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Method for detecting vehicles with loads

The present invention relates to a method for detecting vehicles containing cargo as part of a traffic telematics system, in particular a road toll or road communication system, comprising at least one radio beacon for the radio communication with onboard units (OBUs) carried by the vehicles and cargo, wherein the OBU of a vehicle and the OBU of a cargo load are detected as belonging to each other when an evaluation of the radio communications thereof with the radio beacon shows that they are moving at a limited and constant distance from each other.

Such a method, in which the load is a trailer towed by the vehicle, is known from EP 2 372 667 A1 by the same applicant. It is the object of the invention to refine this method so as to create new fields of application therefor.

This object is achieved by a method of the type mentioned above, which according to the invention is characterized in that the radio beacon transmits characteristic data received from the one OBU - either in edited or unedited form - to the other OBU, which records the received characteristic data in a memory.

The invention thus allows cargo to be declared with the aid of a dedicated cargo OBU, which is associated with the vehicle OBU and can be charged a toll together therewith, resulting in continual recording of the cargo carried by a particular vehicle or of the means of transportation used for a particular cargo load. Every radio beacon that is passed by both OBUs reads characteristic data from the one OBU and writes the same in unedited or edited form to the other OBU, which is to say acts basically as a "copying or editing station" for characteristic data from one OBU to the other. Each time a radio beacon is passed, an additional characteristic data record is thus collected in the memory of an OBU. Over multiple beacon passages, a log, or a good picture, is thus obtained as to which cargo loads a vehicle is carrying or which vehicles transported a cargo load.

The characteristic data of the associated OBUs that are recorded in the memory of an OBU and derived from the last beacon passages can be used for a wide variety of toll collection, enforcement or evidence purposes. For example, the log of cargoes of a vehicle can be included in the computation of the toll thereof, the history of the means of transportation can be included in the computation of the toll for a cargo load, or the compliance with hazardous material identifications, weekend driving bans and the like can be monitored and enforced. The documented characteristic data can therefore preferably be read out via an interface of the OBU for control purposes, particularly

preferably via radio communication. The characteristic data records of one or both OBUs can optionally also be transmitted by a radio beacon to a back office of a traffic telematics system for tracking the cargo or imposing a toll.

It is additionally advantageous for the radio beacon to add a time stamp and/or an identifier of the radio beacon to the characteristic data, so that the location and the time of the copying process of the characteristic data from the one OBU to the other can be recorded. The recorded characteristic data thus constitute a complete logbook in terms of the time at which two OBUs were associated with each other, and at which radio beacon, which is to say what cargo loads a vehicle was transporting or by which vehicles the cargo was transported.

The characteristic data that are read from the one OBU by the radio beacon and written - in edited or unedited form - to the other OBU can be of a variety of types, for example a user identifier or account identifier, a vehicle identifier, such as a chassis number or license plate number, a cargo identifier such as a shipping number, hazard goods declaration or cargo description, parameterized data such as vehicle class, cargo class, weight, hazard goods classification, restrictions in terms of time such as weekend driving permission or ban, and the like. In the simplest case, the characteristic data comprise at least one identifier of the OBU from which the characteristic data is read.

As was already indicated, the characteristic data can be transmitted by the radio beacon both from a vehicle OBU to a cargo OBU and vice versa; even double provision of the method is conceivable, which is to say a mutual exchange of data. In this case, the respective characteristic data of the other OBU are alternately written to an OBU, so that both OBUs always include a complete log of the mutual association thereof.

In a preferred embodiment, the OBU from which the characteristic data is read out is associated with the cargo ("cargo OBU") and the other OBU to which the read-out characteristic data are written (in edited or unedited form) by the radio beacon is associated with the vehicle ("vehicle OBU"). This variant is particularly suited for tolling purposes because here the charging of the toll for the (tractive) vehicle is carried out dependent on a cargo load that is declared by the cargo OBU, and the cargo history can be monitored and verified at any time based on the log in the memory of the vehicle OBU. In this embodiment, the characteristic data preferably comprise an identifier of the cargo, for example the hazardous goods classification, tonnage, shipping data such as origin and destination, or the like.

