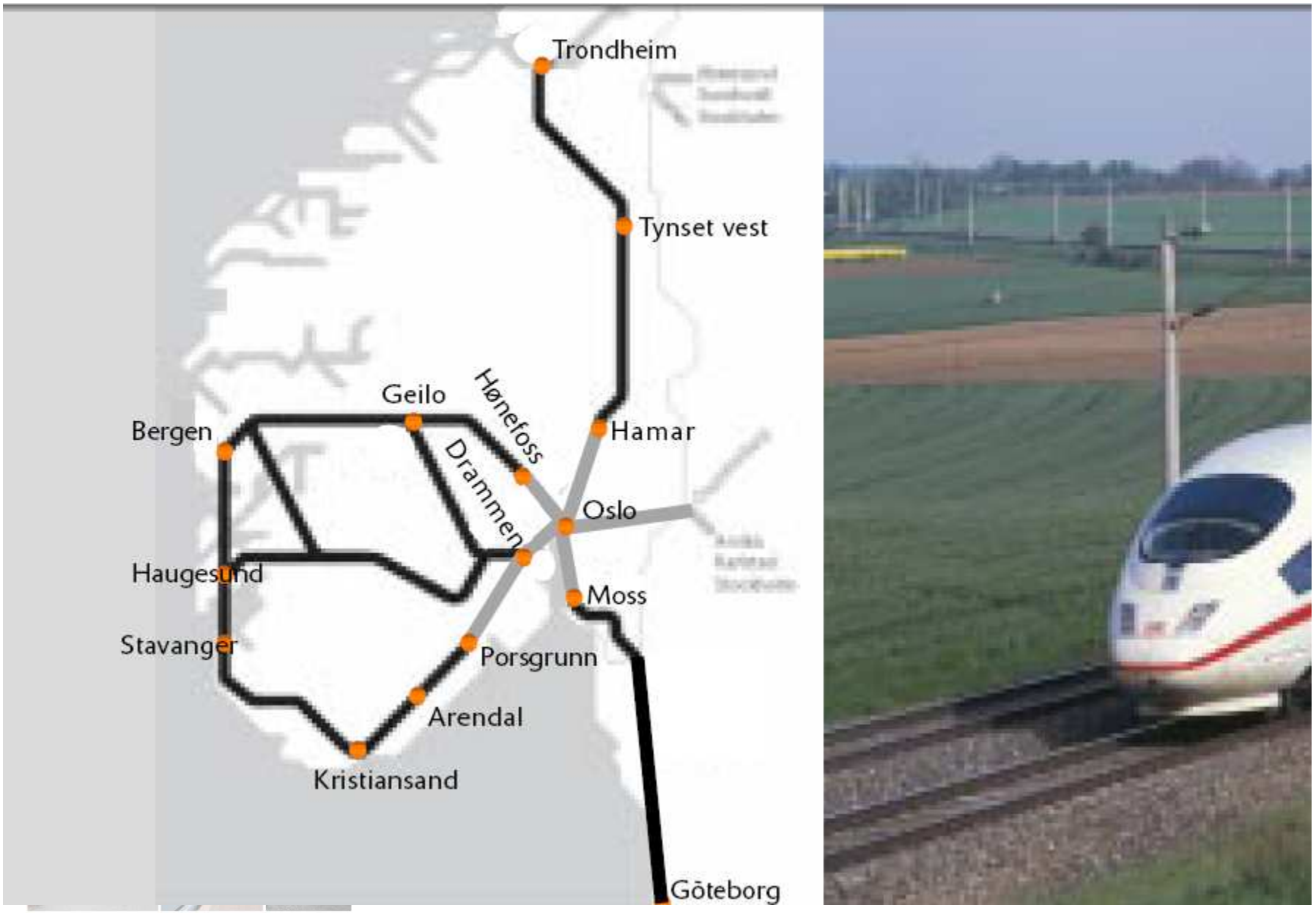
Purpose of the Project is to investigate:

- *Is it advisable to integrate High Speed Trains with other train traffic in IC-area?*
- *Is it advisable to run High Speed Trains in 1 or 2 hr service frequency on single track lines?*

Consultants

- Funkwerk-IT York
- Railconsult AS




Trondheim
Tynset vest
Hamar
Hønefoss
Geilo
Bergen
Drammen
Oslo
Haugesund
Moss
Stavanger
Porsgrunn
Arendal
Kristiansand
Göteborg

Working Method

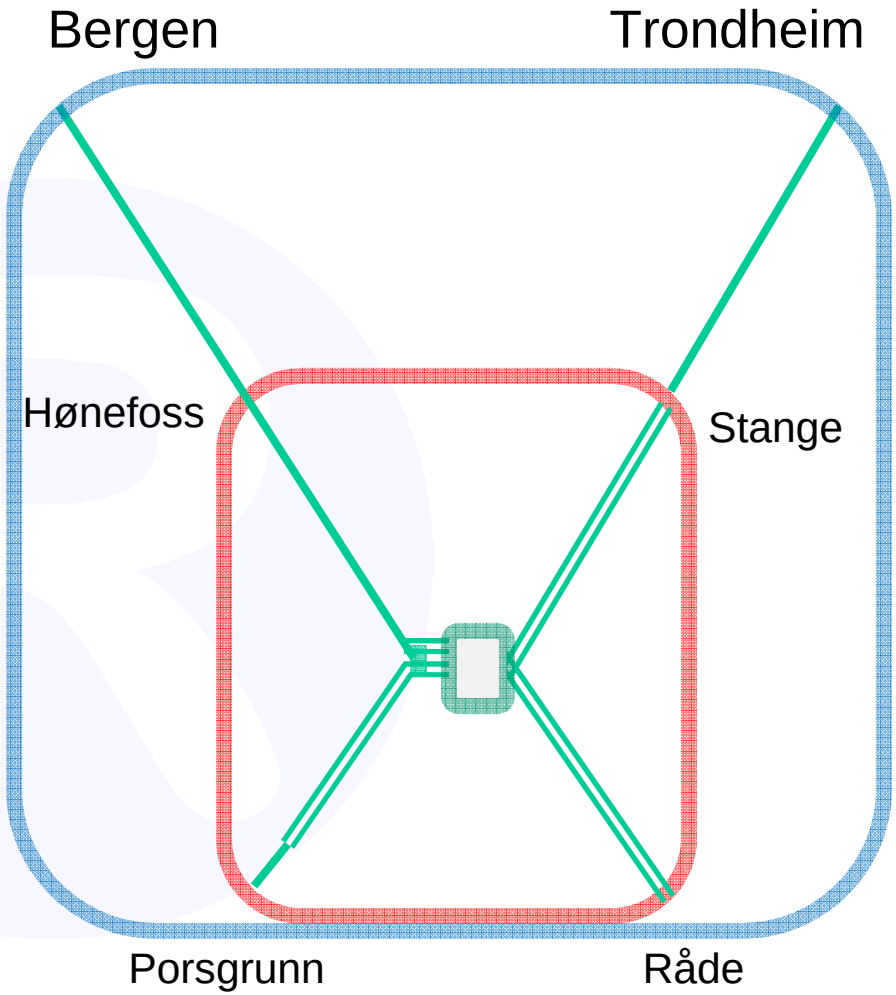
- Workshops with stakeholders; agreement on assumptions.
- Frequent Meetings with JBV Work Group; preliminary reports
- Working in phases; first IC Area and then HSL.
- Modelling, Calculations and Simulations by Funkwerk-IT
  - Modelling Infrastructure
  - Journey Time Calculations
  - Timetabling
  - Robustness Analysis
- Analysis in cooperation Funkwerk-IT and Railconsult AS.
- Project Periode June – October 2008

