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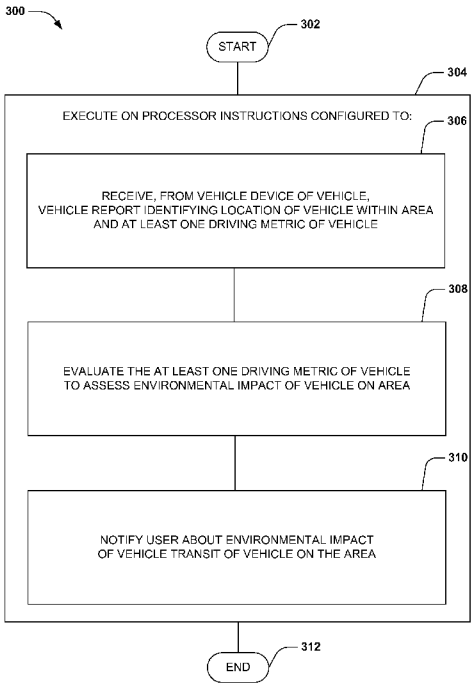

FIG. 3

(57) Abstract: The environmental impact of vehicle transit through an area is often evaluated through indirect and/or aggregate metrics, such as visibility and/or health effects from smog, or the contamination of air or water quality. However, such environmental metrics may be inaccurate, incomplete, delayed, and/or insufficient to inform a user of a vehicle as to the environmental impact of the vehicle transit of his or her vehicle on the environment. Instead, a vehicle device may collect driving metrics for a vehicle, and may transmit such driving metrics to an environmental monitoring service, which may correlate such driving metrics for the vehicle with the environmental impact. A notification of environmental impact may be transmitted back to the vehicle device, which may present the environmental impact to the user, and/or may adjust an autonomous operation of the vehicle, such as a speed or route of the vehicle, in view of the environmental impact.

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ASSESSING ENVIRONMENTAL IMPACT OF VEHICLE TRANSIT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority under 35 U.S.C. § 119(e) to U.S. Patent Application No. 61/946,962, filed on March 3, 2014, the entirety of which is incorporated by reference as if fully rewritten herein.

BACKGROUND

[0002] Within the field of computing, many scenarios involve an evaluation of an environmental impact of vehicle transit on an environment, such as the pollution and/or health impacts caused on a residential neighborhood by a recurring volume of vehicle transit. Such evaluation is often performed by measuring the consequences of such vehicle transit, *e.g.*, measurements of levels of contaminants in the air and water of the environment, or measurements of the health of the residents of the neighborhood. The evaluation of the environmental effects may be generated for the environment and reported to the public, including the residents of the environment, the individuals operating and/or occupying such vehicles in transit through the environment, and/or a transit service that is responsible for managing transit to reduce the environmental impact on the area.

SUMMARY

[0003] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key factors or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0004] While techniques for assessing the environmental impact of vehicle transit in the aggregate may enable policy decisions, some problems may arise that affect the effectiveness of such evaluation. As a first example, the environmental impact and/or its observation may be delayed; *e.g.*, pollution may contaminate an environment slowly but steadily over time, and the

environmental impact may not be appreciated until significant contamination has occurred. As a second such example, the evaluation of the environmental impact through indirect, correlational metrics may be inaccurate and/or untrusted; *e.g.*, the health quality of residents of a neighborhood may be impacted either by vehicle transit or by other environmental factors such as weather patterns, and adjusting transit policy based on such correlation may be ineffective and/or difficult to promote. As a third such example, the reporting of metrics for an aggregate of vehicle transit, such as an entire population of a city over the course of a year, may not adequately inform an individual who operates and/or occupies such a vehicle about the specific impact of his or her transit on the environment. Rather, the individual may perceive his or her contribution to the environmental impact as only a miniscule portion of the aggregate environmental impact, and may not appreciate the significance of the choices of the individual on the environmental impact. Morever, because various choices may have a different environmental impact in different circumstances (*e.g.*, driving a high-pollution vehicle in an area that is not particularly damaged by pollution may be less harmful than driving a low-pollution vehicle in an area that is especially sensitive to pollution, such as a wildlife reserve), heuristics about the general environmental impact of different driving metrics may be inaccurate. As a fourth such example, a transit service may seek to adjust policy for specific individuals and/or groups of individuals (*e.g.*, assessing a selective transit tax to individuals whose driving metric is particularly impactful upon the environment), but it may be difficult for the transit service to do so if environmental impact information is only available in the aggregate.

[0005] Presented herein are techniques for informing users of the environmental impact of vehicle transit in an area. As a first example of the techniques presented herein, a device may receive, from a vehicle device of a vehicle, a identifying a location of the vehicle within the area and at least one driving metric of the vehicle. The device may evaluate the at least one driving metric of the vehicle to assess an environmental impact of the vehicle on the area, and notify the user about the environmental impact of the vehicle transit of the vehicle on the area.

[0006] As a second example of the techniques presented herein, a server (such as a server of a transit service) may utilize a system that informs a user about an environmental impact of vehicle transit in an area. The server may comprise a vehicle report receiver that receives, from a vehicle device of a vehicle, a vehicle report identifying a location of the vehicle within the area and at least one driving metric of the vehicle. The system may comprise an environmental impact evaluator that evaluates the at least one driving metric of the vehicle to assess an environmental impact of the vehicle on the area; and an environmental impact notifier that notifies the user about the environmental impact of the vehicle transit of the vehicle on the area.

[0007] As a third example of the techniques presented herein, a vehicle device may utilize a system that notifies a user of a vehicle about an environmental impact of vehicle transit of the vehicle in an area. The vehicle device may comprise a location detector that detects a location of the vehicle. The system may comprise a vehicle telemetry detector that detects at least one driving metric of the vehicle; a vehicle report transmitter that transmits, to a transit service, a vehicle report indicating the at least one driving metric of the vehicle and a location of the vehicle; and an environmental impact notifier that, upon receiving from the transit service a notification of an environmental impact of the vehicle transit of the vehicle on the area, presents the notification of the environmental impact to the user. In this manner, various embodiments may inform users of the environmental impact of transit navigation in accordance with the techniques presented herein.

[0008] To the accomplishment of the foregoing and related ends, the following description and annexed drawings set forth certain illustrative aspects and implementations. These are indicative of but a few of the various ways in which one or more aspects may be employed. Other aspects, advantages, and novel features of the disclosure will become apparent from the following detailed description when considered in conjunction with the annexed drawings.

DESCRIPTION OF THE DRAWINGS

[0009] Fig. 1 is an illustration of an example scenario featuring an estimation of an environmental impact of vehicle transit on areas of a region.

[0010] Fig. 2 is an illustration of an example scenario featuring an environmental impact report delivered to a user of an environmental impact of vehicle transit on areas of a region in accordance with the techniques presented herein.

[0011] Fig. 3 is an illustration of an example method of informing a user of an environmental impact of vehicle transit on an area, in accordance with the techniques presented herein.

[0012] Fig. 4 is an illustration of an example transit service that notifies users of an environmental impact of vehicle transit on an area, in accordance with the techniques presented herein.

[0013] Fig. 5 is an illustration of an example vehicle device that notifies a user the vehicle of an environmental impact of vehicle transit of the vehicle on an area, in accordance with the techniques presented herein.

[0014] Fig. 6 is an illustration of an example computer-readable medium comprising processor-executable instructions configured to embody one or more of the provisions set forth herein.

[0015] Fig. 7 is an illustration of an example technique for assessing an environmental impact of vehicle transit of a vehicle on an area, in accordance with the techniques presented herein.

[0016] Fig. 8 is an illustration of example techniques for informing an individual of an environmental impact of vehicle travel on various areas, in accordance with the techniques presented herein.

[0017] Fig. 9 is an illustration of an example technique for controlling a transit pattern in a region according to an environmental impact of the vehicle travel on various areas, in accordance with the techniques presented herein.

[0018] Fig. 10 is an illustration of an example computing environment wherein one or more of the provisions set forth herein may be implemented.

DETAILED DESCRIPTION

[0019] The claimed subject matter is now described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the claimed subject matter. It may be evident, however, that the claimed subject matter may be practiced without these specific details. In other instances, structures and devices are shown in block diagram form in order to facilitate describing the claimed subject matter.

[0020] A. Introduction

[0021] Fig. 1 is an illustration of an example scenario 100 featuring techniques for assessing an environmental impact of vehicle transit of various vehicles 104 on a set of areas 102 within a region. In this example scenario 100, a road is provided adjacent to a set of areas 102 of a region such as a city, and users 108 operate or occupy vehicles 104 during vehicle transit through such areas 102 according to a driving metric 106, such as an average speed; braking or acceleration rates; and the use of a broadcast radio that creates loud noise in the area 102. The users 108 and/or vehicles 104 may be equipped with a vehicle device 122, such as a navigation system of the vehicle 104 and/or a mobile device such as a phone, that is capable of monitoring the driving metrics 106 of the user 108. The various types of vehicle transit and driving metrics 106 may have an environmental impact on the areas 102. Such environmental impacts 110 may include pollution 112, such as leakage of chemicals such as fuel and oil, particulate exhaust such as smog, consumption of vehicle components such as tires, heat, noise pollution, and light pollution. Such environmental impacts 110 may also include other factors, such as a safety risk, loss of property value, or reduced quality of life. Together, such environmental impacts 110 may harm the health and numbers of individuals, animals, and plants in the areas 106; may degrade the aesthetic appearance and value of the areas 102; and/or may interfere with or prohibit some uses of the areas 102, such as contaminating farmland in a

manner that is not compatible with growing edible crops. Moreover, it may be appreciated that different vehicle types may create different types and quantities of environmental impact 110; *e.g.*, a truck may have a greater environmental impact 110 than a conventional automobile, which in turn may have a greater environmental impact 110 than a fuel-efficient automobile, such as an electric vehicle.

[0022] A transit service 116 may be provided to perform an assessment 118 of the environmental impact 110 of the vehicle transit on the areas 102. For example, the transit service 116 may monitor levels of pollution 112 over time; perform an assessment 118 of the vehicles 104 of respective users to implement environmental regulatory standards; and/or survey the health quality of the residents and wildlife in areas 102 near the vehicle transit. Correlational patterns of environmental impact 110 on such metrics may enable the transit service 116 to draw conclusions as to the relative and aggregate environmental impact 110 of the respective vehicles 104 on the areas 102, such as trends in the accumulation of pollution 112, and the health hazards to residents of areas 102 exhibiting high levels of pollution 112, such as rates of asthma. The transit service 116 may publicize its findings as an environmental impact report 112, which may describe, in extensive detail, the current environmental impact 110 on respective areas 102, and may establish policy findings around the environmental impact report 112, such as establishing higher tax rates for users who own more impactful vehicles 102 and tax credits for users who own less impactful vehicles 102, and public transit schedules that may reduce the volume and environmental impact 110 of vehicle transit.

[0023] The publication of an environmental impact report 120 reflecting the assessment 118 by the transit service 116 of the environmental impact 110 of vehicle transit may enable users 108 to evaluate broad trends about environmental quality. However, in many respects, such techniques may not adequately inform such users 108 about the direct consequences of their actions and choices on the overall environmental quality on various areas 102 of the environment.

[0024] As a first such example, the assessment 118 of the transit service 116 may produce observations of the environmental impact 110 only after an extensive delay. For example, many forms of pollution 112 may accumulate slowly over time, and may not be assessed or even noticed until crossing a visibility threshold, by which time the consequences may already have manifested and remediation may be costly.

[0025] As a second such example, the evaluation of the environmental impact 110 of vehicle transit through an assessment of indirect factors, such as pollution levels over time, may be inaccurate and/or unreliable. For example, pollution 112 such as smog may accumulate in an area 102 may be assessed as originating from nearby vehicle transit, but may originate at a distant factory and may be carried into the area 102 by air currents. Conversely, pollution 112 in an area 102 from vehicle transit may be deemed inconsequential, when in fact such pollution 112 is considerable but is conveyed to an adjacent area 102 by air currents. Accordingly, measures to increase or decrease a volume of vehicle transit may be implemented, but may not appear to affect the area 102 as anticipated.

