

**Timo Sukuvaara, Kari Mäenpää, Hannu Honkanen, Marjo Hippi and Virve Karsisto.**

Finnish Meteorological Institute, Sodankylä and Helsinki, Finland

## Background

Main objective; Better traffic safety with advanced technology

Accidents involving heavy road vehicles potentially causes high-volume damages  
Human casualties  
Operational losses  
Infrastructure and traffic fluency losses  
Negative environmental impacts.  
Heavy traffic is particularly susceptible to accidents in winter conditions

→ Enhancing heavy traffic safety will have great impact for general traffic safety

## Approach

Eureka Xecs **SafeTrucks** (Heavy traffic safety improvements by advanced dynamics and road weather services)

- Research project between Finland and Canada
- Conduction in 2023-2026
- Leading partner **Finnish Meteorological Institute (FMI)** in Finland, Canadian consortium coordinated by **The National Research Council Canada**
- Improve the safety of heavy traffic by providing warning and information data directly to the driver, adjusted individually to each heavy vehicle unit
- Real-time road weather conditions and forecast based on FMI road weather services, supplemented with on-board monitoring data from the vehicles
- Traffic environment data and warnings
- Vehicle-generated observations about critical conditions
- Vehicle's individual dynamic conditions
- Alert each driver about his/her individual emerging risk before it turns into critical hazards
- Pilot fleets in Finland to field-test services
- Digital Twin modelling of specific vehicles in Canada, importing and exporting SafeTrucks service data for validation

## Architecture

Digital Twin	
Dynamics simulation models of vehicle, environment, sensor, and control system	HIL & DIL: Simulator with motion platform, active control system, haptic force feedback and augmented reality

Physical pilot systems	
EXTERNAL SERVICE DATA: Road weather services, accident & incident warnings	
USER INTERFACE: Combining weather and vehicle-oriented data, user interface with services	
ON-BOARD UNIT: Sensor fusion, external service data input/output, V2X	
VEHICLE DATA: CAN-bus data, FMS-data, static vehicle data, driving analysis and rollover	
TYRE-ROAD INTERACTION: tyre monitoring, tyre-road interaction, tyre interfacing/telemetry	
SURFACE: Surface analysis by sensor monitoring and roadside instrumentation	

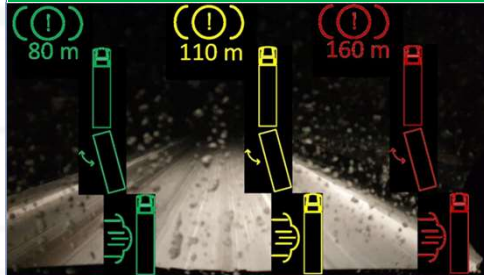
## Pilot vehicles and Sodankylä test track



## Envisioned vehicle-tailored warnings

Service	Contents	Presented data
Active braking distance warning	Real-time estimate of current braking distance based on road friction (estimate and forecast), tyre conditions, vehicle speed, weight and axle-level weights	Braking distance in meters. In red font when critical
Side wind warning	Real-time estimate of side wind effect to the vehicle and its trailer, based on road weather forecast adjusted to geographical area and vehicle and trailer dimensions and weight and speed of the combination	Extreme, high and moderate gust wind warning as blinking text or symbol
Trailer roll-over risk warning	Real-time estimate of trailer roll-over risk based on friction (estimate and forecast) and vehicle dynamics (speed, tyre condition, trailer weight and axle-level weights, lateral movement of vehicle and trailer)	Extreme, high and moderate trailer falling risk as blinking text or symbol
Road/route weather information	Real-time road weather forecast information into the current location and current route ahead. User interface background service, presented when no active warnings.	Map view with current location and route ahead, presenting weather information as colored line in the route.

## Pre-illustration of three levels of SafeTrucks alerts



## Pilot services focused locations

Pilot services will be tested in operative fleets, in a specific locations in Northern Finland, where 1) pilot fleets are operating 2) special conditions of each service are expected.