JBV High Speed Operations 2008 – System Boundaries

<u>IC Area:</u>
- Oslo-Råde
- Oslo-Stange
- Oslo-Porsgrunn
- Oslo-Hønefoss

<u>High Speed Lines:</u>
- Oslo-Hønefoss-Bergen
- Oslo-Stange-Trondheim

Capacity Evaluation of Oslo-Lysaker is in principle not part of this study.



funkwerk
information technologies

Train Service Concepts

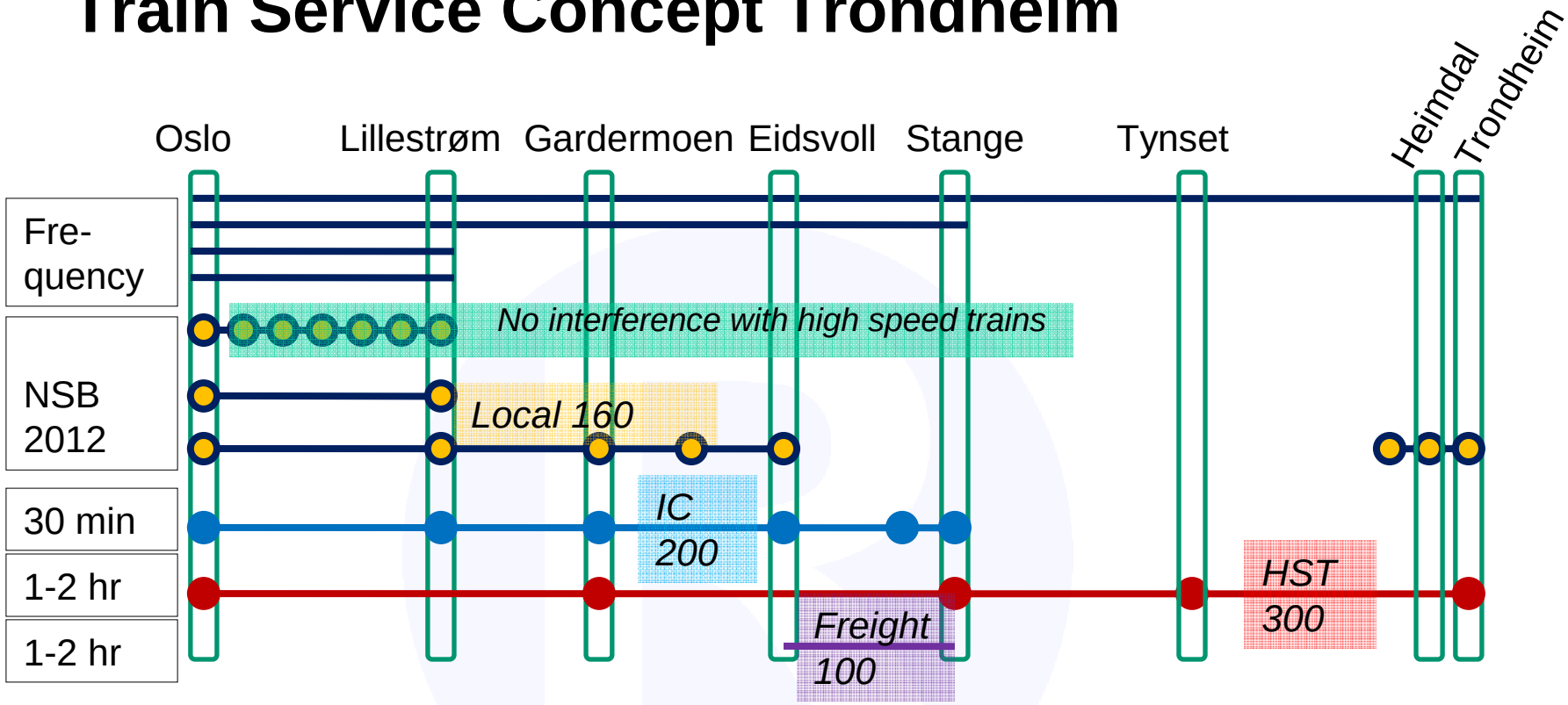
Train Service Concept Definition for this project:

- Frequency
- Stopping Patterns
- Train type (max speed)

Workshop Conclusions:

- Using present 2012 timetable proposal as basic concept through Oslo.
- 6 Flytog per hour (3 Drammen, 3 Lysaker).
- Adjusting concept for reduced journey time when IC Area is completed.
- 2 train paths for high speed trains through the Oslo Tunnel per hour.
- Clockface timetable; same train paths every hour
- One freight train path per hour.

