Artificial intelligence and Future of mobility

Nordic Edge Expo: On the Move

Wednesday 22nd September 2021

Technology for a better society

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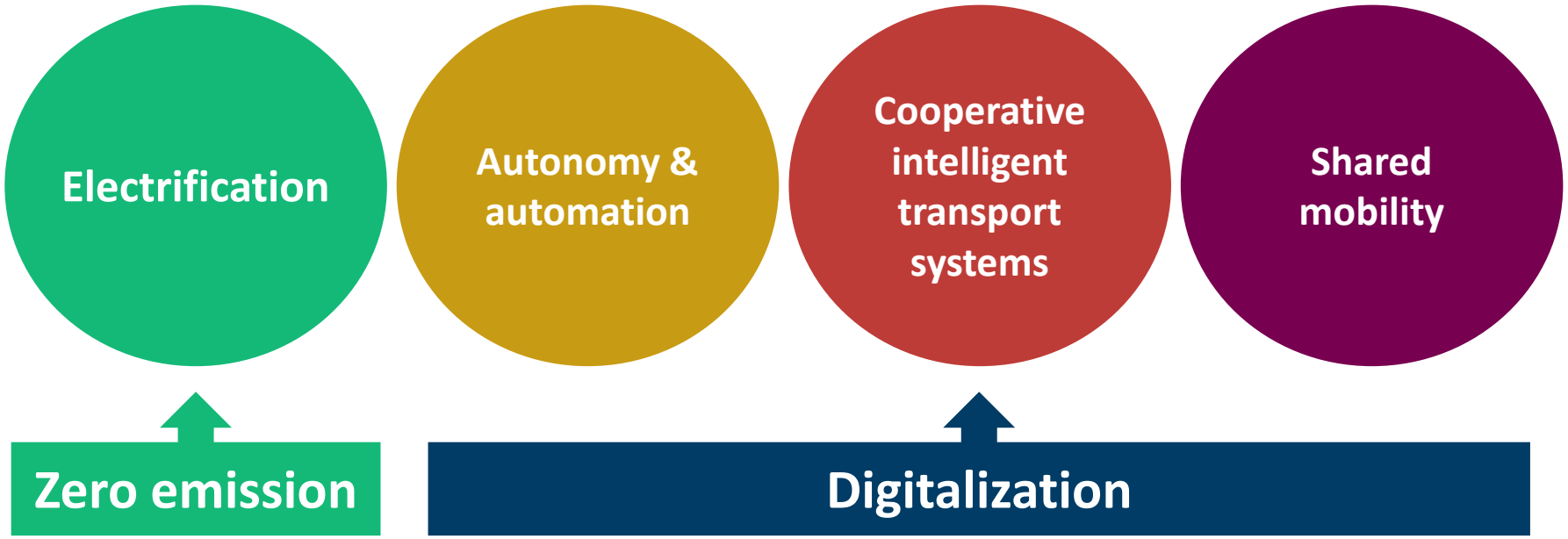
Anne Marthine Rustad, PhD

Research Manager

SINTEF Digital, Analytics og AI

Megatrends changing mobility



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Use AI for

1. Efficient
2. Traffic-safe
3. Zero-emission

mobility

AI and machine learning defined

Artificial Intelligence (AI)

Machines mimic human behaviour as problem solving, planning or giving recommendations

Machine learning (ML)

Algorithms or computer systems that learn from data


Domain expertise
Industrial solutions
Technical expertise

Agenda

Data-driven construction site

The digital mountain crossing

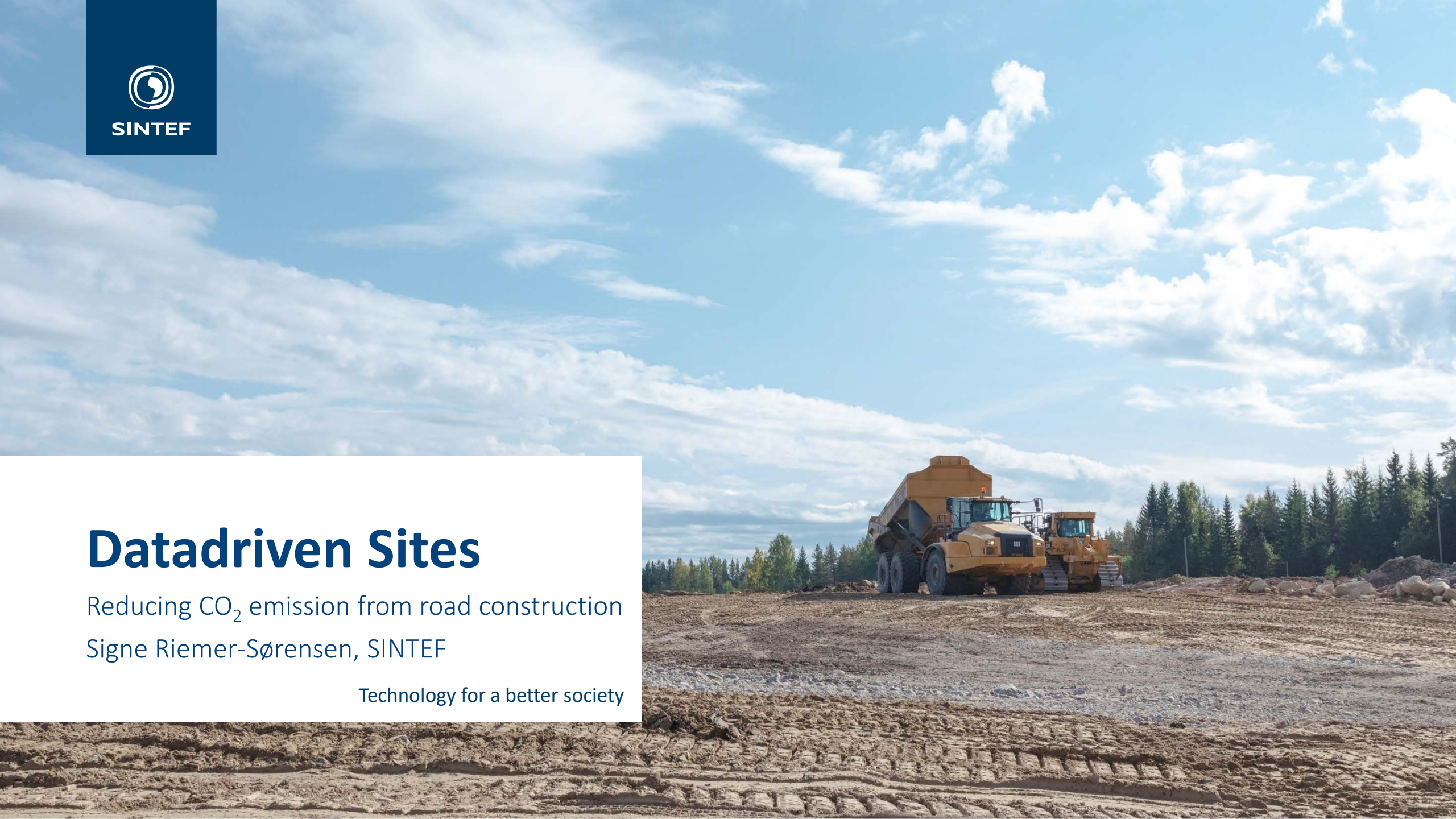
Vessel AI

Smart transportation in rural areas

Signe Riemer-Sørensen, PhD

Research Scientist

SINTEF Digital, Analytics og AI



Datadriven Sites

Reducing CO_2 emission from road construction

Signe Riemer-Sørensen, SINTEF

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Norway's CO_2

15% from construction sector

1/5 from machines

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Datadriven Sites

2020-2022

2M€ funded by Skanska Norway and the Research Council of Norway

(Innovation project for industrial sector)


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VOLVO
Construction Equipment
ditio
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9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION

Objectives

- 10% reduction in idling
- Cost reduction of 5-8%
- Independent of machine type

Components

- Dynamic mapping from GPS data
- Fuel model
- Optimization algorithm

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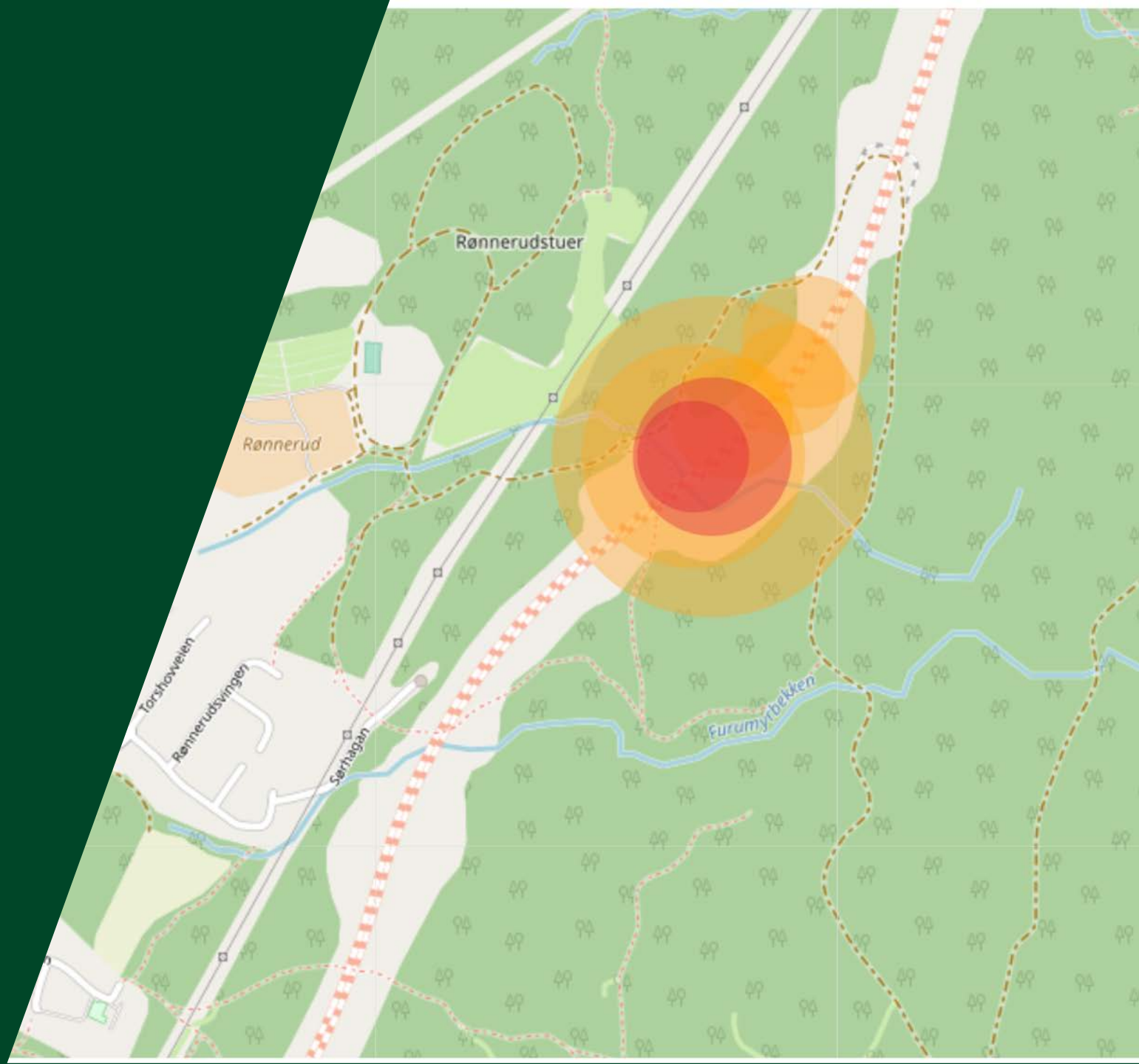
Preliminary results: GPS data to maps

- Decision points
- Road information
- Noise and uncertainty

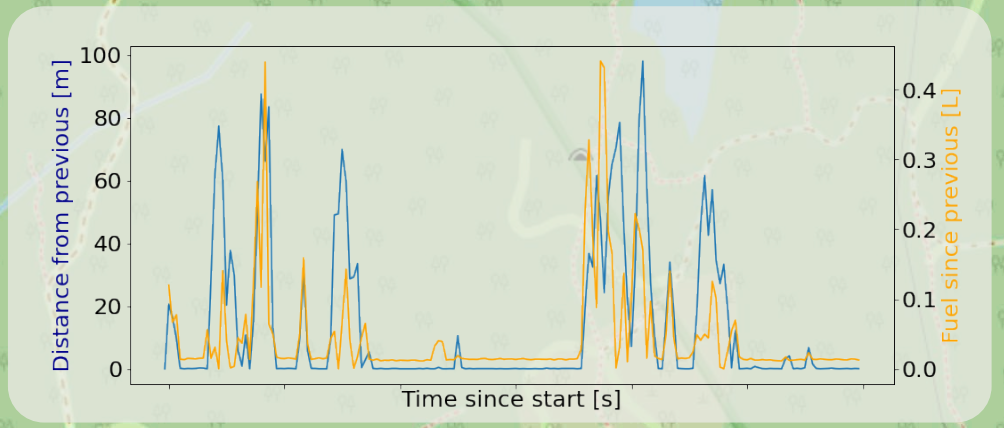
Preliminary results: Hotspots

- Slow driving
- Acceleration
- Speeding



Preliminary results: Fuel consumption

- GPS data and fuel rate
- 33 of 60 min standstill
- 1.5 of 8L standstill
- 1.5L = 4 kg CO_2



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sintef.no/en/projects/2020/data-driven-road-construction-sites


NTNU
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CO_2
H_2

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Senior advisor

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The digital mountain crossing

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Image: NPRA with permission

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Driving over a alpine mountain crossing during the winter months in Norway

What you hope for vs What you (sometimes) get

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Background – mountain crossings in Norway

- Typical mountain crossing in Norway
  - Few or no optional routes/detour
  - Several areas can get completely isolated
  - A detour, if possible, can take many hours
  - Large areas with no railway (northern Norway)

- Between 2010 and 2018, adverse weather conditions led to **2258** cases of temporary road closure or convoy driving on the 12 busiest mountain crossings in northern Norway.

Den digitale fjellovergang

Convoy and temporary closed vinteren 2019/2020

- E6 Doverfjell
  - Convoy 0
  - Temporary closed: 63
- E6 Saltfjellet
  - Convoy 551
  - Temporary closed 508
- E10 Bjørnfjell
  - Convoy 420
  - Temporary closed 481
- Rv7 Hardangervidda
  - Convoy 630
  - Temporary closed 1037

Image: NPRA with permission


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The cost of delays at mountain crossings

Time costs from closing, convoy driving or reduced speed at 17 selected mountain crossings in northern Norway alone:

- 9 Million EURO per year due to delays*
- Delays at E10 over Bjørnfjell alone cost over 20 mil NOK a year.

- This does NOT include follow up costs on additional delays (ferries, train, shipping, HGV driver rest)
- This does NOT include reduced value of cargo (Salmon export from Norway: ~1.1 M tons, 70 B NOK - 2020)

*Kjersti G. Bardal (2018), Fremkommelighet på høyfjellstrekninger. Nordlandsforskning rapport 13/2018.

The Project: "Den Digitale Fjellovergang"

Prediction: can we predict the situation into the future?