### Road/route weather information

Available in the route between city of Kemi and Kersilö village in the E75 road, the route of VR Transpoint mining goods delivery fleet. Lappia-electric truck operates in Kemi-Tornio city area where the service also provided.

Neste trucks are operating (mainly) in the city of Oulu main routes, where the services are also provided, E4 and E20.

### Active braking distance warning

Linearly based on road weather information, this service is offered in the same routes as the road weather service

### Side wind warning

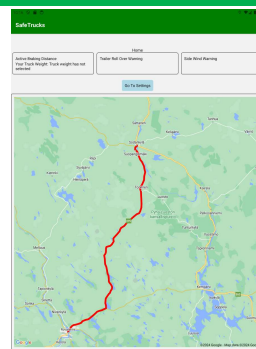
Two locations selected in E75 route, with higher risk of side wind due to suddenly opening roadsides, in village of Torvinen and in village of Vuojärvi. In addition, the service is offered in FMI research road weather stations locations in E75 road and in FMI closed test track (Figure in the bottom-left). The road weather station location allows the simultaneous service verification

### Trailer roll-over warning

Two locations selected in E75 with tight corners, one in the vicinity of village Tainen and two locations near the village Käyrämö, corners located in the relatively tight rise.

## User interface

The user interface when the application is in "idle mode", when no active warnings presented. Active warnings are coming into the top of the screen, covering the map view.



## Services evaluation process

All services are presented in end-user application, provided to the pilot vehicles. Feedback from the drivers is important source of evaluation data, but in addition to this, we evaluate different services as stated below.

### Road/route weather information

Road weather information provided to user application will be evaluated against observed weather conditions in all road weather stations located in the pilot routes.

### Active braking distance warning

Color-coded service (see the figure in the middle column) accuracy is estimated against on-board friction measurements in several pilot trucks.

### Side wind warning

Color-coded service (see the figure in the middle column) accuracy is estimated in selected service locations by comparing the data to 1) Weather radar wind data and 2) fixed wind sensor measurements in location (permanently in road weather stations, campaign-based in other locations).

### Trailer roll-over warning

Color-coded service (see the figure in the middle column) accuracy is estimated in selected service locations by separate test drives with normal vehicles emulating heavy vehicle combination, allowing service-triggering speeds without compromising the safety.

## Conclusion

The heavy vehicles and trailer combinations are vulnerable to severe weather conditions, especially to icy and snowy roads.

A heavy vehicle involved in an accident always means a higher risk of fatalities, material damage or total traffic stops.

SafeTrucks project targets to reduce these risks by introducing More sophisticated road weather and safety services  
Services tailored individually to each heavy vehicle unit and its dynamics.

This paper overviews the general goals of the project and provides a first envisioning of the vehicular services realizing these objectives.

Further project work consists of Fine-tuning the pilot services and creating additional services  
Installing them into the pilot heavy vehicles along with the on-board road and vehicle conditions measurement systems  
Evaluating services in the harsh winter conditions

## Acknowledgements

This work has been supported by Business Finland and the Eureka Xecs program. The authors wish to thank our partners of the project, FMI, Univ. of Oulu, Nokian Heavy Tyres, Ahola Transport, Neste and Taipale Telematics in Finland, and The National Research Council Canada, CM-Labs, Simard Suspensions Inc., Traxara Robotics Inc, Manac inc., Micro Engineering Tech. Inc. and Vehicle Technology Centre in Canada.



## Contact Information

**Dr. Timo Sukuvaara**

Tähteläntie 62  
99600 Sodankylä  
Finland

Tel: +358 40 5294977  
Email: [timo.sukuvaara@fmi.fi](mailto:timo.sukuvaara@fmi.fi)  
Web: <http://fmiarc.fmi.fi>  
<http://safetrucks.fmi.fi>



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101056931