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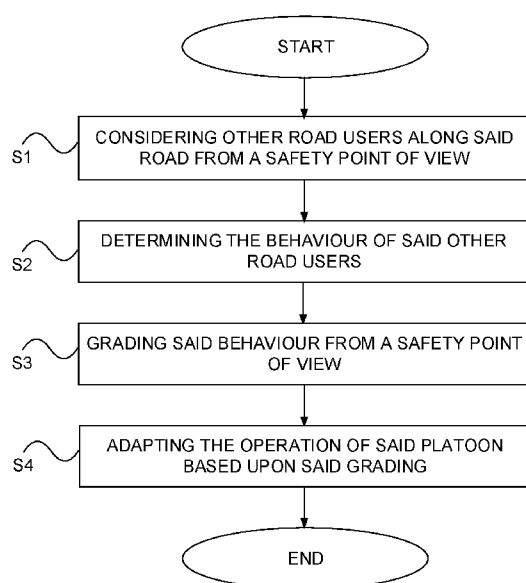


Fig. 3

(57) Abstract: The present invention relates to a method for controlling platooning operation of a platoon (P1) of vehicles (1, 2, 3, 4) along a road (R). The method comprises the step of considering other road users (RU) along said road from a safety point of view. The method further comprises the steps of: determining the behaviour of said other road users (RU); grading said behaviour from a safety point of view; and adapting the operation of said platoon (P1) based upon said grading. The present invention also relates to a system for controlling platooning operation of a platoon of vehicles along a road. The present invention also relates to a platoon. The present invention also relates to a computer program and a computer program product.

**METHOD AND SYSTEM FOR ADAPTING PLATOONING OPERATION
ACCORDING TO BEHAVIOUR OF OTHER ROAD USERS**

TECHNICAL FIELD

5 The invention relates to a method for controlling platooning operation of a platoon of vehicles along a road according to the preamble of claim 1. The invention also relates to a system for controlling platooning operation of a platoon of vehicles along a road. The invention also relates to a vehicle. The invention in addition relates to a computer program and a computer program
10 product.

BACKGROUND ART

Vehicles such as heavy vehicles are continuously looking at ways to reduce energy consumption to reduce energy costs and also to lower emissions.
15 One way of reducing energy consumption is to operate several vehicles in a chain formation, also known as platooning or operating vehicles in a convoy.

Platooning takes advantage of a reduced air drag by operating with small distances between vehicles in the platoon. Under normal circumstances the air drag of a vehicle is proportional to the square of the velocity of the vehicle.
20 By staying close to a forward vehicle, an effect of reduced air drag can be obtained. Hence, by operating several vehicles in a chain formation, here denoted as platoon or platooning, a substantial fuel reduction can be obtained through automated control systems.

By having such small distances between the vehicles safety when controlling
25 driving of the platoon becomes even more important, particularly for autonomous platoons and semi-autonomous platoons but also for operator operated platoons. It is known to consider other road users along said road

from a safety point of view by using e.g. sensor unit units on-board one or more vehicles in the platoon.

There is however a need for improving controlling platooning operation of a platoon of vehicles along a road in order to further improve safety.

5

OBJECTS OF THE INVENTION

An object of the present invention is to provide a method for controlling platooning operation of a platoon of vehicles along a road which minimizes the risk of accidents for vehicle in the platoon without unnecessarily affecting
10 efficient drive of the platoon.

Another object of the present invention is to provide a system for controlling platooning operation of a platoon of vehicles along a road which minimizes the risk of accidents for vehicle in the platoon without unnecessarily affecting efficient drive of the platoon.

15

SUMMARY OF THE INVENTION

These and other objects, apparent from the following description, are achieved by a method, a system, a vehicle, a computer program and a computer program product, as set out in the appended independent claims.
20 Preferred embodiments of the method and the system are defined in appended dependent claims.

Specifically an object of the invention is achieved by a method for controlling platooning operation of a platoon of vehicles along a road. The method comprises the step of considering other road users along said road from a
25 safety point of view. The method further comprises the steps of: determining the behaviour of said other road users; grading said behaviour from a safety

point of view; and adapting the operation of said platoon based upon said grading.

The road user is according to an embodiment another vehicle driving along the road in connection to the platoon. The road user may also be a
5 pedestrian or an animal such as an elk or a deer or the like.

The step of determining the behaviour of said other road users comprises according to an embodiment determining possible strange behaviour of an external vehicle, i.e. a vehicle not part of the platoon, such as irregular speed such as unexpected brake manoeuvres, unexpected accelerations,
10 unexpected change of position on the road comprising positions over lanes and/or driving between two lanes, aggressive behaviour. The step of determining the behaviour of said other road users comprises according to an embodiment determining normal behaviour of other vehicles.

The step of grading said behaviour from a safety point of view comprises
15 giving strange behaviour of an external vehicle a lower grade than normal behaviour. The step of grading said behaviour from a safety point of view may comprise grading strange behaviour of an external vehicle, i.e. very strange behaviour going on for a long time and constituting a major hazard for the vehicles of the platoon from a safety point of view, will get a lower
20 grade than a behaviour that is not so strange and only temporarily.

A strange behaviour may be due to a drunken driver, a driver using a cell phone, a driver who has suffered from sudden illness, a driver falling asleep/on the verge of falling asleep or the like.

The step of adapting the operation of said platoon based upon said grading
25 may comprise adaption of speed, adaption of distance between the vehicles of the platoon and/or adaption of position of the platoon taking the position and speed of the external vehicle behaving in a strange way into consideration. The step of adapting the operation of said platoon based upon said grading may comprise terminating the operation of the platoon, i.e. stop

the platooning operation such that the respective vehicles continue drive on their own, as long as the grading is maintained, i.e. the external road user behaving in a way that may cause an accident. The step of adapting the operation of said platoon based upon said grading may comprise choosing a different route, e.g. taking off at a road exit, so as to minimize the risk of an accident. The step of adapting the operation of said platoon based upon said grading may comprise performing a safe stop of the platoon.

The step of adapting the operation of said platoon based upon said grading may depend on external conditions comprising traffic situation, road conditions and/or weather conditions. External conditions in the form of current traffic situation may affect certain adaptations such as overtaking the external road user. External conditions in the form of road conditions such as slippery road due to snow, ice, gravel, oil or the like on the road may affect certain adaptations such as speed, overtaking of the external road user, positioning of platoon etc. External conditions in the form of weather conditions such as precipitation in the form of snow, rain, hail, and/or wind, sun or the like may affect certain adaptations such as speed, overtaking of the external road user, positioning of platoon etc.

The step of grading said behaviour from a safety point of view may also depend on such external conditions, i.e. traffic situation, road conditions and/or weather conditions.

By thus grading the behaviour of external road users from a safety point of view and adapting the operation of said platoon based upon said grading the risk the risk of accidents for vehicles in the platoon is minimized without unnecessary affecting efficient drive of the platoon. If the grade of the behaviour is low, e.g. if the grade of the behaviour of the external road user such as an external vehicle, corresponds to a strange behaviour the operation of the platoon may require change of speed and/or increase distance between the vehicles of the platoon and/or changing position of the platoon reducing the risk of an accident with regard to the externa vehicle

behaving strangely. If the grade of the behaviour is not so low, e.g. if the grade of the behaviour of the external road user such as an external vehicle, corresponds to a normal behaviour the operation of the platoon may maintain the same such that the platoon may continue driving with the same speed and the same distance between the vehicles of the platoon thus optimizing energy consumption within the platoon and keeping the desired speed such that no unnecessary time is lost.

According to an embodiment of the method the step of determining said behaviour is performed manually and/or based upon information from on-board sensor units of at least one of said vehicles of said platoon.

The step of performing the determination of said behaviour manually may, with an observed strange behaviour, be followed by an action such as activation of means for adapting the operation. Such an action could involve communicating the grade of the behaviour to the other vehicles. The step performing the determination of said behaviour manually may for an operator operated platoon, i.e. with an operator/driver in each vehicle, be performed by one or more of the operators depending on the position of the external road user relative to the platoon. The step performing the determination of said behaviour manually will for a semi-autonomous platoon, e.g. a platoon with an operator/driver in the leading vehicle and the trailing vehicles being autonomous, be performed by the operator, where the operator may take action by activation of means for adaption of the platoon which is then communicated to the trailing autonomous vehicles which will adapt according to the thus determined strange behaviour, which may have been graded by the operator.

