FR8Hub WP3

Real time network management and simulation of increasing speed of freight trains

Magnus Wahlborg, Trafikverket

Magnus.wahlborg@trafikverket.se

Scope and innovations – Real time network management

- Improved interaction between network and yard management

- Focus
  - Adhoc planning (Short term planning and daily timetable planning)
  - Operational process (IM dispatching, operations …)

- IP5
  - ARCC **terminal/yards** – network – **terminal/yards**
    - Focus is terminal/yards and connection to network
    - How to improve processes and requirements of possible decision support
    - No demonstration
    - Invent shortcomings and improvement potential

  - FR8Hub terminal/yards - **network** – terminal/yards
    - ***Focus is network and connection to terminal/yards***
    - ***Demonstration by simulation***

Economy and time

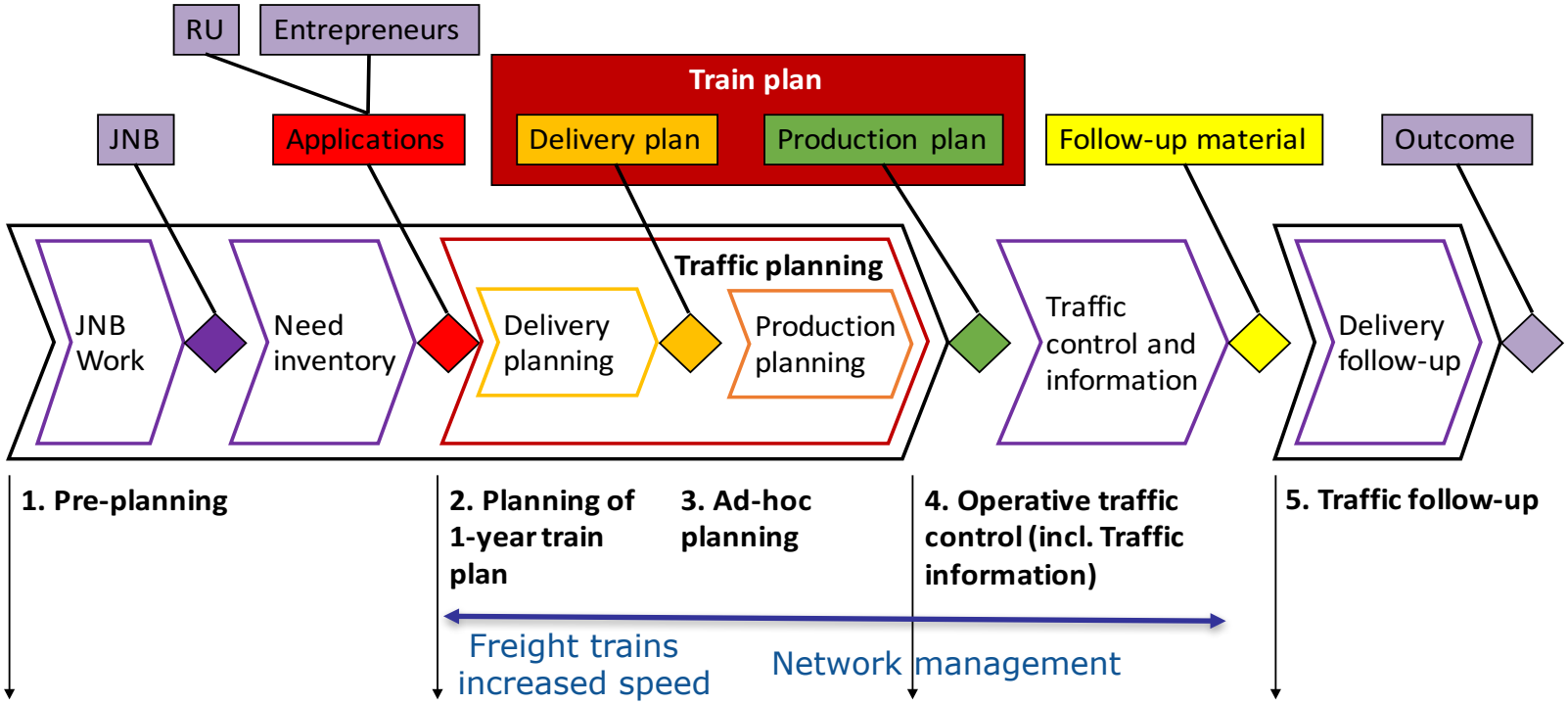
Participants		Contacts	Budget (k€)
Trafikverket	WPL	M Wahlborg	145
KTH	L3P	M Bohlin, B Kordnejad, J Högdahl	479
Linköping U	L3P	A Petersson, C Schmidt, L Jalili	145
CFW – DLR		T Schulmann	600
Indra		J Hernandes	209

