

# DEMONSTRATION OF A COOPERATIVE INFORMATION SYSTEM FOR HEAVY VEHICLES

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## 1. INTRODUCTION

In many urban areas, freight vehicles represent a modest proportion of the vehicles, but a large proportion of the traffic-related emissions. Heavy freight vehicles waiting to be served at terminals, frequently cause queues inside and outside the terminal areas, making the approach to and operations in the terminal areas difficult and less efficient. Emissions from heavy vehicles increase when the vehicles are forced to keep a low or uneven speed profile (Rexeis et al, 2005), which is typical of queueing situations in urban areas. Thus, reducing the heavy vehicles' exposure to queueing situations, either by giving them priority or restricting their access to parts of the road network under certain conditions – or a combination of these - could be ways to reduce this problem.

The Norwegian Research Council sponsors an ongoing research project called GOFER (2009-2012), involving the national and local road authorities, municipalities, terminal- and freight operators, technology suppliers as well as R&D-organisations in Norway, targeting these challenges.

The main objective of the GOFER project is to contribute to a reduction in emissions, queues, accidents and operator costs related to heavy freight, by introducing new technical solutions and ways of cooperation. The GOFER project idea is to develop concepts which facilitate control and management of heavy freight vehicles, much the same way as the air control manages airplanes approaching or leaving an airport. This could mean directing vehicles to specific routes in order to avoid queues, or to designated areas for waiting/resting until they are allowed to continue, but then while being given priority by means of for instance green wave through traffic lights or access to public transport lanes. Such a system could contribute to moving heavy vehicles out of rush-hour traffic and terminal-related queues to areas and time periods where the negative environmental impacts would be fewer and smaller. At the same time this could provide more predictability to the drivers and the terminal operator alike, and time spent in queues could be transformed to resting time or be spent on other tasks.

The first phase of the project focussed on user needs and requirements. This formed the basis for the demonstration activities in the project:

- a ten-week long live demonstration of a cooperative information system with heavy vehicles on the 500 km long route from Oslo to Trondheim
- a test in a heavy vehicle driving simulator, to study possible effects of measures prioritizing heavy vehicles in an urban environment
- a study of full scale effects of and necessary requirements for implementation of a GOFER-system, using a simulation tool for a terminal area in Oslo

The demonstration activities in GOFER were not primarily tests of technology, but demonstrations of services and functionality. This was an important basis for the prioritizing and delimitations made during the design of the demonstrations. At the same time, the objective was to establish a "win-win"-situation, where all participants could benefit from taking part. The remainder of this paper is dedicated to describing the main characteristics and findings from the GOFER live demonstration.

## 2. THE LIVE DEMONSTRATION - AN OUTLINE

During the winter season of 2011-12, eight heavy duty vehicles from the Norwegian transport operator Bring took part in a ten-week long live demonstration on the 500 km long route from Oslo to Trondheim, from mid-November 2011 through January 2012. The vehicles would typically depart from the terminal in Oslo in the afternoon or evening, and arrive at the terminal in Trondheim some time during the night.



Figure 1: GOFER demonstration vehicle and route

### 2.1 Equipment

The vehicles were equipped with on board equipment (OBE) (Samsung Galaxy Tab 7.0) for exchange of information between the drivers involved in the demonstration, between the drivers and the terminal, and between the road authorities and the drivers, using an information system with functionality specially developed for the project. The OBEs had a touch-screen, allowing the drivers to receive information, make choices and enter information to the system, by touching the screen. The drivers who were loyal to the test scheme, got to keep the equipment after the demonstration period.



Figure 2: GOFER On-board equipment: Samsung Galaxy Tab 7.0

Google Maps was used as background for location of the test vehicles and messages along the route. The vehicles were identified on the map with a red dot, whereas two different logos were used to identify the information source for the driver: The ordinary road messages were identified on the map by a "General caution" warning sign, and the driver-initiated messages by the GOFER project logo. When the vehicle came within 5 km range of a message along the anticipated route, the contents of the predefined GOFER messages were identified by a customized symbol on a green background (Figure 2 and Figure 4), without any explanatory text. The ordinary road messages were identified by a "General caution" warning sign on white background. These messages came with an explanatory text which was made available for the driver by touching the warning sign displayed on the screen, but only if the vehicle was not moving.