By thus performing the determination of said behaviour manually the use of the fact that an operator of a vehicle, i.e. a human being, is usually skilled in interpreting the behaviour of other road users and may thus determine whether the behaviour is strange at to what degree. For an operator operated platoon and a semi-autonomous platoon manual determination may thus add

to the safety. Manual determination may according to an embodiment be used in addition to using on-board sensor units.

The step of performing the determination of said behaviour based upon information from on-board sensor units of at least one of said vehicles of said
5 platoon may be performed for an autonomous platoon or a semi-autonomous platoon or a totally operator operated platoon.

The on-board sensor units may comprise sensor units with a forward looking field of view for detecting external road users ahead of the platoon. According to an embodiment at least the leading vehicle is provided with at least one
10 forward looking on-board sensor unit.

The on-board sensor units may comprise sensor units arranged to provide a field of view looking at the sides for detecting external road users on one or both sides of the platoon.

The on-board sensor units may comprise sensor units with a backward
15 looking field of view for detecting external road users behind the platoon. According to an embodiment at least the last vehicle of the platoon is provided with at least one backward looking on-board sensor unit.

The step of performing the determination of said behaviour based upon information from on-board sensor units provides a very efficient way of
20 detecting any road user in connection to the platoon and thus increases safety.

According to an embodiment of the method the step of determining said behaviour is performed based upon information from external sources.

The step of performing the determination of said behaviour based upon
25 information from external sources may comprise communication between infrastructure and one or more vehicles of the platoon within a vehicle-to-infrastructure communication arrangement. Such information may comprise

traffic information regarding strange behaviour of external road user such as an external vehicle.

The step of performing the determination of said behaviour based upon information from external sources further increases safety in that the
5 information may be received before a possible strange behaviour of an external road user is detected by on-board sensor units and/or manually.

External sources may thus comprise any off-board sources, i.e. any sources not on-board one or more vehicles of the platoon.

According to an embodiment the method comprises the step of
10 communicating the thus determined grading of said behaviour of said other road users between the vehicles of the platoon within a vehicle-to-vehicle communication arrangement and/or a vehicle-to-infrastructure communication arrangement. The step of communicating the thus
15 determined grading of said behaviour of said other road users between the vehicles of the platoon within a vehicle-to-infrastructure communication arrangement comprises the step of communicating the information via infrastructure. The infrastructure may comprise means for receiving and communicating information, e.g. one or more electronic control units, one or more server units or the like, comprising the Internet/so called clouds via
20 which said information may be communicated. By thus communicating the grading an efficient way of providing information to the vehicles of the platoon is obtained such that possible required adaption may be performed as soon as e.g. a strange behaviour has been determined.

According to an embodiment of the method the step of adapting the
25 operation of said platoon based upon said grading comprises adapting the speed of the platoon and/or adapting the mutual longitudinal positions of the vehicles of the platoon and/or adapting the mutual lateral positions of the vehicles of the platoon. By thus adapting the operation of the platoon the risk of accidents involving one or more vehicles of the platoon is minimized. The

step of adapting the mutual lateral positions of the vehicles of the platoon comprises according to an embodiment taking the position of the external road user into account.

5 According to an embodiment of the method said platoon comprises an autonomous platoon or a semi-autonomous platoon or a totally operator operated platoon.

According to an embodiment the platoon is an autonomous platoon. According to an embodiment the platoon is a semi-autonomous platoon. The semi-autonomous platoon may have a vehicle operator at least in the leading
10 vehicle of said platoon, where the vehicle operator is a driver driving the vehicle. The semi-autonomous platoon may have at least one vehicle operator remotely controlling at least one of the vehicles of the platoon. The semi-autonomous platoon will comprise at least one autonomous vehicle and at least one operator operated vehicle, where the at least one operator
15 operated vehicle may be operated with a vehicle operator in the vehicle driving the vehicle and/or being remotely operated by a vehicle operator. According to an embodiment the platoon is a totally operator operated platoon. A totally operator operated platoon may be a platoon with a vehicle operator in each vehicle driving that vehicle. A totally operator operated
20 platoon may be a platoon with a vehicle operator remotely controlling the respective vehicle of the platoon.

Specifically an object of the invention is achieved by a system for controlling platooning operation of a platoon of vehicles along a road. The system comprises means for considering other road users along said road from a
25 safety point of view. The system further comprises means for determining the behaviour of said other road users; means for grading said behaviour from a safety point of view; and means for adapting the operation of said platoon based upon said grading.

According to an embodiment of the system the means for determining said behaviour is arranged to be performed manually and/or comprises means for determining said behaviour based upon information from on-board sensor units of at least one of said vehicles of said platoon.

- 5 According to an embodiment of the system the means for determining said behaviour comprises means for determining said behaviour based upon information from external sources.

According to an embodiment the system comprises means for communicating the thus determined grading of said behaviour of said other
10 road users between the vehicles of the platoon within a vehicle-to-vehicle communication arrangement and/or a vehicle-to-infrastructure communication arrangement.

According to an embodiment of the system the means for adapting the operation of said platoon based upon said grading comprises means for
15 adapting the speed of the platoon and/or means for adapting the mutual longitudinal positions of the vehicles of the platoon and/or means for adapting the mutual lateral positions of the vehicles of the platoon.

According to an embodiment of the system said platoon comprises an autonomous platoon or a semi-autonomous platoon or a totally operator
20 operated platoon.

The system for controlling platooning operation of a platoon of vehicles along a road is adapted to perform the methods as set out herein.

The system according to the invention has the advantages according to the corresponding method claims.

- 25 Specifically an object of the invention is achieved by a platoon of vehicles comprising a system as set out herein. The platoon may be autonomous platoon or a semi-autonomous platoon or a totally operator operated platoon.

Specifically an object of the invention is achieved by a computer program for controlling platooning operation of a platoon of vehicles along a road, said computer program comprising program code which, when run on an electronic control unit or another computer connected to the electronic control unit, causes the electronic control unit to perform methods as set out herein.

Specifically an object of the invention is achieved by a computer program product comprising a digital storage medium storing the computer program.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention reference is made to the following detailed description when read in conjunction with the accompanying drawings, wherein like reference characters refer to like parts throughout the several views, and in which:

Fig. 1a-b schematically illustrates a platoon of vehicles travelling along a road according to the present invention;

Fig. 2 schematically illustrates a block diagram of a system for controlling platooning operation of a platoon of vehicles along a road according to an embodiment of the present invention;

Fig. 3 schematically illustrates a block diagram of a method for controlling platooning operation of a platoon of vehicles along a road according to an embodiment of the present invention; and

Fig. 4 schematically illustrates a computer according to an embodiment of the present invention.

DETAILED DESCRIPTION

Hereinafter the term “link” refers to a communication link which may be a physical connector, such as an optoelectronic communication wire, or a non-physical connector such as a wireless connection, for example a radio or microwave link.

- 5 Hereinafter the term “energy consumption” refers to the energy consumed by one or more vehicles of the platoon. The term “energy consumption” comprises the energy consumption due to the driving means of the vehicle. The driving means of the vehicle may be an internal combustion engine in which case the energy consumption comprises fuel consumption. The driving
10 means of the vehicle may comprise an electric machine for a hybrid vehicle or an electric vehicle, in which case the energy consumption comprises electric energy consumption.

Fig. 1a-b schematically illustrates a platoon P1 of vehicles 1, 2, 3, 4 travelling along a road R according to the present invention. The road R has two lanes
15 L1, L2 and the platoon P1 travelling in the right lane L1.

The platoon P1 comprises/is connected to a system I for controlling platooning operation of the platoon along a road.

According to an embodiment the platoon P1 is an autonomous platoon. According to an embodiment the platoon P1 is a semi-autonomous platoon.

