Europes Rail Flaggskepp 1 utvecklar och demonstrerar framtidens kapacitetsplanering och trafikledning

KAJT höstseminarium 2022-11-22

Magnus Wahlborg Trafikverket

Flaggskepp och ansvarig person i Trafikverket

1. **Kapacitetsplanering och Trafikledning – Magnus Wahlborg (KAJT 5 foi utförare)**
2. Digital och automatiserad och / eller autonom tågdrift (ATO) – Mikael Daneilsson **(nära svensk samverkan)**
3. Intelligent och integrerad tillgångsförvaltning (Assets Management) – Anders Carolin
4. Ett hållbart och grönt järnvägssystem (EUs Green Deal) – Tohmmy Bustad
5. Konkurrenskraftig, grön och digital godstrafik på järnväg (Gods) – Jan Bergstrand **(nära svensk samverkan)**
6. Regionala och innovativa järnvägstjänster för lågtrafikerade banor – Malcolm Lundgren
7. Nya framväxande transportsystem och sökande forskning – Michel Gabrielsson

Programchef: Bo Olsson

Projektkoordinator: Michel Gabrielsson

Ordförande styrgruppen: Christer Löfving

Kontakta oss:
eu-rail@trafikverket.se

Flaggskepp 1 Kapacitetsplanering och trafikledning

- Förberedelse sedan september 2019
  - Sedan juni 2021 – 7 st flaggskepp
  - Projektansökan juni 2022
  - Projektstart 1 december 2022

- Siemens leder flaggskepp 1 tillsammans med Trafikverket

- Våg 1 2022 12 – 2026 09; Trv ca 52 milj sek; Totalt ca 850 milj sek

- Hösten 2022 fördjupad planering av arbetet och dialog med EU/Joint Undertaking

- Samverkan sker med EU Systempelare (avstämningsmöten var annan vecka sedan dec 2021) och RNE

Flaggskepp 1 Grundarmedlemmar – aktiva planning and operations

9 st länder Infrastrukturhållare/Railoperators

DB, Adif, Jernbanedirektoratet, SNCF,

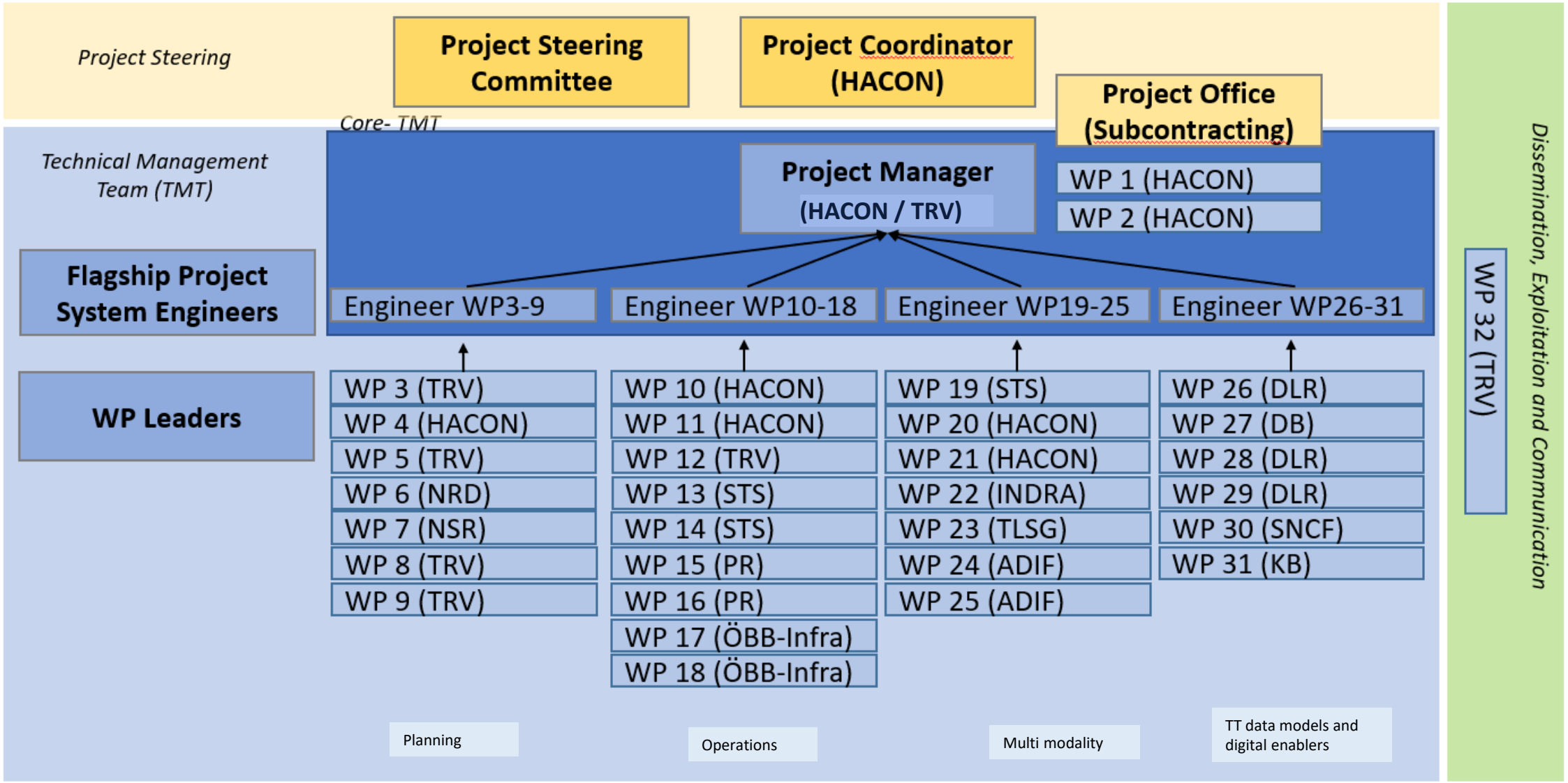
FS/RFI, ÖBB, Trafikverket, PKP, ProRail/NS