[0026] As a third such example, an environmental impact report 120 may be reported to reflect the aggregate effect of vehicle transit on the environment of selected areas 102 or an entire region, and optionally over lengthy periods, such as an annual assessment 118; however, a user 108 of a vehicle 104 may have difficulty understanding the significance of his or her daily actions and choices on such aggregate environmental impact data. For example, the user 108 may deem his or her contribution to the environmental impact to be miniscule, and may therefore not be compelled to alter his or her driving behavior. Moreover, a user 108 may interpret the environmental impact report 120 as describing the region in general, and may not appreciate that the environmental impact 110 affects specific areas 102, such as the user's own neighborhood.

[0027] As a fourth such example, the complexity of such data may cause users 108 to develop incorrect conclusions about their contribution to the aggregate environmental impact. For example, in the example scenario 100 of Fig. 1, a first user 108 and a second user 108 within a first area 102, and the

first user 108 may typically drive more slowly and may drive a more fuel-efficient vehicle. However, because the first user 108 drives through the area 102 much more often than the second user 108, the environmental impact 110 of the first user 108 on the first area 102 may be more severe than that of the second user 108, and may be surprised to learn that the user's daily choices considerably affect the health of residents of a neighborhood 114 within the first area 102. As a second such example, users 108 may occupy vehicles 104 in transit through a second area 104, and may drive at slow rates in order to reduce the impact on the second area 102 in accordance with suggestions from a vehicle device 122, while a user 108 in a third area 104 may drive a highly impactful vehicle 104 at a high rate. However, the environmental impact 110 on the second area 116 may be considerably more severe, because the second area 102 may comprise a wildlife reserve 116 that is highly sensitive to pollution 112, while the third area comprises an abandoned area that is not significantly affected by pollution 112 from the third vehicle 104. Accordingly, the understanding and expectations of the users 108 of the vehicles 104 may not match the actual environmental impact 110 of the users' choices on various areas 102 of the environment. For example, users 108 who routinely operate vehicles 104 near the wildlife reserve 116 may significantly reduce their environmental impact 110 by choosing a different route for routine transit, but may simply not understand the causal relationship or understand the opportunity for such reduction. Indeed, the users' choices may instill a false sense of environmental responsibility, and an entire population of the region that strives to make responsible choices may be surprised by the severe aggregate environmental impact 110 on the region due to the inaccuracy of their self-assessment.

[0028] As a fourth such example, the transit service 116 may seek to adjust policy for specific individuals and/or groups of users 108 (*e.g.*, assessing a selective transit tax to users 108 whose driving metric is particularly impactful upon the environment). However, it may be difficult for the transit service 116 to do so if information about the environmental impact 110 of such driving metrics 106 is only available in the aggregate. For example, the transit service 116 may seek a tax for users 108 who habitually

drive fast, but it may be difficult for the transit service 116 to determine which users 108 chronically operate their vehicles 104 in such a manner, and to distinguish between users 108 who drive fast but in ways that are otherwise not environmentally impactful, and users 108 whose fast driving imposes a significant environmental impact 110 on an area 102. These and other difficulties may arise in the application of an environmental impact report 120 to adjust the driving metric 106 and other actions and choices of users 108 of vehicles 104 in the context of vehicle transit that affects the environment of the areas 102.

[0029] B. Presented Techniques

[0030] Fig. 2 is an illustration of an example scenario 200 featuring techniques for informing users 108 of the environmental impact 110 of their individual operation of a vehicle 104 in transit through an area 102, in accordance with the techniques presented herein.

[0031] In this example scenario 200, various users 108 may operate or occupy vehicles 104 in transit through various areas 102, and may do so according to a driving metric 106, such as a typical speed. Vehicle devices 122 on board such vehicles 104 may issue a vehicle report 202 to the transit service 116 that specifies the location of the vehicle 210, as well as the driving metric 106 of the user 108 while operating the vehicle 104. The transit service 116 may perform a per-vehicle assessment 204 of the specific environmental impact 206 of the transit of the vehicle 104 on the location 102, taking into account both details of the location 102 (*e.g.*, whether the location 102 represents a residential neighborhood, a wildlife reserve, or an abandoned area), and may generate an environmental impact report 206 describing the specific environmental impact 110 of the transit of the vehicle 104 of the user 108 on the specific area 102. The transit service 116 may transmit 208 the environmental impact report 206 to the vehicle 104, which may present the environmental impact report 206 to the user 108, and/or may use the environmental impact report 206 to adjust the operation of the vehicle 104 by a vehicle control system, such as a navigation device that selects a different

route having a lower environmental impact 206, and/or reduces the speed of the vehicle 104 in areas 102 that are affected by the vehicle transit. In this manner, the transit service 106 and vehicle devices 122 may inform users 108 of their individual environmental impact 206 on specific areas 102 of the environment, and may otherwise be utilized to reduce the environmental impact of such vehicle transit, in accordance with the techniques presented herein.

[0032] **C. Technical Effects**

[0033] The techniques presented herein may provide a variety of technical effects in the scenarios provided herein.

[0034] As a first such example, the techniques provided herein may inform users 108 of the relationship between their choices and actions (*e.g.*, their choice of vehicles 104 and routes, and their driving metrics 106) and the environmental impact 206 on specific areas 102 of the environment. Such direct and personalized information may be much more persuasive to the user 108 than generalized information about the environmental impact 206 of all vehicle transit on a general region. Additionally, the techniques presented herein enable the assessment 118 of such environment 206 to be not only personalized, *i.e.*, specific to the user 108 and the user's driving metric 106, and also targeted, *i.e.*, demonstrating the environmental impact 206 on a specific area 102, but also timely; *e.g.*, the automated transmission of a vehicle report 202 to a transit service 116, and the prompt return of the per-vehicle assessment 204 to the vehicle device 122 for presentation to the user 108, may enable a real-time assessment and reporting of the user's environmental impact 206. Such real-time reporting to the user 108 may prompt the user 108 to make different choices, such as reducing speed or taking a different route, as compared with a retrospective environmental impact report 120 explaining the environmental impact 206 of such actions over the past year.

[0035] As a second such example, the automated reporting of vehicle reports 202 by a vehicle device 122 to the transit service 116 may provide

data that is individualized (*e.g.*, enabling the transit service 116 to evaluate driving behaviors and formulate policy that is specific to the driving metrics 106 of respective users 108). The collection of data in this manner may therefore be more accurate, as specific metrics for the driving metrics 106 of users 108 in a particular area 102 and the date and time of such vehicle through the area 102 may enable more direct conclusions about the environmental impact 206 on the area 102.

[0036] As a third such example, the automated reporting of vehicle reports 202 by a vehicle device 122 to the transit service 116 may provide data in a real-time (*e.g.*, informing the transit service 116 that current vehicle transit is causing a strong environmental impact 206 on an area 102, and enabling the transit service 116 to remediate the current environmental impact 206 by altering vehicle transit in the area 102, such as re-routing users 108 around a sensitive or overly impacted area 102). Such techniques therefore enable the transit service 116 to respond to and reduce a presently developing environmental impact 206, rather than an assessment 118 of a previously incurred environmental impact 206, which may impose an irreversible toll on the health of a population and/or may be much more costly to remediate than to reduce in the present. These and other technical advantages may arise from the automated submission and collection of vehicle reports 202, the per-vehicle assessment 204 by the transit service 116, and the individualized and real-time reporting of environmental impact reports 206 to the users 108 engaging in such vehicle transit in accordance with the techniques presented herein.

[0037] **D. Example Embodiments**

[0038] Fig. 3 presents a first example embodiment of the techniques presented herein, illustrated as an example method 300 of informing a user 108 of a vehicle 104 regarding an environmental impact 206 of vehicle transit on an area 102. The example method 300s may be implemented on a device having a processor, such as a server of a transit service 116 that is responsible for assessing the environmental impact 206 of vehicle transit on

the areas 102 of a region. The example method 300 may be implemented, *e.g.*, as a set of instructions stored in a memory component of the device (*e.g.*, a memory circuit, a platter of a hard disk drive, a solid-state memory component, or a magnetic or optical disc) that, when executed by the processor of the device, cause the device to perform the techniques presented herein.

[0039] The example method 300 begins at 302 and involves executing 304 the instructions on the processor. Specifically, the instructions cause the device to receive 306, from a vehicle device 122 of the vehicle 104, a vehicle report 202 identifying a location 210 of the vehicle 104 within the area 102 and at least one driving metric 106 of the vehicle 104. The instructions also cause the device to evaluate 308 the at least one driving metric 106 of the vehicle 104 to assess an environmental impact 206 of the vehicle 104 on the area 102. The instructions also cause the device to notify 310 the user 108 about the environmental impact 206 of the vehicle transit of the vehicle 104 on the area 102. In this manner, the example method 300 causes the device to inform the user 108 of the environmental impact 206 of the vehicle transit of the user's vehicle 104 on a specific area 102 in accordance with the techniques presented herein, and so ends at 312.

[0040] Fig. 4 presents an illustration of an example scenario 400 featuring a second example embodiment of the techniques presented herein, illustrated as an example server 402 comprising a system 412 that informs a user 108 of a vehicle 104 about the environmental impact 206 of the vehicle transit on an area 102. The example system 412 may be implemented, *e.g.*, on a server 402 of a transit service 116 that is responsible for assessing the environmental impact 206 of vehicle transit on the areas 102 of a region. The server 402 may comprise a processor 404 and a vehicle report receiver 406 that receives, from a vehicle device 122 of a vehicle, a vehicle report identifying a location 210 of the vehicle within the area and at least one driving metric 106 of the vehicle 104, and optionally including other information, such as a vehicle description 418 of the vehicle 104 (*e.g.*, a make, model, year, weight, occupancy, and engine type of the vehicle 104). The server 402 may also utilize other resources, such as access to an environmental impact

database 408 (*e.g.*, the Comprehensive Modal Emission Model (CMEM) database). Respective components of the example system 412 may be implemented, *e.g.*, as a set of instructions stored in a memory 408 of the server 402 and executable on the processor 404 of the server 402, such that the interoperation of the components causes the server 402 to operate according to the techniques presented herein.

[0041] The example system 412 comprises an environmental impact evaluator 414, which evaluates the at least one driving metric 106 of the vehicle 104 to assess an environmental impact 206 of the vehicle 104 on the area 102. For example, the server 402 may correlate the location 210, the at least one driving metric 106, and the vehicle description4 18 with the environmental impact database 408 to determine the environmental impact 206 of such vehicle transit on the area 102. The example system 412 further comprises an environmental impact notifier 416, which notifies the user 108 about the environmental impact 206 of the vehicle transit of the vehicle 104 on the area 102. As one such example, the environmental impact notifier 416 may transmit to the vehicle device 122, for presentation to the user 108, an environmental impact report 206 that rates the environmental impact 206 of the vehicle 104 on the area 102, and, optionally, presents suggestions for reducing the environmental impact 206, such as reducing the speed of the vehicle 104 and/or taking a detour that avoids a wildlife reserve located in the area 102. In this manner, the interoperation of the components of the example system 412 enables the server 420 to notify the user 108 of the environmental impact 206 of the vehicle transit of the vehicle 104 on the area 102 in accordance with the techniques presented herein.

[0042] Fig. 5 presents an illustration of an example scenario 500 featuring a third example embodiment of the techniques presented herein, illustrated as an example vehicle device 502 featuring an example system 510 that informs the user 104 of the environmental impact 206 of vehicle transit on the area 102. The example system 510 may be implemented, *e.g.*, on a vehicle device 502 having a processor 504; a location detector 506 that detects a current location 210 of the vehicle 104 (*e.g.*, a global positioning system (GPS) coordinate); and a memory 508. Respective components of the example

system 510 may be implemented, *e.g.*, as a set of instructions stored in the memory 508 of the vehicle device 502 and executable on the processor 504 of the vehicle device 502, such that the interoperation of the components causes the vehicle device 502 to operate according to the techniques presented herein. The vehicle device 502 is also in communication with a transit service 116, which may be remotely accessible to the vehicle device 502 and/or partly or wholly incorporated within the device 502, and which is capable of assessing the environmental impact 206 of the vehicle transit of the vehicle 104 on the area 102.

[0043] The example system 510 comprises a vehicle telemetry detector 512, which detects at least one driving metric 106 of the vehicle 104 (*e.g.*, by interfacing with an On-Board Diagnostics (OBD-II) interface of the vehicle 104). The example system 510 also comprises a vehicle report transmitter 514, which transmits, to the transit service 116, a vehicle report 202 indicating the at least one driving metric 106 of the vehicle 104 and the location 210 of the vehicle 104, and optionally including other information such as a vehicle description 418 (*e.g.*, a make, model, year, weight, occupancy, and engine type of the vehicle 104). The example system 510 further comprises an environmental impact notifier 516, which, upon receiving from the transit service 116 an environmental impact report 206 describing an environmental impact 206 of the vehicle transit of the vehicle 104 on the area 102, presents the environmental impact report 260 to the user 108. In this manner, the interoperation of the components of the example system 510 enables the vehicle device 502 to inform the user 108 of the environmental impact 206 of the vehicle transit of the vehicle 104 on the area 102 in accordance with the techniques presented herein.