## 2.2 Data system

The GOFER data system was specially developed for the project, and is based on open source or free software, including Android, Java and PostGIS. The system is based on the ARKTRANS definition of roles (Natvig et al, 2009).

The GOFER data system has five main components:

- Client: Device (OBE) which is mounted in the vehicle, and conveys information between the driver and the back-end system.
- Servlet: Contact point for the OBEs. The servlet is responsible for receiving the messages and passing these on to the correct agent. The message response can include new messages from the same agent. Other types of clients (administration and map presentations) were serviced by other servlets.
- Agent Pool: Keeps track of which OBE communicates with which agent.
- Agent: This is a process which acts on behalf of the OBE sending the request. It is responsible for updating the database with data from the OBE, and to find and convey the necessary messages back to the clients.
- GOFER database: Database where all data necessary for Gofer system is stored, including location history from clients, as well as assignment definitions, weight of cargo etc.

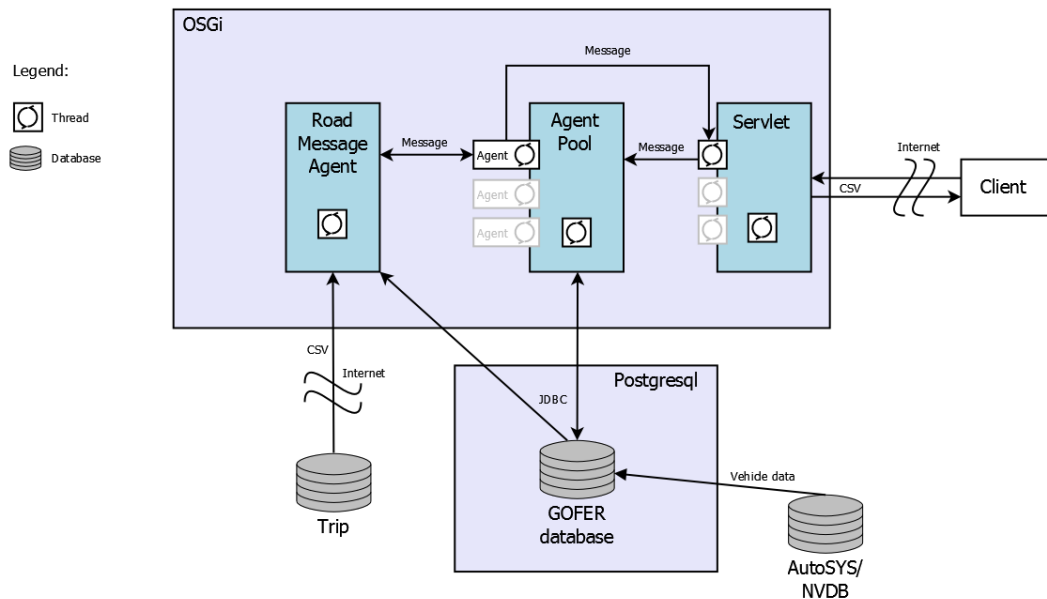


Figure 3: The GOFER System Architecture

#### TRIP:

Information regarding road messages were partly distributed via a system named TRIP (Transport Related Information Platform), courtesy of one of the project partners, Triona. The information platform gives access to road related information, e.g. weather conditions, road mappings, road messages and speed limits.

For the live demonstrator, the road messages for the routes included in the demonstration were periodically imported from TRIP and stored locally in the GOFER database, along with the GOFER messages initiated by the drivers included in the test. The road messages are distributed to the TRIP system by the Norwegian Public Roads Administration (NPRA). In a full scale system, the GOFER system could send the GOFER messages to the TRIP system, for public access.