The method of the invention requires no special positioning of the cargo OBU inside the vehicle, trailer or combination comprising a vehicle and trailer(s). The cargo OBU can be mounted both in a trailer and in the cargo bay or in the driver's cab of a truck or prime mover. The two OBUs are preferably arranged next to each other in the vehicle, for example directly next to each other on the windshield.

The radio communication with the one OBU in the radio beacon is preferably handled with priority over the radio communication with the other OBU. This allows the number of necessary radio communications, which is to say of data packets that are transmitted back and forth between the radio beacon and the OBUs via the radio interface, to be minimized.

The aforementioned evaluation of the radio communications for the purpose of measuring the distance between the two OBUs can be achieved in any manner known in the prior art. For this purpose, the phase shift between the two radio communications is preferably used to measure the distance between the OBUs. As an alternative or in addition, the amplitude difference and/or the Doppler shift of the two radio communications may be used to measure the movements of the OBUs. Preferably only radio communications within a predetermined time window are taken into consideration so as to increase the evaluation reliability.

The method of the invention is particularly suited for road toll systems according to the dedicated short range communication (DSRC) standard, in all the different technological embodiments, for example infrared, microwave at 5.8 GHz or 5.9 GHz and the like. The radio beacons are thus preferably DSRC radio beacons, and the OBUs are preferably DSRC OBUs, particularly preferably based on infrared or microwave.

The aforementioned evaluation of the radio communications can be carried out both centrally in a central system or in a decentralized manner in a radio beacon or a local control unit of the road toll system that is, for example, provided for several radio beacons.

After a pair of OBUs that belong to each other is detected, toll accounts belonging to the OBUs can be associated with each other in the central system and/or the radio beacons. This, for example, allows both toll accounts, this being the one of the vehicle OBU and that of the cargo OBU, to be debited simultaneously, or - particularly preferably - only the toll account of the vehicle OBU to be debited. In the latter case, it is thus possible in a particularly simple manner to prevent that cargo OBUs are charged

tolls as separate "vehicles" and to assure that the vehicle toll account is debited with a cargo toll.

The invention will be described in more detail hereafter based on an exemplary embodiment, which is shown in the accompanying drawings. In the drawings:

5 FIG. 1 shows a block diagram of the components that are used within the scope of the method of the invention;

FIG. 2 is a schematic illustration of radio communications between OBUs and radio beacons during consecutive beacon passages; and

10 FIG. 3 shows a block diagram of a vehicle OBU and of a cargo OBU in connection with a radio beacon.

According to FIG. 1, a tractor-trailer 1 comprising a vehicle 2 and cargo 3, here in the form of a trailer, is traveling on a road 4 as part of a road toll system 5, which charges fees (tolls) for the usage of the road. The road toll system 5 comprises a plurality of roadside radio beacons 6, which can conduct short range radio
15 communications 7, 8 with radio onboard units (OBUs) 9, 10 that are carried by the tractor-trailer 1. The radio communications 7, 8 preferably take place according to a DSRC standard.

Because the locations of the radio beacons 6 are known and the ranges of the radio communications 7, 8 thereof are limited, the OBUs 9, 10 can be located in terms
20 of the respective radio coverage ranges of the radio beacons 6 and thus tolls can be charge for usage of the road 4. For this purpose, the radio beacons 6 also have a data connection with a central system 11, which manages toll accounts (OBU accounts) 13, 14 for the OBUs 9, 10 in a database 12. However, the toll accounts can also be managed in a decentralized manner, for example in local computers at or in the radio
25 beacons 6.

In an alternative embodiment, which the invention also encompasses, the OBUs 9, 10 can be of the self-locating type, for example by way of an integrated satellite navigation receiver, and transmit the positions thereof via the radio communications 7, 8 to the radio beacons 6. In this case, the radio communications 7, 8 need not have
30 locally limited ranges and could, for example, be mobile communication connections, and the radio beacons 6 could be base stations of a mobile communication network, as is known from the prior art.

As is shown in FIG. 1, dedicated OBUs 9, 10 are associated with the vehicle 2 and the cargo 3, respectively. The database 12 of the central system 11 or of the

remote computer thus also has dedicated vehicle accounts 13 for vehicle OBUs 9 and dedicated cargo accounts 14 for cargo OBUs 10.