[0044] Still another embodiment involves a computer-readable medium comprising processor-executable instructions configured to apply the techniques presented herein. Such computer-readable media may include, *e.g.*, computer-readable storage media involving a tangible device, such as a memory semiconductor (*e.g.*, a semiconductor utilizing static random access memory (SRAM), dynamic random access memory (DRAM), and/or synchronous dynamic random access memory (SDRAM) technologies), a

platter of a hard disk drive, a flash memory device, or a magnetic or optical disc (such as a CD-R, DVD-R, or floppy disc), encoding a set of computer-readable instructions that, when executed by a processor of a device, cause the device to implement the techniques presented herein. Such computer-readable media may also include (as a class of technologies that are distinct from computer-readable storage media) various types of communications media, such as a signal that may be propagated through various physical phenomena (*e.g.*, an electromagnetic signal, a sound wave signal, or an optical signal) and in various wired scenarios (*e.g.*, via an Ethernet or fiber optic cable) and/or wireless scenarios (*e.g.*, a wireless local area network (WLAN) such as WiFi, a personal area network (PAN) such as Bluetooth, or a cellular or radio network), and which encodes a set of computer-readable instructions that, when executed by a processor of a device, cause the device to implement the techniques presented herein.

[0045] An example computer-readable medium that may be devised in these ways is illustrated in Fig. 6, wherein the implementation 600 comprises a computer-readable medium 602 (e.g., a CD-R, DVD-R, or a platter of a hard disk drive), on which is encoded computer-readable data 604. This computer-readable data 604 in turn comprises a set of computer instructions 606 configured to operate according to the principles set forth herein. As a first such example, the computer instructions 606 may cause the device 610 to utilize a method of informing a user 108 of an environmental impact 206 of a vehicle transit of a vehicle 104 on an area 102, such as the example method 300 of Fig. 3. As a second such example, the computer instructions 606 may provide a server featuring a system for informing a user 108 of an environmental impact 206 of a vehicle transit of a vehicle 104 on an area 102, such as the example server 402 of Fig. 4. As a third such example, the computer instructions 606 may provide a vehicle device featuring a system that informs a user 108 of an environmental impact 206 of a vehicle transit of a vehicle 104 on an area 102, such as the example vehicle device 502 in the example scenario 500 of Fig. 5. Many such computer-readable media may be devised by those of ordinary skill in the art that are configured to operate in accordance with the techniques presented herein.

[0046] E. Variable Aspects

[0047] The techniques discussed herein may be devised with variations in many aspects, and some variations may present additional advantages and/or reduce disadvantages with respect to other variations of these and other techniques. Moreover, some variations may be implemented in combination, and some combinations may feature additional advantages and/or reduced disadvantages through synergistic cooperation. The variations may be incorporated in various embodiments (*e.g.*, the example method 300 of Fig. 3; the example system 412 of Fig. 4; the example system 510 of Fig. 5; and the example computer-readable storage device 602 of Fig. 6) to confer individual and/or synergistic advantages upon such embodiments.

[0048] E1. Scenarios

[0049] A first aspect that may vary among embodiments of these techniques relates to the scenarios wherein such techniques may be utilized.

[0050] As a first variation of this first aspect, the techniques presented herein may be used with many types of vehicles 104, including vehicles such as automobiles, motorcycles, trucks, trains, buses, watercraft, aircraft, drones, and spacecraft. Such techniques may also apply to vehicles 104 that are operated by one or more users 108, and/or by an autonomous control system, optionally with one or more users 108 occupying the vehicle 104 as a passenger.

[0051] As a second variation of this first aspect, the techniques presented herein may enable the evaluation of a wide range of environmental impacts 206 of vehicle transit on a wide variety of areas 108. For example, the environmental impacts 206 included in such per-vehicle assessment 204 may include pollution 112, such as leakage of chemicals such as fuel and oil, particulate exhaust such as smog, consumption of vehicle components such as tires, heat, noise pollution, and light pollution; health and/or safety risks; loss of property value; reduced quality of life; depletion of wildlife populations; and increases in traffic congestion and transit delays. The areas 102 for which such environmental impacts 206 are evaluated may include residential

neighborhoods; schools; industrial parks; wildlife reserves; farms, gardens, and forests; commercial outlets; undeveloped areas; caves; stores of natural resources, such as reservoirs and quarries; waterways; and airspaces. Many such scenarios may be devised to which the techniques presented herein may be advantageously utilized.

[0052] E2. Collection and Assessment of Vehicle Report

[0053] As second aspect that may vary among embodiments of the techniques presented herein involves the manner of generating, transmitting, and collecting vehicle reports 202 from vehicles 104, as well as evaluating such vehicle reports 202 to determine an environmental impact 206 of the vehicle transit on the area 102.

[0054] As a first variation of this second aspect, the vehicle report 202 may contain a variety of information about the vehicle 104 and the vehicle transit. As a first such example, the location 210 of the vehicle 104 may be specified in various ways, such as global positioning system (GPS) coordinates, regional designations such as zip codes, or a location in a road network, such as a kilometer marker, road name, or intersection. As a second such example, the driving metrics 106 of the vehicle report 202 may include a variety of vehicle telemetry received as a vehicle telemetry input of an operating property of the vehicle 104, such as the speed, acceleration, braking patterns, turning patterns, and gear shift patterns, and/or information about the status of the vehicle 104, such as fuel level, oil level, tire pressure, engine functioning, mileage, and adherence to a maintenance schedule. As a third such example, the vehicle report 202 may include other information, such as a vehicle description 418 identifying a make, model, year, weight, occupancy, and engine type of the vehicle 104. For example, respective vehicles 104 may have a vehicle type, and the vehicle report 202 may include an identification of the vehicle type of the vehicle 104, which may be used while assessing the environmental impact 206 of the vehicle 104 on the area 102 by comparing the driving metrics 106 of vehicles 104 of the vehicle type to determine the

environmental impact 206 of the vehicle transit of the vehicle 104 on the area 102.

[0055] As a second variation of this second aspect, the determination of an environmental impact 206 of vehicle transit of a vehicle 104 on an area 106 may be informed by a variety of sources of information. As a first such example, an environmental impact database 408 (*e.g.*, the Comprehensive Modal Emission Model (CMEM) database) may enable a correlation of the details of a vehicle report 202 with an environmental impact 206 on an area 106. Other sources of information include, *e.g.*, historic pollution surveys; current environmental sensor data, such as smog detectors; area data providing information about the area 106 of the vehicle transit, such as population numbers and density, wildlife population, land uses, infrastructure such as sewage and irrigation drainage, and current levels of pollution; and maps and/or forecasts of weather and water patterns, which may influence the concentration and/or distribution of pollution through an area 102. A transit service 116 may utilize such information while evaluating the environmental impact 206 of vehicle transit on an area 102; *e.g.*, if respective locations within the area 104 are described by an environmental parameter, the environmental impact 206 may be evaluated by comparing the driving metrics of the vehicle transit of the vehicle 104 (*e.g.*, exhaust composition) with the environmental parameter of the location of the vehicle 104 (*e.g.*, the ability of weather patterns to concentrate and/or disperse such exhaust in an area 102) to determine the environmental impact 206 of the vehicle transit on the area 102.

[0056] Fig. 7 presents an illustration of an example scenario 700 featuring a third variation of this second aspect, involving a set of sources of information that inform a per-vehicle assessment 204 of a vehicle report 202 to generate an environmental impact report 206 of the vehicle transit on the area 102. In this example scenario 700, a variety of information is provided that enables correlational analysis, such as access to the Comprehensive Modal Emission Model (CMEM) database 702; a historic pollution survey 704 indicating patterns of distribution of pollution in the area 102; a weather forecast 706, such as a prediction of rain or wind in the area 102; an area map 708 providing information about the area 102 of the vehicle transit; and a

pollution metric 712 of the area 102, such as a smog or traffic congestion metric identified by an aerial device 710 such as a drone. Additionally, this information may be provided to a correlational mechanism. For example, an artificial neural network 714 may be developed and trained with a training set to correlate various input factors with predetermined environmental impacts 206, such as case studies that evaluate various types of vehicle transit and measure the resulting levels of pollution. A fully trained artificial neural network 714 may reliably correlate vehicle transit with an environmental impact 206, and may therefore utilize the sets of input provided in the example scenario 700 of Fig. 7 with the vehicle report 202 to achieve the per-vehicle assessment 204 of the vehicle transit on the environmental impact 206 of the area 102, and may therefore generate an environmental impact report 206 to inform the user 108 of such environmental impact 206 in accordance with the techniques presented herein.

[0057] As a fourth variation of this second aspect, the determination of an environmental impact 206 of the vehicle transit on an area 102, and particularly involving a selected driving metric such as vehicle speed, may be compared with a further assessment of the environment. As a first such example, the transit service 116 may further determine a period including vehicle travel of the vehicle 104 in the area 102, and may aggregate the environmental impact 206 of vehicle transit on the area 102 according to the period of the vehicle transit (*e.g.*, tallying the environmental impact 206 of the per-vehicle assessment 204 over various periods, such as times of day or days of the week). The transit service 116 may then compare the environmental impact 206 of vehicle travel on an area 102 during respective periods to identify an environmental impact trend, and may notify the user 108 of the environmental impact trend. As a second such example, the per-vehicle assessment 204 of the environmental impact 206 of vehicle transit on an area 102 may later be compared with an aggregate measurement of the environmental impact 206 to verify or correct the correlational assessment. Moreover, such correlation may enable an update of an environmental impact database 702 with the observed environmental impact 206, and/or a retraining of a correlational mechanism such as an artificial neural network 714 as a

refinement of the correlational assessment. Many such techniques may be utilized to collect vehicle reports 202 and evaluate the environmental impact 206 of vehicle transit of vehicles 104 on an area 102 in accordance with the techniques presented herein.

[0058] E3. Uses of Environmental Impact Assessment

[0059] A third aspect that may vary among embodiments of the techniques presented herein involves the uses of the determination of the environmental impact 206 of vehicle transit on respective areas 102.

[0060] Fig. 8 presents an illustration of a set of exemplary scenarios 800 featuring a first set of variations of this third aspect, whereby vehicle devices 122 may notify the user 108 about the environmental impact 206 of vehicle transit of the vehicle 104 on an area 102, such as the presentation of an environmental impact report 210 generated by a per-vehicle assessment 204 of a transit service 116. As a first such example, a visual and/or audial indicator may be presented to the user 108 by the vehicle device 122, such as a light on the dashboard of the vehicle 104 or an audio or voice cue 804 notifying the user 108 of the environmental impact 206, and optionally including a suggestion for mitigating and/or adjusting to such an environmental impact 206, *e.g.*, that reducing the speed of the vehicle 104 may significantly reduce the environmental impact 206. As a second such example, a visual indicator 810 may be presented on a window 808 of the vehicle 104, and, optionally, may be presented at a selected location 814 on the window 808 that correlates the visual indicator 810 with the location 812 of the area 102 through the window 808 from the perspective of the user 108 (*e.g.*, presenting a visual arrow and/or highlighting the area 102 upon which the environmental impact 206 of the vehicle transit is inflicted). As a third such example, the user 108 may wear one or more wearable devices while operating the vehicle 104, such as a pair of eyeglasses 816 or a wristwatch 818. An environmental impact report 210 may be presented to the use r108 through such wearable devices, *e.g.*, as a visual indicator 820 within the viewable region of the eyeglasses 816 worn by the user 108, and/or as a

vibration alert 822 through the wristwatch 818 of the user 108 to indicate that the environmental impact 206 of the user's operation of the vehicle 104 is significantly high.

[0061] As a second variation of this third aspect, the contents of the environmental impact report 210 may be reevaluated and presented to the user 108 in various ways.

[0062] As a first such example, the user 108 may operate the vehicle 104 during a travel period, and a vehicle device 122 and/or transit service 116 may identify a tally of the environmental impact 206 of the vehicle transit of the vehicle 104 on the area 102 during the travel period (*e.g.*, a total amount of carbon dioxide emitted during the month), and may present the tally to the user 108.