9 Systemleverantörer/företag:

Alstom, Mermec, AZD, CAF, SGR (Spanien),

Hitachi, Indra, Siemens, Thales

Project Structure



WP4/5 –Integration of Planning Systems and Processes

Cross-border

Integration of Planning Systems

Planning/
TMS integration

Stations/yards
planning

Capacity
restrictions

Very short-term path
requests

New Planning Processes

Rolling planning

Automated path allocation

WP6/7 – Decision Support and Optimization

Short and long term capacity planning

Decision Support

Rolling stock rotation and stabling

Sand-boxes

Punctuality (timetable
robustness)

Energy saving

Optimization

Optimum
train paths

Capacity
efficiency

WP3 – Alignment of Specification for Enabler 1-7

WP2 – FA1 Technical Coordination

EU-Rail Destinations / System Pillar

WP8/9 – Simulation and Operational Feedback

Punctuality forecast

Capacity evaluation
ETCS-L2, LR

Driver
simulation

Rail traffic simulation models

Micro- and macro
traffic simulation

C-DAS/ATO operations

ERTMS

Feedback Loops from Operations

C-DAS/ATO

Planning focus

Expected results are demonstrators and solutions for the following technical enablers:

WP4/5
- Enabler 1: European cross-border scheduling with international train path planning

WP4/5
- Enabler 2: Improved capacity allocation using rolling planning and TTR

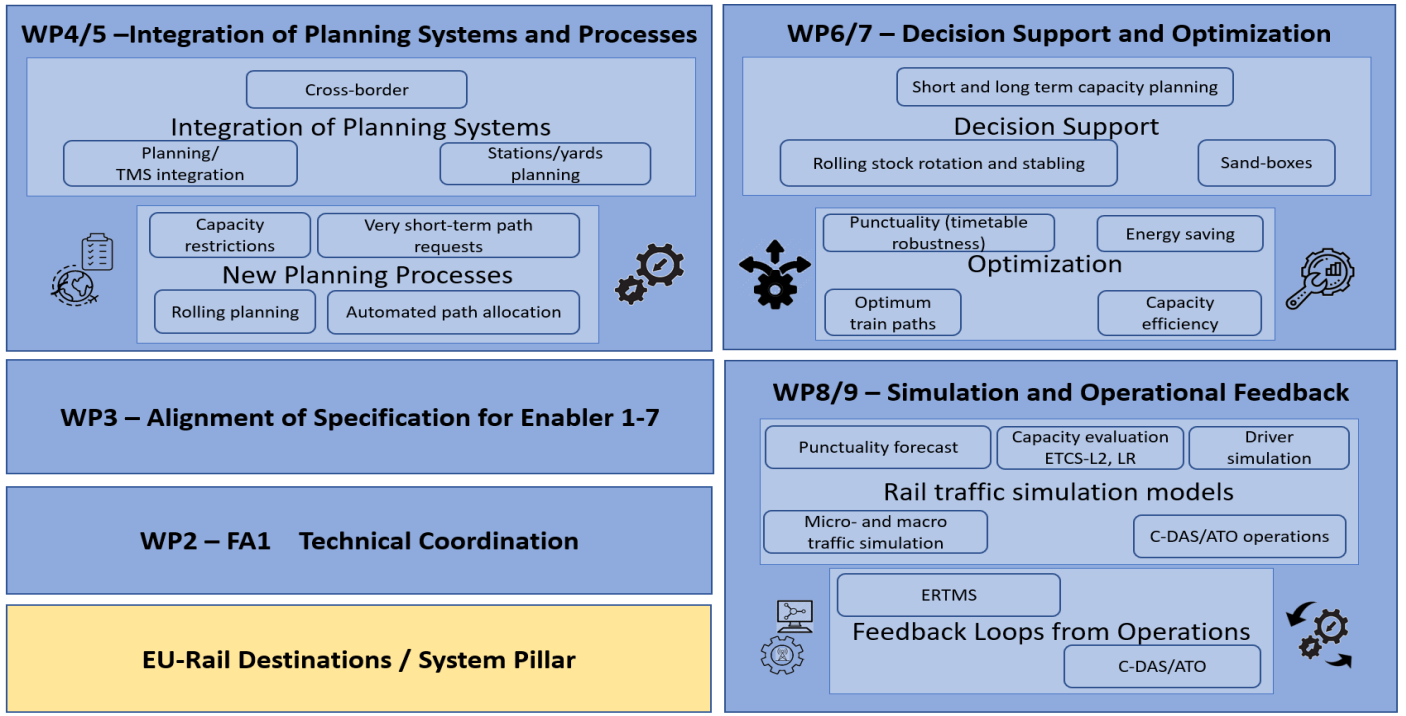
WP6/7
- Enabler 3: Decision support for short term planning

WP6/7
- Enabler 4: Train path and schedule optimisation methods and strategies for capacity efficiency, punctuality and energy saving for different parts of the network and different traffic situations (level of punctuality).