Train Service Concept Trondheim



Conclusions:

- Complete double track Gardermoen-Venjar-Eidsvoll
- Operational double track Trondheim M – Trondheim S.
- Passing loop for freight trains between Eidsvoll and Stange.
- Discuss speed 160/ 200 for Eidsvoll trains (from Kongsberg /Skien)

Rolling Stock Assumptions

Typical trains chosen for the 4 categories - without relating to any commercial or existing type of rolling stock:

- Local Trains: Max speed 160 km/h. NSB AS type 72, Siemens Desiro EMU.
- InterCity Trains: Max speed 200 km/h. Flytoget T71 with 4 powered cars.
- High Speed Trains: Max speed 300 km/h. ICE 3 (VWI-study)
- Freight Trains: Traxx loco with 1200 ton train.

Capacity measured in # of trains (not seats or passengers) per time unit.

Infrastructure

The railway infrastructure for this study consists of:

- The existing infrastructure.
- New infrastructure under construction, planned to be inaugurated in 2012. Future alignment is known.
- New infrastructure planned to be established before 2025, but future alignment not yet known
  - *4 Track Oslo – Ski (Oslo S section)*
  - *Double Track Tønsberg-Larvik*
- New High Speed lines. Future alignment has been drawn up in the VWI study.

Timetable Assumptions

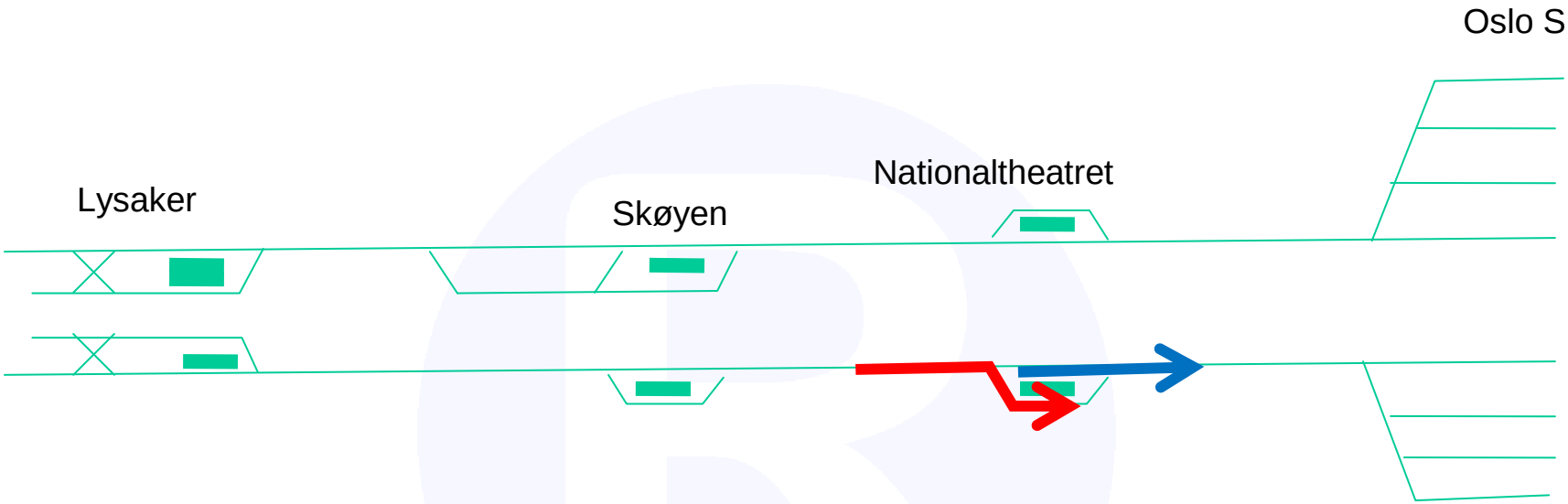
- Half hourly IC to Lillehammer and Skien: As first solution extension of Lillehammer-Drammen trains to Porsgrunn, and Skien-Eidsvoll trains to Hamar.
- High speed trains replace existing long distance passenger trains (Bergen/ Kristiansand) Oslo - Drammen.
- Planning headway 2 min Lillestrøm-Oslo-Lysaker *(assuming sufficient improvements before traffic start)* and 3 min elsewhere
- Follobanen Freight trains timetabled from Oslo S, due to uncertainty about future connection from Alnabru (Loenga or Bryndiagonal).
- Sufficient capacity for turning trains from Oslo west of Lysaker (substituting Skøyen/ Bestun).

Timetabling Priorities

1. Oslo-Lysaker; follow NSB 2012 proposal, with cross city trains
2. IC Network.
3. High Speed Trains.
4. Local Trains Bergen/ Trondheim.

Buffer times added when trains entering into the Lysaker-Oslo section.

Oslo – Lysaker Principle



funkwerk
information technologies

Methods

Journey Time Calculation

- Follobanen/ Østfoldbanen: JBV Calculations
- IC Area: RailPlan
- High Speed Lines: RailPlan

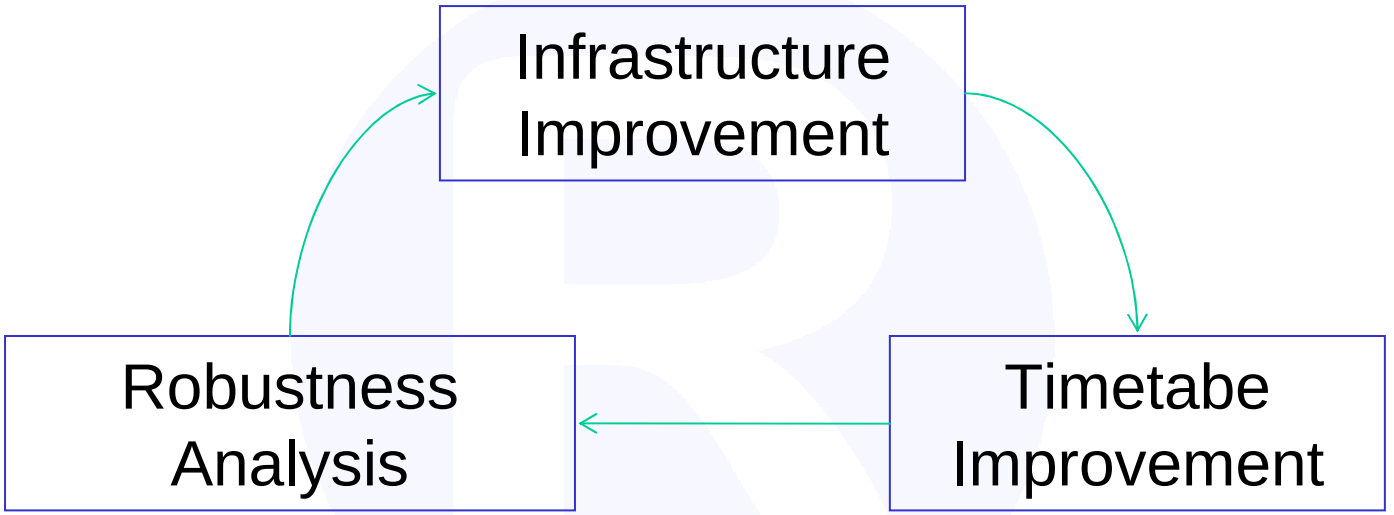
Timetabling:

- TrainPlan

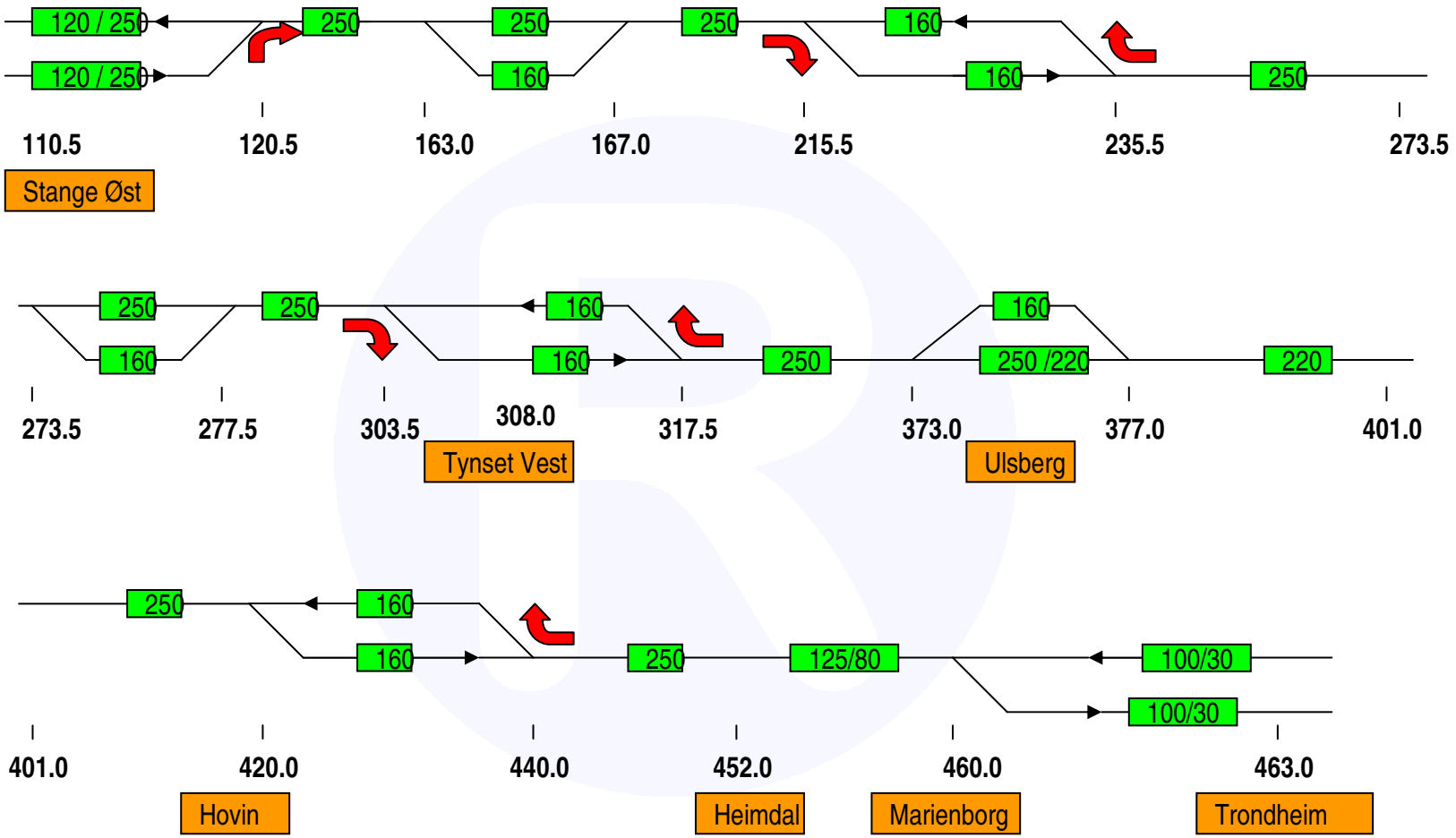
Robustness Analysis:

- Oslo – Lysaker: UIC Capacity Method
- IC Area: TrainPlan TTRA
- High Speed Lines: RailPlan