- Lead and financed by NPRA
  - Prosjektleder SINTEF: Jo Skjermo
  - Prosjektleder NPRA: Karl Magne Nilssen
- Public tender
  - 3Mil NOK ink. mva. Option 1+1 år

3 Mountain Crossings:

- E10 Bjørnfjell
- E6 Saltfjellet
- Rv7 Hardangervidda

E6 Dovrefjell used for prototyping

What data do we have?

At specific points along the road…

- Road weather sensors (NPRA, Vegvær)

  Include road surface temperature, friction estimate a.s.o

- Vehicle count and speed (NPRA

  10 min aggregates for small and HGV

- Weather data from (MET Norway)

  Weather forecast

Travel time over the mountains (NPRA)*

Snow depth (senorge.no)*

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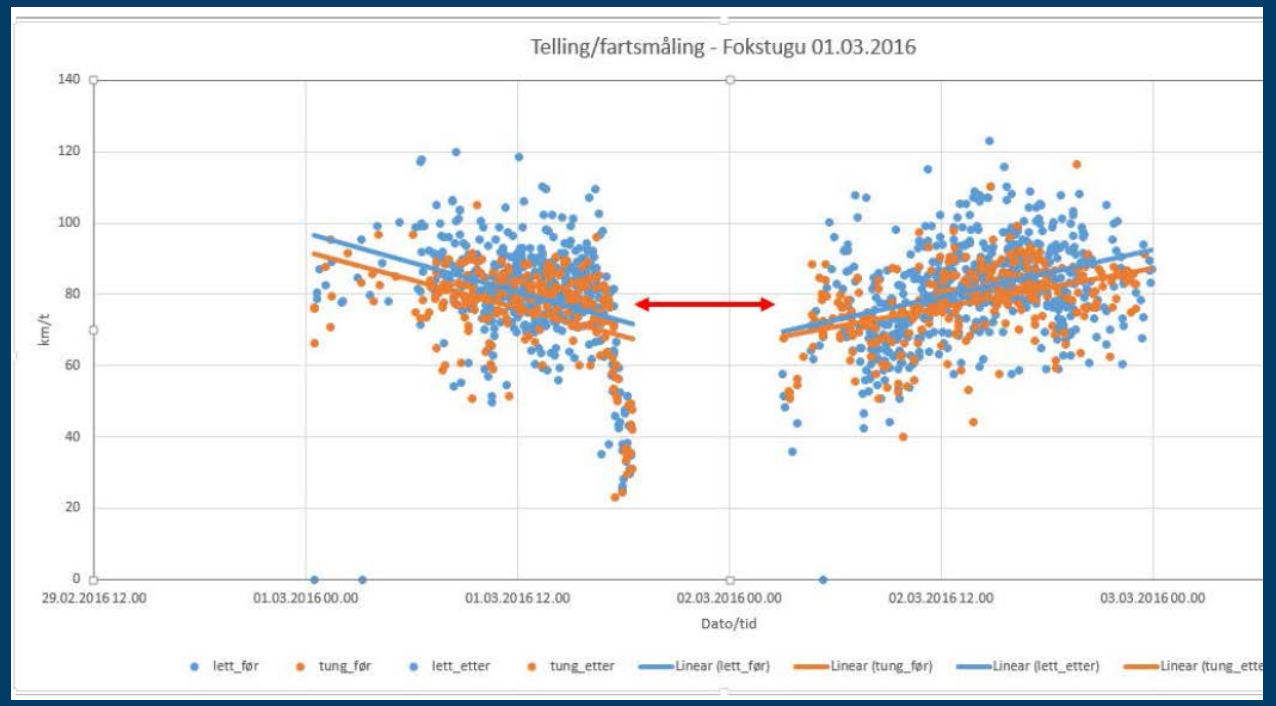
Method - the concept for prediction

- Human as a sensor – observable behaviour
  - Perceived driving condition
- Speed measurement vs driving conditions
  - **Typically, speed goes down more than 20% of speed limit leading up to a road closure from winter conditions**
- Concept: use weather data, road weather data and speed measurements to **predict future speed** – use for decision support



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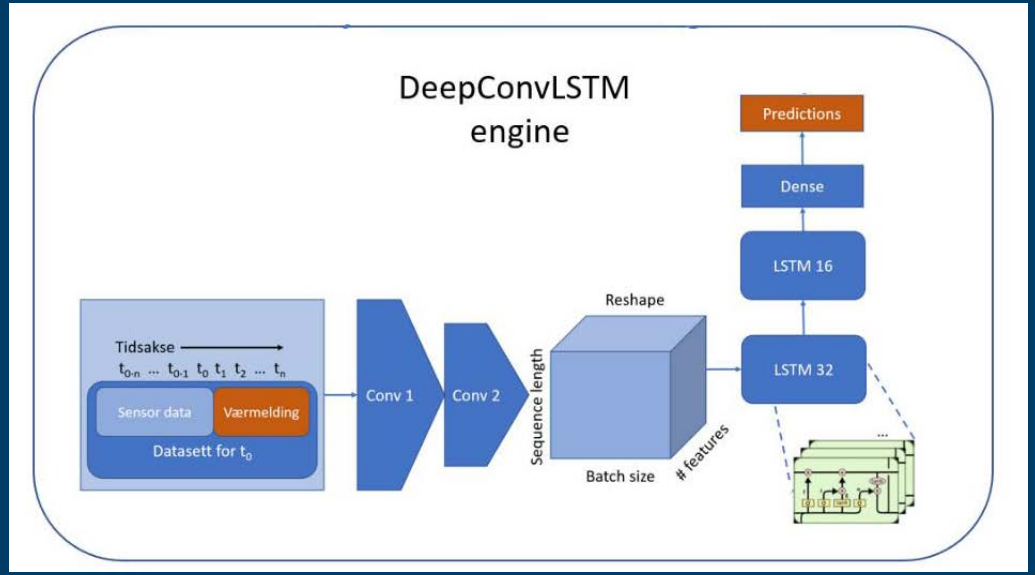
Method – DeepConvLSTM for speed prediction

- AI model based on DeepConvLSTM
  - Developed for senor based Human Activity Classification
  - 2xConvolution layers to find features
    - convolve all sensor layers simultaneous, not separately
  - ***2xLSTM layers to take into account temporal aspects***
    - LSTM layers are extended to produce multivariate multi-step predictions



- Input data per timestep – aggregated 10min
  - 10 past (100 minutes) time steps a 14 params
  - 36 future (six hours) time-steps a 6 params

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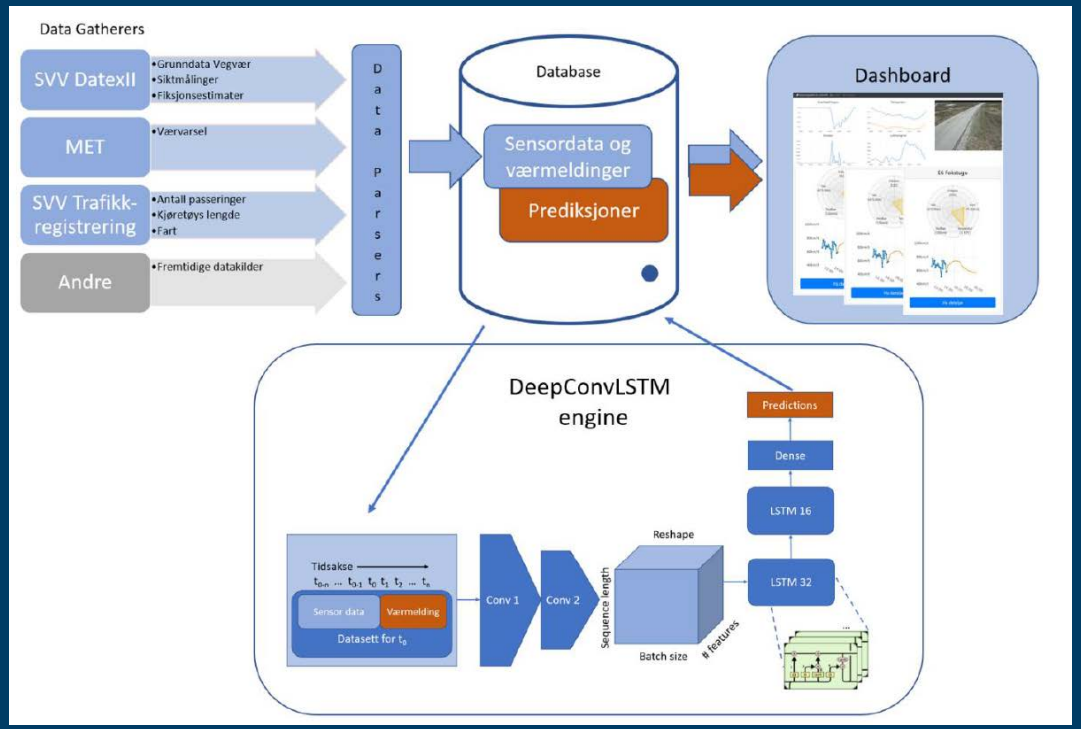
Prototype