#### AutoSYS:

AutoSYS holds information about all vehicles registered in Norway. For the GOFER demonstration, this data base was used to collect the necessary vehicle data before the test started. The data included engine power, vehicle height and vehicle weight for the vehicles and trailers involved in the demonstration. These parameters were used to calculate estimated arrival time at the destination terminal. In a full scale system, the GOFER system could link directly to the full AutoSYS data base.

#### NVDB:

The Norwegian Road Data Bank (NVDB) was used to build the transport network with all necessary parameters. The parameters were used in the calculations of the estimated arrival time at the terminal, as well as filtering relevant road and GOFER messages.

### **2.3 Main features**

Creating a win-win-situation is particularly important for a demonstration where participation is voluntarily, and with a risk of the participants dropping out if the system imposes too much hassle and disturbance without any compensating measures. Initial plans were to include real-life prioritizing with access to public transport lanes and green waves in traffic signals. This, however, turned out to be unfeasible. Effects of these prioritizing measures were instead studied in a heavy vehicle driving simulator (Engen & Meland, 2012). With the planned prioritizing instruments gone from the demonstrator, any measures imposing delays, such as ordering the vehicle to a waiting area, was out of the question. Also, route guidance had to be given as recommendations, not as orders. In the process of identifying alternative functionality which could make the participation more interesting and worthwhile for the drivers, the geographical scope of the demonstration was expanded from the initial plan to just cover the Trondheim area, to include the entire 500 km route between Oslo and Trondheim.

The final design of the demonstration included the following features:

- The drivers could send pre-defined messages (GOFER messages) about conditions along the route to their fellow demo-drivers, by touching a simple symbol on the OBE screen.
- In addition to the GOFER messages, the drivers would also receive ordinary road messages, distributed by the NPRA, on the same equipment.
- Expected remaining driving time to first place of delivery in Trondheim was calculated using formulas for a newly developed Speed model for heavy vehicles. These calculations are based on factors which affects the actual driving speed for heavy vehicles under different conditions: Total vehicle weight and engine power, and road characteristics such as curvature, slope and width.
- Arrival time at destination in Trondheim was predicted, based on the remaining driving time, combined with logging of how much of the mandatory 45 minutes resting time had been used.
- The staff at the Trondheim terminal could see the predicted arrival time for each vehicle on a GOFER website, "airport-style".
- When approaching Trondheim, the driver would get information about recommended route to first destination, and a message with information about space/time slot booked at the terminal.

Vehicle positions and time and position for exchange of information were logged continuously as a part of the demonstration. This information was collected under the agreement that it was not to be used to record any violation of speed limits or resting time regulations.

A video from the demonstration is available on the project web site.

### **2.4 The information**

At the start of each trip in the demonstration, the driver would give information about cargo weight, planned destination and route, using the OBE. The

equipment communicated with a data system holding detailed information about the vehicle, location of destinations, characteristics of the road network included in the route in question, and road messages relevant for this route. Based on information about total weight and location of destination, the system would estimate time of arrival to the destination. At the start of the journey, the driver received information about any road closures affecting the planned route, allowing the driver to reschedule if necessary.

En route, the driver received updated information about predicted time of arrival. The system held information about public road messages, made available through the information platform TRIP. The system also allowed the drivers to send a range of pre-defined GOFER messages which were stored in the data system and made available for the other drivers taking part in the demonstration.

The regular road messages and the GOFER messages were indicated on the OBE with icons on a map, as well as an adapted warning sign as the vehicles approached the location of the "event". The eight pre-defined GOFER messages were:

- Ongoing road works
- Moose/animals close to the road
- Snow chains required
- Strong crosswind
- Slippery road surface
- Need assistance
- Detour for heavy vehicles
- Queue



Figure 4: Icons for pre-defined GOFER messages

The GOFER messages had varying "life time", depending on topic, and were distributed for as long as they lasted.