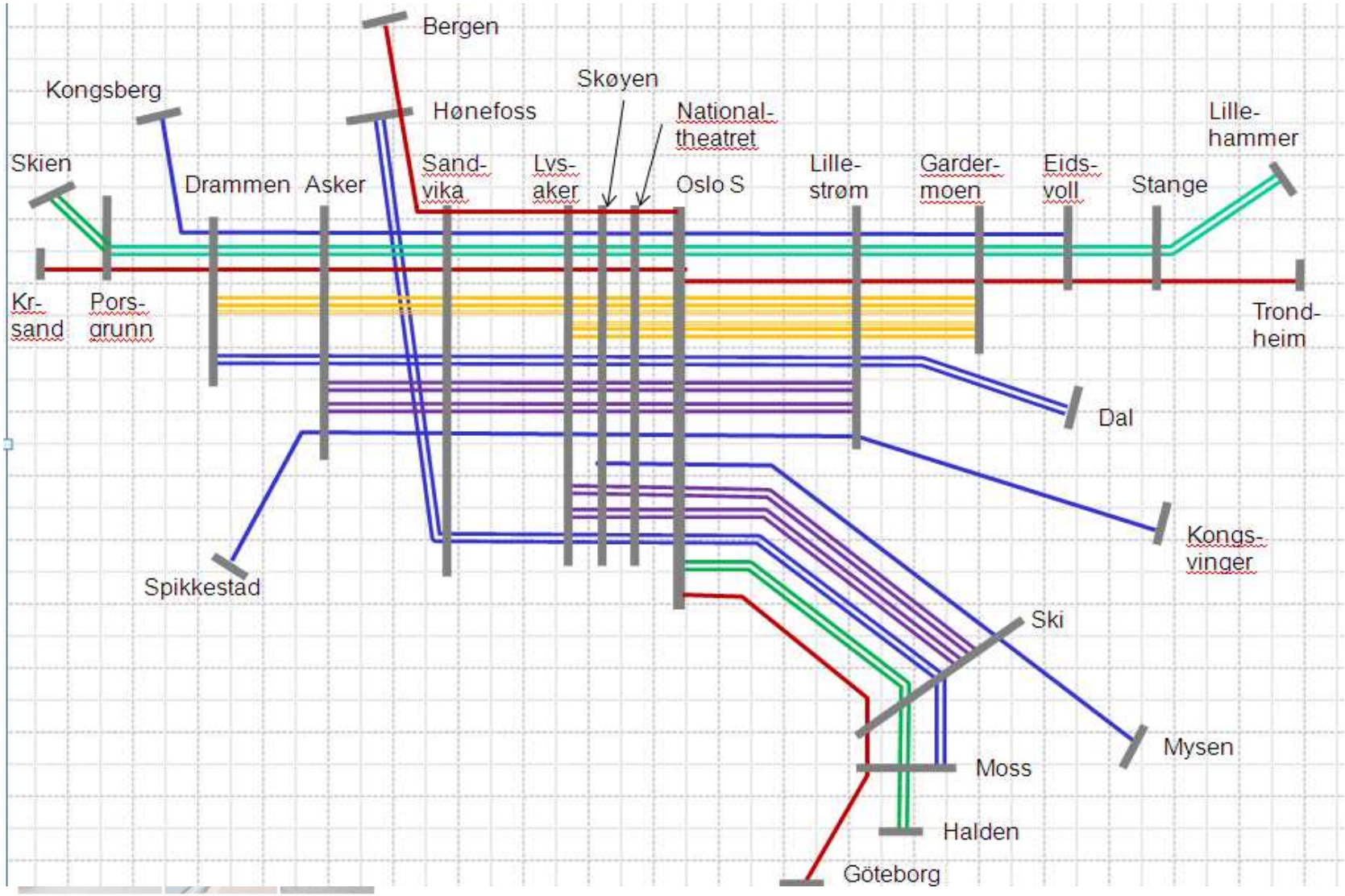
Planning Iteration/ Optimalisation Process



Stange -Trondheim Track and Speed Profile



Oslo – Lysaker. Distribution of Train Paths.