- Postgresql/timescaledb
- Keras/Tesnorflow model
- Graphana Dasboard
  - Overview/status for each crossing
  - Drill down in weather forecast
  - Drill down in Road weather data



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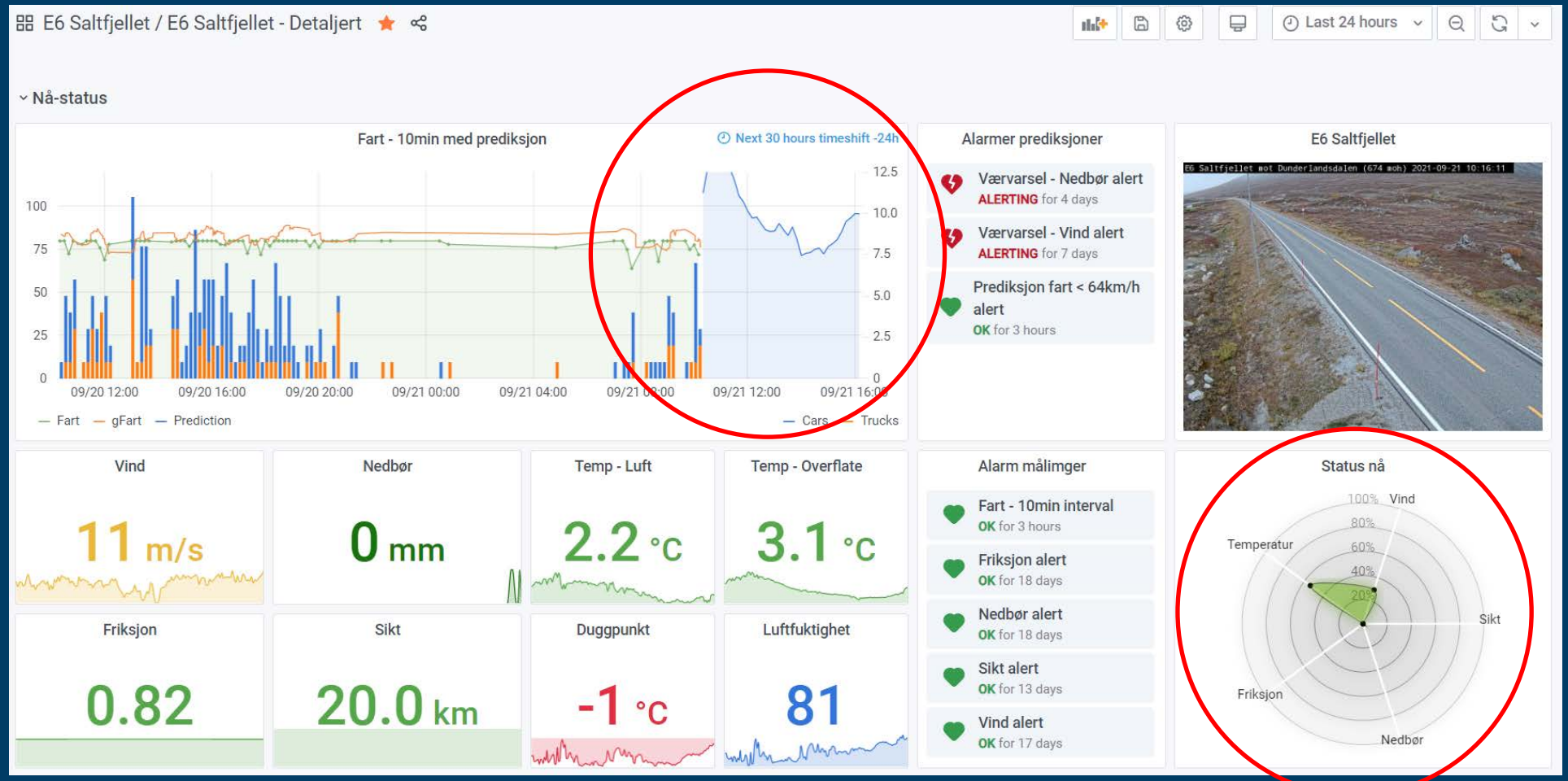
Prototype - overview/status



Ongoing work

- Ongoing
  - Training/adaption for each local site
  - Looking into use of autoencoders for bootstrapping local training (unsuperviced learning)
  - Use of travel time measurements
  - How do snow plowing/snow banks/snow depth impact visibility from wind-swept snow, and how can this be modelled/predicted?

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Marianne Hagaseth

Senior Research Scientist

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VesselAI
Autonomous Ships in Short Sea Transport

Marianne Hagaseth

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22 September 2021

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Oslofjordtunnelen planlagt stengt til 17. august

Publisert 5. august 2021

NRK Logg inn

20. september 2021 kl. 07:33 Stenger Oslofjordtunnelen på natta • Frå og med tysdag og fram til fredag 1. oktober blir Oslofjordtunnelen stengt på natta.

