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A Process for Transmitting Information Between Moving Bodies and a Communication Device for Carrying Out This Process

The invention relates to a process for transmitting information between moving bodies according to the preamble to claim 1 and a communication device for carrying out the process according to the preamble to claim 4.

Communications systems have been disclosed in which information is sent to a particular receiver by means of a correspondingly modulated radio message originating from a stationary or mobile sender. For many uses, this bilateral communication is completely sufficient. However, there is an increasing demand for multilateral information exchange between moving bodies. Moving bodies are understood here to mean, in the broadest sense, any bodies which can change location in relation to one another, for example even driverless transport systems which are equipped with a separate intelligence and coordinate their movements with one another. In the following, though, the considerations primarily relate to vehicles of street, rail, and air traffic.

The object of the invention is to disclose a process and a communication device by means of which information can

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be very rapidly transmitted to a large number of moving bodies, in particular vehicles.

According to the invention, the object is attained by means of the characterizing features of claims 1 and 4, respectively. The transmission of information is based on the cascade-like dissemination of a radio message, wherein the communication device of each vehicle in a sense functions as a relay station. The original radio message designated for transmission can be generated by a stationary transmitter as well as by a vehicle. The radio message contains limit parameters to end the information transmission. One such limit parameter can be a predetermined dissemination time, a location-based dissemination area in which the relevant information is of interest, or also a response to a query.

For example, the whereabouts of a vehicle, in particular one being sought by the police can be of interest. To that end, according to claim 2, each communication device contains a vehicle-specific identification, which in the event of the receipt of a radio message, is automatically added to the radio message and transmitted further. The identification of the vehicle from which the radio message was received can also be overwritten by this new identification.

According to an advantageous modification described in

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claim 3, when there is a result of the query, a new radio message that contains this result is generated and disseminated. After a period of time, the search result is consequently sent back to the requesting point, for example a police station, in the same manner as the query. However, it is also possible to retrieve the search result at another point in the communication cascade.

The dissemination speed of a radio message or the time that elapses between the dissemination of a query and the existence of a response depends in a completely crucial manner on the equipment density of vehicles with the communication device for receiving and sending radio messages. At an equipment density of approximately 0.1% and a range of the radio message of approximately 100 m, a piece of information is disseminated to all of Germany within approximately 10 hours. If the equipment density is 10%, the dissemination time for Germany falls to a few seconds.

Even if when turned off, a sought after vehicle identifies itself as the vehicle sought to another vehicle that is disseminating the search message. Then a new, (secret) message as to where the sought after vehicle was found, travels in the same manner back to the sender of the search message, in particular the police, who can trace the vehicle in a well-directed manner. Preferably, a send/receive antenna is cast into the windshield and is

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embodied as a retroreflector. The retroreflector responds even when the remaining subassemblies of the communication system are not operational or have been shut down by manipulation.

Interests of data protection can be taken into consideration by virtue of the fact that a sought after vehicle only identifies itself if the requesting point, in particular the police, has a code which can be communicated only to the vehicle owner, wherein this code is a component of the vehicle identification.

The process claimed is distinguished in particular by means of speed and economy. A particular infrastructure is not required so that communication costs are not incurred.

In order to give the vehicle owner an incentive to purchase the communication device, in addition to devices for receiving and sending radio messages, the communication device according to claim 4 should also have a device for evaluating the radio message. As a result, the vehicle is used not only as a passive relay station, in which information is received and passed along. In addition, there is the possibility of using all of the information or particular information contained in the radio message for one's own purposes.