The cargo OBUs 10 can be mounted both in or on the cargo 3 itself, and in the vehicle 2, for example directly next to the vehicle OBU 9 on the windshield of the driver's cab of the vehicle 2.

The cargo 3 can, of course, be transported not only in the form of a separate trailer, but in any other form on the tractor-trailer 1, for example as units on pallets, by the trailer or directly by the vehicle 2. For example, the vehicle 2 could transport in the cargo bay thereof several cargo loads 3 comprising several cargo OBUs 10. Everything that is described here with respect to the association of a vehicle OBU 9 with a single cargo OBU 10 thus applies similarly to the association of a vehicle OBU 9 with multiple cargo OBUs 10 for multiple cargo loads 3 transported by the vehicle 2.

Because the two OBUs 9, 10 move on the tractor-trailer 1 at a small and constant distance from each other, this circumstance can be determined by evaluating the physical parameters of the radio communications 7, 8. For example, the phase shift between the radio communications 7, 8 can be used to measure the distance between the OBUs 9, 10 and, if this distance is smaller than a predetermined maximum distance and does not change significantly over a monitoring period in the coverage range of a radio beacon 6, a pair of vehicle OBU 9 and cargo OBU 10 that belong to each other can be concluded. As an alternative or in addition, the Doppler shift in the radio communications 7, 8 could be measured and, based thereon, the movements of the OBUs 9, 10 could be determined; if these take place in the same direction and at the same speed, again pair of OBUs 9, 10 that belong to each other can be concluded.

As an alternative or in addition, the physical proximity of two OBUs 9, 10 can be concluded solely from the temporal coincidence of radio communications 7, 8, for example if the vehicles on the road 4 are accordingly separated or the radio communications 7, 8 are handled in a very short time (as a "burst"); thus, the passage of two closely adjacent OBUs 9, 10 could be inferred from two burst communications 7, 8 that follow each other in quick succession.

After detecting a pair of OBUs 9, 10 that belong to each other, the related vehicle and cargo accounts 13, 14 could also be associated with each other in the central system 11 or the remote computers of the beacons 6. This way, for example, both accounts 13, 14 could be debited simultaneously or - particularly preferably - only the vehicle account 13 could be debited, whereby this can prevent that cargo OBUs 10 are

charged tolls as separate "vehicles" and also assure that the vehicle account 13 is debited with a cargo toll.

FIGS. 2 and 3 show an expansion of the method of FIG. 1 for simultaneously recording the associations, as detected during the beacon passages, of jointly moving vehicle OBUs 9 and cargo OBUs 10. According to FIG. 2, the tractor-trailer 1, which here is a vehicle 2 together with cargo 3 carried onboard, passes several successive beacons 6 having the beacon identifiers RS_1 , RS_2 , ..., or RS_n in general, at consecutive times t_1 , t_2 , ..., or t_n in general. Every time a beacon is passed, radio communications 7, 8 take place between the vehicle and cargo OBUs 9, 10 on the one hand and the radio beacons 6 on the other; the radio communications 7, 8 in each case consist of individual radio communications (data packets) that are transmitted back and forth between the OBUs 9, 10 and the radio beacons 6, as is known to a person skilled in the art.

In the example shown, the vehicle OBUs 9 are equipped with unique OBU identifiers OID_A , which are stored in a memory 15 (FIG. 3) of the vehicle OBUs 9, for example. Similarly, the cargo OBUs 10 are each equipped with a unique OBU identifier OID_B or OID_C , which is stored in a memory 16 of the cargo OBU 10. Moreover, the cargo OBUs 10 (optionally) comprise cargo declarations LD_{B1} , LD_{B2} , ..., or LD_{Bi} in general (in the case of the cargo OBU 10 having the identifier OID_B), or LD_{C1} , LD_{C2} , ..., or LD_{Ci} in general (in the case of the cargo OBU 10 having the identifier OID_C). The cargo declarations LD_{Bi} or LD_{Ci} are each stored in a memory 17 of the cargo OBU 10.