WP4/5 WP6/7
- Enabler 6: Integration of planning systems and TMS with a) yard capacity planning and b) station capacity planning

WP8/9
- Enabler 5: Improved rail traffic simulation models for selected Use Cases to forecast punctuality in the network (e.g., simulating proportion primary and secondary delays, simulations drivers vs. ATO over ETCS).

WP 8/9
- Enabler 7: New planning and operational processes using feedback loops from ERTMS ATO and C-DAS



Planning – TRV/KAJT (aktiva i 7 av total 13 demonstrationer)

Demonstrations for Workstream 1.1

No.	Beneficiaries	WP(s)	Task(s)	Description of Demonstration	Indicative Timeframe	TRL
1	MER	5	5.2.1	Cross-border scheduling. Specification on how TRL 4 is reached for TE 1	M40-M43	4/5
2	TRV AE-KTH	5	5.2.1	Handling both, national and cross-border traffic with focus on cross-border freight trains		4/5
3	HAC	5	5.2.1	Interfaces for interaction with external national or central planning applications (TRL 6/7); cross-border planning including Short Timetable Planning and process improvement among actors.		6/7
4	TRV (A.E.-RISE)	5	5.2.1	Collaborative yard capacity planning for Technical Enabler 6		4/5
5	HAC	5	5.2.2	Improved capacity allocation and new processes. Integration of new planning processes and the production of standard reports.		6/7
6	HAC	5	5.2.3	Integration of traffic management system with network capacity planning. The feedback loop between planning and operation will be jointly demonstrated with WP11 (task 11.3)/ WP12 and WP 13/14.		5/6
7	HAC, TRV (AE KTH and RISE)	5	5.2.4	Integration of network capacity planning with yard and station capacity planning. Integration of nodes and lines using specified interfaces.		5/6
8	NSR, NRD (A.E. Sintef), TRV (A.E. Rise)	7	7.3.2	Advanced algorithms for the generation of timetables from scratch to accommodate for scenarios that will occur more than one year ahead (long term planning)		5/6
9	HAC	7	7.4.2	Timetable optimiser and decision support system for adjusting the annual timetable on a line or network level based on the activities of subtask 6.3.1		5/6
10	NSR, NRD (AE Sintef), TRV (AE LiU), SNCF, Indra, STS	7	7.4.3	Demonstrate the robustness of the algorithms developed in Task 6.3 and Subtask 7.4.1, on relevant test instances defined in Task 7.2		5/6
11	NSR	7	7.5.2	Algorithms for rolling stock planning and demonstrating its use in railway practice.		5/6
12	TRV, NSR (and A.E. SISCOG), PR, SNCF, MERMEC, INDRA	9	9.1	Simulation methods and models for improved feedback loops between planning and operations		5/6
13	PR, NSR, SNCF, ADIF, MERMEC, INDRA, CAF, CEIT, TRV	9	9.2	Simulation methods and models for capacity evaluation of ETCS and C-DAS/ATO		6/7

Rise och KTH gränsöverskridande kapacitetsplanering för godståg

Rise och KTH koppling bangård och järnvägsnät

Optimering av tågplan långtidsplanering över 1 år. RISE

Optimering av tågplan justering av tågplan LiU

Mikro och makrosimuleringsmetoder KTH och Lund U, återkoppling mellen Operations och planning

ERTMS simulering KTH och VTI

Operations

WP11/12 – TMS Integration

Electric Traction System

Train Control and ATO

Rolling-stock/crew

TMS2X

Stations/yards

Infrastructure asset and maintenance

Network Capacity Planning

TMS2TMS

Cross-border, multiple TMS areas & involved actors

WP13/14 – TMS Resilience and Efficiency

UX design

Human-in-the-loop

Multi-media HMI

Cooperative Planning

Decision support

Multi-actor

Incident & Disruption Management

AI/Machine Learning

Multi-actors Workflow

WP15/16 – Operational Feedback and ATO

Train speed regulation

Dynamic timetables

Realtime Convergence with Planning

Precise routes and target times

Human-in-the-loop simulator

TMS - traffic simulation

Feedback Loops

TMS – C-DAS/ATO

TMS - planning

WP17/18 – Automated Decisions & Optimization

Train Control Interfacing

AI based algorithms

Automated Train Control Decisions

Realtime Requests of Movement Authorities

Train Prediction Calculation

Conflict Detection and Resolution

Lines and Regions

Realtime Optimization

Depot& Terminal Areas

WP10 – Alignment of Specification for Enabler 8-17

WP2 – FA1 Technical Coordination

EU-Rail Destinations / System Pillar

Operational focus

Expected results are demonstrators and solutions for the folllowing technical enablers:

WP11/12

- Enabler 8: Real-time connection of rail networks as managed by TMSs and involved actors

WP11/12

- Enabler 9: Modelling and decision support for cross-border traffic management

WP11/12

- Enabler 10: Integration of TMS with a) yard management system and processes; b) station management system and processes; c) energy management (Electric Traction System) real-time crew / rolling stock dispatching

WP13/14

- Enabler 11: HMI for TMS based on User Experience (UX) Design and user input

WP15/16

- Enabler 12: Real-time convergence between planning & feedbac loop from

WP13/14

- Enabler 13: Cooperative planning multi-actors within rail

WP13/14

- Enabler 14: Integration of incident management and customer information, with IM and RU interaction and Decision Support for Disruption management

WP15/16

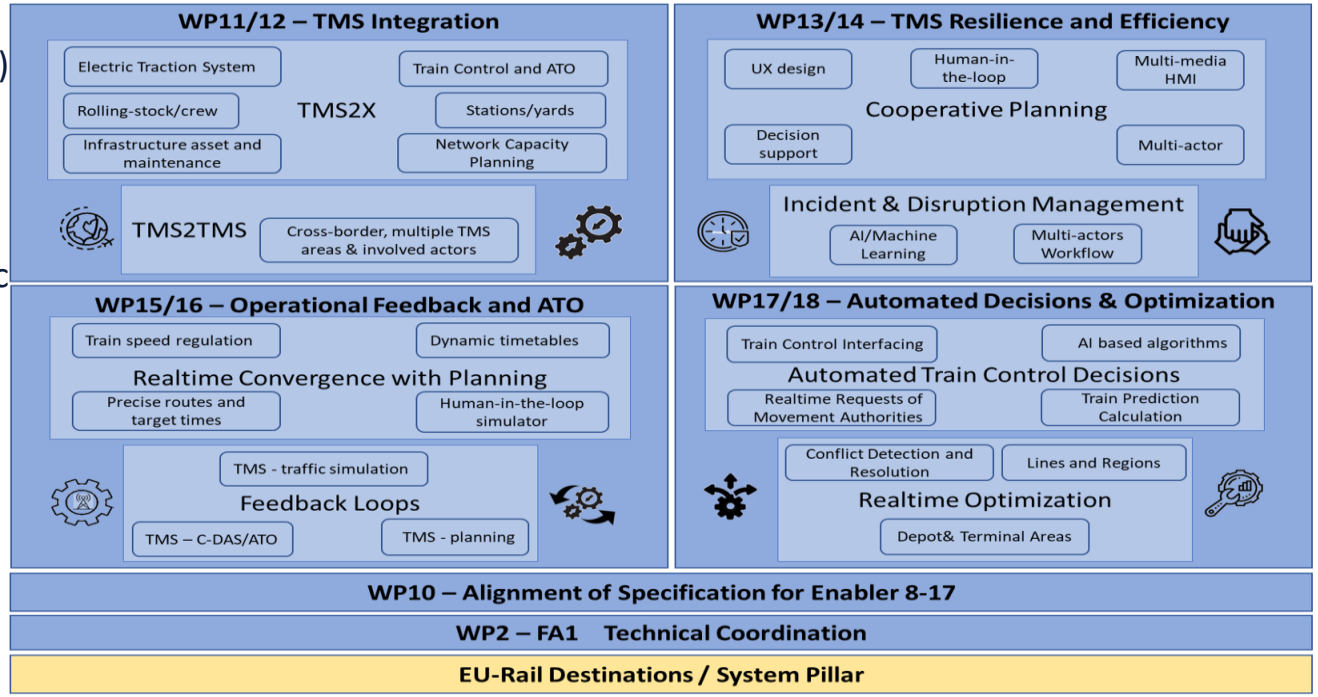
- Enabler 15: TMS speed regulation of trains, precise routes and target times for ATO and dynamic timetables

WP17/18

- Enabler 16: Automation of very short-term train control decisions

WP17/18

- Enabler 17: Real-time conflict detection & resolution for main line and optimisation



Operations – TRV/KAJT (aktiva i 6 av totalt 25 demonstrationer)

Demonstrations for Workstream 1.2

No.	Beneficiaries	WP(s)	Task(s)	Description of Demonstration		TRL
1	ATSA	12	12.2.1	Interfaces TRL 5 from the communication Platform to the Timetable Management Applications and to the Traffic Control (RBC, Interlocking).		5
2	PKP	12	12.2.2	Integration solution for the data exchange and storage system (data lake) allowing the exchange through interfaces, data quality assessment, and metadata generation. This solution will be used for integrating disparate decision support systems.		6
3	STS	12	12.2.3	Interface from TMS Planning system to ATO-TS control module to maximise the energy efficiency of the train operation in a short-term action.		5
4	INDRA	12	12.2.4	Interfaces from the communication Platform to wayside C-DAS operation system, focusing on speed profiles functionalities.		5
5	MERMEC	12	12.2.5	Demonstrator based on the interfaces coming from subtask 11.3.5 (implementing interfaces between neighbouring TMSs and IMs) to provide a TMS and IM real-time connection of rail networks focused on cross border traffic management.		5
6	HACON	12	12.2.6	TRL 6 interfaces and TRL 5 decision support module for integration and traffic management of two neighbouring TMSs and IMs including cross-border operations (supporting Destination 5 activities).		5/6
7	HACON	12	12.2.7	Interfaces for integration of TMS with other services such as station and yard management systems (supporting Destination 5 activities), digital maintenance systems (supporting Destination 3 activities), Passenger Information Services (supporting Destination 6) as well as electric traction systems and crew/ rolling stock management systems.		6
8	TRV	12	12.2.8	Interface of TMS to Yard Coordination System 2.0 in Malmö node. Work connects to WP 4.		5