[0063] As a second such example, a vehicle device 122 may receive, from the transit service 116, a comparison of the environmental impact 206 of the vehicle transit of the vehicle 104 on the area 102 with the environmental impact 206 of the vehicle transit of a second vehicle 104 on the area 102. The vehicle device 122 may then present the comparison to the user 108 (*e.g.*, an indication that the user's high driving speed is causing 50% more pollution on an area 102 as compared with a vehicle 104 in the adjacent lane of the road that is driving 20% slower).

[0064] As a third such example, the vehicle device 122 and/or transit service 122 may present, with the environmental impact report 210, a recommendation of a vehicle transit adjustment that reduces the environmental impact 206 of the vehicle transit of the vehicle 104 on the area 102 (*e.g.*, a recommendation to inflate the tires of the vehicle 104 by 5000 pascals in order to improve engine efficiency and reduce pollution on the area 102 by 20%).

[0065] As a fourth such example, the vehicle transit may involve a route of the vehicle 104 to a destination. A route adjuster may identify an alternate route to the destination that reduces the environmental impact 206 of the vehicle 104 on the area 102, and may recommend the alternative route to the user 108. For example, in the example scenario 800 of Fig. 8, the vehicle

device 122 detects that an area 102 ahead of the vehicle 104 on the road exhibits a high concentration of pollution, and may advise the user 108 to take a detour in order to avoid exacerbating the pollution of the area 102, and/or to avoid exposing the user 108 to the pollution. As a second such example, respective locations within the area 102 may be associated with an environmental sensitivity to vehicle transit, and an alternate route may be identified through locations within the area 102 that together exhibit a lower environmental sensitivity to vehicle transit than the locations of the current route (*e.g.*, routing around a wildlife reserve that is susceptible to pollution).

[0066] As a third variation of this third aspect, the transit service 116 may utilize the per-vehicle assessment 204 of the environmental impact 206 of vehicle transit on an area 102 to adjust vehicle transit. Such adjustment may be achieved, *e.g.*, by providing instruction to various transit control devices deployed in or near the area 102, such as stoplights, speed limits, entry barriers, lane restriction signs, and tolls, and may enable the transit service 116 to reduce vehicle transit in order to avoid, prevent, or reduce an environmental impact 206, which may be more cost-effective and beneficial to the area 102 than remediation efforts applied after such environmental impact 206 has occurred.

[0067] As a first such example, a transit control may further comprise a toll booth that assesses a vehicle transit toll for vehicle transit in the area 102. The transit service 116 may instruct the transit control to adjust the vehicle transit toll according to the environmental impact 206 of the vehicle transit on the area 102. In particular, respective vehicles 104 may have a vehicle type, and the a vehicle transit toll may be assessed for vehicle transit by a selected vehicle according to the vehicle type of the vehicle 104 (*e.g.*, a higher toll rate for trucks that exhibit a high environmental impact 206 on an area 102 than for fuel-efficient automobiles that exhibit a comparatively low environmental impact 206 on the area 102). The transit adjuster may therefore instruct the transit control to adjust the vehicle transit toll of respective vehicle types according to the environmental impact 206 of the vehicle travel of the vehicle 104 on the area 102. Moreover, the vehicle device 122 may notify the user 108 about the vehicle transit toll incurred by vehicle travel of the vehicle 104 in

the area 102, and may do so before the vehicle 104 enters the area 102 and incurs the vehicle transit toll, in order to persuade the user 108 to choose an alternative route that imposes a less significant environmental impact 206 on a different area 102.

[0068] Fig. 9 is an illustration of an example scenario 900 featuring the use of several such variations by a transit service 116 to control adjust vehicle transit through various areas 102 of a region 902. In this example scenario 900, the transit service 116 may impose a transit restriction through a transit control, in proportion with the environmental impact 206 of the vehicle transit on the areas 102, which may persuade users 108 to choose routes and driving behaviors that reduce the overall environmental impact 206 on the region 902. At a first time 908, the transit service 116 may generate estimates of vehicle transit in various areas 102, and a transit toll 1004 is assessed to each user 108 of a vehicle 104 in transit in the area 102. The estimates of vehicle transit may indicate that the first area 102 is incurring a significant environmental impact 206, while a second area 102 exhibits comparatively light vehicle transit and a comparatively low environmental impact 206. In order to reduce this disparity, at a second time 910, the transit tolls 904 for the respective areas 102 may be adjusted (*e.g.*, increasing the toll 904 for the first area 102 while reducing the toll 904 for the second area 102) in order to persuade users 108 to choose a detour through the second area 102. The transit service 116 may transmit a signal to transit control devices that collect the tolls 904 from the users 108, and may therefore instruct the transit control devices to adjust the tolls 904 in proportion with the vehicle transit in each area 102. Additional estimates of vehicle transit may continue to be collected, and the adjustment of the tolls 904 may reveal modest, but not adequate, redistribution of vehicle transit. Accordingly, at a third time 912, a second transit control device 906 may be adjusted, *e.g.*, a stoplight that periodically restricts entry to the first area 102, and thereby reduces vehicle transit therein. For example, to the transit service 116 may recommend to the users 108 a detour area exit, which may provide an alternative route to traveling through the first area 108 having high vehicle transit. In this manner, the transit service 116 may utilize transit controls to adjust the vehicle transit through various

areas 102 of the region 902 in order to reduce the environmental impact 206 thereof in accordance with the techniques presented herein.

[0069] F. Computing Environment

[0070] Fig. 10 and the following discussion provide a brief, general description of a suitable computing environment to implement embodiments of one or more of the provisions set forth herein. The operating environment of Fig. 10 is only one example of a suitable operating environment and is not intended to suggest any limitation as to the scope of use or functionality of the operating environment. Example computing devices include, but are not limited to, personal computers, server computers, hand-held or laptop devices, mobile devices (such as mobile phones, Personal Digital Assistants (PDAs), media players, and the like), multiprocessor systems, consumer electronics, mini computers, mainframe computers, distributed computing environments that include any of the above systems or devices, and the like.

[0071] Although not required, embodiments are described in the general context of "computer readable instructions" being executed by one or more computing devices. Computer readable instructions may be distributed via computer readable media (discussed below). Computer readable instructions may be implemented as program modules, such as functions, objects, Application Programming Interfaces (APIs), data structures, and the like, that perform particular tasks or implement particular abstract data types. Typically, the functionality of the computer readable instructions may be combined or distributed as desired in various environments.

[0072] Fig. 10 illustrates an example of a system 1000 comprising a computing device 1002 configured to implement one or more embodiments provided herein. In one configuration, computing device 1002 includes at least one processing unit 1006 and memory 1008. Depending on the exact configuration and type of computing device, memory 1008 may be volatile (such as RAM, for example), non-volatile (such as ROM, flash memory, etc., for example) or some combination of the two. This configuration is illustrated in Fig. 10 by dashed line 1004.

[0073] In other embodiments, device 1002 may include additional features and/or functionality. For example, device 1002 may also include additional storage (e.g., removable and/or non-removable) including, but not limited to, magnetic storage, optical storage, and the like. Such additional storage is illustrated in Fig. 10 by storage 1100. In one embodiment, computer readable instructions to implement one or more embodiments provided herein may be in storage 1100. Storage 1100 may also store other computer readable instructions to implement an operating system, an application program, and the like. Computer readable instructions may be loaded in memory 1008 for execution by processing unit 1006, for example.

[0074] The term "computer readable media" as used herein includes computer storage media. Computer storage media includes volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information such as computer readable instructions or other data. Memory 1008 and storage 1100 are examples of computer storage media. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, Digital Versatile Disks (DVDs) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by device 1002. Any such computer storage media may be part of device 1002.

[0075] Device 1002 may also include communication connection(s) 1016 that allows device 1002 to communicate with other devices. Communication connection(s) 1016 may include, but is not limited to, a modem, a Network Interface Card (NIC), an integrated network interface, a radio frequency transmitter/receiver, an infrared port, a USB connection, or other interfaces for connecting computing device 1002 to other computing devices. Communication connection(s) 1016 may include a wired connection or a wireless connection. Communication connection(s) 1016 may transmit and/or receive communication media.

[0076] The term "computer readable media" may include communication media. Communication media typically embodies computer readable

instructions or other data in a "modulated data signal" such as a carrier wave or other transport mechanism and includes any information delivery media. The term "modulated data signal" may include a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal.

[0077] Device 1002 may include input device(s) 1014 such as keyboard, mouse, pen, voice input device, touch input device, infrared cameras, video input devices, and/or any other input device. Output device(s) 1012 such as one or more displays, speakers, printers, and/or any other output device may also be included in device 1002. Input device(s) 1014 and output device(s) 1012 may be connected to device 1002 via a wired connection, wireless connection, or any combination thereof. In one embodiment, an input device or an output device from another computing device may be used as input device(s) 1014 or output device(s) 1012 for computing device 1002.

[0078] Components of computing device 1002 may be connected by various interconnects, such as a bus. Such interconnects may include a Peripheral Component Interconnect (PCI), such as PCI Express, a Universal Serial Bus (USB), firewire (IEEE 1394), an optical bus structure, and the like. In another embodiment, components of computing device 1002 may be interconnected by a network. For example, memory 1008 may be comprised of multiple physical memory units located in different physical locations interconnected by a network.

[0079] Those skilled in the art will realize that storage devices utilized to store computer readable instructions may be distributed across a network. For example, a computing device 1020 accessible via network 1018 may store computer readable instructions to implement one or more embodiments provided herein. Computing device 1002 may access computing device 1020 and download a part or all of the computer readable instructions for execution. Alternatively, computing device 1002 may download pieces of the computer readable instructions, as needed, or some instructions may be executed at computing device 1002 and some at computing device 1020.

[0080] G. Usage of Terms

[0081] Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

[0082] As used in this application, the terms "component," "module," "system", "interface", and the like are generally intended to refer to a computer-related entity, either hardware, a combination of hardware and software, software, or software in execution. For example, a component may be, but is not limited to being, a process running on a processor, a processor, an object, an executable, a thread of execution, a program, and/or a computer. By way of illustration, both an application running on a controller and the controller can be a component. One or more components may reside within a process and/or thread of execution and a component may be localized on one computer and/or distributed between two or more computers.

[0083] Furthermore, the claimed subject matter may be implemented as a method, apparatus, or article of manufacture using standard programming and/or engineering techniques to produce software, firmware, hardware, or any combination thereof to control a computer to implement the disclosed subject matter. The term "article of manufacture" as used herein is intended to encompass a computer program accessible from any computer-readable device, carrier, or media. Of course, those skilled in the art will recognize many modifications may be made to this configuration without departing from the scope or spirit of the claimed subject matter.

[0084] Various operations of embodiments are provided herein. In one embodiment, one or more of the operations described may constitute computer readable instructions stored on one or more computer readable media, which if executed by a computing device, will cause the computing device to perform the operations described. The order in which some or all of the operations are described should not be construed as to imply that these

operations are necessarily order dependent. Alternative ordering will be appreciated by one skilled in the art having the benefit of this description. Further, it will be understood that not all operations are necessarily present in each embodiment provided herein.

[0085] Moreover, the word "example" is used herein to mean serving as an example, instance, or illustration. Any aspect or design described herein as "example" is not necessarily to be construed as advantageous over other aspects or designs. Rather, use of the word example is intended to present concepts in a concrete fashion. As used in this application, the term "or" is intended to mean an inclusive "or" rather than an exclusive "or". That is, unless specified otherwise, or clear from context, "X employs A or B" is intended to mean any of the natural inclusive permutations. That is, if X employs A; X employs B; or X employs both A and B, then "X employs A or B" is satisfied under any of the foregoing instances. In addition, the articles "a" and "an" as used in this application and the appended claims may generally be construed to mean "one or more" unless specified otherwise or clear from context to be directed to a singular form.

[0086] Also, although the disclosure has been shown and described with respect to one or more implementations, equivalent alterations and modifications will occur to others skilled in the art based upon a reading and understanding of this specification and the annexed drawings. The disclosure includes all such modifications and alterations and is limited only by the scope of the following claims. In particular regard to the various functions performed by the above described components (e.g., elements, resources, etc.), the terms used to describe such components are intended to correspond, unless otherwise indicated, to any component which performs the specified function of the described component (*e.g.*, that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the function in the herein illustrated example implementations of the disclosure. In addition, while a particular feature of the disclosure may have been disclosed with respect to only one of several implementations, such feature may be combined with one or more other features of the other implementations as may be desired and advantageous for any given or

particular application. Furthermore, to the extent that the terms "includes", "having", "has", "with", or variants thereof are used in either the detailed description or the claims, such terms are intended to be inclusive in a manner similar to the term "comprising."