As the vehicle approached the destination in Trondheim, the driver received information about recommended route to the destination, and information about reservations of slot time made for the vehicle at the terminal. The recommended route was based on information from the data system about the location of the destination, vehicle characteristics, restrictions with regard to weight or height in the road system, and any road closures. The slot time reservations were based on the calculated time of arrival.

## 2.5 Web site

A designated web site for the live demonstration gave an overview of active vehicles and GOFER messages in the demonstration at all times.

For each active vehicle, the web site would give time of start, estimated time of arrival and - after arrival; the actual time of arrival. The information about each vehicle would be displayed for 24 hours after the start of the journey, helping the terminal staff to avoid waking up drivers during their required sleeping time after arrival. The overview of the vehicles was only available for the transport operator and their staff at the terminal in Trondheim

The GOFER messages were displayed on a map on the web site for the duration of their "life time". This part of the web site was available to the public.

## 2.6 Demonstration statistics

During the ten week test period, a total of 135 more or less complete trips were registered. The eight drivers sent from 1 to 44 GOFER messages each - a total of 138 between them. This gives an average of one message per trip, and 17 per driver over the entire test period.

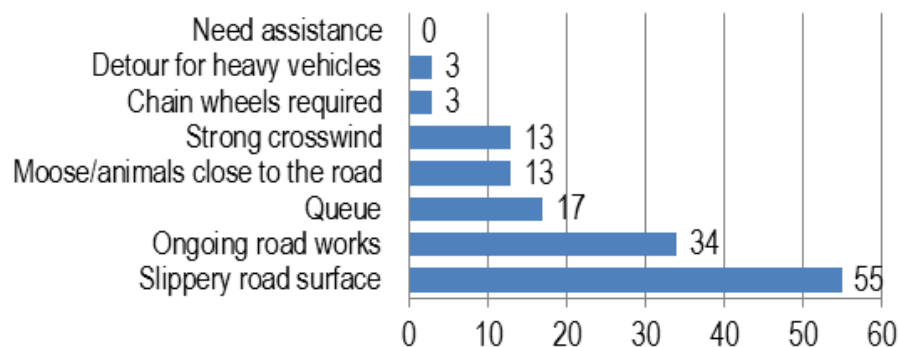


Figure 5: GOFER messages sent during the test period

The system was up and running without any interruptions during the entire demonstration period (16.11.2011 – 31.01.2012).

## 3. THE LIVE DEMONSTRATION – THE DRIVERS' ASSESSMENT

As part of the evaluation process, the drivers taking part in the demonstration were all interviewed at the end of the demonstration period. The interview consisted of four main parts:

1. About the driver; background and previous experience with information systems and technology
2. About the equipment and functionality of the information system
3. About the various types of information included in the test, the usefulness, timing, etc.
4. An overall assessment of the demonstration and the information tested.

### 3.1 The drivers

All eight participants drove the test route several times per week, and most of them had long experience operating a heavy vehicle: at least six years - on average 28 years. Two of the drivers had little experience with digital media before the test started. Most of the drivers used weather- and traffic-

information via the radio on a regular basis, and would adapt driving behaviour and route choice to these messages. Half of the drivers said they were influenced by traffic sign informing about difficult driving conditions and risk of animals along the road, while nearly all stated that signed road works would sharpen their attention.