- 20 The semi-autonomous platoon may have a vehicle operator at least in the leading vehicle of said platoon, where the vehicle operator is a driver driving the vehicle. The semi-autonomous platoon may have at least one vehicle operator remotely controlling at least one of the vehicles of the platoon. The semi-autonomous platoon will comprise at least one autonomous vehicle and
25 at least one operator operated vehicle, where the at least one operator operated vehicle may be operated with a vehicle operator in the vehicle driving the vehicle and/or being remotely operated by a vehicle operator. According to an embodiment the platoon P1 is a totally operator operated platoon P1. A totally operator operated platoon may be a platoon with a

vehicle operator in each vehicle driving that vehicle. A totally operator operated platoon may be a platoon with a vehicle operator remotely controlling the respective vehicle of the platoon.

Fig. 1a schematically illustrates a plan view of a platoon P1 of vehicles 1, 2, 3, 4 travelling along a road R according to the present invention. In fig. 1a the platooning operation is controlled such that the platoon is travelling along the road R in the lane L1 essentially in the centre of the lane L1 and with a mutual distance between the vehicles and a certain speed so as to optimize the energy consumption of the platoon.

Here the leading vehicle 1 is provided with a sensor unit 112 for determining other road users comprising determining behaviour of other road users. The sensor unit 112 is directed for providing a forward looking field of view F for detecting external road users ahead of the platoon P1. The leading vehicle 1 of the platoon may further have sensor units arranged to provide a field of view looking at the sides for detecting external road users on one or both sides of the platoon, and/or sensor units with a backward looking field of view for detecting external road users behind the platoon.

The on-board sensor units may be arranged in one or more of the other vehicles 2, 3, 4 of the platoon P1 and may comprise sensor units with a forward looking field of view for detecting external road users ahead of the platoon, sensor units arranged to provide a field of view looking at the sides for detecting external road users on one or both sides of the platoon, and/or sensor units with a backward looking field of view for detecting external road users behind the platoon.

An external road user RU in the form of an external vehicle is present at the road ahead of the platoon P1.

In fig. 1a the external road user RU is detected and the behaviour determined by means of the sensor unit 112. The behaviour of the external road user RU is graded as a behaviour that may affect the safety of one or more vehicle of

the platoon P1. The thus determined grading of said behaviour of said other road user RU is according to an embodiment communicated between the vehicles 1, 2, 3, 4 of the platoon P1 within a vehicle-to-vehicle communication arrangement and/or a vehicle-to-infrastructure communication arrangement.

In fig. 1b the operation of the platoon P1 has been adapted based upon the thus determined grading by adapting the mutual longitudinal positions of the vehicles 1, 2, 3, 4 of the platoon by increasing the distance between the respective vehicles 1, 2, 3, 4 of the platoon P1. The operation of the platoon P1 has been adapted based upon the thus determined grading by adapting the mutual lateral positions of the vehicles 1, 2, 3, 4 of the platoon P1 such that the vehicles of the platoon P1 are positioned closer to the right side of the lane L1.

Fig. 2 schematically illustrates a system I for controlling platooning operation of a platoon of vehicles along a road.

The system I comprises an electronic control unit 100. The electronic control unit 100 may comprise one or more electronic control units. The electronic control unit 100 may comprise one or more electronic control units in the respective vehicle of the platoon.

The system I comprises means 110 for considering other road users along said road from a safety point of view.

The system I comprises means 120 for determining the behaviour of said other road users.

The means 120 for determining said behaviour is arranged to be performed manually.

The means 120 for determining said behaviour comprises means 122 for determining said behaviour based upon information from on-board sensor units of at least one of said vehicles of said platoon. The means 122 for

determining said behaviour based upon information from on-board sensor units of at least one of said vehicles of said platoon comprises at least one on-board sensor unit 122a for detecting the external road user. The at least one sensor unit 122a may comprise any suitable sensor unit such as a camera unit and/or a laser scanner unit and/or a radar unit.

The means 120 for determining said behaviour comprises means 124 for determining said behaviour based upon information from external sources. The means 124 for determining said behaviour based upon information from external sources comprises means 124a for communicating between infrastructure and one or more vehicles of the platoon within a vehicle-to-infrastructure communication arrangement V2I.

The system I further comprises means 130 for determining external conditions.

The means 130 for determining external conditions comprises means 132 for determining weather conditions in connection to the platoon driving along said road.

The means 132 for determining weather conditions in connection to the platoon driving along said road may comprise any suitable means for determining weather conditions.

The means 132 for determining weather conditions in connection to the platoon driving along said road comprises one or more weather sensor units. The weather sensor units may comprise one or more rain sensor units. The weather sensor units may comprise one or more temperature sensor units. The weather sensor units may comprise one or more wind sensor units.

The means 132 for determining weather conditions in connection to the platoon driving along said road comprises according to an embodiment means for extracting external weather data from one or more external weather data units comprising any suitable external server unit. The means

132 for determining weather conditions in connection to the vehicle platoon along said road comprises one or more external weather data units.

Thus determined weather conditions may comprise rain and extent of rain, snow and extent of snow, current temperature, wind conditions or the like.

- 5 The means 130 for determining external conditions comprises means 134 for determining road conditions in connection to the platoon driving along said road.

The means 134 for determining road conditions in connection to the platoon driving along said road comprises means for detecting road conditions in
10 connection to the platoon driving along said road. The means for detecting road conditions comprises any suitable detector unit for detecting the surface of the road along which the vehicle is travelling such as one or more camera units and/or one or more laser scanner units and/or one or more radar units.

The means 134 for determining road conditions in connection to the platoon
15 driving along said road comprises means for extracting information about road conditions from one or more external units comprising any suitable server unit.

Thus determined road conditions may comprise slippery road due to e.g. ice on the road, snow on the road, oil on the road, gravel on the road, water on
20 the road, curves of the road or other road conditions that may affect driving along the road.

The means 130 for determining external conditions comprises means 136 for determining current traffic situation. The means 136 for determining current traffic situation may comprise means for detecting the surroundings so as to
25 determine traffic situation. The means 136 for determining current traffic situation may comprise means for extracting information about current traffic situation from one or more external units comprising any suitable server unit.

The system I comprises means 140 for grading said behaviour from a safety point of view. The means 140 for grading said behaviour from a safety point of view may comprise any suitable means for analysing the behaviour comprising any suitable processing means for processing the information
5 about the behaviour of the external road user so as to set a grade based upon the risk said behaviour may pose. The means 140 for grading said behaviour from a safety point of view comprises giving strange behaviour, i.e. behaviour posing a high risk, of an external road user such as an external vehicle a lower grade than normal behaviour.

10 The means 140 for grading said behaviour from a safety point of view comprises according to an embodiment means 142 for considering external conditions comprising current weather conditions, road conditions and/or traffic conditions into account. The means 142 for considering external conditions is according to an embodiment arranged to extract such
15 information from the means 130.

The system I comprises means 150 for adapting the operation of said platoon based upon said grading.

The means 150 for adapting the operation of said platoon based upon said grading comprises according to an embodiment means 150a for considering
20 external conditions comprising current weather conditions, road conditions and/or traffic conditions into account. The means 150a for considering external conditions is according to an embodiment arranged to extract such information from the means 130.

25 The means 150 for adapting the operation of said platoon based upon said grading comprises means 152 for adapting the speed of the platoon. The means 152 for adapting the speed of the platoon comprises means for adapting the speed of the respective vehicle of the platoon, where the adaption of the speed may be adaption to a speed corresponding to all vehicles of the platoon or different speeds for one or more vehicle of the

platoon if the grading and situation so requires. The means 152 for adapting the speed may comprise means for controlling the torque demand for the respective vehicles, means for controlling brakes of the respective vehicles or the like.

- 5 The means 150 for adapting the operation of said platoon based upon said grading comprises means 154 for adapting the mutual longitudinal positions of the vehicles of the platoon. The means 154 for adapting the mutual longitudinal positions of the vehicles of the platoon comprises according to an embodiment means for determining the distance between the respective
- 10 vehicles of the platoon comprising e.g. a radar unit, a camera unit and/or a laser scanner unit or other suitable distance sensor unit. The means 154 for adapting the mutual longitudinal positions of the vehicles of the platoon comprises according to an embodiment means for controlling the torque demand for the respective vehicles, means for controlling brakes of the
- 15 respective vehicles or the like.