What is claimed is:

1. A method of informing a user about an environmental impact of vehicle transit in an area, the method involving a device having a processor and comprising:

executing, by the processor, instructions that cause the device to:

receive, from a vehicle device of a vehicle, a vehicle report identifying a location of the vehicle within the area and at least one driving metric of the vehicle;

evaluate the at least one driving metric of the vehicle to assess an environmental impact of the vehicle on the area; and

notify the user about the environmental impact of the vehicle transit of the vehicle on the area.

2. The method of claim 1, wherein:

receiving the vehicle report further comprises: receiving, from the vehicle device of the vehicle, a vehicle report identifying at least one driving metric according to at least one vehicle telemetry input of an operating property of the vehicle; and

assessing the environmental impact of the vehicle on the area further comprises: evaluating the at least one vehicle telemetry input of the operating property of the vehicle to assess the environmental impact of the vehicle on the area.

3. The method of claim 1, wherein:

the device further has access to an environmental impact database identifying, for respective driving metrics, the environmental impact of the vehicle transit of vehicles operated with the driving metric; and

assessing the environmental impact of the vehicle on the area further comprises: correlating the at least one driving metric of the vehicle with the environmental impact of the vehicle transit of the vehicle according to the environmental impact database.

4. The method of claim 1, wherein executing the instructions by the processor further causes the device to, upon determining an environmental impact of vehicle transit of a vehicle on an area according to a selected driving metric, update the environmental impact database with the environmental impact.

5. The method of claim 1, wherein:

respective vehicles have a vehicle type;

receiving the vehicle report further comprises: receiving, from the vehicle device of the vehicle, an identification of the vehicle type of the vehicle; and

assessing the environmental impact of the vehicle on the area further comprises: comparing the at least one driving metric of vehicles of the vehicle type to determine the environmental impact of the vehicle transit of the vehicle on the area.

6. The method of claim 1, wherein:

respective locations within the area is described by an environmental parameter; and

assessing the environmental impact of the vehicle on the area further comprises: comparing the at least one driving metric of the vehicle transit of the vehicle with the environmental parameter of the location of the vehicle to determine the environmental impact on the area.

7. A server that informs a user about an environmental impact of vehicle transit in an area, the server comprising:

a processor;

a vehicle report receiver that receives, from a vehicle device of a vehicle, a vehicle report identifying a location of the vehicle within the area and at least one driving metric of the vehicle; and

a memory storing instructions that, when executed by the processor, provide a system comprising:

an environmental impact evaluator that evaluates the at least one driving metric of the vehicle to assess an environmental impact of the vehicle on the area; and

an environmental impact notifier that notifies the user about the environmental impact of the vehicle transit of the vehicle on the area.

8. The server of claim 7, wherein:

the vehicle comprises a vehicle device and is operated by a driver; and

the environmental impact notifier transmits, to the vehicle device for presentation to the driver, a notification of the environmental impact of the vehicle transit of the vehicle on the area.

9. The server of claim 7, wherein:

the vehicle report receiver further determines a period including the vehicle travel of the vehicle in the area;

the environmental impact evaluator:

aggregates the environmental impact of vehicle transit on the area according to the period of the vehicle transit, and

compares the environmental impact of vehicle travel on an area during respective periods to identify an environmental impact trend; and

the environmental impact notifier further notifies the user of the environmental impact trend.

10. The server of claim 7, wherein:

vehicle transit in the area is restricted by a transit control; and

the system further comprises: a transit adjuster that instructs the transit control to restrict vehicle transit in the area according to the environmental impact of the vehicle transit on the area.

11. The server of claim 10, wherein:

the transit control further assesses a vehicle transit toll for vehicle transit in the area; and

the transit adjuster instructs the transit control to adjust the vehicle transit toll according to the environmental impact of the vehicle transit on the area.

12. The server of claim 11, wherein:

respective vehicles have a vehicle type;

the transit control further assesses a vehicle transit toll for vehicle transit by a selected vehicle according to the vehicle type of the selected vehicle; and

the transit adjuster instructs the transit control to adjust the vehicle transit toll of respective vehicle types according to the environmental impact of the vehicle travel of the selected vehicle on the area.

13. A vehicle device that notifies a user of a vehicle about an environmental impact of vehicle transit of the vehicle in an area, the vehicle device comprising:

a processor;

a location detector that detects a location of the vehicle;

a memory storing instructions that, when executed by the processor, provide a system comprising:

a vehicle telemetry detector that detects at least one driving metric of the vehicle;

a vehicle report transmitter that transmits, to a transit service, a vehicle report indicating the at least one driving metric of the vehicle and a location of the vehicle; and

an environmental impact notifier that, upon receiving from the transit service a notification of an environmental impact of the vehicle transit of the vehicle on the area, presents the notification of the environmental impact to the user.

14. The vehicle device of claim 13, wherein:

the vehicle is operated by the user during a travel period; and

presenting the notification to the user further comprises:

identifying a tally of the environmental impact of the vehicle transit of the vehicle on the area during the travel period; and

presenting the tally to the user.

15. The vehicle device of claim 13, wherein:

receiving the notification from the transit service further comprises: receiving, from the transit service, a comparison of the environmental impact of the vehicle transit of the vehicle on the area with the environmental impact of the vehicle transit of a second vehicle on the area; and

presenting the notification to the user further comprises: presenting the comparison of the environmental impact of the vehicle with the environmental impact of the second vehicle.

16. The vehicle device of claim 13, wherein presenting the notification to the user further comprises: presenting, to the user, a recommendation of a vehicle transit adjustment that reduces the environmental impact of the vehicle transit of the vehicle on the area.

17. The vehicle device of claim 13, wherein:

the vehicle transit involves a route of the vehicle to a destination;

the system further comprises: a route adjuster that identifies an alternate route to the destination that reduces the environmental impact of the vehicle on the area; and

the environmental impact notifier further recommends the alternative route to the user.

18. The vehicle device of claim 13, wherein:

the vehicle transit involves a route of the vehicle to a destination;

respective locations within the area are associated with an environmental sensitivity to vehicle transit;

the system further comprises: a route adjuster that identifies an alternate route to the destination through locations within the area that together exhibit a lower environmental sensitivity to vehicle transit than the locations of the route; and

the environmental impact notifier further recommends the alternative route to the user.

19. The vehicle device of claim 13, wherein:

vehicle transit in the area is restricted by a vehicle transit toll; and

the environmental impact notifier further notifies the user of the vehicle transit toll incurred by vehicle travel of the vehicle in the area.

20. The vehicle device of claim 19, wherein notifying the user of the vehicle transit toll further comprises: notifying the user of the vehicle transit toll before the vehicle enters the area and incurs the vehicle transit toll.

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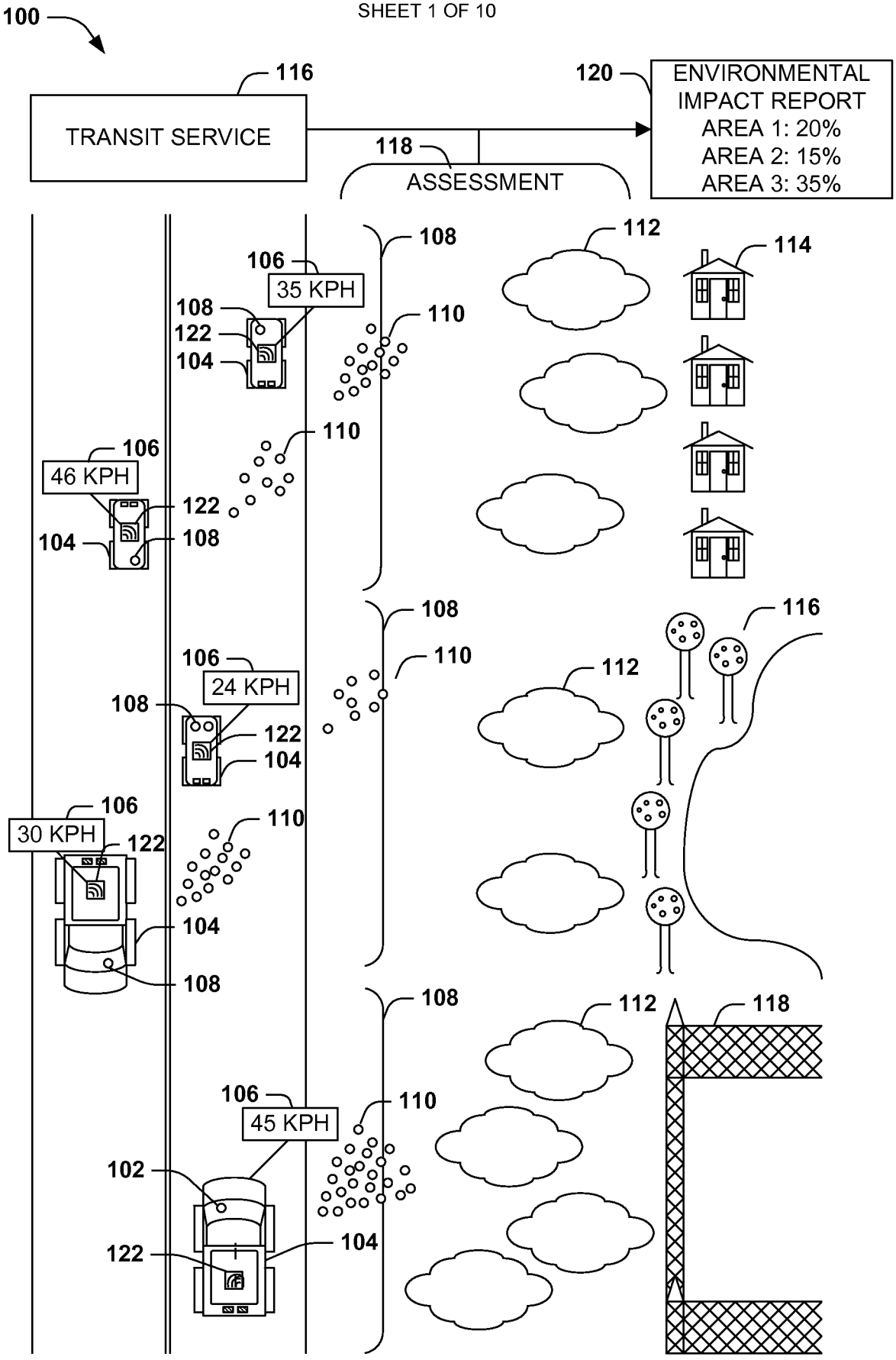