Project duration: 2017-09-01 to 2020-09-01

Deliverables and Milestones

Item	Task	Name	Lead	Due	Date	Type
MS7	*T3.1*	*Specification of innovations and demonstrator*	*TRV*	*M6*	*Feb 18*	
D3.1	**T3.2, T3.3**	**State-of-art and specification of innovations, demonstrations and simulations**	**TRV**	**M12**	**Aug 18**	**R, PU**
MS8	T3.4	Overall high-level architecture of Data-Exchange Platform and connection to terminal intelligent videogate	TRV	M18	Feb 19	
D3.2	T3.4	Demonstration of FR8HUB Network management concept	TRV	M24	Aug 19	R, PU
D3.3	T3.5	Results of traffic simulation of defined scenarios and evaluation	DLR	M36	Aug 20	R, PU

Work subdivision in planning process



FR8HUB WP3 functionality Subdivision:

T3.1 Scanning of innovations and best practice
T3.2 Define scenarios for simulations and demonstrations

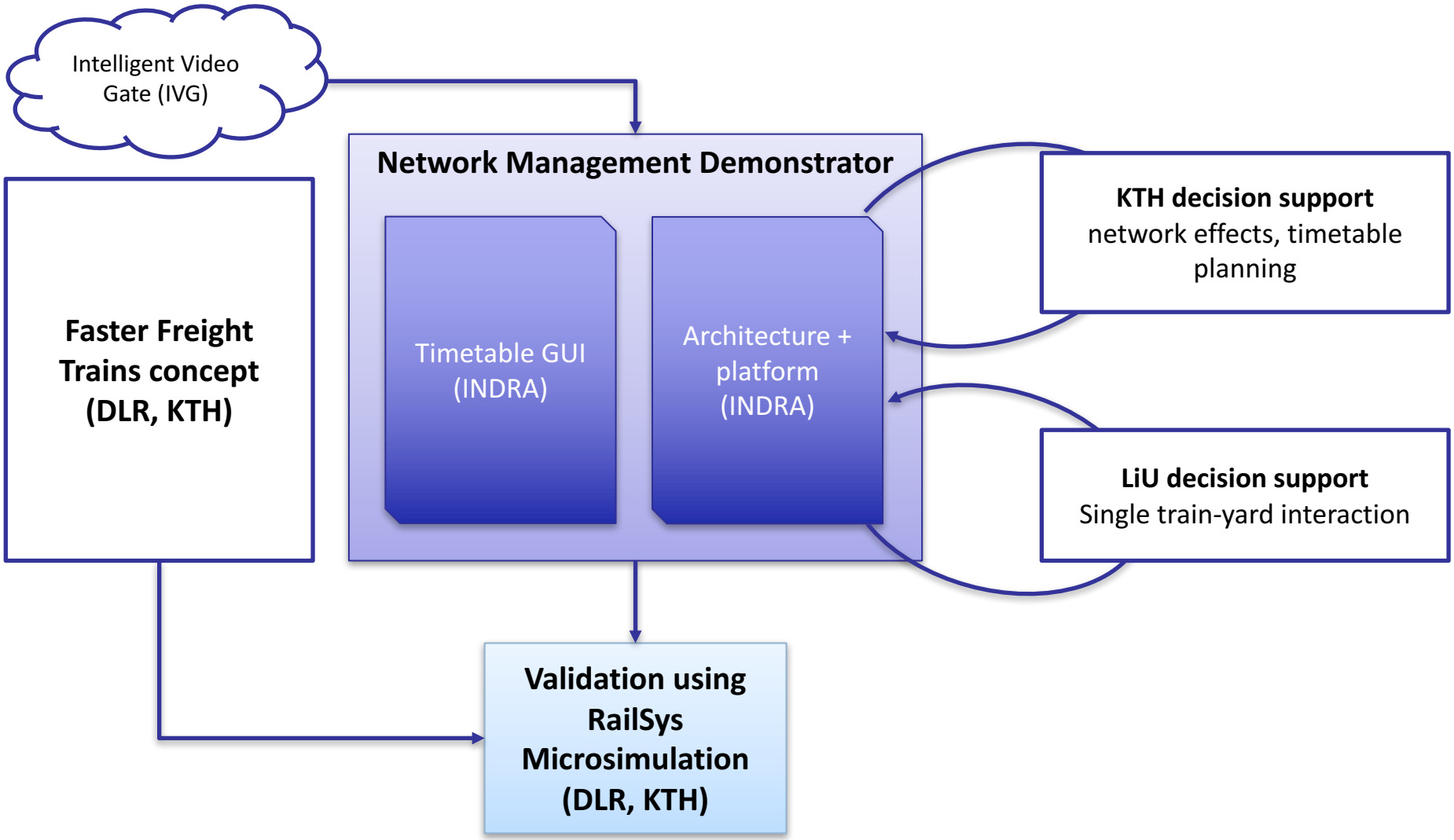
High-level system architecture and IVG info (INDRA) T3.4