The cargo declarations LD_{Bi} , LD_{Ci} may contain additional information about the content, properties, weight, volume, hazard category, weekend driving authorization, countries of origin and destination or the like, of the respective cargo 3, as described above.

In the example shown in FIG. 2, during passage of the first radio beacon 6 or RS_1 , the tractor-trailer 1 carries a cargo 3 having the identifier OID_B and two cargo declarations LD_{B1} and LD_{B2} ; during passage of the second radio beacon RS_2 , a portion of the cargo 3, and accordingly also the cargo declaration LD_{B2} , had been removed, which is to say the cargo OBU 10 here only contains the cargo declaration LD_{B1} in addition to the OBU identifier OID_B ; and during passage of a later radio beacon RS_n , the entire cargo 3 had been replaced, and the tractor trailer 1 is composed of a vehicle comprising the vehicle OBU 9 having the OBU identifier OID_A and new cargo 3 comprising the new cargo OBU 10 having the identifier OID_C with three new cargo declarations LD_{C1} , LD_{C2} , LD_{C3} .

With every such passage of the beacons, in a first step characteristic data KD are read from the cargo OBU 10 and into the radio beacon 6 as part of the radio communications 7 between the radio beacon 6 and the cargo OBU 10; see the specially highlighted radio communication 7' in FIGS. 2 and 3. The characteristic data KD can be the OBU identifier OID_B of the cargo OBU 10 and/or one or several of the cargo declarations LD_{Bi} , LD_{Ci} ; in the example shown, the characteristic data KD comprise all these data available in the memories 16 and 17 of the cargo OBU 10. For this purpose, the cargo OBU 10 contains, in the known manner, a central processor 19 and a transceiver 20, with the aid of which components the cargo OBU transmits the characteristic data KD from the memories 16, 17, either automatically or upon request from a radio beacon 6, to the radio beacon 6 as part of the radio communication 7'.

The radio beacon 6 thereupon transmits the received characteristic data KD as part of one of the radio communications 8 with the vehicle OBU 9 that was recognized as belonging to the cargo OBU 10; see the radio communication 8' shown by way of example. The radio beacon 6 can forward the characteristic data KD in unmodified form to the vehicle OBU 9 or in edited form, for example in a processed and/or supplemented form. In the example shown, the radio beacon 6 supplements the characteristic data KD with a current time stamp t_n and its own radio beacon identifier RS_n to obtain edited characteristic data KD'. The vehicle OBU 9 receives the characteristic data KD, KD' forwarded from the radio beacon 6 by way of a transceiver 21 and processor 22 and writes the same to a memory 23.

Every time a radio beacon 6 is passed, a new characteristic data record KD or KD' is written to the memory 23. The memory 23 thus contains a complete log of the respective associations that were detected during the radio beacon passages between a first OBU 9, which here is the vehicle OBU, and a second OBU 10, which here is the cargo OBU, which were part of a common tractor-trailer 1.

The operating principles of the cargo OBU 10 and vehicle OBU 9 in FIGS. 2 and 3 can of course be interchanged, which is to say the radio beacon 6 can read out the characteristic data KD from a vehicle OBU 9 and write to a cargo OBU 10, so that a cargo OBU 10 can prepare a log of the means by which this was transported. It is also possible for double provision of the described method, which is to say to transmit both characteristic data from the one OBU 9 to the other OBU 10 and from the other OBU 10 to the one OBU 9 - either in edited or unedited form - so that both OBUs 9, 10 fill a respective memory 23 with a log of pass associations.

The content of the memory 23 can thereafter be read from the respective OBU 9, 10 for control, enforcement or evidence purposes, for example via a wired interface or the transceiver 20, 21. For this purpose, for example, a portable read device can be used, which establishes a radio communication 7, 8 with the OBU 9, 10 and reads out the content of the memory.

Optionally, with each beacon passage, the determined association between two OBUs 9, 10 can be recorded in the radio beacon 6 and/or the central system 11 in conjunction with the read-out characteristic data KD. For example, the content of the memory 23 can be "mirrored" in the database 12 - in each case supplemented with the identifier OID_A of the OBU in which the memory 23 is located - for further enforcement and evidence purposes.