Rise utvecklar och demonstrerar YCS 2.0 samplanering Malmö

Operations – TRV/KAJT (aktiva i 6 av totalt 25 demonstrationer)

9	CEIT	12	12.2.9	Interface in view of the future autonomous inspection vehicle for the infrastructure (Destination 3) and its integration with the Intelligent Asset Management System (IAMS). To receive information about asset status and planned interventions and deliver allocated paths to execute inspections and interventions		5
10	STS, FS, TRV, NSR, HACON, INDRA	14	14.1	Collaborative DSS for efficient and effective disruption management		4/5
11	TRV, STS, INDRA	14	14.2	HMI for TMS based on User Experience (UX) Design and user input		8
12	PR, TRV, NSR, KB, ADIF, CAF, ADIF	16	16.2	Linking TMS to ATO/C-DAS for optimised operations "Live" demonstration for the public (or by video) of future TMS-ATO operations, including human factors: • In alignment with FA2 "Mainline demonstration preparation"- a project of a complex network use case including very short headways, disruption, and conflict resolution where TMS and ATO together show their added value, also indicating how this new kind of operation will impact the involved operational actors (train drivers and signallers HF research) by ProRail/NSR. • Testing HF impact when applying in FA2 developed new optimised braking functionality. • In alignment with FA6 test bench demonstration simulation.		4/5
13	TRV, PR, NSR, INDRA, CEIT, STS	16	16.3	Prioritized enhancements developed from WP15 for improved efficiency of C-DAS operations from a traffic management perspective.		4/5
14	PR, TRV, NSR, KB	16	16.4	Human-in-the-loop simulations test the ATO operational concept in emulated active practice and using tailor-made TMS/ ATO/C-DAS algorithms.		4/5
15	AZD, PR, ADIF, CAF, STS	16	16.5	ATO – TMS integration platform developed in subtask 15.3.4, implementing possible new requirements and architecture based on FA2&System Pillar specifications regarding ATO / TMS to support the autonomous train operations. Also, testing and demonstrating results the modelling for future operation of traffic regulation strategies (Operational Concept) for improved global behaviour of the traffic under minor timetable disturbances (delays and unfulfilled headways), based on different criteria and taking into account the global situations of the line through TMS – ATO interaction.		4/5
16	ENYSE, ÖBB-INFRA, PR, NRD	18	18.2.1	Demonstrator for Real Time Conflict Identification & Resolution.		5

VTI utför forskning om MTO och UX design för framtidens trafikledning

Trafikverket tar fram forskningsmiljö digital graf – CDAS, RISE utvecklar och demonstration utökad funktionalitet.
VTI bidrar med MTO kompetens.

Operations – TRV/KAJT deltar inte I WP 18 Automated decisions and optimisation

17	ENYSE	18	18.2.2	Demonstrator specific application to Depots and Terminal Stations environments of Algorithms for Automatic Conflict Detection and Resolution using AI		5
18	HACON	18	18.2.3	Demonstrator for Improved Decision Support		5
19	TLSG	18	18.2.4	Demonstrator for Advanced Automation of Real time Operation		5
20	STS	18	18.2.5	Demonstrator for Advanced Decision Support for Real time Operation		5
21	AZD	18	18.2.6	Demonstrator for Advanced Conflict Decision Support and Route Setting		5
22	INDRA	18	18.2.7	Decision Support for improved traffic management operation		5
23	MERMEC	18	18.2.8	Demonstrator for Automation of Real time Operation		5
24	ÖBB-INFRA, PR, NSR, ENYSE, NRD	18	18.3.1	Simulation of real time conflict identification and resolution		5
25	SNCF	18	18.3.2	Performance evaluation of optimisation algorithms for local level traffic management in a single region		5