- The means 150 for adapting the operation of said platoon based upon said grading comprises means 156 for adapting the mutual lateral positions of the vehicles of the platoon. The means 156 for adapting the mutual lateral positions of the vehicles of the platoon may comprise means for determining
- 20 the lateral position of the platoon relative to the lane of the road comprising according to an embodiment any suitable sensor unit such as a radar unit, a camera unit and/or a laser scanner unit or other suitable means for determining the position such as a Global Navigation satellite System, GNSS, e.g. a global positioning system, GPS, for continuously determining
- 25 the position of the vehicle. The means 156 for adapting the mutual lateral positions of the vehicles of the platoon may comprise means for determining the lateral position of the platoon relative to the graded external road user comprising according to an embodiment any suitable sensor unit such as a radar unit, a camera unit and/or a laser scanner unit.

The means 110 for considering other road users along said road from a safety point of view may comprise any of the means 120, means 140 and means 150.

- 5 The system I comprises means 160 for communicating the thus determined grading of said behaviour of said other road users between the vehicles of the platoon within a vehicle-to-vehicle communication arrangement V2V.

The other vehicle/vehicles of the platoon may comprise means 200 for receiving and communicating information, e.g. one or more electronic control units or the like.

- 10 The system I comprises means 170 for communicating the thus determined grading of said behaviour of said other road users between the vehicles of the platoon within a vehicle-to-infrastructure communication arrangement V2I. The thus determined grading of said behaviour of said other road users is thus communicated between the vehicles of the platoon via infrastructure
15 within a vehicle-to-infrastructure communication arrangement V2I.

The infrastructure may comprise means 300 for receiving and communicating information, e.g. one or more electronic control units, one or more server units or the like, comprising the Internet/so called clouds via which said information may be communicated.

- 20 According to an embodiment of the system said platoon comprises an autonomous platoon or a semi-autonomous platoon or a totally operator operated platoon.

- The electronic control unit 100 is operably connected to the at least one on-board sensor unit 122a for detecting the external road user via a link 22. The
25 electronic control unit 100 is via the link 22 arranged to receive a signal from said means 122a representing data about other road users along said road.

The electronic control unit 100 is operably connected to the means 122 for determining said behaviour based upon information from on-board sensor

units of at least one of said vehicles of said platoon via a link 22a. The electronic control unit 100 is via the link 22a arranged to send a signal to said means 122 representing data about other road users along said road comprising data of movement, data of speed and change of speed, data of positioning on the road and relative to the platoon.

The electronic control unit 100 is operably connected to the means 122 for determining said behaviour based upon information from on-board sensor units of at least one of said vehicles of said platoon via a link 22b. The electronic control unit 100 is via the link 22b arranged to receive a signal from said means 122 representing data about other road users along said road comprising data of movement, data of speed and change of speed, data of positioning on the road and relative to the platoon.

The electronic control unit 100 is operably connected to means 124a for communicating between infrastructure and one or more vehicles of the platoon within a vehicle-to-infrastructure communication arrangement via a link 24. The electronic control unit 100 is via the link 24 arranged to receive a signal from said means 124a representing data about other road users along said road.

The electronic control unit 100 is operably connected to the means 124 for determining said behaviour based upon information from external sources via a link 24a. The electronic control unit 100 is via the link 24a arranged to receive a signal from said means 124 representing data about other road users along said road comprising data of movement, data of speed and change of speed, data of positioning on the road and relative to the platoon.

The electronic control unit 100 is operably connected to the means 124 for determining said behaviour based upon information from external sources via a link 24b. The electronic control unit 100 is via the link 24b arranged to send a signal to said means 124 representing data about other road users along

said road comprising data of movement, data of speed and change of speed, data of positioning on the road and relative to the platoon.

The electronic control unit 100 is operably connected to means 120 for determining the behaviour of said other road users via a link 20. The
5 electronic control unit 100 is via the link 20 arranged to receive a signal from said means 120 representing data about behaviour of other road users.

The electronic control unit 100 is operably connected to means 130 for determining external conditions via a link 30. The electronic control unit 100 is via the link 30 arranged to receive a signal from said means 130
10 representing data about current conditions.

The electronic control unit 100 is operably connected to means 132 for determining weather conditions in connection to the platoon driving along said road via a link 32. The electronic control unit 100 is via the link 32 arranged to receive a signal from said means 132 representing data about
15 current weather conditions.

The electronic control unit 100 is operably connected to means 134 for determining road conditions in connection to the platoon driving along said road via a link 34. The electronic control unit 100 is via the link 34 arranged to receive a signal from said means 134 representing data about current road
20 conditions.

The electronic control unit 100 is operably connected to means 136 for determining current traffic situation via a link 36. The electronic control unit 100 is via the link 36 arranged to receive a signal from said means 136 representing data about current traffic situation.

25 The electronic control unit 100 is operably connected to means 142 for considering external conditions comprising current weather conditions, road conditions and/or traffic conditions into account via a link 42. The electronic control unit 100 is via the link 42 arranged to send a signal from to said

means 142 representing data for external conditions comprising data for current weather conditions, data for road conditions and/or data for traffic conditions.

5 The electronic control unit 100 is operably connected to means 140 for grading said behaviour from a safety point of view via a link 40a. The electronic control unit 100 is via the link 40a arranged to send a signal to said means 140 representing data for external conditions comprising data for current weather conditions, data for road conditions and/or data for traffic conditions.

10 The electronic control unit 100 is operably connected to means 140 for grading said behaviour from a safety point of view via a link 40b. The electronic control unit 100 is via the link 40b arranged to receive a signal from said means 140 representing data for grades of behaviour of external road users.

15 The electronic control unit 100 is operably connected to means 150a for considering external conditions comprising current weather conditions, road conditions and/or traffic conditions into account via a link 50a. The electronic control unit 100 is via the link 50a arranged to send a signal to said means 150a representing data for external conditions comprising data for current
20 weather conditions, data for road conditions and/or data for traffic conditions.

The electronic control unit 100 is operably connected to means 152 for adapting the speed of the platoon via a link 52. The electronic control unit 100 is via the link 52 arranged to receive a signal from said means 152 representing data for adapting the speed of the platoon comprising data for
25 adapting the speed of the respective vehicle of the platoon.

The electronic control unit 100 is operably connected to means 154 for adapting the mutual longitudinal positions of the vehicles of the platoon via a link 54. The electronic control unit 100 is via the link 54 arranged to receive a

signal from said means 154 representing data for adapting the mutual longitudinal positions of the vehicles of the platoon.

The electronic control unit 100 is operably connected to means 156 for adapting the mutual lateral positions of the vehicles of the platoon via a link
5 55. The electronic control unit 100 is via the link 56 arranged to receive a signal from said means 156 representing data for adapting the speed of the platoon comprising data for adapting the mutual lateral positions of the vehicles of the platoon.

The electronic control unit 100 is operably connected to means 160 for
10 communicating the thus determined grading of said behaviour of said other road users between the vehicles of the platoon within a vehicle-to-vehicle communication arrangement V2V via a link 60a. The electronic control unit 100 is via the link 60a arranged to send a signal to said means 160 representing data for determined grading of said behaviour of said other road
15 users.

The electronic control unit 100 is operably connected to means 160 for communicating the thus determined grading of said behaviour of said other road users between the vehicles of the platoon within a vehicle-to-vehicle communication arrangement V2V via a link 60b. The electronic control unit
20 100 is via the link 60b arranged to receive a signal from said means 160 representing data for determined grading of said behaviour of said other road users.

The means 160 for communicating the thus determined grading of said behaviour of said other road users between the vehicles of the platoon within
25 a vehicle-to-vehicle communication arrangement V2V is operably connected to means 200 for communicating, i.e. sending and/or receiving information via links, the means 200 being means for one or more vehicles of the platoon. The means 160 is via said link arranged to send and/or receive data for determined grading of said behaviour of said other road users.

The electronic control unit 100 is operably connected to means 170 for communicating the thus determined grading of said behaviour of said other road users between the vehicles of the platoon within a vehicle-to-infrastructure communication arrangement V2I via a link 70a. The electronic control unit 100 is via the link 70a arranged to send a signal to said means 170 representing data for determined grading of said behaviour of said other road users.