If desired, the radio beacon 6 can prioritize the radio communications 7 or 7' with the OBU from which the characteristic data record KD is supposed to be read, over the radio communications 8 or 8', by way of which the characteristic data record KD, KD' is written to another OUB. For this purpose, all prioritization methods that are known in the prior art for radio communications between a radio beacon and several OBUs passing the same may be employed. The methods described in EP 2 431 946 A1 by the same applicant are particularly suited.

It is thus possible, for example based on properties, identifiers, speeds, locations and the like of the OBUs 9, 10, to identify the respective OBU 10 to be read out first and to prioritize, in terms of time, the radio communications 7 with respect to the radio communications 8. It can thus be assured that the characteristic data KD from a previously concluded, because of a higher priority, radio communication 7' are already available during the radio communication 8'.

The invention is not limited to the shown embodiments, but encompasses all variants and modifications that are covered by the scope of the accompanying claims.

FREMANGSMÅDE TIL DETEKTERING AF KØRETØJER MED LAST

PATENTKRAV

1. Fremgangsmåde til detektering af køretøjer (2) med last (3) i et trafiktelematiksystem (5), som omfatter mindst ét radiofyr (6) til radiokommunikation (7, 8) med OBU'er (=on-board units, køretøjsenheder) (9, 10), der medføres af køretøjerne (2) og lasten (3),
 hvor OBU'en (9) for et køretøj (2) og OBU'en (10) for en last (3) detekteres som tilhørende hinanden, når en evaluering af deres radiokommunikationer (7, 8) med radiofyret (6) viser, at de bevæger sig med begrænset og konstant indbyrdes afstand,
kendetegnet ved, at radiofyret (6) sender karakteristiske data (KD), som modtages fra den ene OBU (10), enten i redigeret eller uredigeret form, til den anden OBU (9), som registrerer de modtagne karakteristiske data (KD, KD') i en hukommelse (23).
2. Fremgangsmåde ifølge krav 1, **kendetegnet ved**, at de registrerede karakteristiske data (KD, KD') udlæses via et interface (21) til kontrolformål, fortrinsvis via radiokommunikation.
3. Fremgangsmåde ifølge krav 1 eller 2, **kendetegnet ved**, at radiofyret (6) tilføjer et tidsstempel (t_n) og/eller en identifikator (RS_n) for radiofyret (6) til de karakteristiske data (KD, KD').
4. Fremgangsmåde ifølge et af kravene 1 til 3, **kendetegnet ved**, at de karakteristiske data (KD, KD') omfatter en identifikator (OID_B , OID_C) for den ene OBU (10).
5. Fremgangsmåde ifølge et af kravene 1 til 4, **kendetegnet ved**, at den ene OBU (10) er forbundet med lasten (3), og den anden OBU (9) er forbundet med køretøjet (2).
6. Fremgangsmåde ifølge krav 5, **kendetegnet ved**, at de karakteristiske data (KD, KD') omfatter en identifikator (LD_{Bi} , LD_{Ci}) for lasten (3).
7. Fremgangsmåde ifølge et af kravene 1 til 6, **kendetegnet ved**, at de to OBU'er (9, 10) er anbragt ved siden af hinanden i køretøjet (3).