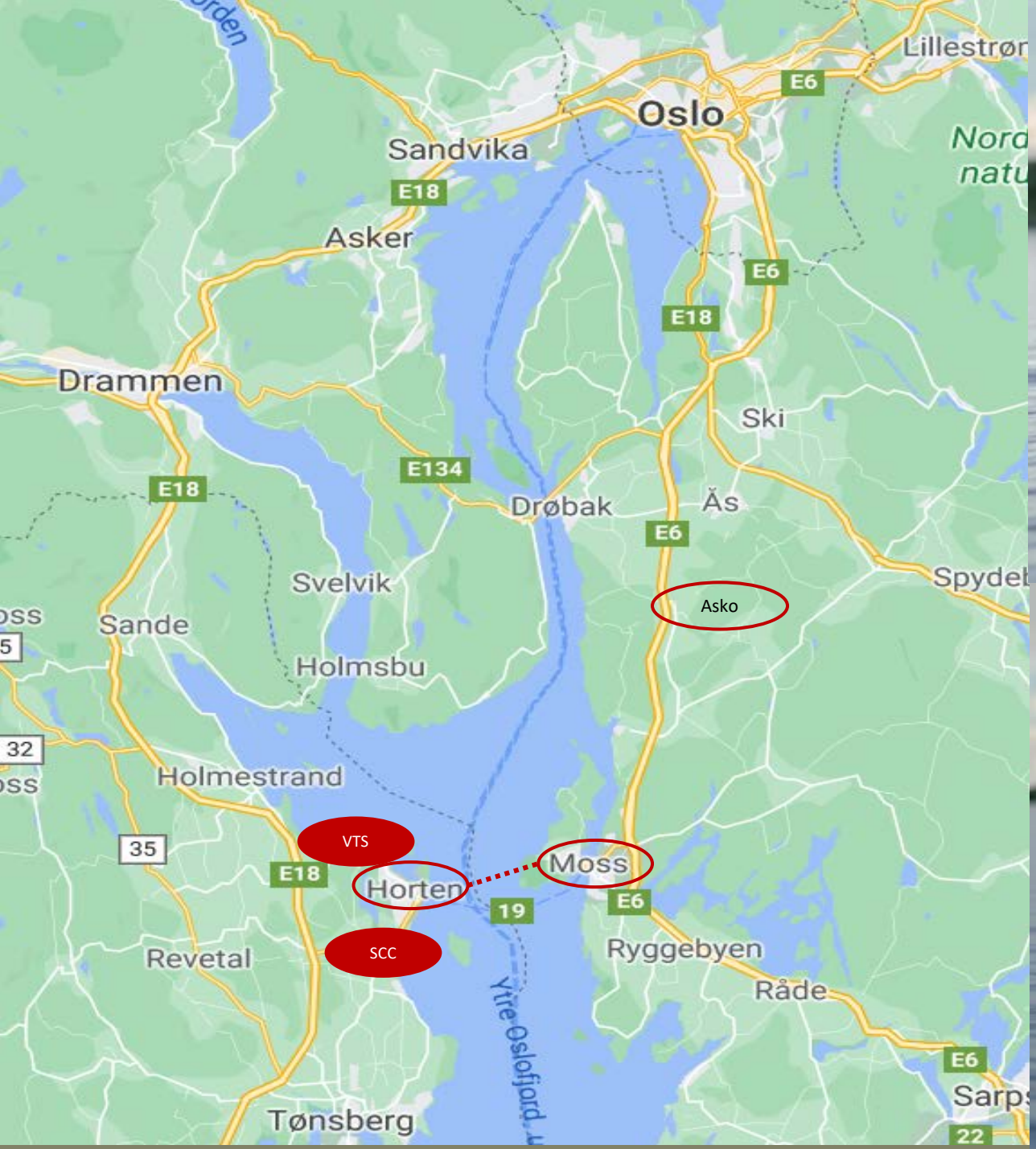
Grunnen er at rundt tusen lysarmatur skal bytast ut, skriv Drammens Tidende.

Når nye led-. lys er på plass, skal det gi betre lys i tunnelen.

en semitrailer mandag ga
ader i Oslofjordtunnelen. Slik
t etter at ødelagte
turer var demontert, og
dingsarbeidet var påbegynt.
m Ferdinand Luther, Statens
en