The electronic control unit 100 is operably connected to means 170 for communicating the thus determined grading of said behaviour of said other road users between the vehicles of the platoon within a vehicle-to-infrastructure communication arrangement V2I via a link 70b. The electronic control unit 100 is via the link 60b arranged to receive a signal from said means 170 representing data for determined grading of said behaviour of said other road users.

The means 170 for communicating the thus determined grading of said behaviour of said other road users between the vehicles of the platoon within a vehicle-to-infrastructure communication arrangement V2I is operably connected to means 300 for communicating, i.e. sending and/or receiving information via links. The means 170 is via said link arranged to send and/or receive data for determined grading of said behaviour of said other road users.

Fig. 3 schematically illustrates a block diagram of a method for controlling platooning operation of a platoon of vehicles along a road according to an embodiment of the present invention.

According to the embodiment the method for controlling platooning operation of a platoon of vehicles along a road comprises a step S1. In this step other road users along said road are considered from a safety point of view.

According to the embodiment the method for controlling platooning operation of a platoon of vehicles along a road comprises a step S2. In this step the behaviour of said other road users is determined.

- 5 According to the embodiment the method for controlling platooning operation of a platoon of vehicles along a road comprises a step S3. In this step said behaviour is graded from a safety point of view.

According to the embodiment the method for controlling platooning operation of a platoon of vehicles along a road comprises a step S4. In this step the operation of said platoon is adapted based upon said grading.

- 10 The road user is according to an embodiment another vehicle driving along the road in connection to the platoon. The road user may also be a pedestrian or an animal such as an elk or a deer or the like.

- The step of determining the behaviour of said other road users comprises according to an embodiment determining possible strange behaviour of an external vehicle, i.e. a vehicle not part of the platoon, such as irregular speed
15 such as unexpected brake manoeuvres, unexpected accelerations, unexpected change of position on the road comprising positions over lanes and/or driving between two lanes, aggressive behaviour. The step of determining the behaviour of said other road users comprises according to
20 an embodiment determining normal behaviour of other vehicles.

- The step of grading said behaviour from a safety point of view comprises giving strange behaviour of an external vehicle a lower grade than normal behaviour. The step of grading said behaviour from a safety point of view may comprise grading strange behaviour of an external vehicle, i.e. very
25 strange behaviour going on for a long time and constituting a major hazard for the vehicles of the platoon from a safety point of view, will get a lower grade than a behaviour that is not so strange and only temporarily.

A strange behaviour may be due to a drunken driver, a driver using a cell phone, a driver who has suffered from sudden illness, a driver falling asleep/on the verge of falling asleep or the like.

5 The step of adapting the operation of said platoon based upon said grading may comprise adaption of speed, adaption of distance between the vehicles of the platoon and/or adaption of position of the platoon taking the position and speed of the external vehicle behaving in a strange way into consideration. The step of adapting the operation of said platoon based upon said grading may comprise terminating the operation of the platoon, i.e. stop
10 the platooning operation such that the respective vehicles continue drive on their own, as long as the grading is maintained, i.e. the external road user behaving in a way that may cause an accident. The step of adapting the operation of said platoon based upon said grading may comprise choosing a different route, e.g. taking off at a road exit, so as to minimize the risk of an
15 accident. The step of adapting the operation of said platoon based upon said grading may comprise performing a safe stop of the platoon.

The step of adapting the operation of said platoon based upon said grading may depend on external conditions comprising traffic situation, road conditions and/or weather conditions. External conditions in the form of
20 current traffic situation may affect certain adaptations such as overtaking the external road user. External conditions in the form of road conditions such as slippery road due to snow, ice, gravel, oil or the like on the road may affect certain adaptations such as speed, overtaking of the external road user, positioning of platoon etc. External conditions in the form of weather
25 conditions such as precipitation in the form of snow, rain, hail, and/or wind, sun or the like may affect certain adaptations such as speed, overtaking of the external road user, positioning of platoon etc.

The step of grading said behaviour from a safety point of view may also depend on such external conditions, i.e. traffic situation, road conditions
30 and/or weather conditions.

By thus grading the behaviour of external road users from a safety point of view and adapting the operation of said platoon based upon said grading the risk the risk of accidents for vehicles in the platoon is minimized without unnecessary affecting efficient drive of the platoon. If the grade of the behaviour is low, e.g. if the grade of the behaviour of the external road user such as an external vehicle, corresponds to a strange behaviour the operation of the platoon may require change of speed and/or increase distance between the vehicles of the platoon and/or changing position of the platoon reducing the risk of an accident with regard to the external vehicle behaving strangely. If the grade of the behaviour is not so low, e.g. if the grade of the behaviour of the external road user such as an external vehicle, corresponds to a normal behaviour the operation of the platoon may maintain the same such that the platoon may continue driving with the same speed and the same distance between the vehicles of the platoon thus optimizing energy consumption within the platoon and keeping the desired speed such that no unnecessary time is lost.

According to an embodiment of the method the step of determining said behaviour is performed manually and/or based upon information from on-board sensor units of at least one of said vehicles of said platoon.

The step of performing the determination of said behaviour manually may, with an observed strange behaviour, be followed by an action such as activation of means for adapting the operation. Such an action could involve communicating the grade of the behaviour to the other vehicles. The step performing the determination of said behaviour manually may for an operator operated platoon, i.e. with an operator/driver in each vehicle, be performed by one or more of the operators depending on the position of the external road user relative to the platoon. The step performing the determination of said behaviour manually will for a semi-autonomous platoon, e.g. a platoon with an operator/driver in the leading vehicle and the trailing vehicles being autonomous, be performed by the operator, where the operator may take

action by activation of means for adaption of the platoon which is then communicated to the trailing autonomous vehicles which will adapt according to the thus determined strange behaviour, which may have been graded by the operator.

- 5 By thus performing the determination of said behaviour manually the use of the fact that an operator of a vehicle, i.e. a human being, is usually skilled in interpreting the behaviour of other road users and may thus determine whether the behaviour is strange at to what degree. For an operator operated platoon and a semi-autonomous platoon manual determination may thus add
- 10 to the safety. Manual determination may according to an embodiment be used in addition to using on-board sensor units.

- The step of performing the determination of said behaviour based upon information from on-board sensor units of at least one of said vehicles of said platoon may be performed for an autonomous platoon or a semi-autonomous
- 15 platoon or a totally operator operated platoon.

The on-board sensor units may comprise sensor units with a forward looking field of view for detecting external road users ahead of the platoon. According to an embodiment at least the leading vehicle is provided with at least one forward looking on-board sensor unit.

- 20 The on-board sensor units may comprise sensor units arranged to provide a field of view looking at the sides for detecting external road users on one or both sides of the platoon.

- The on-board sensor units may comprise sensor units with a backward looking field of view for detecting external road users behind the platoon.
- 25 According to an embodiment at least the last vehicle of the platoon is provided with at least one backward looking on-board sensor unit.

The step of performing the determination of said behaviour based upon information from on-board sensor units provides a very efficient way of

detecting any road user in connection to the platoon and thus increases safety.

According to an embodiment of the method the step of determining said behaviour is performed based upon information from external sources.

- 5 The step of performing the determination of said behaviour based upon information from external sources may comprise communication between infrastructure and one or more vehicles of the platoon within a vehicle-to-infrastructure communication arrangement. Such information may comprise traffic information regarding strange behaviour of external road user such as
- 10 an external vehicle.

The step of performing the determination of said behaviour based upon information from external sources further increases safety in that the information may be received before a possible strange behaviour of an external road user is detected by on-board sensor units and/or manually.

- 15 According to an embodiment the method comprises the step of communicating the thus determined grading of said behaviour of said other road users between the vehicles of the platoon within a vehicle-to-vehicle communication arrangement and/or a vehicle-to-infrastructure communication arrangement. By thus communicating the grading an efficient
- 20 way of providing information to the vehicles of the platoon is obtained such that possible required adaption may be performed as soon as e.g. a strange behaviour has been determined.

- According to an embodiment of the method the step of adapting the operation of said platoon based upon said grading comprises adapting the
- 25 speed of the platoon and/or adapting the mutual longitudinal positions of the vehicles of the platoon and/or adapting the mutual lateral positions of the vehicles of the platoon. By thus adapting the operation of the platoon the risk of accidents involving one or more vehicles of the platoon is minimized. The step of adapting the mutual lateral positions of the vehicles of the platoon

comprises according to an embodiment taking the position of the external road user into account.