FIG. 1

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SHEET 2 OF 10

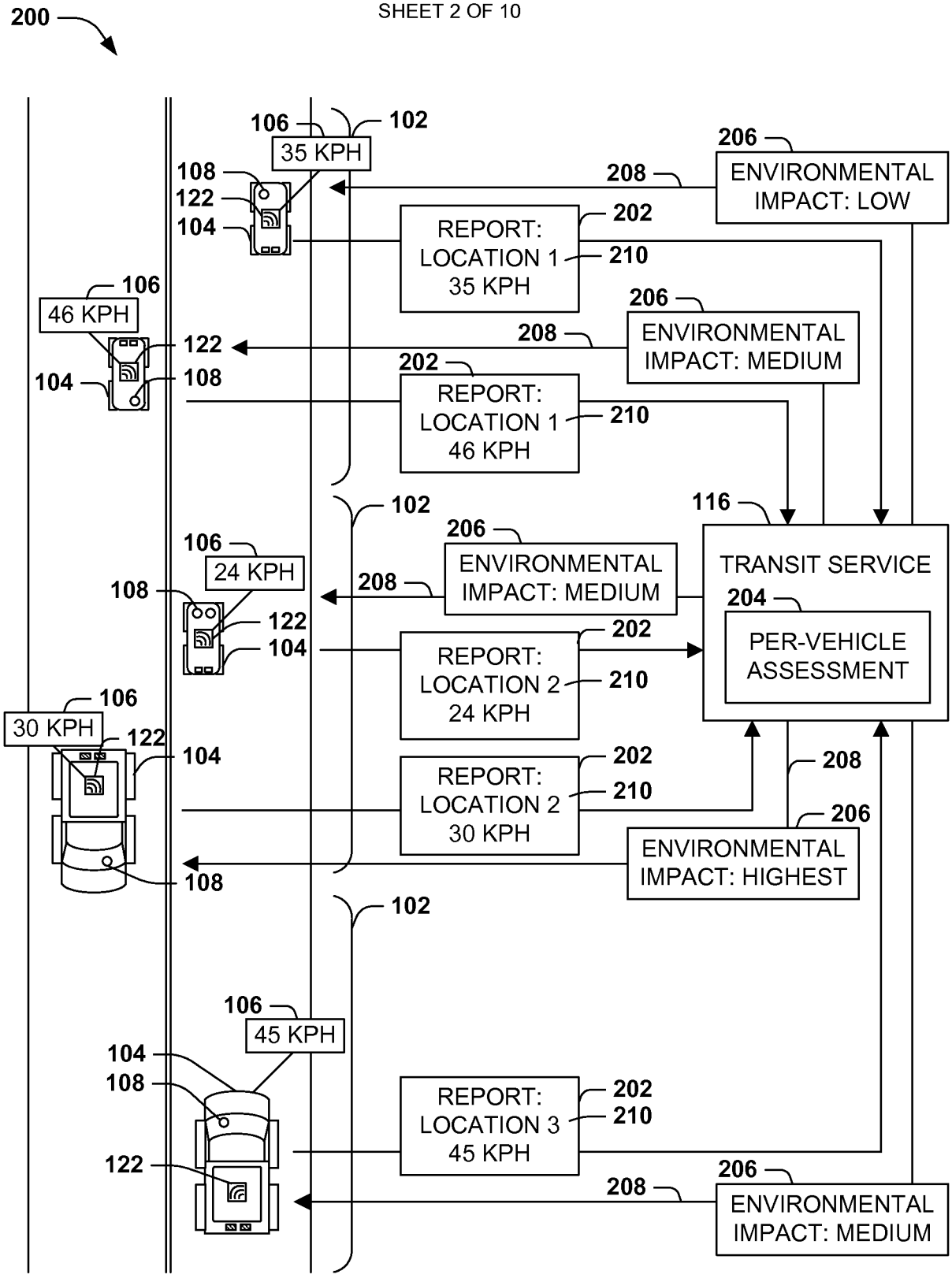

FIG. 2

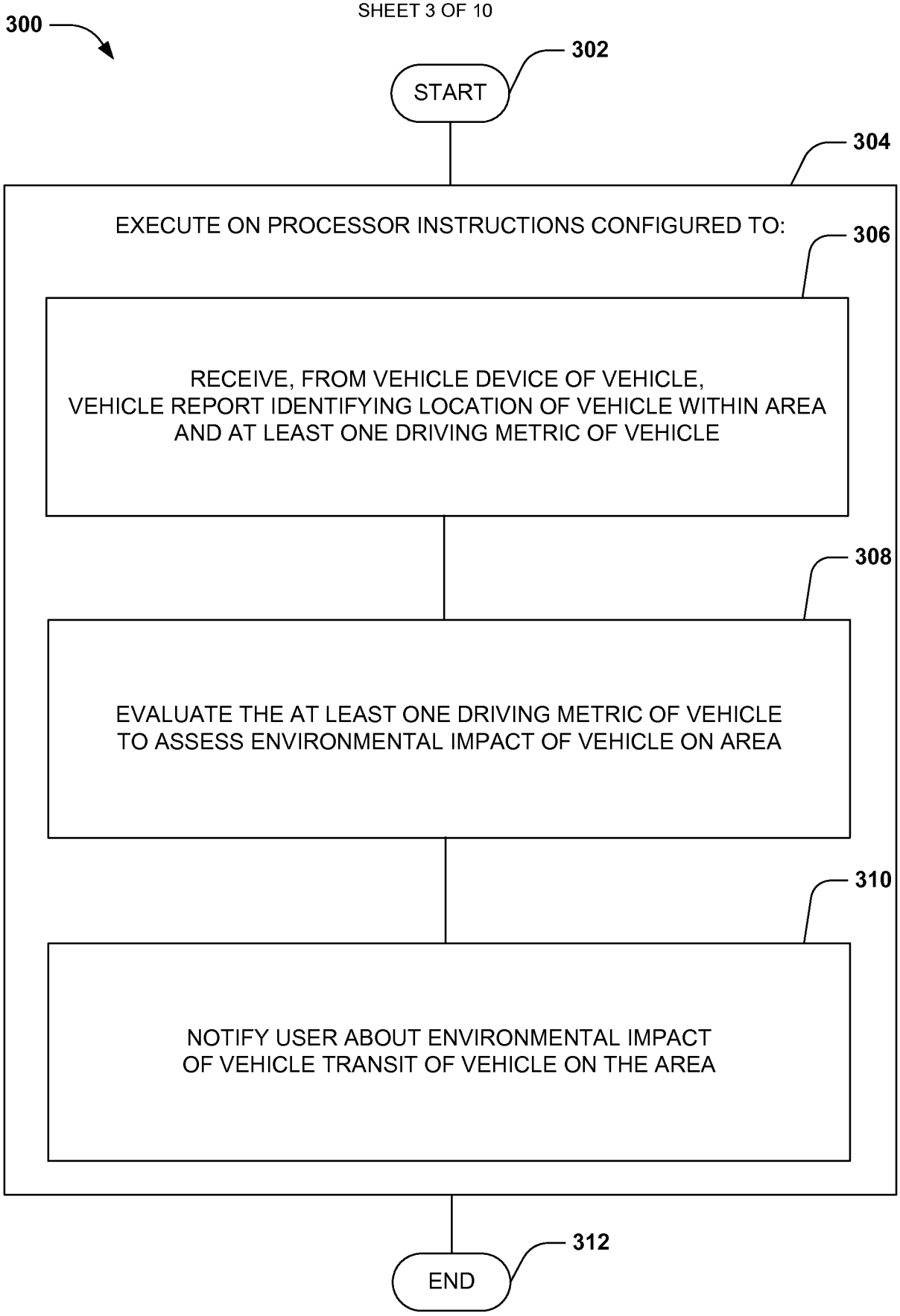
300
302
START
304
EXECUTE ON PROCESSOR INSTRUCTIONS CONFIGURED TO:
306
RECEIVE, FROM VEHICLE DEVICE OF VEHICLE,
VEHICLE REPORT IDENTIFYING LOCATION OF VEHICLE WITHIN AREA
AND AT LEAST ONE DRIVING METRIC OF VEHICLE
308
EVALUATE THE AT LEAST ONE DRIVING METRIC OF VEHICLE
TO ASSESS ENVIRONMENTAL IMPACT OF VEHICLE ON AREA
310
NOTIFY USER ABOUT ENVIRONMENTAL IMPACT
OF VEHICLE TRANSIT OF VEHICLE ON THE AREA
312
END