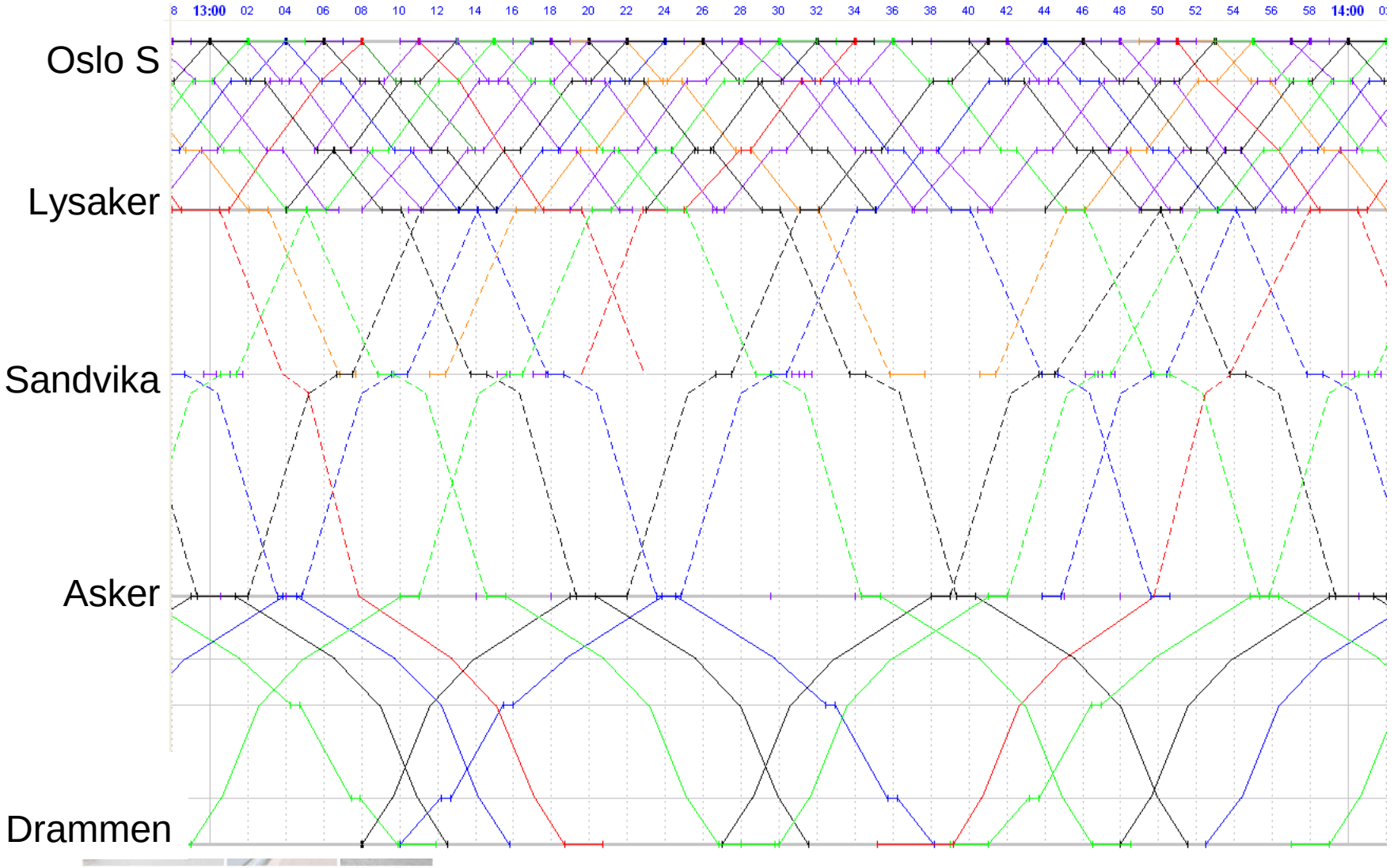


IC Area Timetable Example Oslo - Drammen

		2220	3732	2722	1672	3532	1222	611
		From LLS	From GAR	From SKI	From DAL	From GAR	From MYS	From OSL
		B693/130	REG/200	LKL/130	LKL/160	REG/200	LKL/130	HHT/300
Oslo S	dep	10:57	11:00	11:02	11:04	11:06	11:08	11:11
Nationaltheatret	arr	10:59	11:02	11:04	11:06	11:08	11:10	|
	dep	11:00	11:03	11:05	11:07	11:09	11:11	11/13
Skøyen	arr	11:03	11:05	11:07	11:09	11:11	11:14	|
	dep	11:04	11:06	11:08	11:10	11:12		11/15
Lysaker	arr	11:06	11:09	11:11	11:13	11:15		11:17
	dep	11:07	11:10		11:14			11:19
	line		HSL		HSL			HSL
Sandvika	arr	11:15	11:14		11:18			|
	dep	11:16	11:14		11:18			11/23
Tanumåsen Bp,			11/16		11/20			
Asker	arr	11:29	11:19		11:23			
	dep		11:20		11:24			
Eriksrud			11/25		11/30			
Lier	arr		|		11:32			
Brakerøya	arr		|		11:35			
Drammen	arr		11:31		11:38			

funkwerk
information technologies

IC Area Train Graph Oslo to Drammen



Oslo – Lysaker. Capacity Utilisation.

Which technical headway is necassary to run the proposed timetable with acceptable robustness?

%utilisation	Technical headway		
Route section	80 secs	100 secs	120 secs
Lillestrøm to Oslo S (Romeriksporten)	35.0	40.8	47.3
Oslo S to Nationaltheatret	56.0	70.3	84.1
Nationaltheatret to Skøyen	56.2	70.6	84.5
Skøyen to Lysaker	55.6	69.4	83.3
Lysaker to Sandvika (new line)	30.0	37.5	44.9

Technical headway of 80-90 sec is necessary to satisfy UIC robustness recommendations (60-70% capacity utilisation).

Simulation Scenarios

Delay Pattern	Technical headway = 100 % of planning headway.	Technical headway = 75 % of planning headway.
Small departure and station dwell delays (short delay scenario, ref chapter 2.8).	Scenario 0	Scenario 1
Severe departure and station dwell delays (long delay scenario, ref chapter 2.8).	Scenario 2	Scenario 3

IC Area Robustness Analysis Results

Sce-na-rio	Delay Pattern	Technical/ planning headway	Number of Trains in simulation	Delay Ratio	Change in average lateness for all trains	Recovery rate
0	Small	100 %	1129	0.63	85 sec	45.3%
1	Small	75 %	1129	0.21	41 sec	53.8%
2	Severe	100 %	1129	0.38	223 sec	24.0%
3	Severe	75 %	1129	0.18	155 sec	27.3%
"Robustness advisability value"				*< 0,3*	*< 0*	*>50 %*

IC Area Conclusions

IC Area

- Simulation of full service in IC area suggests that this timetable is not very robust. Whilst theoretically feasible to operate, we forecast it very difficult to recover from significant delays.

Oslo - Lysaker

- Provided <90 second technical headway can be achieved Oslo - Lysaker, we forecast it possible to operate proposed timetable with 25 trains per hour.
- The change from the proposed 2012 timetable to this study is marginal.

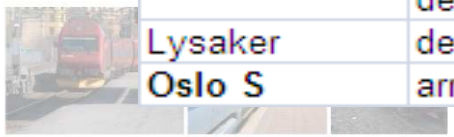
IC Area Single Track Lines

- We have been unable to identify a good service pattern on Ringeriksbanen which can operate reliably as planned with the proposed crossing points.

HSL Timetable Example Bergen

		609	611	613	617
		HHT/300	HHT/300	HHT/300	HHT/300
Oslo S	dep	06:11	07:11	08:11	10:11
Lysaker	dep	06:19	07:19	08:19	10:19
Hønefoss	arr	06:45	07:45	08:45	10:45
	dep	06:48	07:48	08:48	10:48
Gol	arr	|	08:18	|	|
Geilo	arr	07:32	|	09:32	11:32
	dep	07:34	08/37	09:34	11:34
Voss	arr	08:08	09:09	10:08	12:08
	dep	08:10	09:11	10:10	12:10
Bergen	arr	08:34	09:40	10:34	12:34