Simulation (DLR) T3.5, T3.7

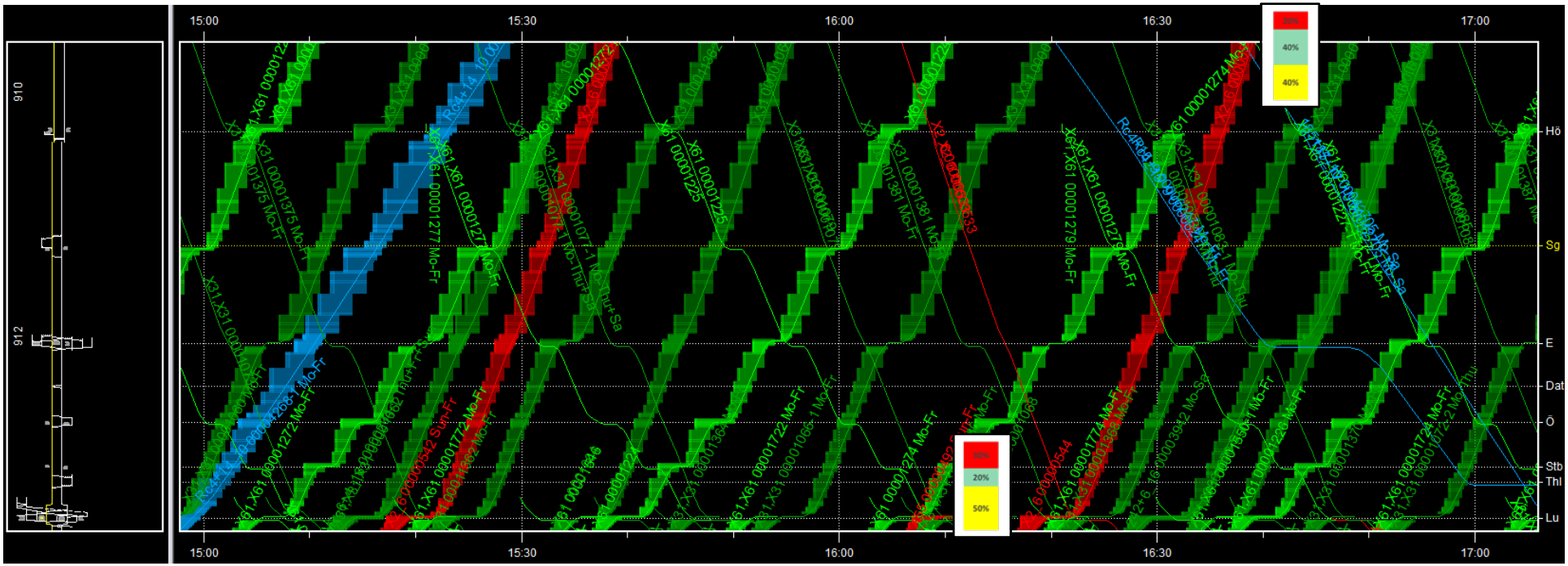
Sim.based timetabling (KTH) T3.3, T3.6

Cancellations / New trips (LiU) T3.3, T3.6

System overview



Timetable GUI mock-up



Current status

- The Railsys extension (v0.1) of RailML has been defined.
- A small example file in the RailML has been constructed.
  - Single track line with stations A-L
  - Two trains are scheduled, one in each direction.
- A github-repo has been created for working with the project specific implementation of the railml interface.