8. Fremgangsmåde ifølge et af kravene 1 til 7 **kendetegnet ved**, at afviklingen af radiokommunikationen (7') med den ene OBU (10) behandles i radiofyret (6) med højere prioritet end afviklingen af radiokommunikationen (8') med den anden OBU (9).
9. Fremgangsmåde ifølge et af kravene 1 til 8, **kendetegnet ved**, at den førnævnte evaluering, faseskiftet mellem de to radiokommunikationer (7, 8), anvendes til at måle afstanden mellem OBU'erne (9, 10).
10. Fremgangsmåde ifølge et af kravene 1 til 9, **kendetegnet ved**, at den førnævnte evaluering, amplitudeforskellen mellem de to radiokommunikationer (7, 8), anvendes til at måle afstanden mellem OBU'erne (9, 10).
- 10 11. Fremgangsmåde ifølge et af kravene 1 til 10, **kendetegnet ved**, at den førnævnte evaluering, Doppler-forskydningerne i de to radiokommunikationer (7, 8), anvendes til at måle OBU'ernes (9, 10) bevægelser.
12. Fremgangsmåde ifølge et af kravene 1 til 11, **kendetegnet ved**, at den førnævnte evaluering, kun radiokommunikationer (7, 8) i et forudbestemt tidsvindue, 15 tages i betragtning.
13. Fremgangsmåde ifølge et af kravene 1 til 12, **kendetegnet ved**, at radiofyrene (6) er DSRC-radiofyre, og OBU'erne (9, 10) er DSRC-OBU'er.
14. Fremgangsmåde ifølge et af kravene 1 til 13, **kendetegnet ved**, at lasten (3) trækkes af køretøjet (2) i form af en anhænger.
- 20 15. Fremgangsmåde ifølge et af kravene 1 til 13, **kendetegnet ved**, at lasten (3) transporteres på køretøjet (2) eller en anhænger dertil.
-