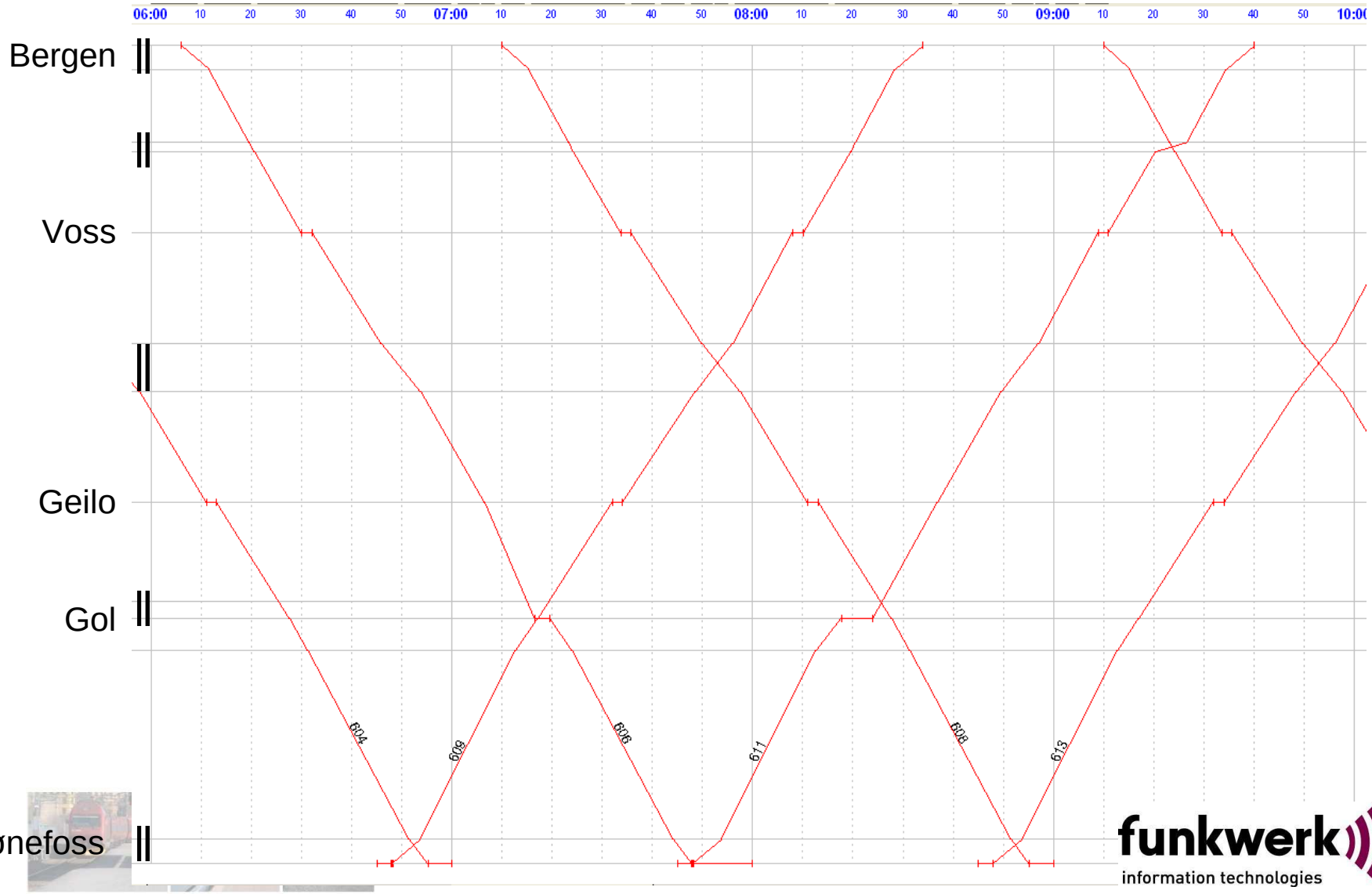
		604	606	608	612
		HHT/300	HHT/300	HHT/300	HHT/300
Bergen	dep	05:10	06:06	07:10	09:10
Voss	arr	05:33	06:30	07:33	09:33
	dep	05:35	06:32	07:35	09:35
Geilo	arr	06:11	|	08:11	10:11
	dep	06:13	07/06	08:13	10:13
Gol	dep	|	07:19	|	|
Hønefoss	arr	06:55	07:48	08:55	10:55
	dep	07:00	08:00	09:00	11:00
Lysaker	dep	07:25	08:25	09:25	11:25
Oslo S	arr	07:34	08:34	09:34	11:34



funkwerk
information technologies

Railconsult

HSL Train Graph Bergen - Hønefoss. AM Peak hour



funkwerk
information technologies

HSL Crossing Loops Assumptions

- In principle: Crossing Loops where necessary.
- Location of double track sections and crossing loops recommended in this report is slightly different from VWI proposal, reflecting timetable constraints approaching Oslo.
- After some iterations, the sites selected are:

Approximate location	***Start point (km)***	***Length (km)***	***Type***	***Purpose***
Bergen to Arna	*0*	*9.5*	*Double track*	*Local traffic*
Dale	*40*	*4.0*	*Bi-directional loop*	*Peak hour crossing*
Voss	*75*	*4.0*	*Station loop*	*Perturbed running*
Hallingskeid	*123*	*20.0*	*Double track*	*Regular crossing*
Geilo	*187*	*4.0*	*Station loop*	*Perturbed running*
Gol	*230*	*20.0*	*Bi-directional loop*	*Peak hour crossing*
Gulsvik	*290*	*4.0*	*Bi-directional loop*	*Perturbed running*
Veme to Hønefoss	*323*	*15.0*	*Double track*	*Regular crossing*

HSL Bergen Robustness Analysis

	Lateness (seconds)			
Delay Scenario	**Lateness at start**	**Lateness at finish**	**Change in area**	**Delay ratio**
Severe delays	214	169	-45	-0,21
Small delays	28	4	-24	-0,86
"Robustness advisability value":			< 0	< 0,3

Our conclusion is that, even with quite severe delays at the start of the journey, the high speed line service is still quite robust with the modeled timetable and infrastructure.