According to claim 5, information of this kind is preferably indicated optically or acoustically. It can, for

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example, be information as to the traffic density. Vehicles that can automatically detect traffic jams by evaluating the speed profile or the emergency blinkers of other vehicles, transmit corresponding information into the surrounding area. This information as well as the corresponding information regarding the breaking up of the traffic jam are then disseminated in accordance with the process described above. Primarily location-based limitations are used as the limit parameters in this instance so that the dissemination area is of a size in which a traffic report can be expected to be of interest. Moreover, vehicles can also automatically determine the road conditions, in particular, whether the road is slippery. The outside temperature and the slip detected in the driving wheels can be used as measurement values for this. Furthermore, the detection of empty parking spaces or spaces that have just opened up is of practical significance. Vehicles can automatically detect when they are leaving a parking space. This fact and the location of the parking space can be disseminated via a radio message. The device for evaluating the radio message displays this information to interested drivers of other vehicles. Vehicles can furthermore automatically detect when they are involved in an accident. The location of the accident, possibly along with details that are of interest to a rescue service, can be automatically disseminated by means of a

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radio message. The drivers of other vehicles can use this information in order to avoid chain reaction accidents. Vehicles which are equipped with a map navigation device can automatically determine deviations between the path traveled and the streets plotted. These can be either newly constructed roads or changes due to construction sites. Occasional forays into open country can be detected because they do not recur. The information as to map changes that is obtained in this manner can be transmitted with the dissemination of radio messages by means of the device for evaluating radio messages from other vehicles and stationary dispatch centers and the like.

Claim 6 relates to determination of ones own position and the support of other vehicles in service of the same task. Vehicles that can determine their relative position in relation to other vehicles can determine their own absolute position if they use absolute position data from another vehicle. The absolute position determined in this manner is transmitted to other vehicles, which can determine their own absolute position from it. The precision decreases with each successive coupling. Occasionally, though, there are vehicles within range of the radio message, which can determine an absolute position directly by means of cartographic correlation and/or GPS, by means of which errors due to successive coupling are corrected. In actual

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use, an acceptable precision is achieved for all participating vehicles if there is a minimum density of vehicles with absolute positioning determination. In order to increase this density, sending beacons, for example stationed at the side of the road can also be used. This kind of sending beacons, which continuously transmit a position signal, can be used to particular advantage in position determinations whose height coordinate is important, for example in parking structures.

A communication device with a device for evaluating radio messages can be used according to claim 7, preferably for fleet management tasks, in particular of public mass transit, by shipping entities, and vehicle rental companies. The fleet members communicate with dispatch centers and with one another without having to pay for a cost-intensive infrastructure for the transmission of information.

Preferably, the communication device according to claim 8 is based on the use of DSRC frequencies (dedicated short range communication) of 5.8 GHz and/or 64 GHz, wherein the range of the radio message is approximately 100 m and the data rate lies in the Mbit/sec range.

The invention will be explained in detail below in conjunction with two graphic representations.

Fig. 1 is a symbolic depiction of the process and

Fig. 2 is a schematic representation of the components

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for realizing the process.

In the example of a police search message, Fig. 1 shows the tracing of a vehicle 1 with a particular identification with code data of the vehicle owner. Once sent, the radio message (dash-and-dot depiction), which contains the request and limit parameters for ending the request, is sent by a police station 2 at time (t_1). A first vehicle 3 that happens to pass by is the first to receive this radio message. Immediately after this, a second vehicle 4 and a third vehicle 5 come within range of the radio message, which is now being transmitted by the first vehicle 3. The three vehicles 3, 4, and 5 transmit the radio message with the search request to each vehicle that comes within range of the radio message, which for its part provides for further dissemination in the same manner. It is apparent that even with a low range of the radio message and a low equipment density of the overall number of vehicles with a communication device required for sending and receiving, a cascade-like dissemination occurs with explosive speed. With a range of approximately 100 m and an equipment density of approximately 10%, the information has spread over the entire territory of the Federal Republic of Germany within a few seconds. The sought after vehicle 1 is consequently radio contacted by a vehicle 6 at a time t_2, wherein even when the sought after vehicle continues the journey and

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there is a similar return path, a restriction to a relatively small search area is possible. Even if the return path, i.e. the sending of the response from the sought after vehicle 1 to the police station 2 is comprised by means of another distance made up of the radio transmission between different vehicles, due to very rapid intermixing and multiple contacting, an overall time between the sending of the request by the police station 2 and the receipt of a response by the police station 2 amounts to only approximately $\delta t = 2\ (t_2 - t_1)$.