WP No	Work Package Title	Lead Participant No	Lead Participant Short Name	Person	Person 2
1	Project Management	1	HACON	Lars Deiterding	**Magnus Wahlborg**
2	Technical Coordination	1	HACON	Lars Deiterding	**Magnus Wahlborg**
3	Specifications for improved strategic and tactical planning of the rail network	24	TRV	**Magnus Wahlborg**	Thomas Nygren
4	Development - Integration of planning systems and processes including cross-border planning	1	HACON	Mahnam Saeednia	Rolf Goossmann
5	Demonstration - Integration of planning systems and processes including cross-border planning	24	TRV	**Jan Byström**	Rolf Goossmann
6	Development - Decision support for planning and timetable optimisation	16	NRD	Carlo Mannino	Dennis Huisman
7	Demonstration - Decision support for planning and timetable optimisation	21	NSR	Dennis Huisman	Giorgio Sartor
8	Development - Simulation and operational feedback for improved planning	24	TRV	**Per Köhler**	Henri Olink
9	Demonstration - Simulation and operational feedback for improved planning	24	TRV	**Per Köhler**	Henri Olink
10	Alignment of specifications	1	HACON	Rolf Goossmann	Mahnam Saeednia
11	Development - Integration of TMSs and processes including cross-border traffic management	1	HACON	Mahnam Saeednia	Rolf Goossmann
12	Demonstration - Integration of TMSs and processes including cross-border traffic management	24	TRV	**Jan Byström**	Rolf Goossmann
13	Development - Improved resilience and efficiency of disruption management	14	STS	Luigi Velardi	**Jonny Gustafsson**
14	Demonstration - Improved resilience and efficiency in disruption management	14	STS	Luigi Velardi	**Jonny Gustafsson**
15	Development - Linking TMS to ATO/C-DAS for optimised operations	20	PR	Henri Olink	**Peter Olsson**
16	Demonstration - Linking TMS to ATO/C-DAS for optimised operations	20	PR	Henri Olink	Erwin Abbink
17	Development - Automated decisions and decision support for traffic management optimisation	18	ÖBB-Infra	Amirreza Tahamtan	Francisco Lozano
18	Demonstration - Automated decisions and decision support for traffic management optimisation	18	ÖBB-Infra	Amirreza Tahamtan	Francisco Lozano

Flaggskepp 1 inre TRV

Inre grupp - Trafikverket och FOI-utförare i Flaggskepp 1 - Sverige					
Ftg/Part	**Namn**	**Avdelning**	**Mail**	**WP**	**Annat**
TRV	Wahlborg Magnus	PLek	magnus.wahlborg@trafikverket.se	WP1/WP2/WP3	FA1-ledn
TRV	Johnson Anders	UHvätv Konsult	anders.johnson@trafikverket.se	WP1/WP2/WP32	FA1-ledn
TRV	Viklund Anders	TRpku	anders.viklund@trafikverket.se	WP11/WP12	RG ordf
TRV	Persson Kristian	Plek	Kristian.b.persson@trafikverket.se	WP4/WP5, WP6/WP7	
TRV	Jonas Bälter	TRp	jonas.balter@trafikverket.se	WP4/WP5 WP6/WP7	TTR, gränsöversk. planering
TRV	Emma Solinen	PLek	emma.solinen@trafikverket.se	WP6/WP7	
TRV	Köhler Per	Plek	per.kohler@trafikverket.se	WP8/WP9	
TRV	Byström Jan	PRefpt	jan.bystrom@trafikverket.se	WP10/WP11/WP12	
TRV	Gustafsson Jonny	PLnpv	jonny.gustafsson@trafikverket.se	WP13/WP14	
TRV	behov MTO person				
TRV	Cecilia Olofsson		cecilia.olofsson@trafikverket.se	WP11/WP12 WP13/WP14	RNE, gränsöversk. trafikledning
TRV	Olsson Peter	IKTjv	peter.olsson@trafikverket.se	WP15/WP16	
TRV	Mathias Hofren	Uhjj	mathias.hofren@trafikverket.se	WP26/WP30	
TRV	Peter Axelsson	EVI	peter.axelsson@trafikverket.se	WP26/WP30	

Forskare

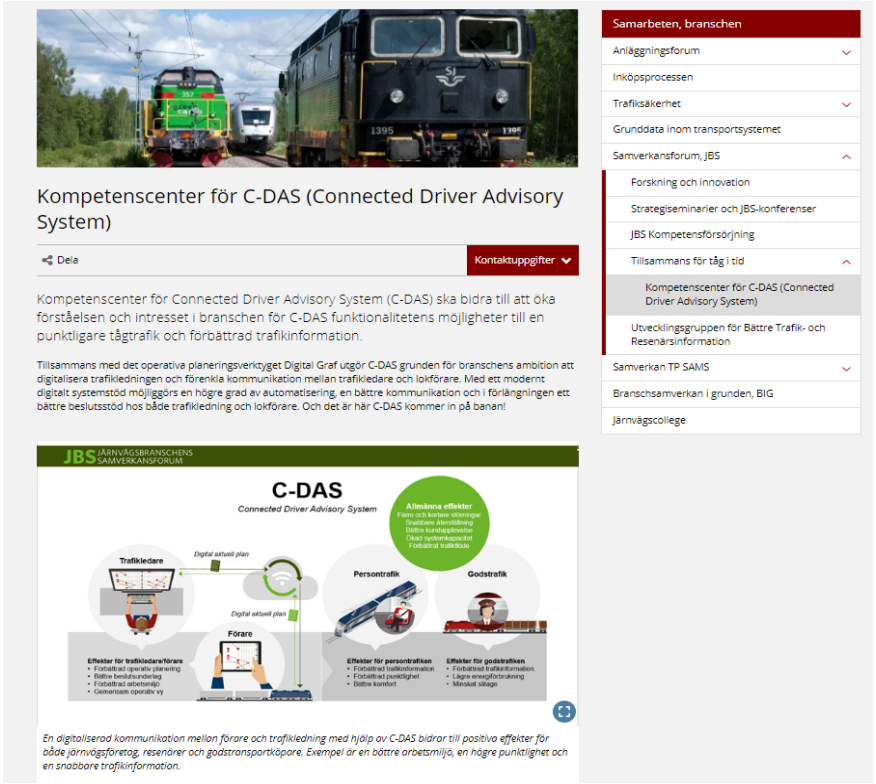
Ftg/Part	Namn	
RISE	Martin Joborn	
KTH	Hans Sipilä	KTH kontaktperson
KTH	Behzad Kordnejad	Koppling Flaggskepp 5
Lund	Carl-William Palmqvist	
Linköping U	Carl-Henrik Häll	
VTI	Gunilla Björklund	VTI kontaktperson, MTO
VTI	Jan Andersson	MTO
VTI	Niklas Olsson	ERTMS simulering
VTI	Tomas Rosberg	ERTMS simulering