Next step

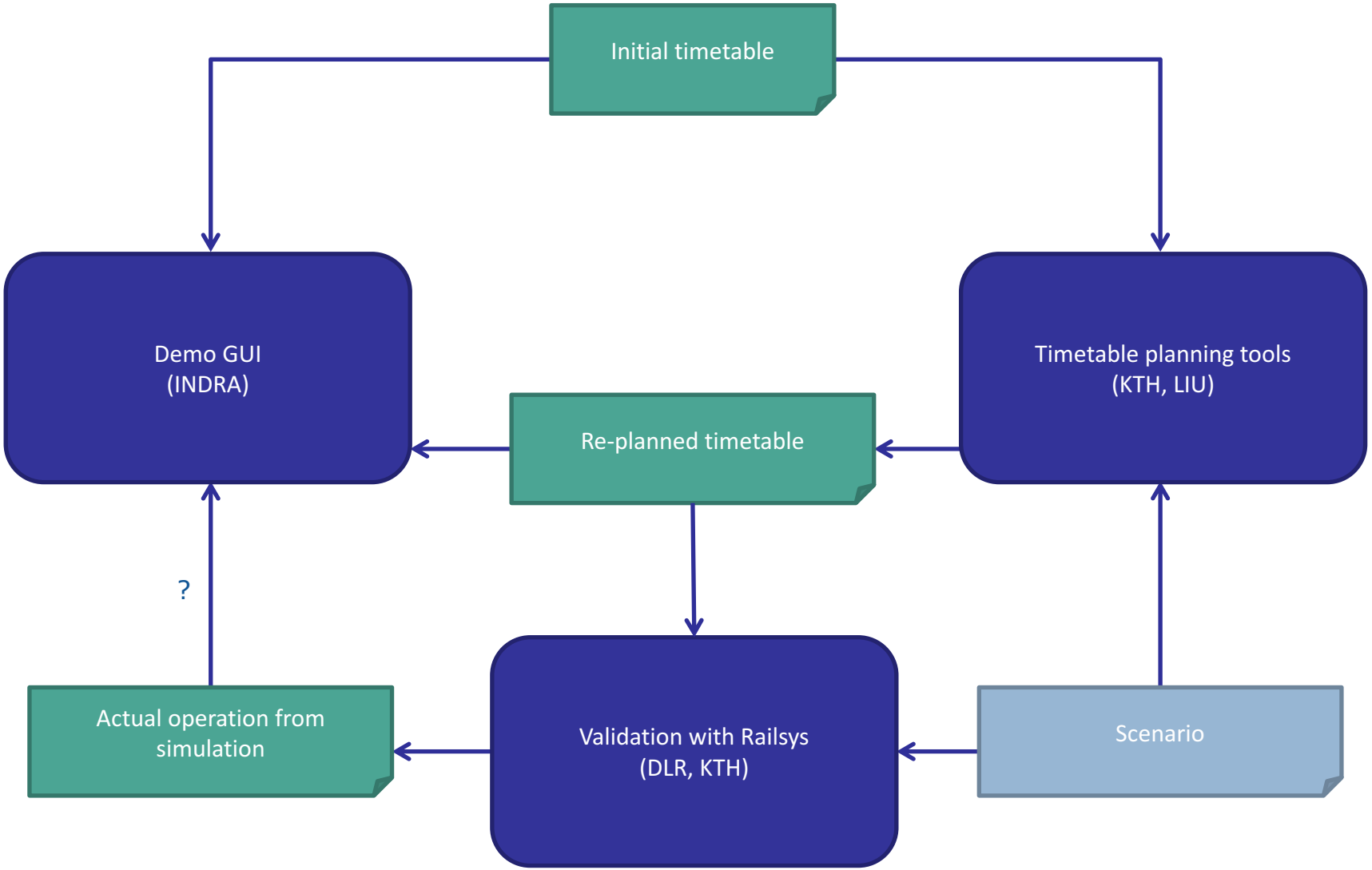
- Define the scenario files used as input to the timetabling modules and Railsys.
- Implement prototypes/stubs of each subsystem.
- INDRA:
  - Internal project plan for the implementation
  - Implement a first mock-up that can visualize a RailML-file as a graphical timetable.
- KTH/LIU:
  - Implement a first mock-up that can generate an alternative timetable given an initial timetable and a scenario.