FIG. 3

INRIP117WO
SHEET 4 OF 10

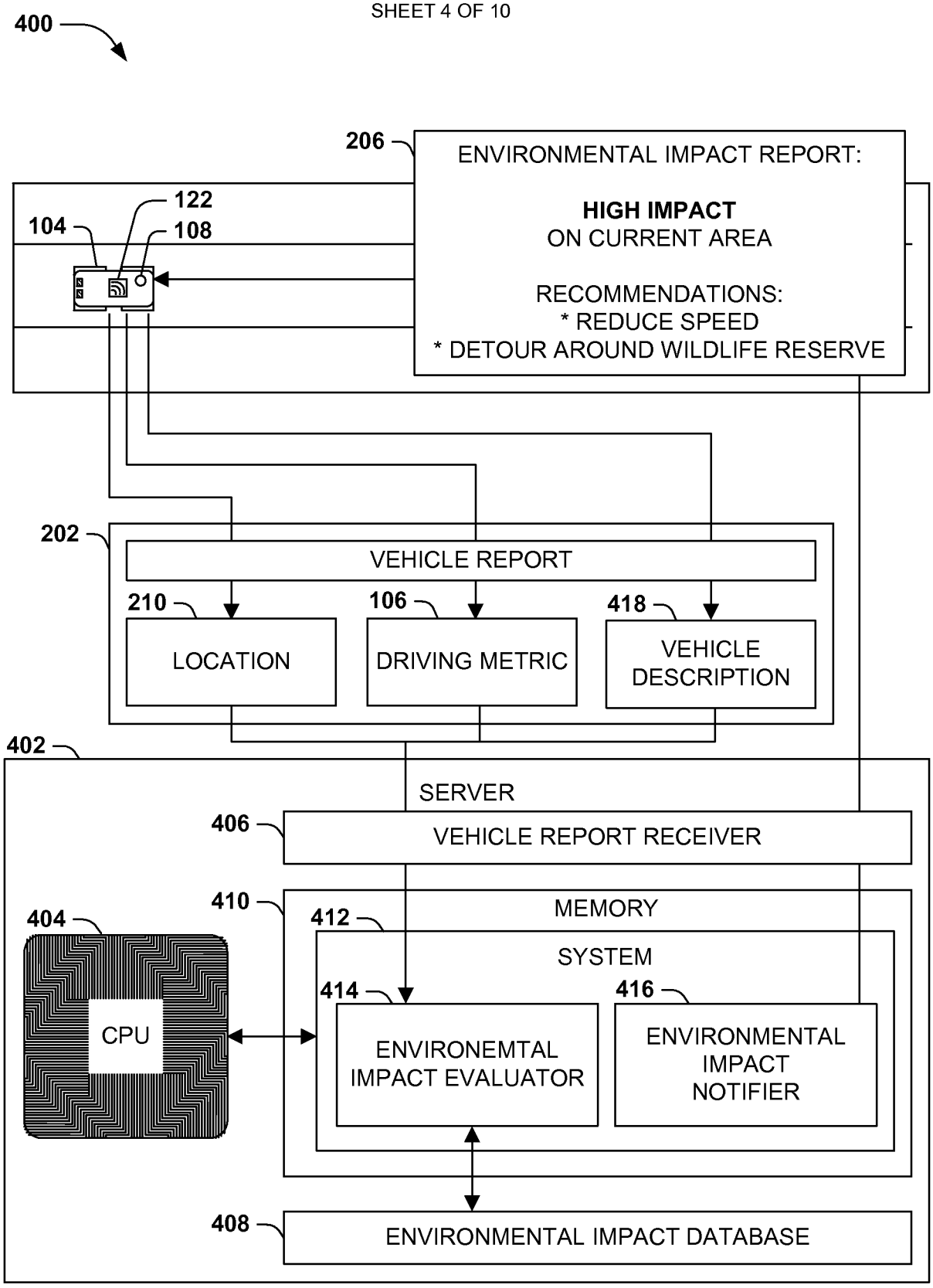

FIG. 4

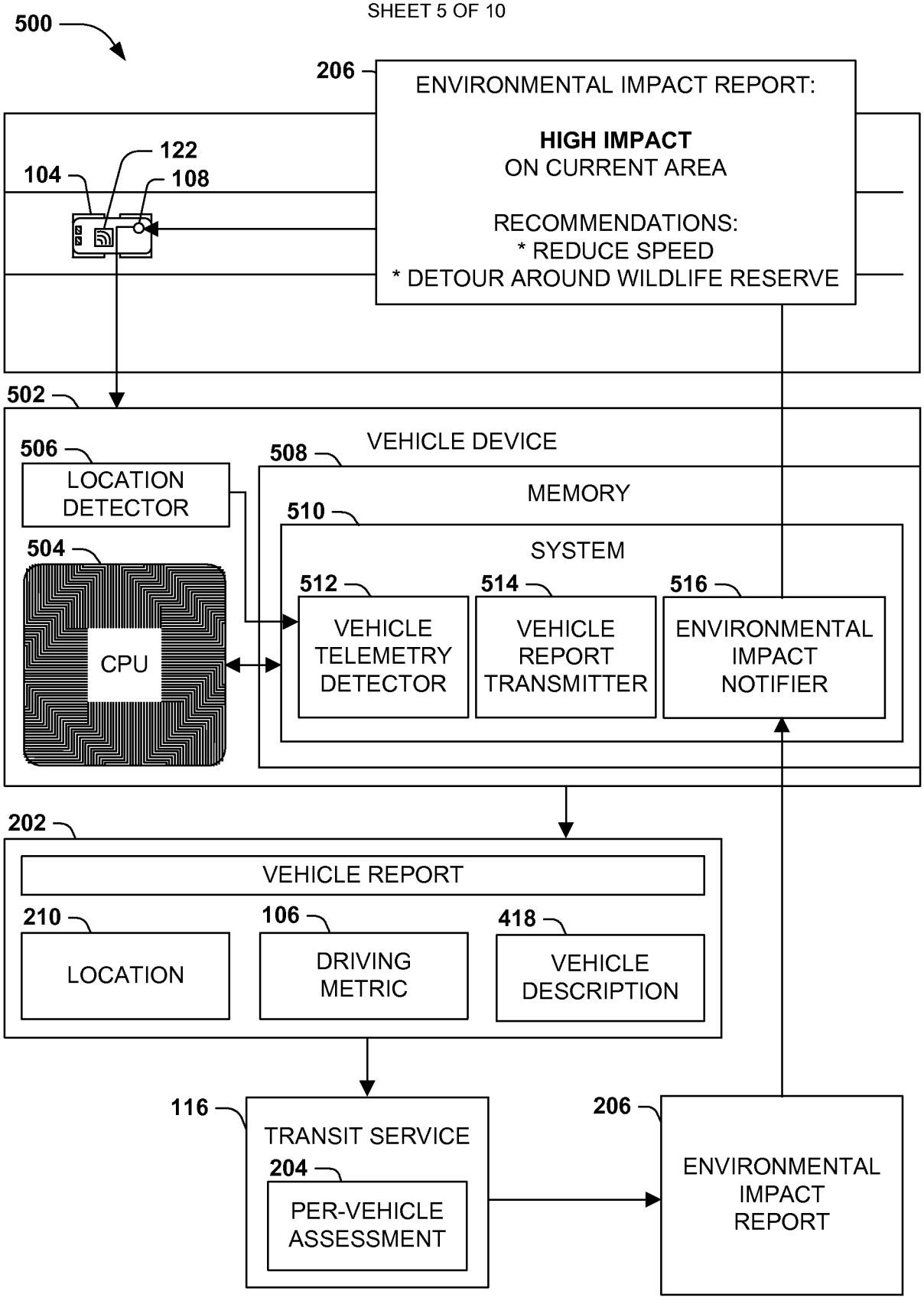
500
206
ENVIRONMENTAL IMPACT REPORT:
HIGH IMPACT
ON CURRENT AREA
RECOMMENDATIONS:
* REDUCE SPEED
* DETOUR AROUND WILDLIFE RESERVE
104
122
108
502
VEHICLE DEVICE
506
LOCATION DETECTOR
508
MEMORY
510
SYSTEM
504
CPU
512
VEHICLE TELEMETRY DETECTOR
514
VEHICLE REPORT TRANSMITTER
516
ENVIRONMENTAL IMPACT NOTIFIER
202
VEHICLE REPORT
210
LOCATION
106
DRIVING METRIC
418
VEHICLE DESCRIPTION
116
TRANSIT SERVICE
204
PER-VEHICLE ASSESSMENT
206
ENVIRONMENTAL IMPACT REPORT

FIG. 5

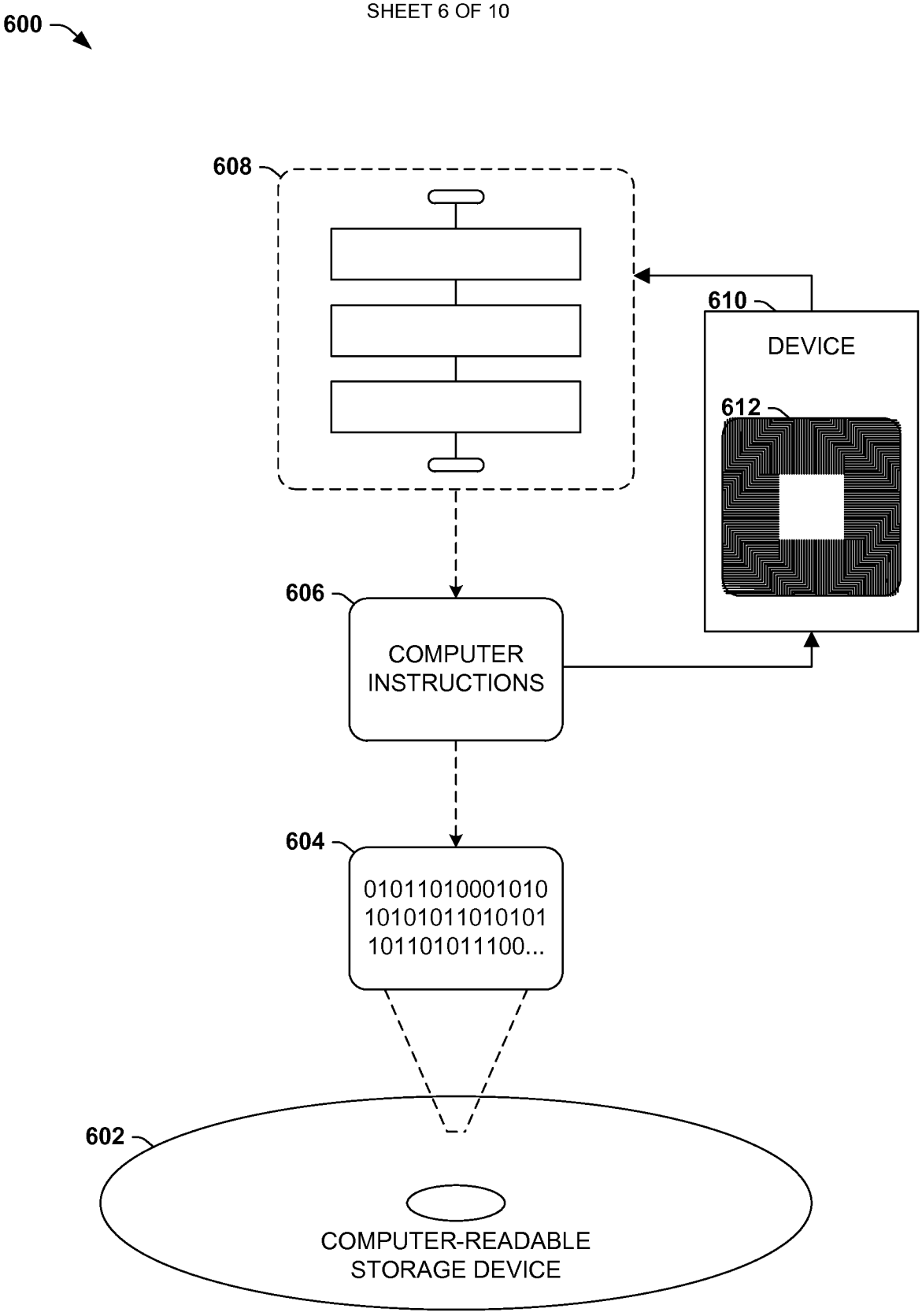
600
608
610
DEVICE
612
606
COMPUTER INSTRUCTIONS
604
01011010001010
10101011010101
101101011100...
602
COMPUTER-READABLE STORAGE DEVICE

FIG. 6

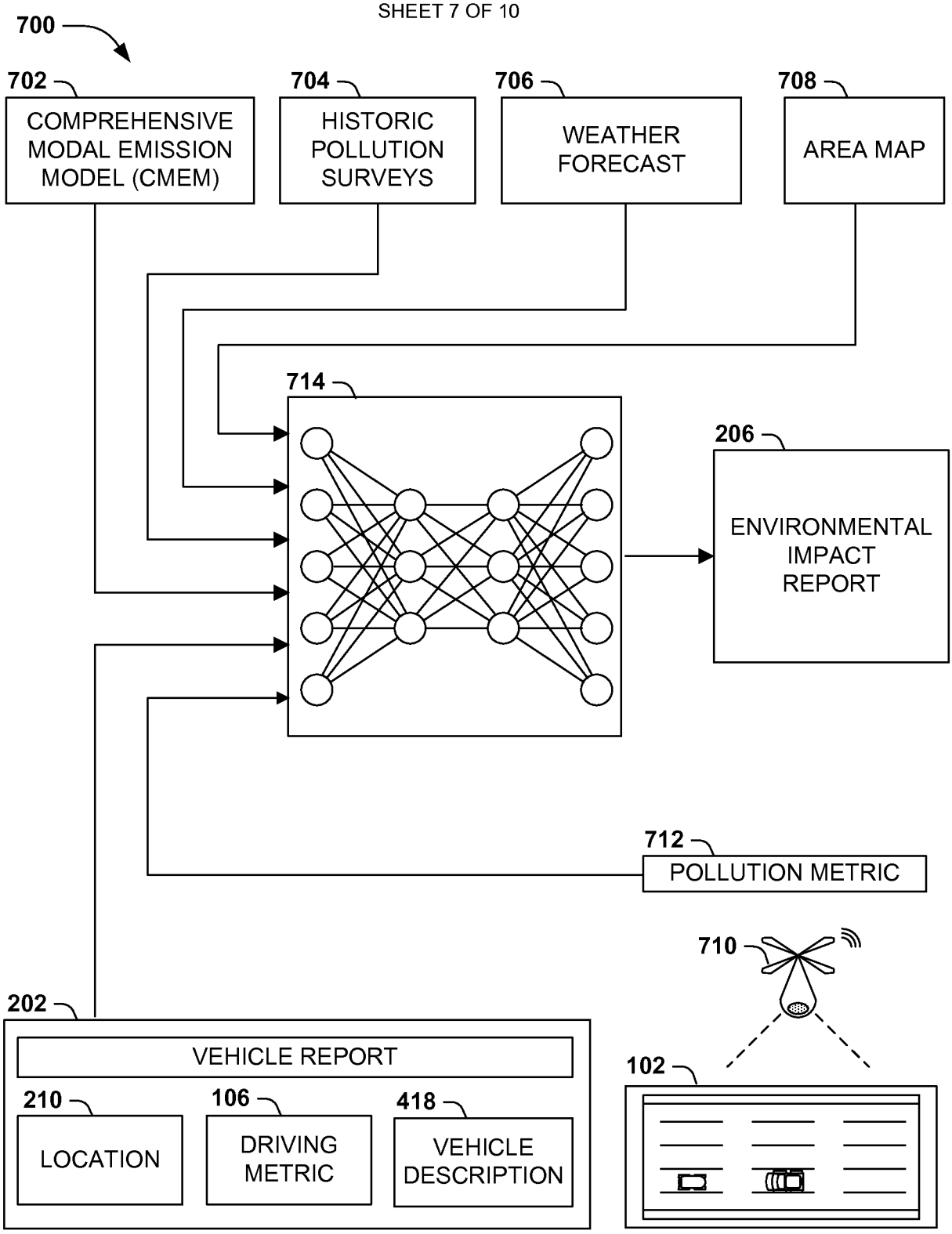
700
702
COMPREHENSIVE MODAL EMISSION MODEL (CMEM)
704
HISTORIC POLLUTION SURVEYS
706
WEATHER FORECAST
708
AREA MAP
714
206
ENVIRONMENTAL IMPACT REPORT
712
POLLUTION METRIC
710
202
VEHICLE REPORT
210
LOCATION
106
DRIVING METRIC
418
VEHICLE DESCRIPTION
102