Fig. 2 shows the cooperation of the most important components of a piece of vehicle equipment for carrying out the information dissemination process, which is described by way of example in conjunction with Fig. 1. The central subassembly is a communication device 6, which receives radio messages 7 from other vehicles 8 and sends them to still other vehicles 8'. The communication device 6 cooperates with an evaluation device 9. Depending on the application, this evaluation device 9 processes information that the communication device 6 has received from other vehicles 8 and data from vehicle sensors 11. Via a database 12 that cooperates with the applications 10, the output signals of the evaluation device 9 are supplied to a user interface 13. According to options set at the user interface 13, an optical and/or acoustical signalization 14 of the

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evaluated information is carried out. The driver of a vehicle thus equipped can select applications 10 by means of the user interface 13 and with the aid of similarly equipped vehicles 8, 8', these applications can, for example, facilitate the vehicle search in the event of theft, visually display traffic conditions, disseminate an accident report, or support automatic driving.

The invention is not limited to the exemplary embodiments given above. Rather, an embodiment of the invention is possible even with the use of fundamentally different types of subassemblies. In particular, the invention is not limited to realization with analog components, but can also be advantageously realized by means of integrated logic components.

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Claims

1. A process for transmitting information between moving bodies, in particular vehicles (3, 4, 5, 8, 8'), wherein each of the moving bodies has a communication device (6) for receiving and sending radio messages (7), characterized in that

   - a radio message (7) is generated, which contains the information and limit parameters, which signalize an end of the information transmission,
   - at least one of the moving bodies receives the radio message (7) and sends it to every other moving body that comes within range of the radio message (7), and
   - for the cascade-like dissemination of the information, every other moving body that has received the radio message (7), sends it to every other moving body that comes within range of the radio message (7).

2. The process according to claim 1, characterized in that the communication device (6) adds specific data to the radio message (7), in particular an identification of

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the moving body.

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3. The device according to claim 2, characterized in that the information includes queries, in particular with regard to the whereabouts of a moving body with a particular identification, wherein the result of the queries is disseminated as a new radio message (7).

4. A communication device (6) for vehicles (3, 4, 5, 8, 8') for carrying out the process according to one of the preceding claims, characterized in that devices are provided for receiving, evaluating, and sending radio messages (7).

5. The communication device (6) according to claim 4, characterized in that the device (9) for evaluating radio messages (7) contains means for optical and/or acoustic signalization (14) of information about:

- traffic density, in particular about the onset and breakup of traffic jams and/or
- road conditions, in particular slipperiness and/or
- empty parking spaces and/or
- traffic accidents, in particular for transmission to emergency services and for the avoidance of chain reaction accidents and/or
- the street network, in particular with regard to new roads or construction sites.

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6. The communication device (6) according to claim 4 or 5, characterized in that the device (9) for evaluating radio messages (7) includes means for the optical and/or acoustic signalization (14) of information about its own whereabouts, wherein at least one reference point is taken as the basis for it, in particular the coordinates of a sending beacon or the whereabouts of other vehicles (3, 4, 5, 8, 8'), determined by means of cartographic correlation, GPS, etc.

7. The communication device (6) according to one of claims 4 to 6, characterized in that in the case of fleet members of public mass transit, shipping entities, and vehicle rental companies, the device (9) for evaluating radio messages (7) includes means for the optical and/or acoustic signalization (14) of information as to whereabouts, status, route planning, etc. of other fleet members.

8. The communication device (6) according to one of claims 4 to 7, characterized in that the radio messages (7) are designed for the DSRC frequencies (dedicated short range communication) 5,8 GHz and/or 64 GHz, wherein the range of the radio message (7) is approx. 100m and the data rate lies in the Mbit/second range.

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