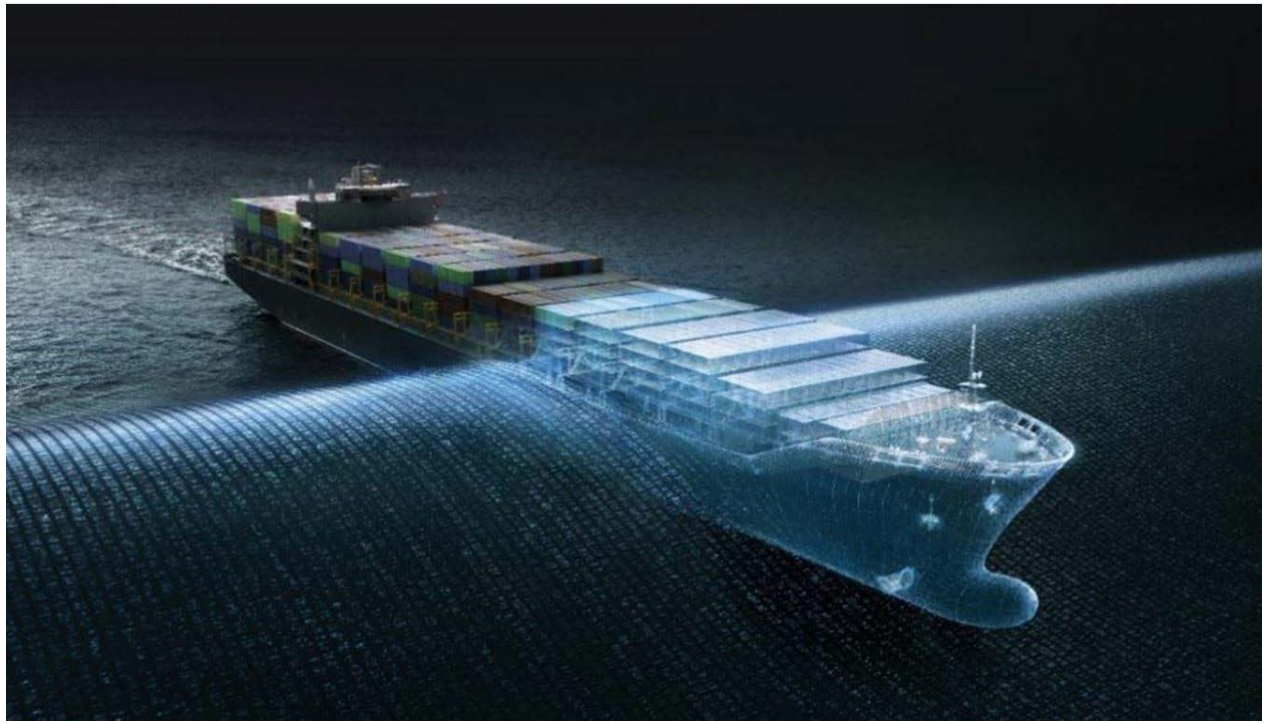
Oslo

Oslo har Nordens verste ettermiddagsrush



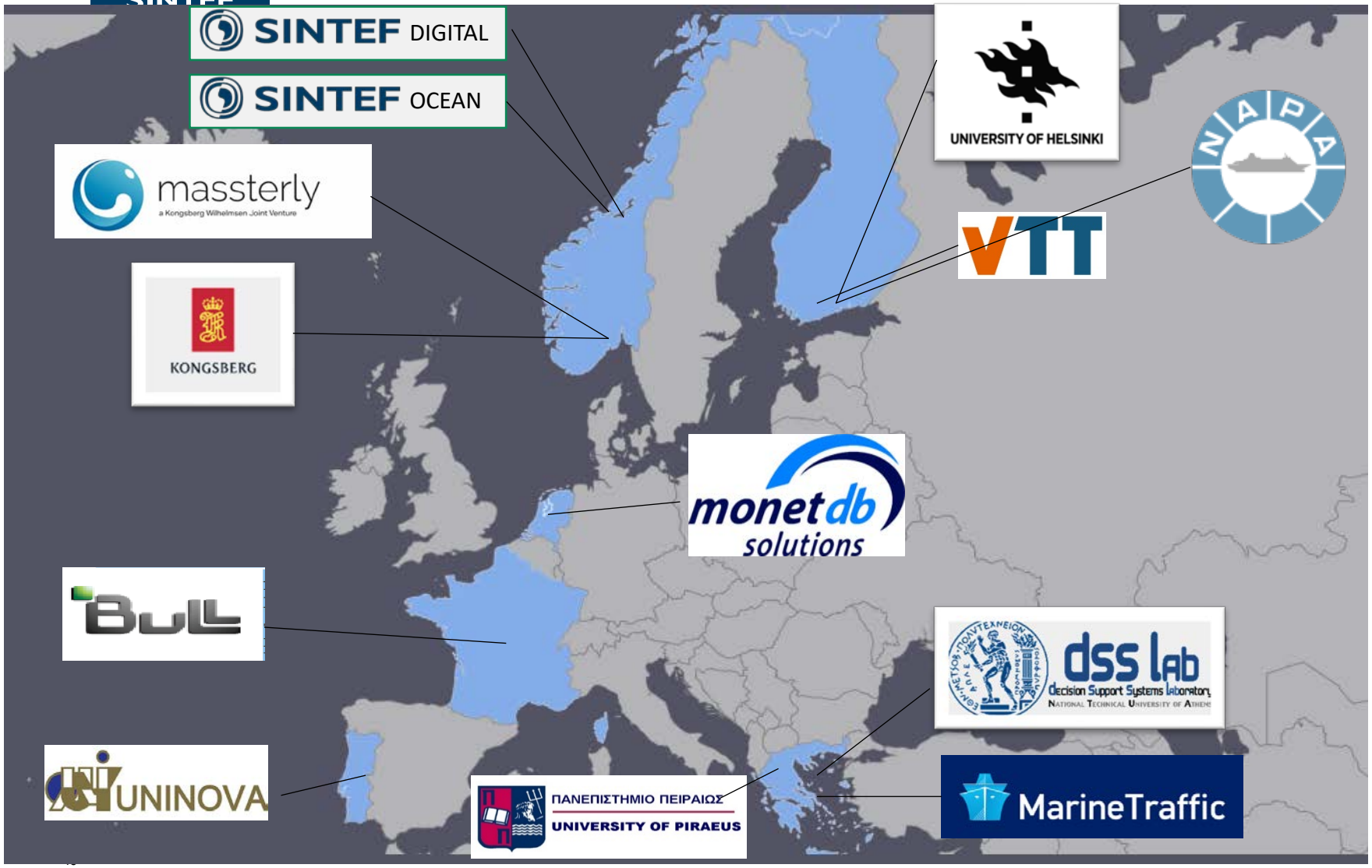
Source: https://www.massterly.com/

VesselAI project (https://vessel-ai.eu/)



- Horizon 2020 project
- 2021-2023
- Develop AI and HPC based framework for decision support in maritime applications

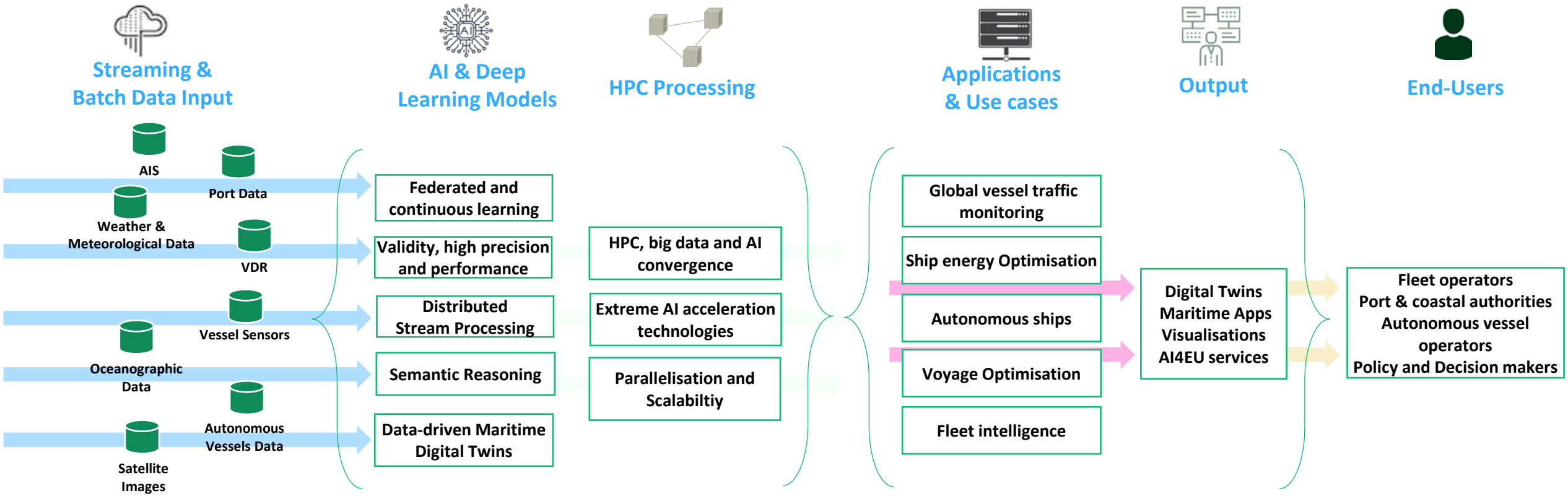
VesselAI project (https://vessel-ai.eu/)



Pilot partners within maritime technology and Technology partners within

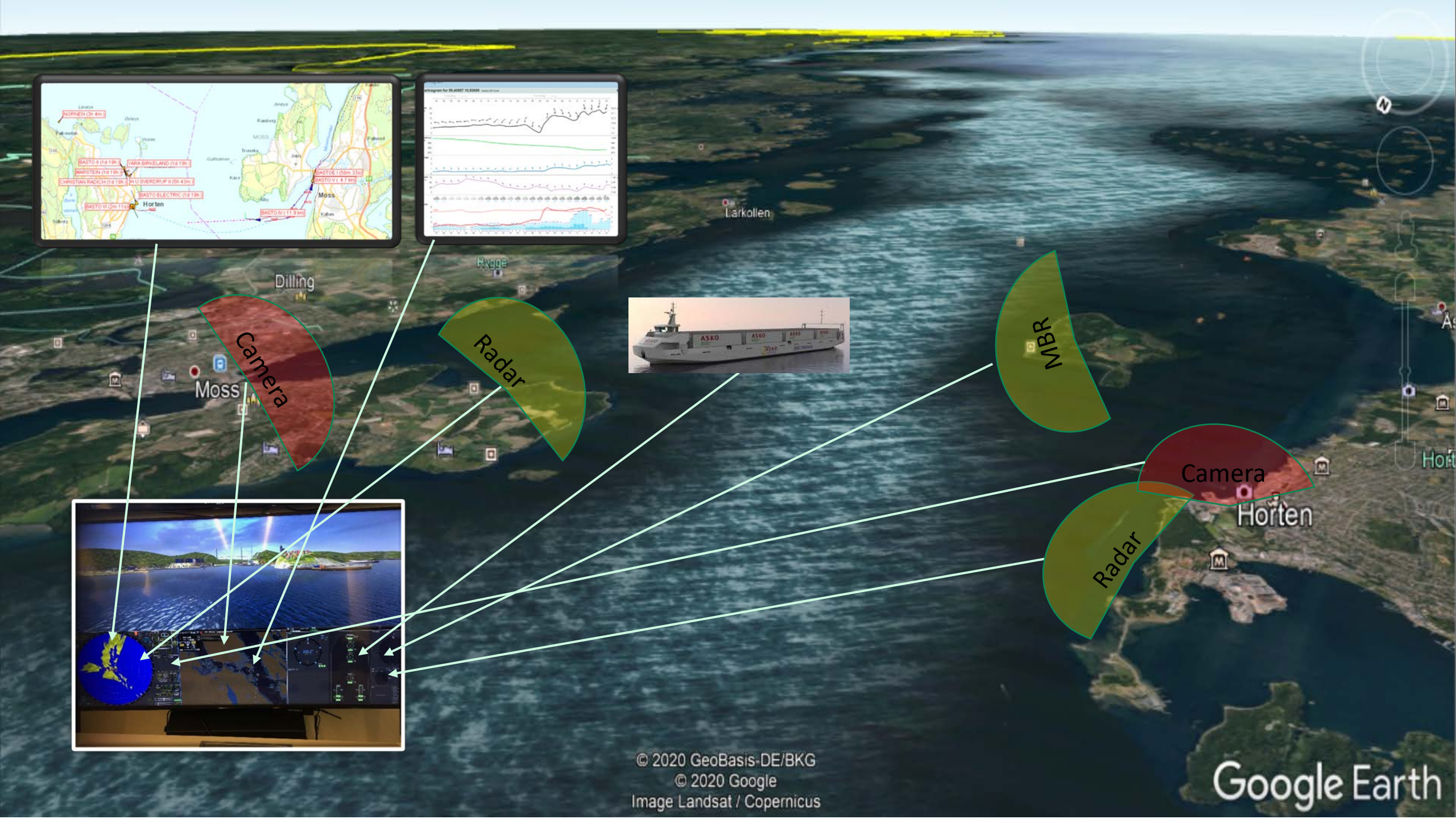
- **Data engineering and analytics**
- **HPC technologies and AI acceleration hardware**
- **Artificial Intelligence**