EU Rail Flaggskepp 1 Samverkan

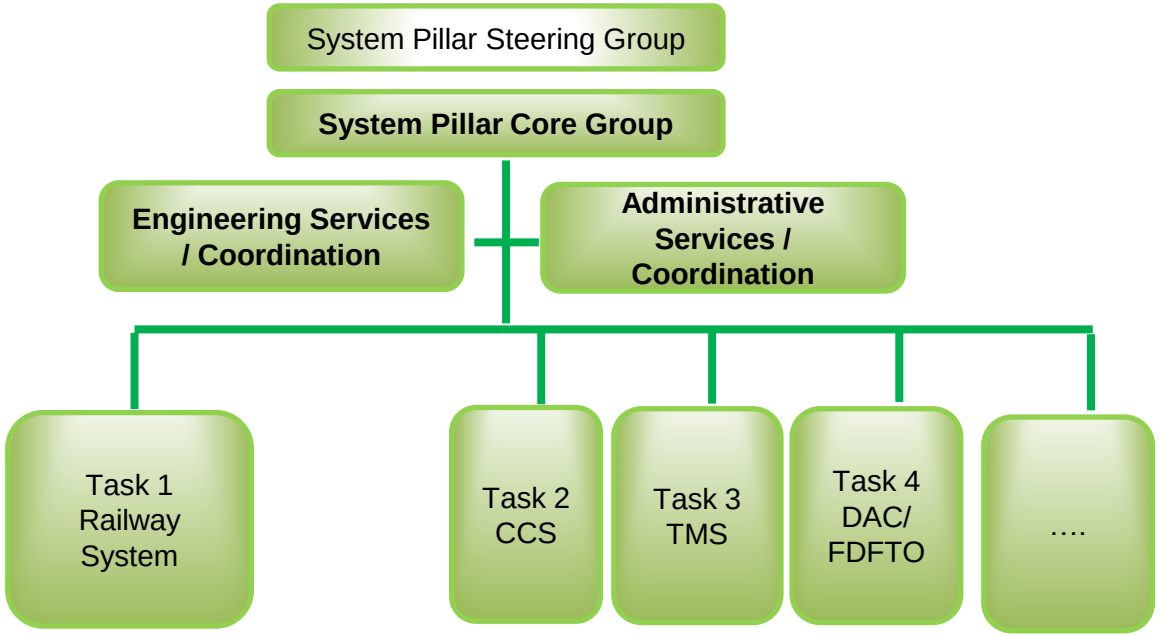
- KAJT

- Trafikledningscentral Malmö/Trafikledningsområde Syd, (kopplar till nationell nivå)
  - Gränsöverskridande trafikledning/kapacitetsplanering
- JBS/TTT Samplanering Malmö
- TMS – CDAS/ATO (CDAS Kompetenscenter)

- Systempelare
- RNE och TTR
- Jernbanedirektorat
- ProRail, SNCF och DB
  - Påskrivet avtal med DB om fortsatt Proton samarbete



System Pillar



Samverkan flaggskepp 1 - SystemPelare

- En tät kontakt hålls med System Pelare sedan oktober 2021, nu hålls möten var annan vecka
- Syfte är att få en samsyn om framtidens processer och pågående automation, TMS arkitektur samt att stämma av begrepp definitioner och kunskapsdokument, white paper m.m.
- Funktioner framtidens TMS
  - Planera infrastruktur användning och trafik
  - Avvikelse hantering/styrning
  - Incident hantering/styrning
- Pågående automation:
  - CCS+ och TMS+ (signalsystem och traffic management)
  - TMS – CDAS/ATO
- Systempelaren har även kontakt med flaggskepp 2 om ATO

FA1 – RNE Operativa delen, samverkansmöjligheter är identifierade

- European Traffic Management
  - Projekt inom RNE, med möjligheter till samverkan