FR8Hub

Shift2Rail Joint Undertaking
White Atrium building, 2nd Floor
Avenue de la Toison d'Or 56-60,
B-1060 Brussels

www.shift2rail.org

Modules and data flow



Input/output

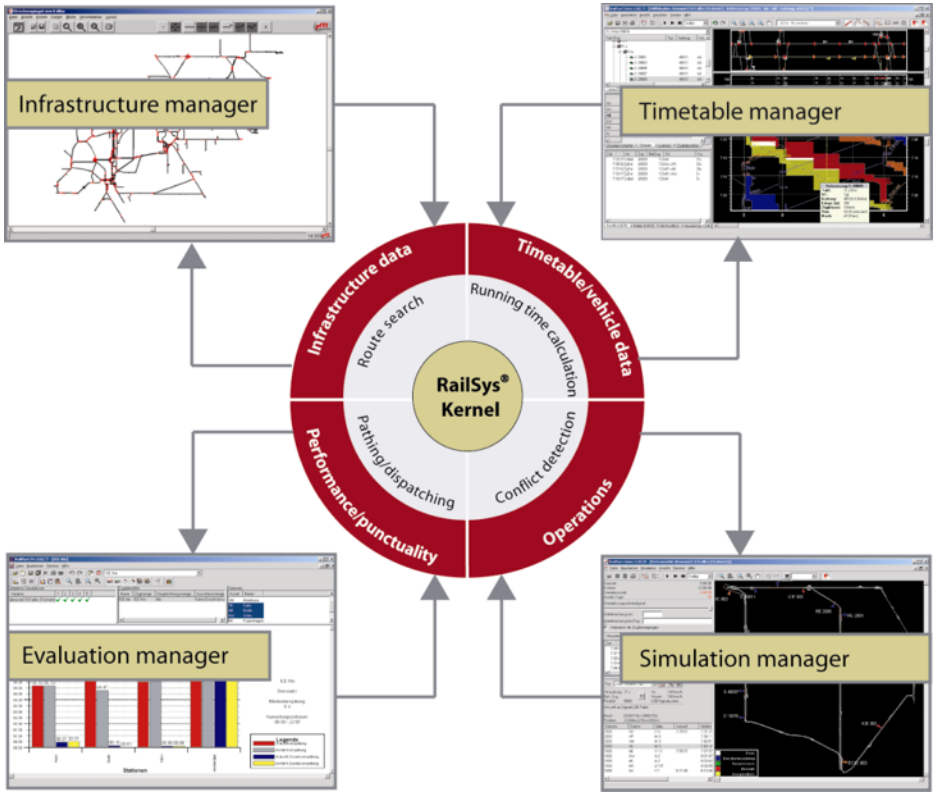
- Timetable planning tools
  - Input: RailML-file + scenario-file
  - Output: RailML-file
- Network management demonstrator
  - Input: RailML-file(s)
  - Output: None
- Validation with Railsys (possibly with a wrapper module)
  - Input: RailML-file + scenario-file
  - Output: RailML-file (maybe?)