VesselAI Concept



Shore Control Centre

- VTS-like systems
- Improved situational awareness
- Operator will act on behalf of the autonomous ship


Camera
Radar
MBR
Camera
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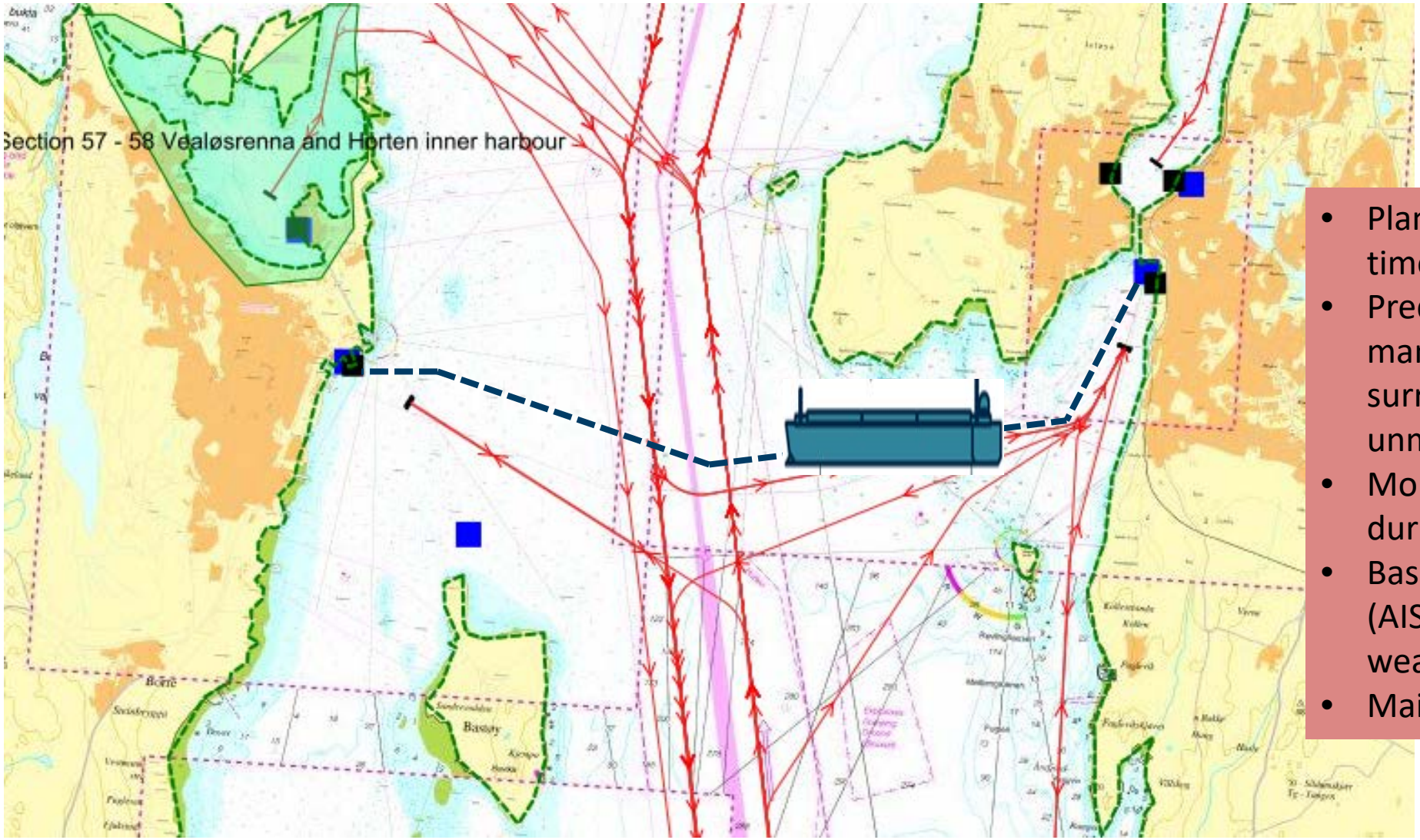
Expected Benefits

- Detect anomalies
- See beyond the next maneuver
- Early warnings
- Ensure safe and efficient traffic flow
- Automatic monitoring
- Increased situational awareness

KPIs

- Anomaly detection from > 5 minutes to < 5 seconds
- Route prediction from > 5 minutes to < 5 seconds
- Accuracy

Shore Control Centre (SCC) Route Planning and Monitoring for Unmanned Vessels



- Plan best route at a given time
- Predict routes for all manned vessels surrounding the unmanned vessel.
- Monitoring of the traffic during the voyage
- Based on historical data (AIS), routeinfo, weather predections
- Main user: SCC Operator

Amela Karahasanovic, PhD

Senior Research Scientist

SINTEF Digital &

Associate Professor at the University of Oslo

Department of Informatics

SMART TRANSPORT IN RURAL AREAS
AI FOR SUSTAINABLE MOBILITY

Amela Karahasanović – SINTEF Digital

Nordic Edge Expo: On the Move, 22nd October 2021

Innlandet County
Area 52 072.44 km^2
Population 371 385 (4th quarter 2019)
Population density 7.1 innhabitants per km^2

Wikipedia.org

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11 SUSTAINABLE CITIES AND COMMUNITIES

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CAN AI HELP US TO PROVIDE GOOD TRANSPORT KEEPING FINANCIAL AND ENVIRONMENTAL COSTS LOW?

Smart transport in rural areas

- Develop Mobility as a Service (MaaS) tools and services specifically tailored for sparsely populated rural areas
- MaaS services – services offering passengers the transport that suits their needs by combining transport services from different providers through a unique platform
- Create a holistic system for transport planning that dynamically coordinates the transport of people and goods to make the most of transport resources

Transport of patients, blood samples, food, elderly, school children

County municipalities transport section (public transport in county)

Service provider

Research on human-centred design and optimisation

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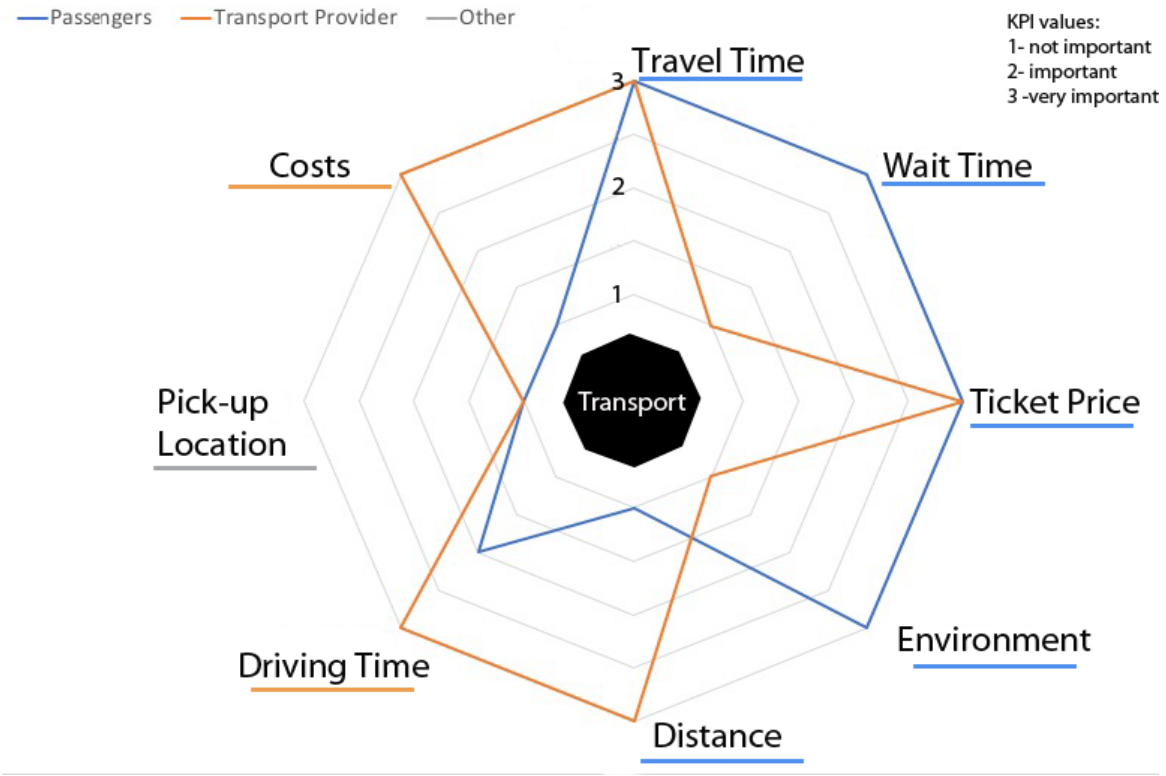
Holistic system for transport planning