According to an embodiment of the method said platoon comprises an autonomous platoon or a semi-autonomous platoon or a totally operator
5 operated platoon.

According to an embodiment the platoon is an autonomous platoon. According to an embodiment the platoon is a semi-autonomous platoon. The semi-autonomous platoon may have a vehicle operator at least in the leading vehicle of said platoon, where the vehicle operator is a driver driving the
10 vehicle. The semi-autonomous platoon may have at least one vehicle operator remotely controlling at least one of the vehicles of the platoon. The semi-autonomous platoon will comprise at least one autonomous vehicle and at least one operator operated vehicle, where the at least one operator operated vehicle may be operated with a vehicle operator in the vehicle
15 driving the vehicle and/or being remotely operated by a vehicle operator. According to an embodiment the platoon is a totally operator operated platoon. A totally operator operated platoon may be a platoon with a vehicle operator in each vehicle driving that vehicle. A totally operator operated platoon may be a platoon with a vehicle operator remotely controlling the
20 respective vehicle of the platoon.

With reference to figure 4, a diagram of an apparatus 500 is shown. The control unit 100 described with reference to fig. 2 may according to an embodiment comprise apparatus 500. Apparatus 500 comprises a non-volatile memory 520, a data processing device 510 and a read/write memory
25 550. Non-volatile memory 520 has a first memory portion 530 wherein a computer program, such as an operating system, is stored for controlling the function of apparatus 500. Further, apparatus 500 comprises a bus controller, a serial communication port, I/O-means, an A/D-converter, a time date entry and transmission unit, an event counter and an interrupt controller (not
30 shown). Non-volatile memory 520 also has a second memory portion 540.

A computer program P is provided comprising routines for controlling platooning operation of a platoon of vehicles along a road. The program P comprises routines for considering other road users along said road from a safety point of view. The program P comprises routines for determining the behaviour of said other road users. The program P comprises routines for grading said behaviour from a safety point of view. The program P comprises routines for adapting the operation of said platoon based upon said grading. The routines for determining said behaviour comprises routines for manually performing the determination and/or routines for basing performance of the determination upon information from on-board sensor units of at least one of said vehicles of said platoon. The routines for determining said behaviour comprises routines for performing the determination based upon information from external sources. The program P comprises routines for communicating the thus determined grading of said behaviour of said other road users between the vehicles of the platoon within a vehicle-to-vehicle communication arrangement and/or a vehicle-to-infrastructure communication arrangement. The routines for determining the characteristics of the different vehicles of the platoon, wherein the routines for adapting the operation of said platoon based upon said grading comprises adapting the speed of the platoon and/or adapting the mutual longitudinal positions of the vehicles of the platoon and/or adapting the mutual lateral positions of the vehicles of the platoon. Said platoon comprises an autonomous platoon or a semi-autonomous platoon or a totally operator operated platoon. The computer program P may be stored in an executable manner or in a compressed condition in a separate memory 560 and/or in read/write memory 550.

When it is stated that data processing device 510 performs a certain function it should be understood that data processing device 510 performs a certain part of the program which is stored in separate memory 560, or a certain part of the program which is stored in read/write memory 550.

Data processing device 510 may communicate with a data communications port 599 by means of a data bus 515. Non-volatile memory 520 is adapted for communication with data processing device 510 via a data bus 512. Separate memory 560 is adapted for communication with data processing
5 device 510 via a data bus 511. Read/write memory 550 is adapted for communication with data processing device 510 via a data bus 514. To the data communications port 599 e.g. the links connected to the control units 100 may be connected.

When data is received on data port 599 it is temporarily stored in second
10 memory portion 540. When the received input data has been temporarily stored, data processing device 510 is set up to perform execution of code in a manner described above. The signals received on data port 599 can be used by apparatus 500 for considering other road users along said road from a safety point of view. The signals received on data port 599 can be used by
15 apparatus 500 for determining the behaviour of said other road users. The signals received on data port 599 can be used by apparatus 500 for adapting the operation of said platoon based upon said grading. The signals used for determining said behaviour are used for manually performing the determination and/or used for basing performance of the determination upon
20 information from on-board sensor units of at least one of said vehicles of said platoon. The signals used for determining said behaviour are used for performing the determination based upon information from external sources. The signals received on data port 599 can be used by apparatus 500 for communicating the thus determined grading of said behaviour of said other
25 road users between the vehicles of the platoon within a vehicle-to-vehicle communication arrangement and/or a vehicle-to-infrastructure communication arrangement. The signals used for adapting the operation of said platoon based upon said grading are used for adapting the speed of the platoon and/or for adapting the mutual longitudinal positions of the vehicles of
30 the platoon and/or for adapting the mutual lateral positions of the vehicles of

the platoon. Said platoon comprises an autonomous platoon or a semi-autonomous platoon or a totally operator operated platoon.

Parts of the methods described herein can be performed by apparatus 500 by means of data processing device 510 running the program stored in
5 separate memory 560 or read/write memory 550. When apparatus 500 runs the program, parts of the methods described herein are executed.

The foregoing description of the preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms
10 disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are
15 suited to the particular use contemplated.

CLAIMS

1. A method for controlling platooning operation of a platoon (P1) of vehicles (1, 2, 3, 4) along a road (R), comprising the step of considering (S1) other road users (RU) along said road from a safety point of view, **characterized**
5 **by** the steps of:
 - determining (S2) the behaviour of said other road users (RU);
 - grading (S3) said behaviour from a safety point of view; and
 - adapting (S4) the operation of said platoon (P1) based upon said grading.
2. A method according to claim 1, wherein the step of determining said
10 behaviour is performed manually and/or based upon information from on-board sensor units of at least one of said vehicles of said platoon (P1).
3. A method according to claim 1 or 2, wherein the step of determining said behaviour is performed based upon information from external sources.
4. A method according to any of claims 1-3, comprising the step of
15 communicating the thus determined grading of said behaviour of said other road users (RU) between the vehicles of the platoon (P1) within a vehicle-to-vehicle communication arrangement (V2V) and/or a vehicle-to-infrastructure communication arrangement (V2I).
5. A method according to any of claims 1-4, wherein the step of adapting
20 the operation of said platoon (P1) based upon said grading comprises adapting the speed of the platoon (P1) and/or adapting the mutual longitudinal positions of the vehicles of the platoon (P1) and/or adapting the mutual lateral positions of the vehicles of the platoon (P1).
6. A method according to any of claims 1-5, wherein said platoon (P1)
25 comprises an autonomous platoon or a semi-autonomous platoon or a totally operator operated platoon.

7. A system (I) for controlling platooning operation of a platoon (P1) of vehicles (1, 2, 3, 4) along a road (R), comprising means (110) for considering (S1) other road users (RU) along said road from a safety point of view, **characterized by** means (120) for determining (S2) the behaviour of said other road users (RU); means (140) for grading (S3) said behaviour from a safety point of view; and means (150) for adapting the operation of said platoon (P1) based upon said grading.
8. A system according to claim 7, wherein the means (120) for determining said behaviour is arranged to be performed manually and/or comprises means (122) for determining said behaviour based upon information from on-board sensor units of at least one of said vehicles of said platoon (P1).
9. A system according to claim 7 or 8, wherein the means (120) for determining said behaviour comprises means (124) for determining said behaviour based upon information from external sources.
10. A system according to any of claims 7-9, comprising means (160) for communicating the thus determined grading of said behaviour of said other road users (RU) between the vehicles of the platoon (P1) within a vehicle-to-vehicle communication arrangement (V2V) and/or a vehicle-to-infrastructure communication arrangement (V2I).
11. A system according to any of claims 7-10, wherein the means for adapting the operation of said platoon (P1) based upon said grading comprises means for adapting the speed of the platoon (P1) and/or means for adapting the mutual longitudinal positions of the vehicles of the platoon (P1) and/or means for adapting the mutual lateral positions of the vehicles of the platoon (P1).
12. A system according to any of claims 7-11, wherein said platoon (P1) comprises an autonomous platoon or a semi-autonomous platoon or a totally operator operated platoon.