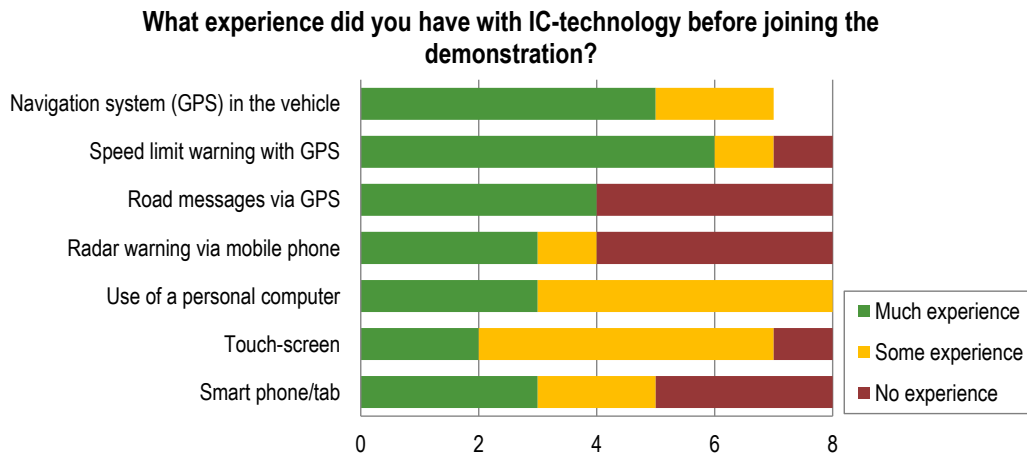


Figure 6: The GOFER demonstration drivers' ICT-background

### 3.2 The equipment and functionality

The drivers were mostly happy about the startup process with regard to extent, time use and messages, but half of the drivers expressed wish for some degree of personal adaptations to make this process easier and less time consuming.

Some of the drivers found the equipment somewhat annoying/disturbing. Screen and icons were considered to be of suitable size, but several of the drivers found the screen to be emitting too much (annoying) light while driving in the dark.

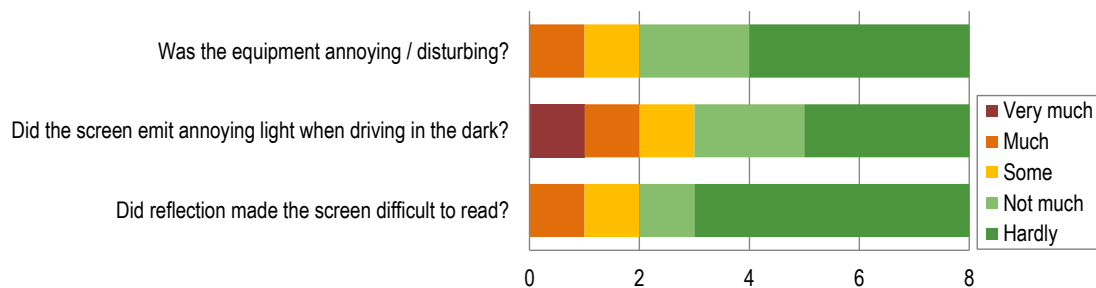


Figure 7: The drivers' valuation of the equipment and screen

When asked, the drivers suggested a range of possible improvements to the functionality of the screen and on-board equipment, such as the possibility for free scrolling in the map, reducing the general light emission from the OBE, but increase it and/or use audio signal when a message is received. Also, some of the drivers found the "confirm" buttons too small.



### 3.3 The information

All pre-defined GOFER messages were considered useful by most of the drivers. The message "Slippery road surface" was considered "Very useful" by all drivers.