- ETA-hantering
  - Estimated Time of Arrival
  - Estimated time of hand over

- Internationell störningshantering

Huvudnyttor KAJT

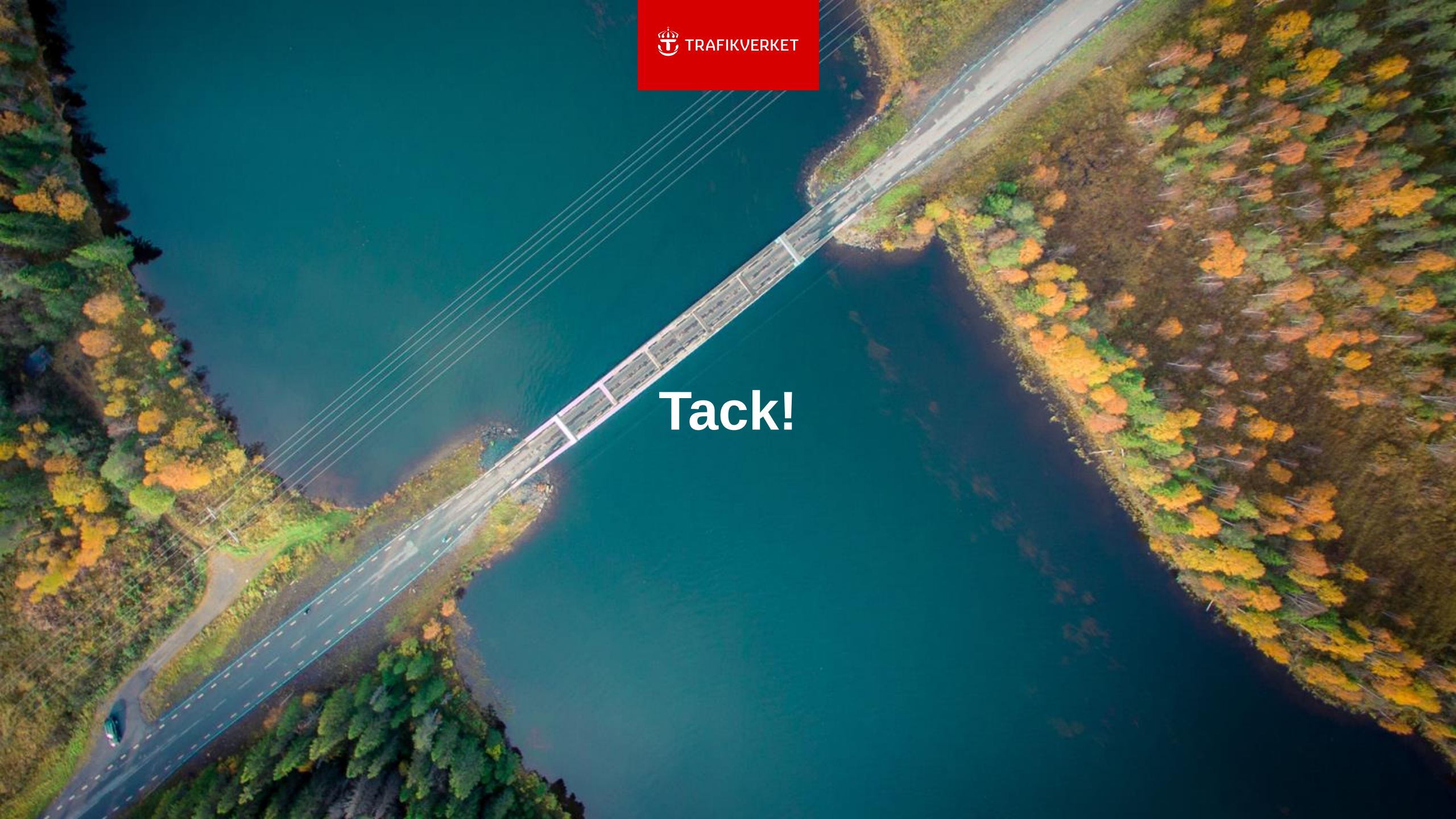
- **Bygga förmågor/kunskap och Excellens i samverkan**
  - Demonstratorerna blir mer skarpa, större/mer betydelsefulla och nyttan för Trafikverket och bransch ökar
- **Utveckla kunskap och metoder för framtidens järnvägssystem**
  - Ökad kapacitet och punktlighet genom förbättrade metoder
- **Digitalisering, automation och ERTMS**
  - Ta fram lösningar i Europeisk samverkan
    - Människan i loopen (Sverige)
    - Automation (Europa)
    - TMS – CDAS/ATO
- **Europa nivå**
  - Gränsöverskridande kapacitetsplanering och styrning tex RNE och TTR
  - Ta hem kunskap och påverka Europas inriktning/harmonisering och samverka/delta med arbete i System Pelare
  - Utveckla samverkan Europa nivå – Jernbanedirektorat m fl.
- **Samverkan Svensk nivå andra excellensområden**
  - Systemkunnande hur saker hänger ihop
  - Tydliggör koppling och behov av förmågor

Europes rail innovation days

- Europes rail innovation days är en digital plattform där resultat från Shift2Rail presenteras

- Resultat från IP5 godstrafik ”FR8Rail III” presenteras
  - Fredag 9 December kl 9:00 – 12:00
    - Yard and network management, YCS demonstration by Sara Gestrelius, demonstration and evaluation co-operative planning Malmö freight node
    - Intelligent videogate

- Europe's Rail 2022 Innovation Days - Europe's Rail (europa.eu)


TRAFIKVERKET
Tack!


Excellensområden
- Långsiktig bas-finansiering
- Kunskapshöjande
FOI-portföljer
- Verksamhets-nära projekt
- Doktorand-projekt
Europes Rail
- Högre TRL-nivåer
- Demonstration