# SAFETRUCKS - ROAD WEATHER SERVICES TAILORED FOR HEAVY VEHICLES

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## Summary

Wintertime traffic accidents involving heavy traffic often cause major effects on the whole traffic entity, such as delays, operating losses, and in the worst case, loss of life. Eureka Xecs SafeTrucks-project develops real-time vehicle-specific weather and safety services tailored to each vehicle, based on the vehicles' own observations combined with data from the service systems and an analysis of the vehicle's own dynamics.

## Introduction

The SafeTrucks project's (Heavy traffic safety improvements by advanced dynamics and road weather services) [1] objective is to improve the driving safety by providing warning and information data directly to the heavy vehicle driver. The project is done in co-operation with Finnish and Canadian partners. The main goal of the project is to create advanced safety systems for heavy traffic to improve traffic safety, especially in severe winter conditions, which typically occur in both Finland and Canada.

The current traffic environment contains various risks. The amount of traffic, the condition of the road and the slipperiness of the road sections can vary a lot. Getting off the road by accident due to an unexpected local road condition may happen especially on smaller roads, where the road maintenance is slow to respond. Accidents can cause traffic stops, and detours in remote areas are often long and possibly even worse maintained. General slipperiness warnings in vehicles tend to activate too often and too imprecisely to be taken seriously enough.

Heavy traffic often faces different problems compared to normal passenger cars as, for example, the dimensions and mass of the vehicles differ significantly. This creates challenges for braking distances and rises the risk of overturning due to crosswinds and curves or other abnormal or unexpected movements. For example, with the normal size passenger car the braking distance in dry asphalt conditions with 60 km/h speed is roughly 14 meters, while with truck-trailer combination weighing 70 tons, the distance is already 70 meters in winter conditions [2].

The data in the project is based on real-time conditions in road weather, traffic entity and vehicle's individual dynamic conditions. The driver is alerted about the emerging risks before they turn into critical hazards. Data is analysed by Digital Twin modelling and communicated to the driver through a hardware system in real-time.

## Road weather and safety services individually tailored for heavy vehicles

The SafeTrucks project is piloting three different safety services for heavy vehicles. Those are 1) braking distance information, 2) warning of trailer roll-over risk and 3) side wind warning. The sketch of the service is presented in Fig. 1 and more detailed information about the service and warnings is presented on Table 1. FMI provides weather and road condition

related information whereas transport companies need to specify vehicle related information that needs to be considered when assuming the risk level of driving.

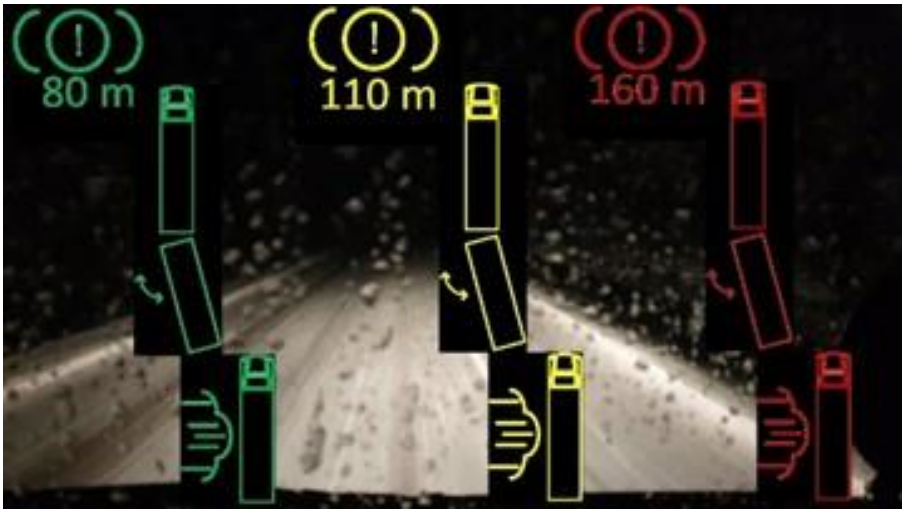


*Fig. 1. The sketch of three levels of SafeTrucks alerts. Braking distance information (top), trailer roll-over risk (middle) and side wind warning (bottom).*

Weather and road condition information in the pilots include wind (speed and direction), temperature, precipitation, road condition and friction. Weather and road weather information is taken from road weather station or FMI's road weather model output [3] or from other observation sources, like weather radars. Vehicle related information contains, for example, the size of the vehicle and trailer, braking capacity, speed, tire condition, cargo, CAN-bus data and other vehicle dynamics.