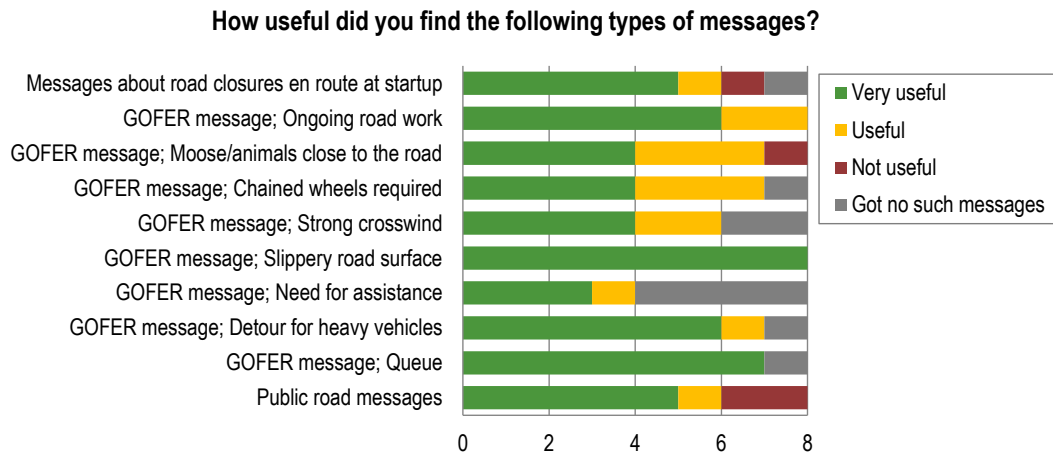


Figure 8: The drivers' valuation of the usefulness of the information distributed

Messages about recommended route and information about waiting areas and slot-times were considered to be very useful by the majority.

Comments from drivers indicated a request for increased precision level for the regular road messages, in terms of both localization and time period. Here, however, it must be noted that not all available information of these messages were included in the demonstration.

Most messages were given suitable time in advance, but many of the messages were left too long in the system, and were obsolete when drivers got them. Most drivers had wanted to cancel some of the messages they received.

Several of the drivers had wanted to know who had submitted the messages. This was true, in particular, for those drivers who were most active submitters of driver messages.

None of the drivers had problems understanding the symbols that were used. Well half of drivers used the opportunity to bring forward additional text to the messages - at least one of them to find out when the message was sent.

All drivers found the map to be useful, and most found the map view and size of the screen to be suitable. Several, however, had difficulty seeing the message symbol on the map.

Information about the expected time of arrival was considered very accurate and mostly helpful, while notification of remaining required resting time did not get as good a rating. This may be because this feature did not work as planned on trips where the driver took out more than the mandatory rest time (45 minutes).

The drivers suggested some additional features for the message-services, such as the possibility to identify the precise stretch or road the message applies for (start and stop location), as well as the location of the obstacle on the map. There was also a suggestion for using extra alerts related to traffic accidents.

### 3.4 The demonstration - the system

Overall, the test was considered useful and realistic, and the system was easy to understand and use. Most of the information from the system was considered helpful, and quite a number of the drivers found their driving to be affected by the test. Whether this was a positive or negative thing, can not be concluded from this question alone, but combined with the drivers' responses to other questions about the effects of the test and the GOFER system, it can be derived that they found that their driving was affected in a positive way.

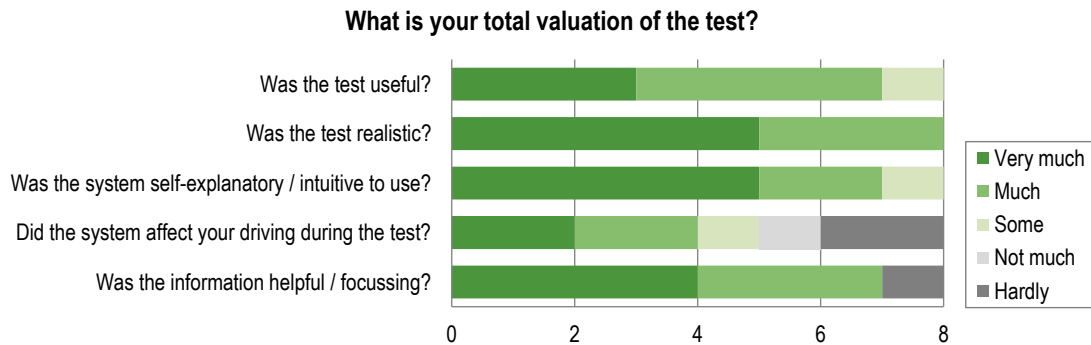


Figure 9: The drivers' valuation of the test

Most believed that the test had a suitable duration and number of vehicles involved, even though there were mixed opinions about the duration. All the drivers would have advised his employer or others to adopt this system, but only half of them would demand this system in the car at the time the test was terminated.