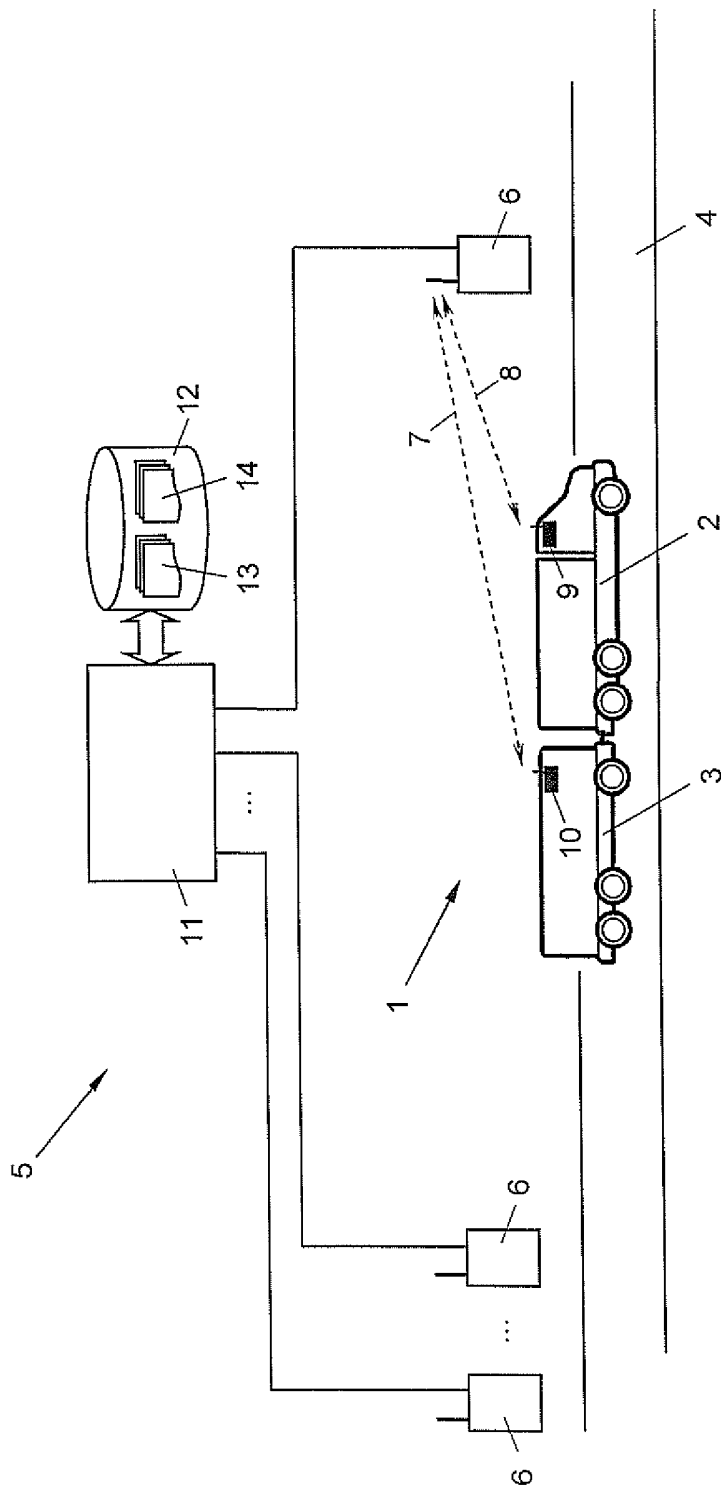


Fig. 1

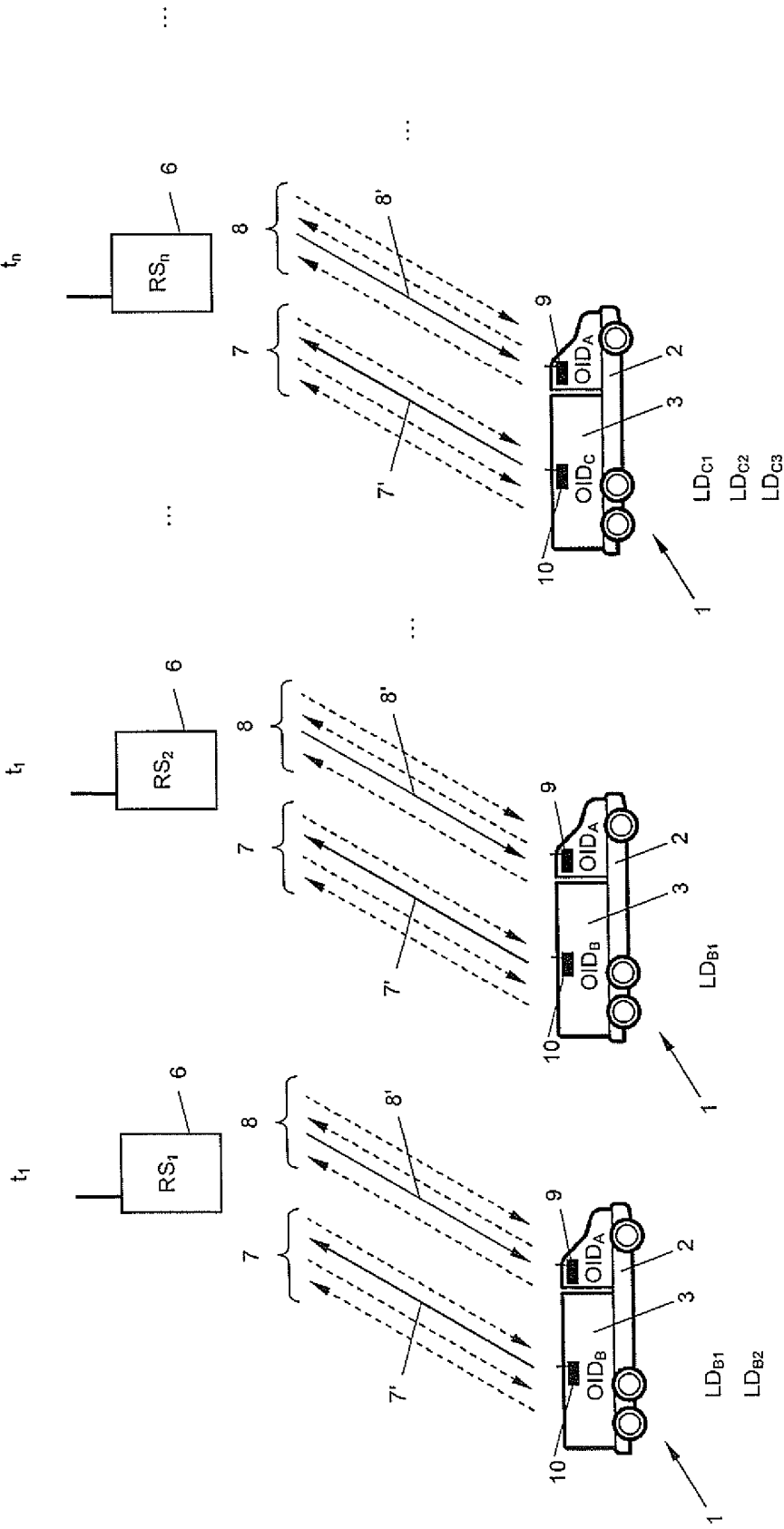