13. A platoon (P1) of vehicles (1, 2, 3, 4) comprising a system (I) according to any of claims 7-12.
14. A computer program (P) for controlling platooning operation of a platoon of vehicles along a road, said computer program (P) comprising program
5 code which, when run on an electronic control unit (100) or another computer (500) connected to the electronic control unit (100), causes the electronic control unit to perform the steps according to claim 1-6.
15. A computer program product comprising a digital storage medium storing the computer program according to claim 14.

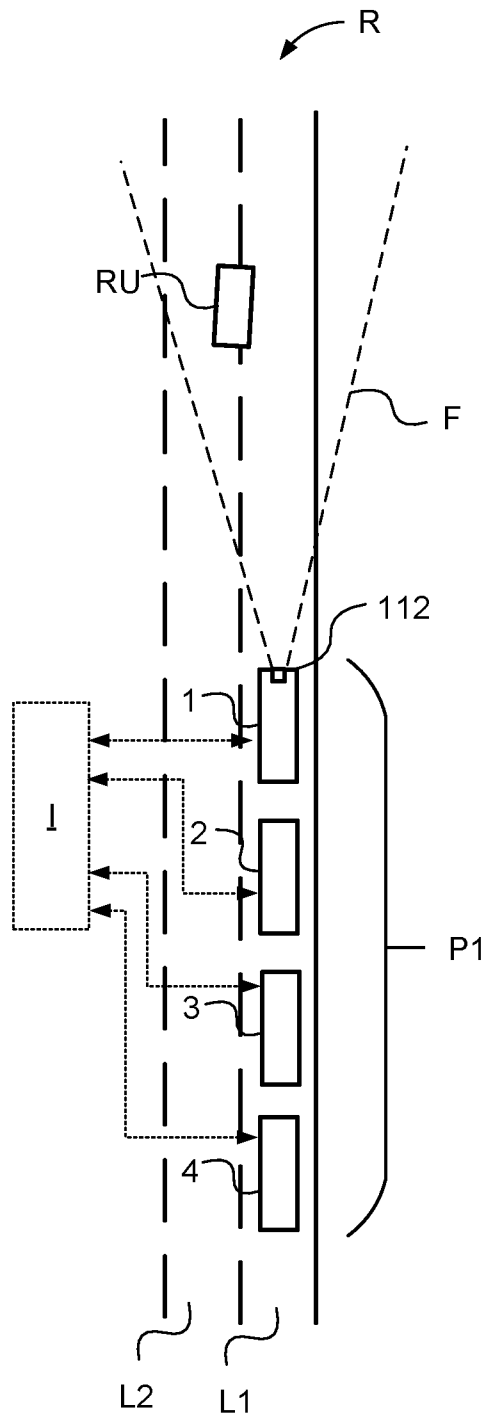


Fig. 1a

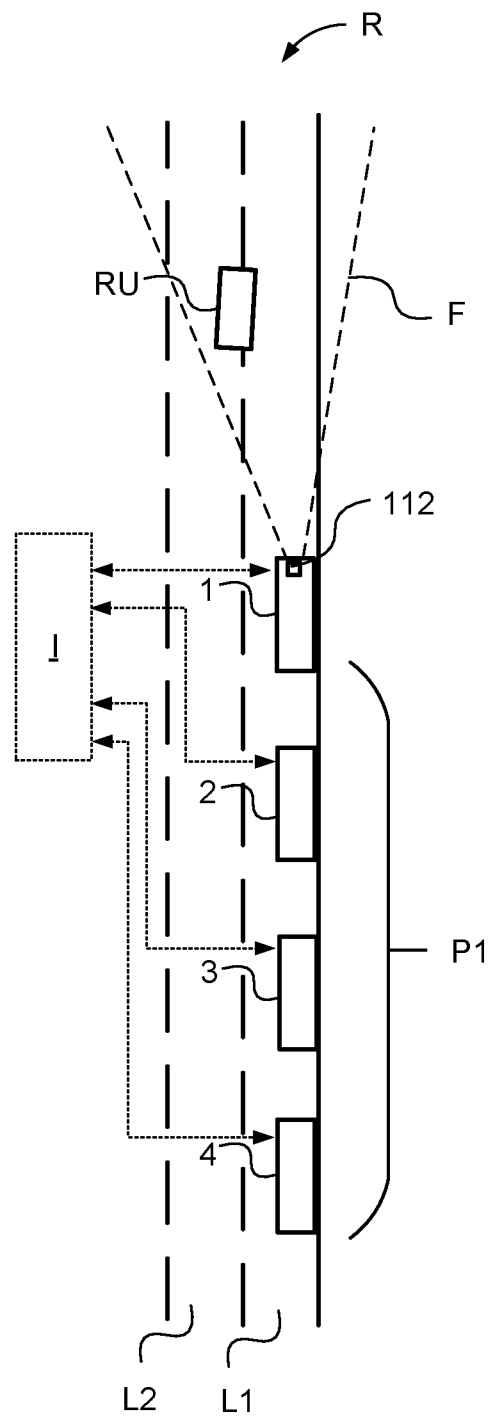


Fig. 1b

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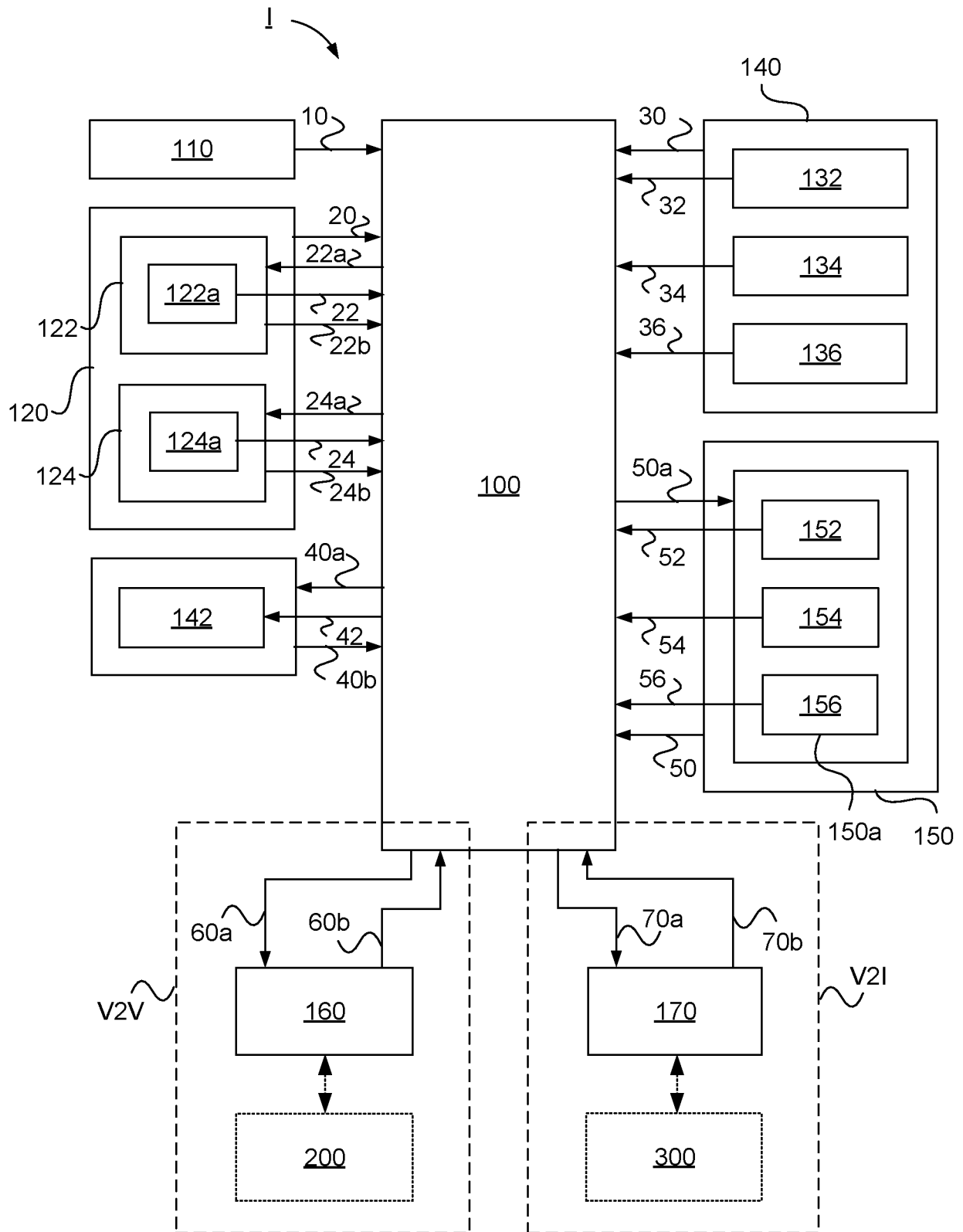