Integration with Railsys

- It is possible to export most of the timetable from Railsys in RailML v2.2
  - Some additions is required to meet our requirements (distances between stations, vehicles)
- To import the timetables it is necessary to convert the RailML into a Railsys-compatible format.
  - This requires us to extend the RailML-scheme to store some Railsys-data.

Simulation of increasing speed of freight trains

Trafficsimulation – Railsys

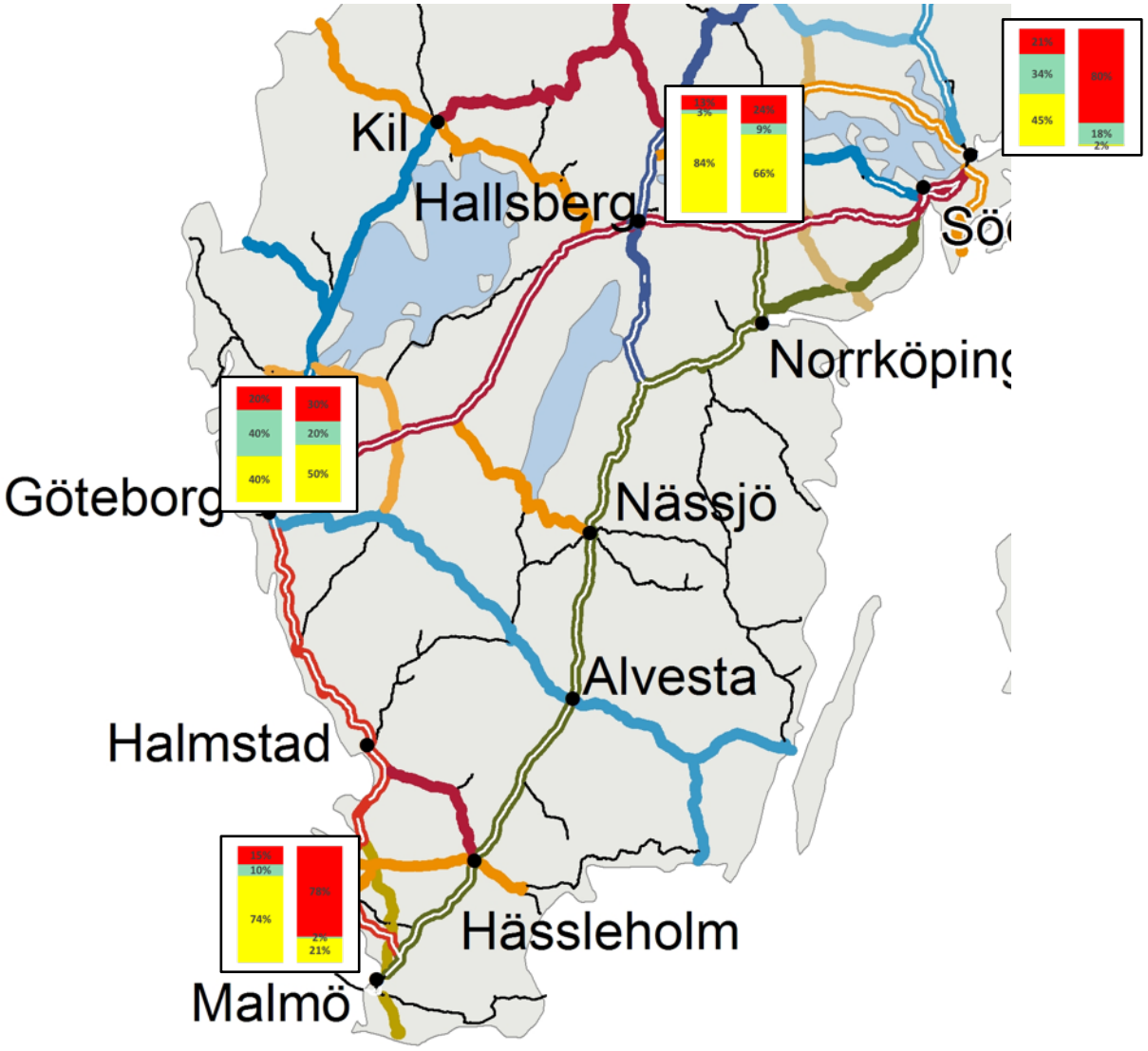


Realtime network management and increasing speed freight trains

TDs	TASKS	TRL	###				###				###				###				###				input from other TD (same IP or different IP)
tasks	Name		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
3.1	Scanning of innovations and best practice M1 – M9 Trv, CFW, Indra (Trv lead)	2																					IP5 ARCC and WP4 Intelligent videogate
3.2	To define scenarios for simulations and network management M7 – M12 TRV, CFW (Trv lead)	2																					
3.3	Design of demonstrator functionality and high-level methods for network management M7-M12 TRV (Trv lead)																						
3.4	High level System architecture and videogate information M7 – M18 Indra, Trv, CFW (Indra lead)	2																					IP5 ARCC and WP4 Intelligent videogate
3.5	Traffic simulation of defined scenarios M13 – M36 Trv, CFW (CFW lead)	3																					
3.6	Develop demonstrator for FR8Hub networkmanagement concept M13 – M24 Indra, CFW, Trv (Trv lead)	3																					IP5 ARCC and WP4 Intelligent videogate
3.7	Evaluation of the defined scenarios M27 – M36 Trv, CFW (CFW lead)	4																					

Network management demonstrator

Overview of approach



- Fraction early/late arrivals/departures from IVG data
- **Operational** decision (LiU)
  - Once a shipment deviates from plan, what should we do?
  - Cancellations, new slots
- **Tactical** decision (KTH)