### 3.5 Traffic management aspects of a GOFER system

The drivers considered messages about recommended route and information about the waiting area and slot-time to be very useful as instruments to prevent heavy vehicles from being stuck in queues related to terminals and urban traffic.

### What would be the best measures to compensate for imposed waiting?

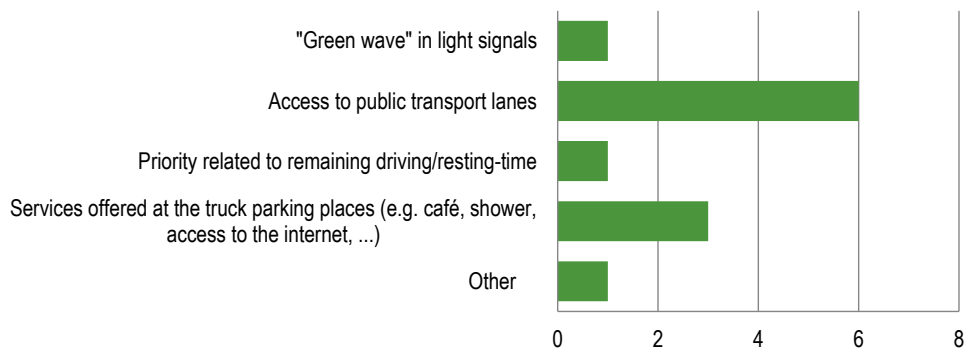


Figure 10: Compensation for imposed waiting time

Access to the use of the public transport lanes was the most popular measure in order to "compensate" for any imposed waiting, while the development of service facilities at the waiting area was ranked second.

A full scale introduction of the GOFER system was predicted to have positive effects on heavy vehicle drivers' work situation, traffic safety and the environment. Safety and driving time were considered to be the most important arguments for introducing a GOFER system, and the majority of drivers believed such a system should be introduced as soon as possible. At the same time a majority also believed that one should be allowed to switch off the equipment, if it became standard equipment in heavy vehicles.

## 4. THE ROAD AHEAD

Results from the demonstration will be used to contribute to the development of new information services specifically aimed at the drivers of heavy vehicles. Data from the position logging and calculated driving times will be used to further develop the tool for calculating driving time for heavy vehicles on the Norwegian road network, and to seek to further develop tools for calculations of the fuel consumption and emissions from heavy vehicles.

The GOFER system is based on off-the-shelf equipment and free or open source software. Although some components of the demonstration were just examples of how information for the individual vehicle/driver could be communicated, the system is prepared for communicating with real booking systems, and more complex route guidance criteria, based on e.g. vehicle- and/or cargo characteristics.

At a project workshop held after the demonstration was over, the project partners presented their thoughts about what role a GOFER system can have in meeting the challenges related to heavy goods transport in urban areas, and how such a system can be brought forward.

Bring considered the GOFER live-demonstration to be a further development of navigation systems, with an "online" future. To get to a more integrated solution and direct access to input data such as weight, car manufacturers

should be involved in any further development. Bring also sees the possibility to include available models of eco-driving in the system. The technical solutions and user interfaces applied in the test were considered very intuitive and easy for the drivers to understand.

The Norwegian Public Roads Administration (NPRA) considers the results from the GOFER demonstration to be relevant for many of their areas of responsibility. Driver-initiated messages about the road conditions, especially during winter time, can be a useful source of information to identify the need for winter maintenance measures. They also consider initiating a follow-up demonstration, distributing information about friction conditions in the road network, to the public. The NPRA are responsible for following up Action 3.5: Services for safe and secure truck parking places in the ITS Action Plan (EU DG MOVE, 2011). Although the GOFER demonstration did not include a real booking system, the NPRA are interested in following up the possibilities to use a GOFER-like system to facilitate booking for such facilities.

Based on the drivers' assessment of the demonstration, one can also see some suitable ingredients for a possible "Road information system for the freight industry", with predictions of driving time for heavy vehicles, and driver-initiated messages.

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