Fig. 2

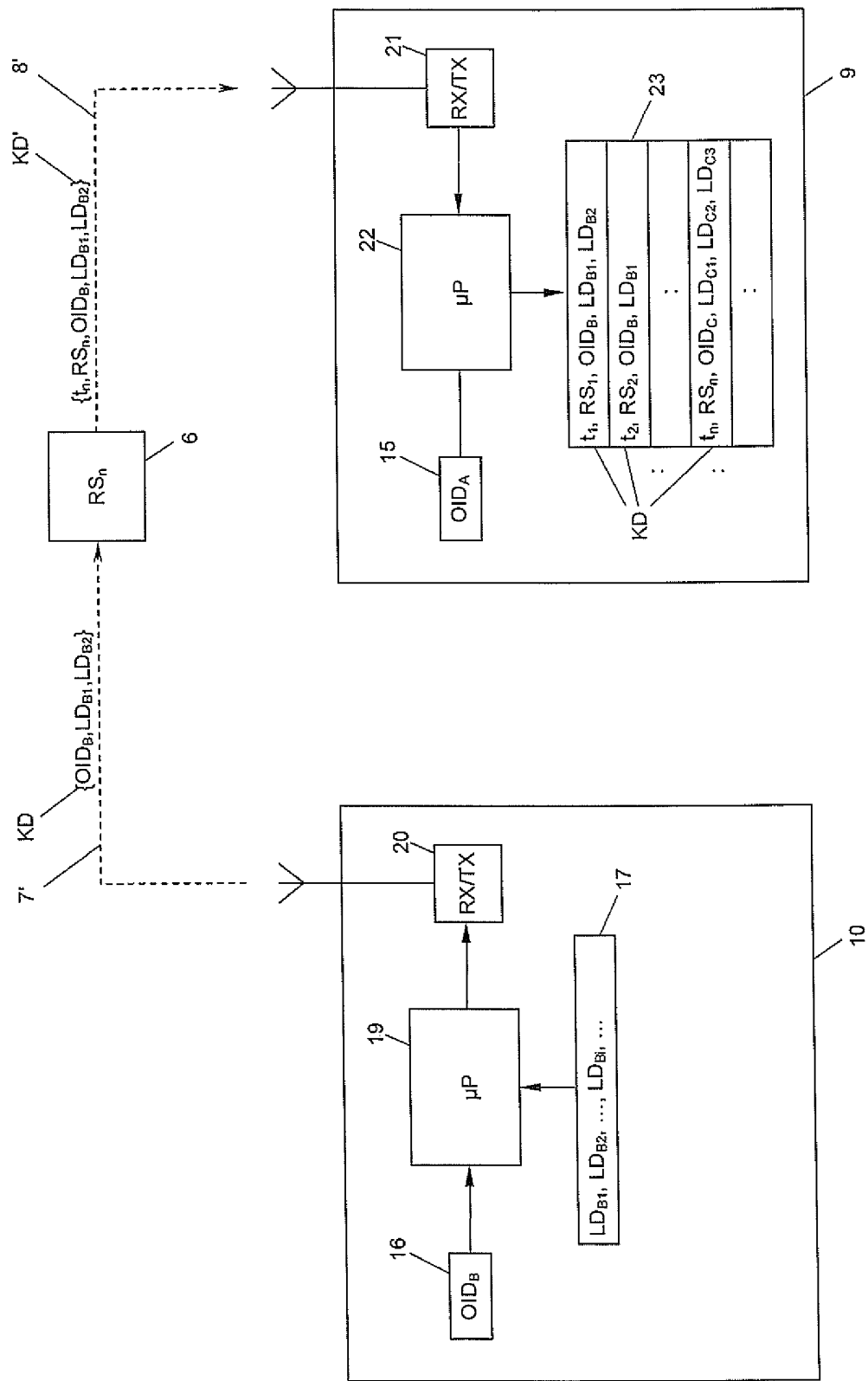


Fig. 3