FIG. 7

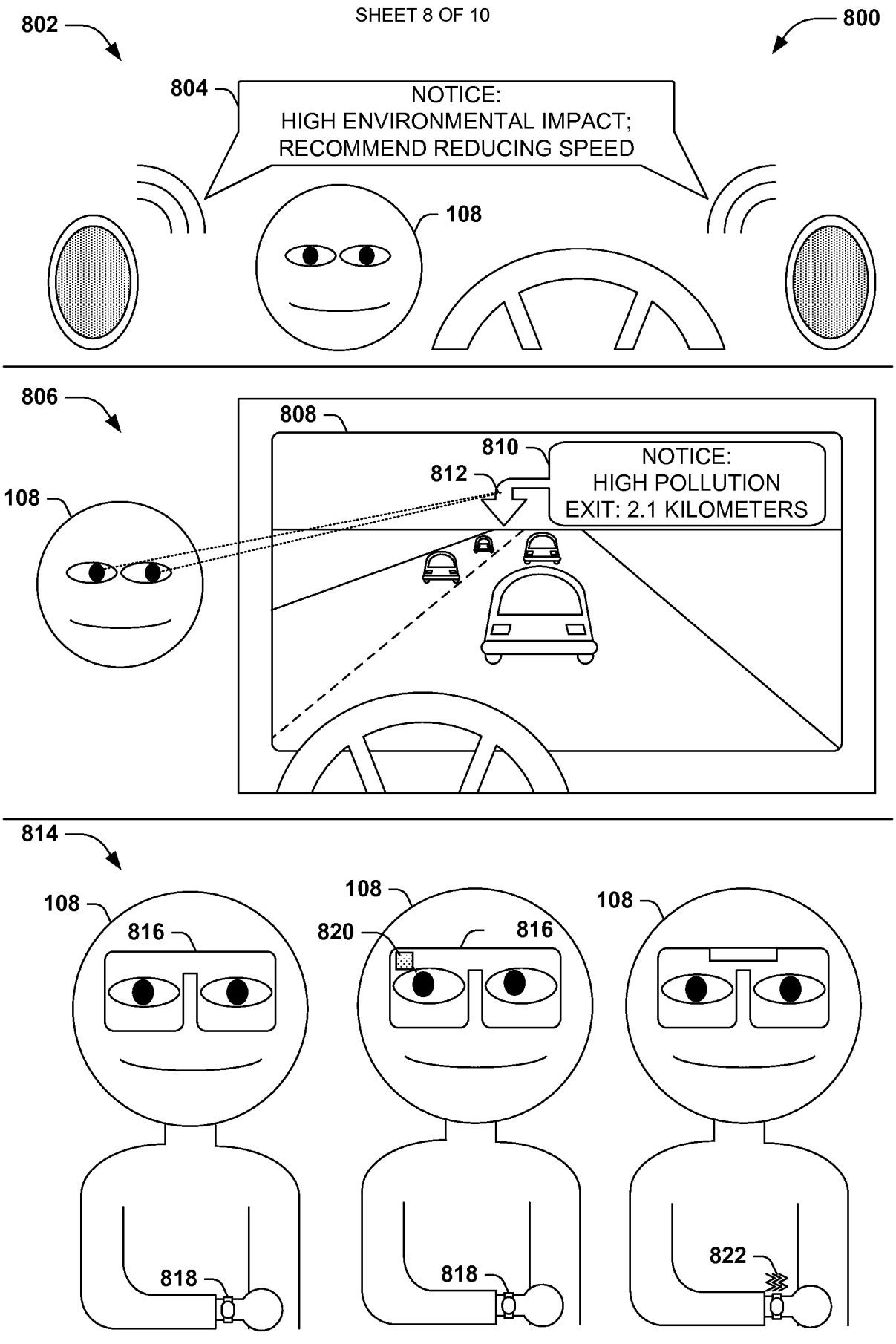
802
800
804
NOTICE:
HIGH ENVIRONMENTAL IMPACT;
RECOMMEND REDUCING SPEED
108
806
808
810
812
NOTICE:
HIGH POLLUTION
EXIT: 2.1 KILOMETERS
108
814
108
816
818
108
820
816
818
108
822

FIG. 8

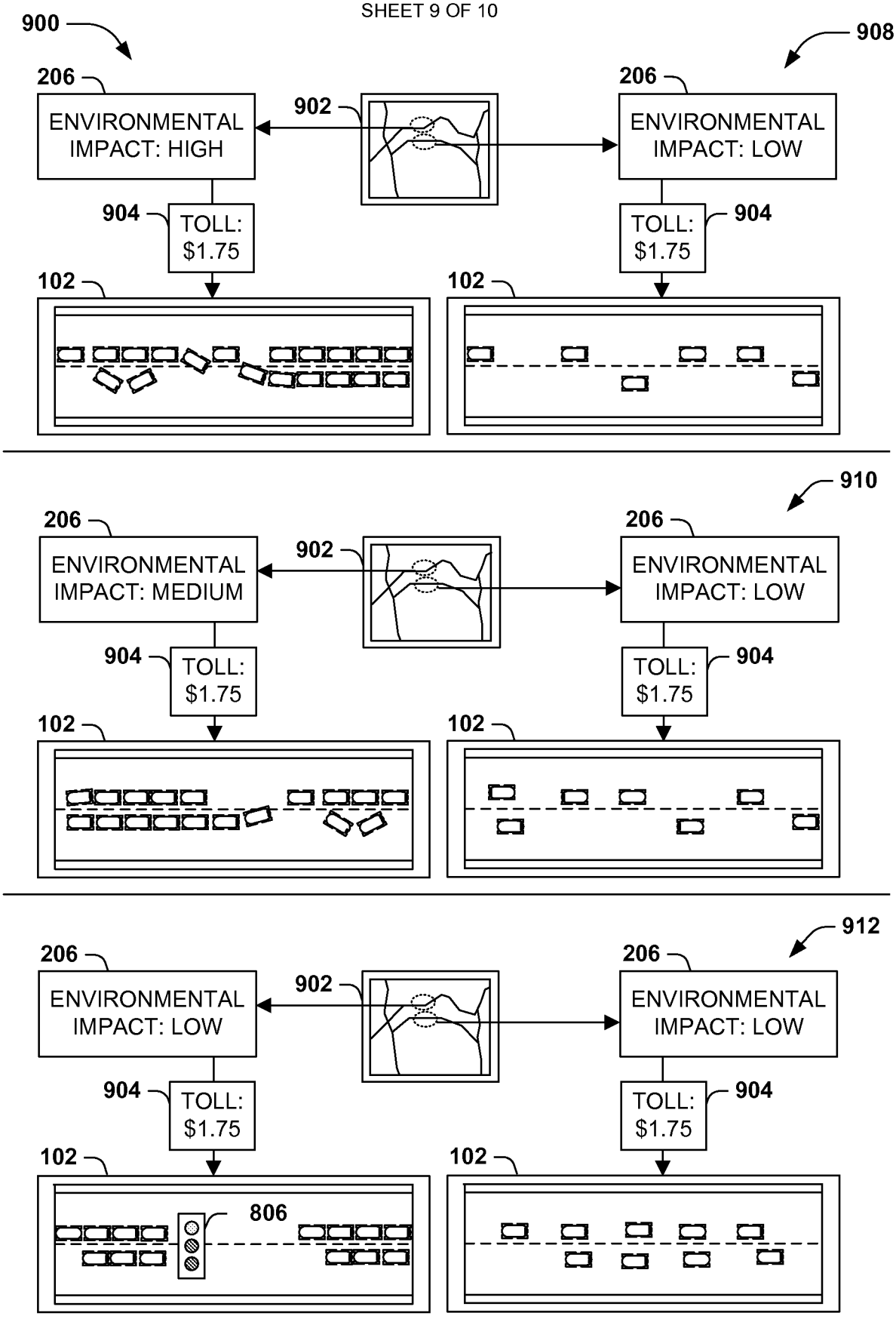
900
908
206
ENVIRONMENTAL IMPACT: HIGH
902
206
ENVIRONMENTAL IMPACT: LOW
904
TOLL: $1.75
904
TOLL: $1.75
102
102
910
206
ENVIRONMENTAL IMPACT: MEDIUM
902
206
ENVIRONMENTAL IMPACT: LOW
904
TOLL: $1.75
904
TOLL: $1.75
102
102
912
206
ENVIRONMENTAL IMPACT: LOW
902
206
ENVIRONMENTAL IMPACT: LOW
904
TOLL: $1.75
904
TOLL: $1.75
102
806
102

FIG. 9

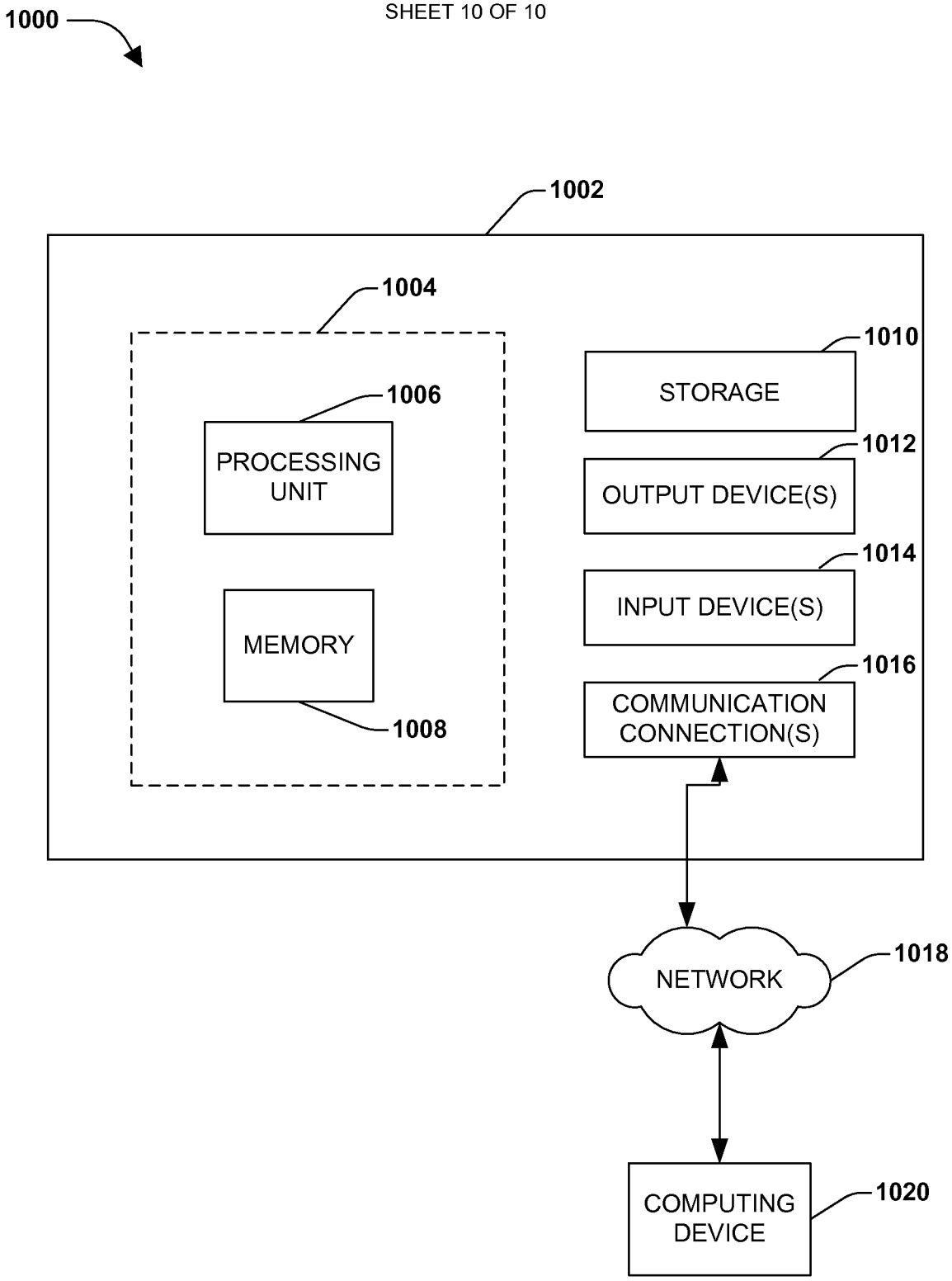
1000
1002
1004
1006
PROCESSING UNIT
MEMORY
1008
1010
STORAGE
1012
OUTPUT DEVICE(S)
1014
INPUT DEVICE(S)
1016
COMMUNICATION CONNECTION(S)
NETWORK
1018
COMPUTING DEVICE
1020

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/018391

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06F 17/00 (2015.01)
CPC - F16H 61/0213 (2015.04)
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(8) - G06F 7/00, 17/00, 19/00 (2015.01)
USPC - 701/33, 51, 705/1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - B60W 10/06, F16H 61/061, 61/0213 (2015.04) (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Orbit, Google Patents, Google
Search terms used: driver, environmental, impact, trend

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013/0218427 A1 (MUKHOPADHYAY et al) 22 August 2013 (22.08.2013) entire document	1-20
Y	US 2010/0153191 A1 (HAMILTON II et al) 17 June 2010 (17.06.2010) entire document	1-20
Y	US 2012/0215594 A1 (GRAVELLE) 23 August 2012 (23.08.2012) entire document	19, 20
A	US 2010/0305807 A1 (BASIR et al) 02 December 2010 (02.12.2010) entire document	1-20

☐ Further documents are listed in the continuation of Box C. ☐

* 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
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"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
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"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	Date of mailing of the international search report
26 April 2015	03 JUN 2015
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774