  - Once a significant quality decrease have occurred, what should we do?
  - Adjustment of part of the timetable
- **Strategic** decision (DLR)
  - Simulations to increase transport quality.

Task 3.1 **Scanning of innovations and best practice**

M1 – M12 Trv, CFW, Indra (Trv lead)

To **describe state-of-art and best practice** in interaction Network management and yard management. To specify benefit and need for real-time yard management and real-time network management applications. To further **specify the innovations in WP3 and how they will be evaluated and demonstrated**. To establish contact with current ARCC project and **describe Network management and yard management visions for FR8Hub WP3.**

Task 3.2 **To define scenarios for simulations and demonstrations**

M7 – M18 Trv, CFW (Trv lead) (slide 1 (2))

There are two areas for simulation and demonstration in FR8HUB; **higher speed freight trains** (raising speed, train performance, improved infrastructure) and **automation and improved processes between network and yards and terminals.**

The work content in this task will be to:
Analyse actions to increase average and absolute speed for freight trains. What actions are relevant and what is the impact? To select most promising actions to be further studied. For **selected actions describe how they can be evaluated and simulated.**

Task 3.2 **To define scenarios for simulations and demonstrations**

M7 – M12 Trv, CFW (Trv lead) (slide 2 (2))

Create an overview and **select relevant bottle neck lines which is of importance for freight traffic in the Scandinavian-Mediterranean Corridor in the TEN-T network (Malmö – Hallsberg and Hamburg – Hannover).**

Define a base scenario of selected bottleneck lines according to current state.
Timetables will be validated **using a commercial microsimulation tool RailSys**. This tool is used for timetable analysis today at Trafikverket.