Fig. 2

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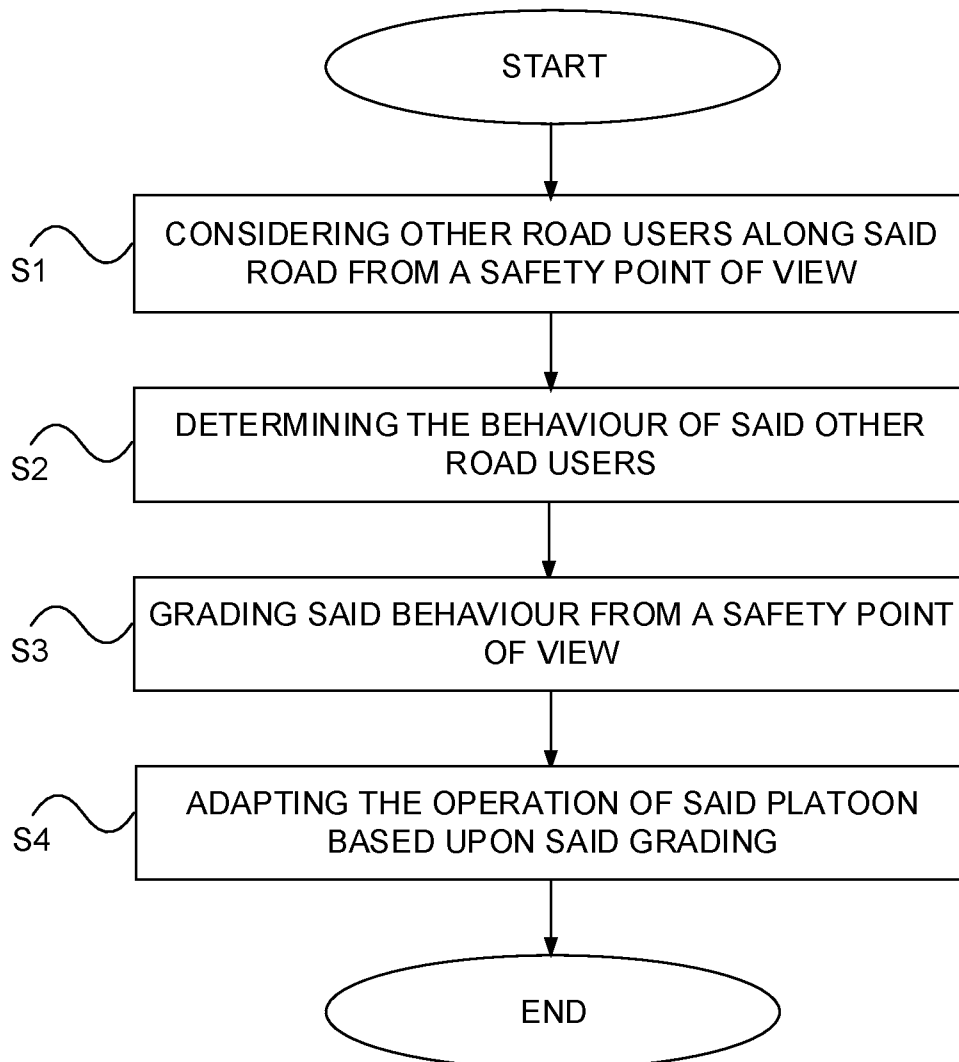


Fig. 3

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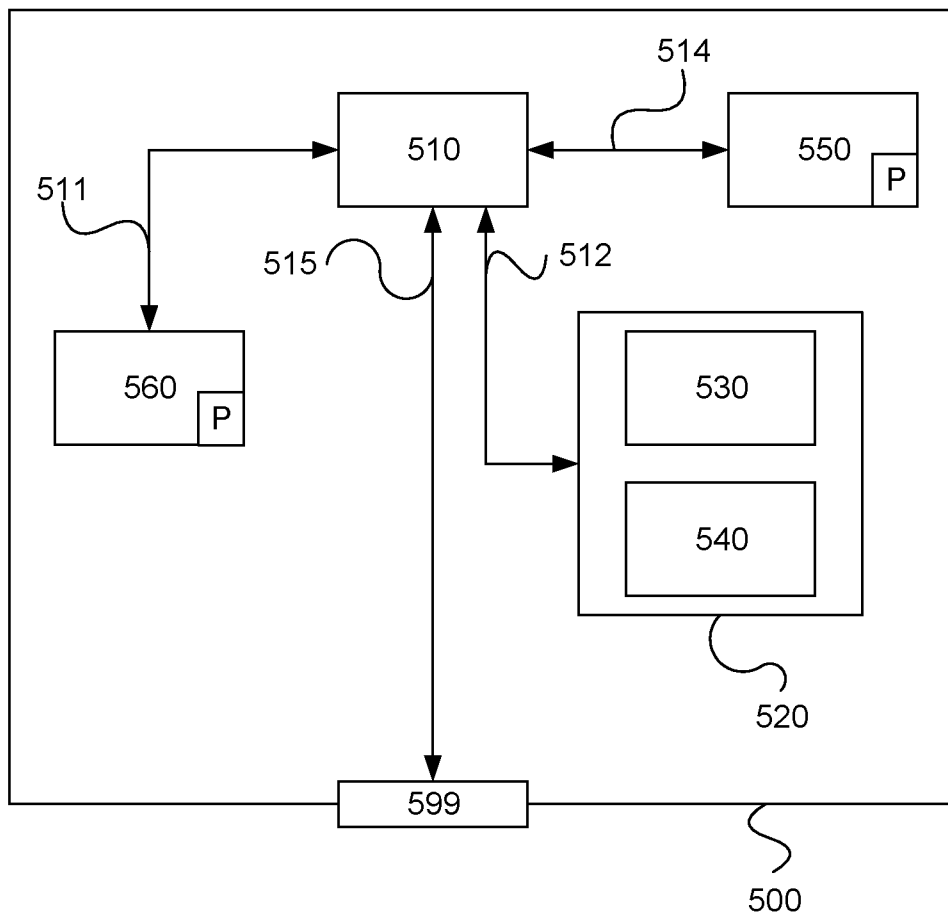


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050381

A. CLASSIFICATION OF SUBJECT MATTER IPC: see extra sheet According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC: B60W, G08G		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched SE, DK, FI, NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, PAJ, WPI data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2015126318 A1 (SCANIA CV AB), 27 August 2015 (2015-08-27); abstract; claims 1,8; description: page 5, lines 26-33; page 7, lines 17-35; page 8, line 32 - page 11, line 14; page 16, lines 13-20 --	1-15
A	US 20120290146 A1 (DEDES GEORGE C ET AL), 15 November 2012 (2012-11-15); figure 1; claim 1; paragraph [0005] --	1-15
A	SE 1050980 A1 (SCANIA CV AB), 18 July 2011 (2011-07-18); abstract; claims 1,10 --	1-15
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search 21-07-2017	Date of mailing of the international search report 21-07-2017	
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Laura Enflo Telephone No. + 46 8 782 28 00	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050381

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 104916165 A (UNIV CHANGAN), 16 September 2015 (2015-09-16); abstracts from EPODOC and WPI -- -----	1-15

Continuation of: second sheet

International Patent Classification (IPC)

B60W 30/08 (2012.01)

B60W 40/08 (2012.01)

G08G 1/16 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2017/050381

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			SE	1450193 A1	20/08/2015
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			US	9099003 B2	04/08/2015
			US	8639426 B2	28/01/2014
SE	1050980 A1	18/07/2011	NONE		
CN	104916165 A	16/09/2015	NONE		