Warnings are presented to drivers via on-board unit screen. The on-board unit works also as a V2X communication system in a vehicle receiving up-to-date localized weather and safety warnings. Accurate safety alerts are presented only when they occur and in a way that they don't disturb the driving operations.

*Table 1. Vehicle-tailored safety services envisioned.*

| Service | Contents | Presented data |
|---|---|---|
| Active braking distance | Real-time estimate of braking distance, based on road friction (estimate & forecast), tyre conditions, vehicle speed, weight and axel-level weights. | Braking distance in meters, in red font when critical |
| Gust wind warning | Real-time estimate of trailer roll-over risk, based on friction (estimate & forecast), vehicle dynamics. | Extreme, high and moderate gust wind warning as blinking text or symbol |
| Trailer roll-over risk | Real-time estimate of trailer roll-over risk, based on friction (estimate & forecast), vehicle dynamics (speed, tyre condition, trailer weight and axel-level weights, lateral movement of vehicle and trailer). | Extreme, high and moderate trailer roll-over risk as blinking text or symbol |

## SafeTrucks architecture

The main idea of the SafeTrucks architecture is presented in Fig. 2. Starting from the bottom, we collect a high variety of environment and vehicle dynamics data from roadside instrumentation and on-board road surface monitoring sensors. The on-board sensors installed on tires give road interaction -inherited information and vehicles' own monitoring data comes from CAN-bus, FMS-data and driving analysis systems. An on-board unit with V2X communication capabilities combines this data, exchanges it with external service data systems (especially road weather and safety service systems of FMI) and receives up-to-date, localized weather and safety data. This data is further tailored based on the vehicle-specific dynamics information to present vehicle-specific warnings in the user interface of the vehicle.

Special active control systems for trailer and vehicle combinations are developed by Canadian partners in simulation modelling. They will be

presented as service extensions within Digital Twin traffic model and interact closely with physical pilot system operated by Finnish partners.


*Fig. 2. SafeTrucks system architecture.*

## Conclusions and future work

The heavy vehicles and trailer combinations are vulnerable to severe road weather conditions, especially to icy and snowy roads. Furthermore, a heavy vehicle involved in an accident always means a higher risk of fatalities, material damage or total traffic stops. In the SafeTrucks project, the target is to reduce these risks by introducing more sophisticated road weather and safety services that are 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. The SafeTrucks service will be piloted in winter 2024-2025. Further project work consists of fine-tuning these services, installing them into the pilot heavy

vehicles along with the on-board road and vehicle conditions measurement systems, and ultimately evaluating them in the harsh winter conditions.

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## References

[1] Sukuvaara T., Mäenpää K., Stepanova D. and Karsisto V.,"Vehicular Networking Road Weather Information System Tailored for Arctic Winter Conditions", International Journal of Communication Networks and Information Security (IJCNIS) Vol. 12, No. 2, August 2020, pp. 281-288..

[2] Pirnes V., Tuutijärvi M. and Haataja M., "HCT-puutatavarayhdistelmien ajoseuranta ja stabiliteettitutkimus, yhdistelmien liikkuvuus ja ajovakaus", University of Oulu, Mechanical Engineering, Report 5, 2018, http://urn.fi/urn:isbn:9789526221441 (in Finnish) [Accessed on 8th March 2024]

[3] Kangas M., Heikinheimo M. and Hippi M. **2015**. "RoadSurf: a modelling system for predicting road weather and road surface conditions". *Meteorological Application*, *22*, 544–533. *https://doi.org/10.1002/met.1486*