School children
Public transport, self driving public transport
Drones
Taxi
Self driving cars, car sharing, carpooling
Rental bicycles and scooters
Lorries
Post transport
Transport of goods
Delivering food
Transport of patients, elderly and disabled persons
Passengers

STD TOOLS AND METHODS

Key Performance Indicators



KPIs identified and used

Workshops and meetings - problem owner, researchers
Based on UN and national goals, input from experts

Used at all stages of design from the development of the project idea, requirement analysis to interaction between AI and users (passengers, operators, decision makers)

Workshops and interviews with experts using spider diagram
Different perspectives
Drivers' workload, operating costs, utilisation of resources, reduced use of private cars, costs (passengers, municipalities, transport providers) Increased income, possibility for new indicators

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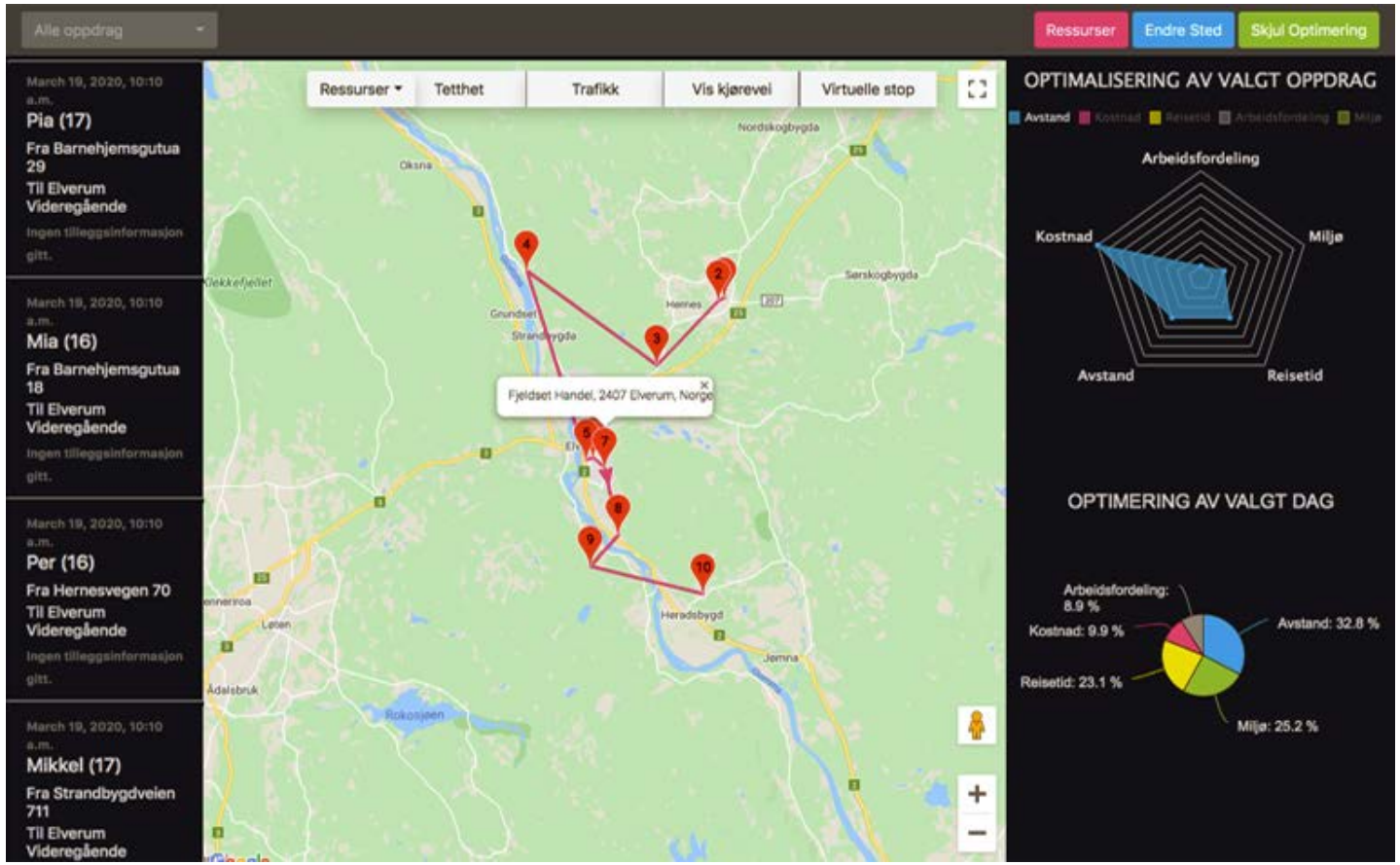
STD Planner – Folldal case



- Engaging citizens in more environmental behavior
- Enabling operators to choose more environmentally friendly alternatives considering an individual journey or the traffic for the longer periods (a day, a week)

- Presenting impact of a proposed solution on KPIs
- KPIs as an input to the tool

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STD Simulator - Innlandet Hospital case

- Real-life data about transport of patients from the Innlandet Hospital, Hammar area, week 4 2019
- We have planned one scenario with 3 cars owned by the hospital
- These cars are in Hammar, Elverum and Stange
- The cars are driving from 7:00 to 17:00 and take maximum 7 persons
- There are in total 1531 orders this week
- Simulation was done for Monday with the orders known before 7:00
  - 290 orders in the period 7:00 – 17:00
  - 196 orders known before 7:00

Results

- The hospital self can serve 39 orders saving 59% compared outsourcing these orders to an external transport provider
- 18% reduced driving distance - very good reduction of environmental costs; external transport provider would also need to drive from and to start and stop location
- 11% reduced working hours for drivers – without considering that an external driver would also need to travel from and to start and stop location
- The average travel time for patients increase 10,5 minutes (28%)

CONCLUSIONS AND FUTURE WORK

STD approach

- KPI concept - useful for mapping the problem and stakeholder concerns, obtaining user insights, identifying the current situations that contribute to the problem, and designing interventions
- KPI concept - helped keeping the focus on sustainability and interacting with the AI behind the scene
- STD Simulator - there is a clear potential for reduction of environmental and financial costs; the optimization algorithms performs well; good quality data is a challenge

Ongoing work

- Further evaluation of STD Planner and STD Simulator
- Design of future services around these tools

Thank you for your attention!

Contact: amela@sintef.no

The project is funded by the Research Council of Norway, the Transport 2025 program (grant nr. 296639)

Thanks to all partners and the participants in our studies

Project team: Hasle Geir, Karahasanović Amela, Kjenstad Dag, Kloster Oddvar, Prillard Ophelia, Skjetne Jan Håvard, Smedsrud Morten

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More questions?

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