Railconsult

HSL Trondheim Robustness Analysis

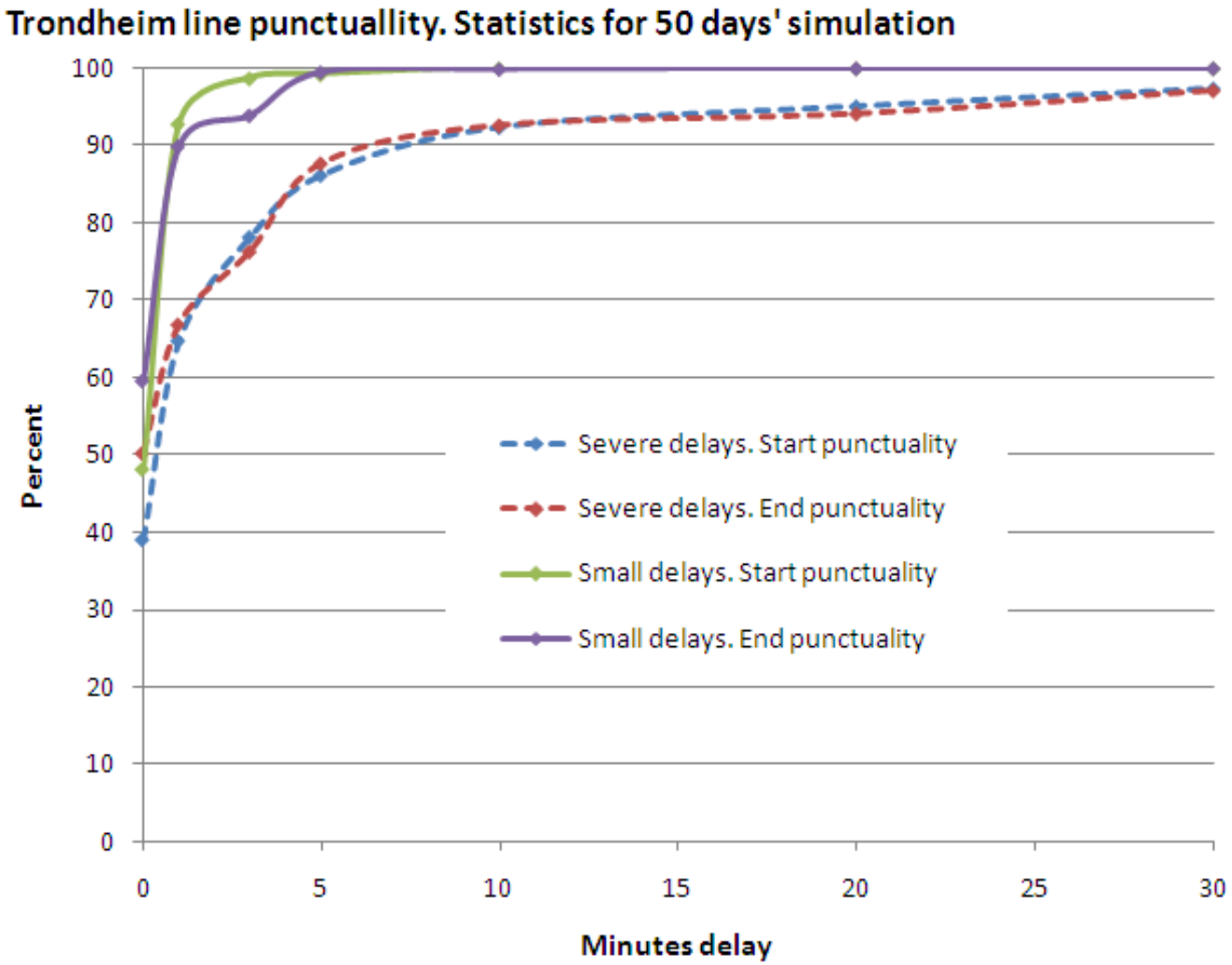
	Lateness (seconds)			
Delay Scenario	**Lateness at start**	**Lateness at finish**	**Change in area**	**Delay ratio**
Severe delays	185	182	-3	-0,02
Small delays	17	19	2	0,12
"Robustness advisability value"			< 0	< 0,3

Our conclusion is that, even with quite severe delays at the start of the journey, the high speed line service is still quite robust with the modeled timetable and infrastructure.

funkwerk
information technologies

Railconsult

HSL Trondheim Delay Distributions



funkwerk
information technologies

High Speed Line Robustness Conclusion

- This report concludes that a two-hourly high speed service with some extra peak trains can operate robustly on the two routes examined, Oslo – Bergen and Oslo – Trondheim.
- One-hourly frequency can operate at a robustness level comparable with IC Area.
- As may be expected on a single line, significantly late trains cause further knock-on delays and rarely recover time themselves. However, the track configurations and timetables tested here are very good at absorbing small delays, with most trains recovering fully from start delays of 5 minutes or less.
- As identified by VWI, siting of crossing loops is crucial and is tied very closely to the timetable selected.

Konklusjoner:

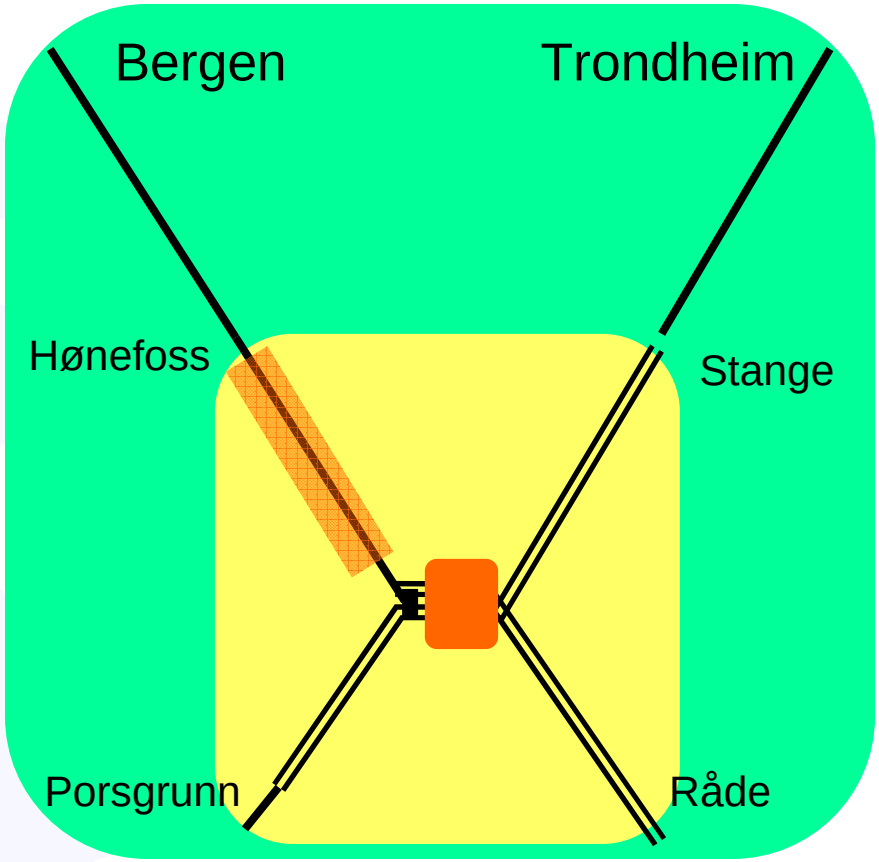
Under de gitte forutsetninger tyder dette studiet på at:

•Det vil kunne etableres et driftsopplegg med høyhastighetstog i totimersfrekvens på enkeltspor.

•Høyhastighetstog i timesfrekvens vil kunne implementeres på dobbeltsporede strekninger i InterCityområdet.

•Med nødvendige kapasitets-forsterkende tiltak vil det skisserte driftsopplegget kunne gjennomføres mellom Oslo S og Lysaker med tilfredsstillende kvalitet.

Dette studiet er basert på dette samme antall tog mellom Oslo S og Lysaker som er planlagt for 2012.



Further Planning

- If JBV chooses to go further in preparing for HST we recommend that the planning of infrastructure and timetables are done in an iterative process, including complete review of the IC Area timetables.
- Thereby it should be possible to optimise the design of the High Speed Lines, particularly when it comes to crossing loops.
- Alternative approach: Planning for double track with single track sections.