Task 3.3 **Design of demonstrator functionality and high-level methods for network management**

M7 – M12 Trv, CFW (Trv lead) (slide 1 (2))

The task will **define demonstrator functionality and methods for interaction between network management and yard management.**

Define a core mathematical method and select models for timetable planning, integrating capacity analysis at both lines and yards. The method will consider interactions between timetable planning on lines and terminals/yards on a higher level, based on available statistics on arrivals and departures of trains, wagons and intermodal loading units, with the intended use mainly at earlier phases of timetable planning (1-12 months in advance).

Task 3.3 **Design of demonstrator functionality and high-level methods for network management**

M7 – M12 Trv, CFW (Trv lead) (slide 2 (2))

The method will be adapted for using data according to what is produced from **WP4 (IVG). Input about models from the ARCC project will be considered.**
Describe the components and functionality for the demonstrator. For automation and improved processes between railway network (railway lines and nodes) and yards and terminals a new prototype will be developed. The results will be validated using traffic simulations in Railsys.

Task 3.4 **High level System architecture and video gate information**

M 7 – M 18 Indra, CFW, Trv (Indra lead) (slide 1 (2))

This task focus on the definition of the high level architecture of the Data-Exchange Platform and information from video gates in terminals.
Define the general architecture of Multimodal Freight Data-Exchange Platform for data exchange between freight transports stakeholders, in order to ensure the full integration of freight transport stakeholders in global railway operations.
perform a joint workshop with ARCC project to collect the outputs of this project for the connection between data-Exchange Platform, time Table Planning and Real-time Yard Management with the ex, in order to consolidate and overall high level architecture to ensure that all different systems can be combined and aligned.

Task 3.4 **High level System architecture and video gate information**

M7 – M18 Indra, CFW, Trv (Indra lead) (slide 2 (2))

ARCC project will be monitored to collect requirements on system concept and data exchange in FR8Hub Wp3.
Follow and monitor the results and performance effects of WP 4 Intelligent Video gate on freight traffic. To describe how a multimodal exchange platform could connect and exchange data between video gate and infrastructure manager, Railway undertakings and other stake holders.
Describe and further develop the system concept connecting yards/terminals with network. It will be collected the requirement specification, both technical and functional, for integration platform for rail freight.
Perform a study of open and standards solutions (TAF TSI evolution) to connect the different final systems.
Define Use Cases and Operational tests to validate the defined architecture in relevant environment (Task T3.5).

Task 3.5 **Traffic simulation of defined scenarios**
M13 – M36 CFW, Trv (CFW lead)

Simulations will be made according to the defined methods. Higher speed freight trains (raising speed, train performance, improved infrastructure); Study operational scenarios on freight corridors to increase the average speed improving train dynamics with the aim to increase capacity of the line. Automation and improved processes between network and yards and terminals;

Study scenarios on improved processes and data exchange between network and yards and terminals. To describe and study technological upgrade of one hub and how the hub will affect other hubs and nodes in the network.

Task 3.6 **Develop demonstrator for FR8Hub network management concept**

M13 – M24 Indra, CFW, Trv (TRV lead)

A network management simulation prototype will be developed, based on the design developed in previous tasks. The prototype will be used to demonstrate the network management concept of FR8HUB, based on the high-level system architecture from Task 3.4 and the high level methods of freight capacity and interaction between yards/terminals and railway network from Task 3.3. The demonstrator will use data from a current timetable and infrastructure descriptions to facilitate the operation of mixed traffic (passengers and freight). The demonstration will be performed in a simulated environment on selected bottleneck lines and yards/terminals along the TEN-T corridors in Sweden and in Germany, and will be validated using micro-

Task 3.7 **Evaluation of the defined scenarios for higher speed freight trains**

M27 – M36 CFW, Trv (CFW lead)

Economical evaluation of studied scenarios regarding cost and benefit from the perspective of train operating and Infrastructure Manager. Other benefits may be commented.