

(12) **United States Patent**  
**Kilaru**

(10) **Patent No.:** **US 12,387,601 B2**  
(45) **Date of Patent:** **Aug. 12, 2025**

(54) **VEHICLE DETERMINATION FOR MEDIA COLLABORATION**

(71) Applicant: **TOYOTA CONNECTED NORTH AMERICA, INC.**, Plano, TX (US)

(72) Inventor: **Raja Shekar Kilaru**, Celina, TX (US)

(73) Assignee: **TOYOTA CONNECTED NORTH AMERICA, INC.**, Plano, TX (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 309 days.

(21) Appl. No.: **18/077,337**

(22) Filed: **Dec. 8, 2022**

(65) **Prior Publication Data**

US 2024/0194068 A1 Jun. 13, 2024

(51) **Int. Cl.**  
**G08G 1/0967** (2006.01)  
**G07C 5/00** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **G08G 1/096791** (2013.01); **G07C 5/008** (2013.01)

(58) **Field of Classification Search**  
CPC ..... G08G 1/096791; G07C 5/008  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,494,943 B2 11/2016 Harvey  
10,204,519 B2 2/2019 Uysal et al.  
10,240,937 B2 3/2019 Chung et al.

10,582,163 B2 3/2020 Hodge et al.  
10,805,696 B1 10/2020 Suiter et al.  
11,124,121 B2 9/2021 Weller et al.  
11,188,769 B2 11/2021 Kuehnle et al.  
2010/0253539 A1\* 10/2010 Seder ..... G01C 21/365 340/902  
2010/0253596 A1 10/2010 Szczërba et al.  
2014/0111540 A1 4/2014 Morimoto et al.  
2014/0218509 A1\* 8/2014 Kondo ..... G01C 21/3658 348/118  
2014/0341434 A1\* 11/2014 Lin ..... G08G 1/167 382/104  
2015/0331238 A1\* 11/2015 Roth ..... B60K 37/00 348/115  
2016/0257199 A1\* 9/2016 Bark ..... B60K 37/20  
2016/0349066 A1\* 12/2016 Chung ..... G01C 21/3602  
2017/0140603 A1 5/2017 Ricci  
2018/0134217 A1 5/2018 Peterson et al.  
2019/0243492 A1 8/2019 Uken et al.  
2019/0251848 A1 8/2019 Sivanesan et al.  
2020/0057453 A1 2/2020 Laws et al.  
2020/0349666 A1 11/2020 Hodge et al.

FOREIGN PATENT DOCUMENTS

CN 103770648 A 5/2014  
CN 101872066 B 7/2014

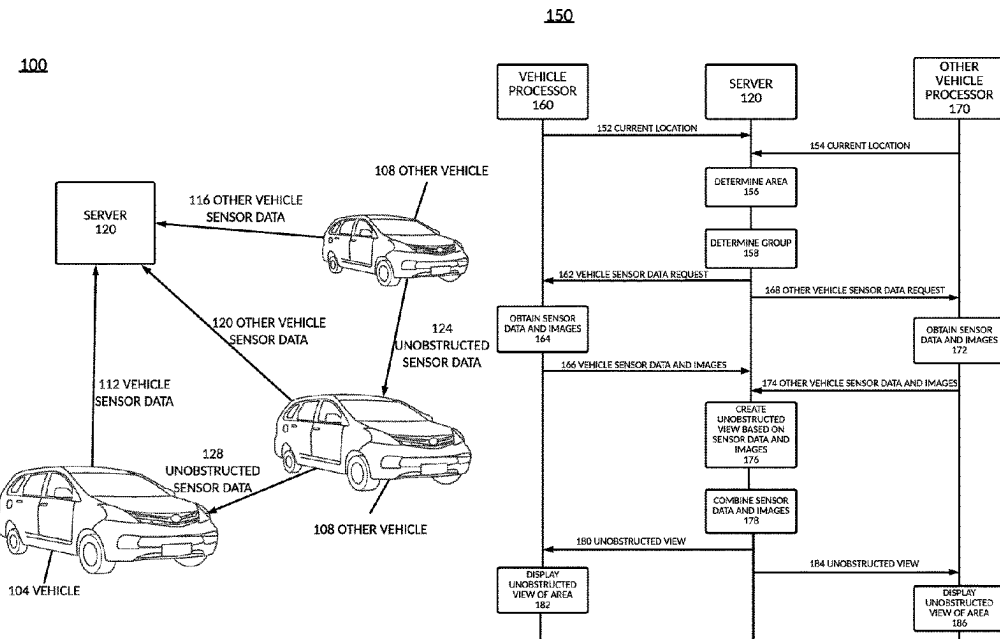
\* cited by examiner

Primary Examiner — Sisay Yacob

(57) **ABSTRACT**

An example operation includes one or more of determining a vehicle in a group of vehicles that has an unobstructed view of an area ahead of the group, collecting data from sensors on the vehicle, sending the data to one or more other vehicles in the group of vehicles, and providing the unobstructed view of the area ahead of the group on a display of the one or more other vehicles.

17 Claims, 27 Drawing Sheets



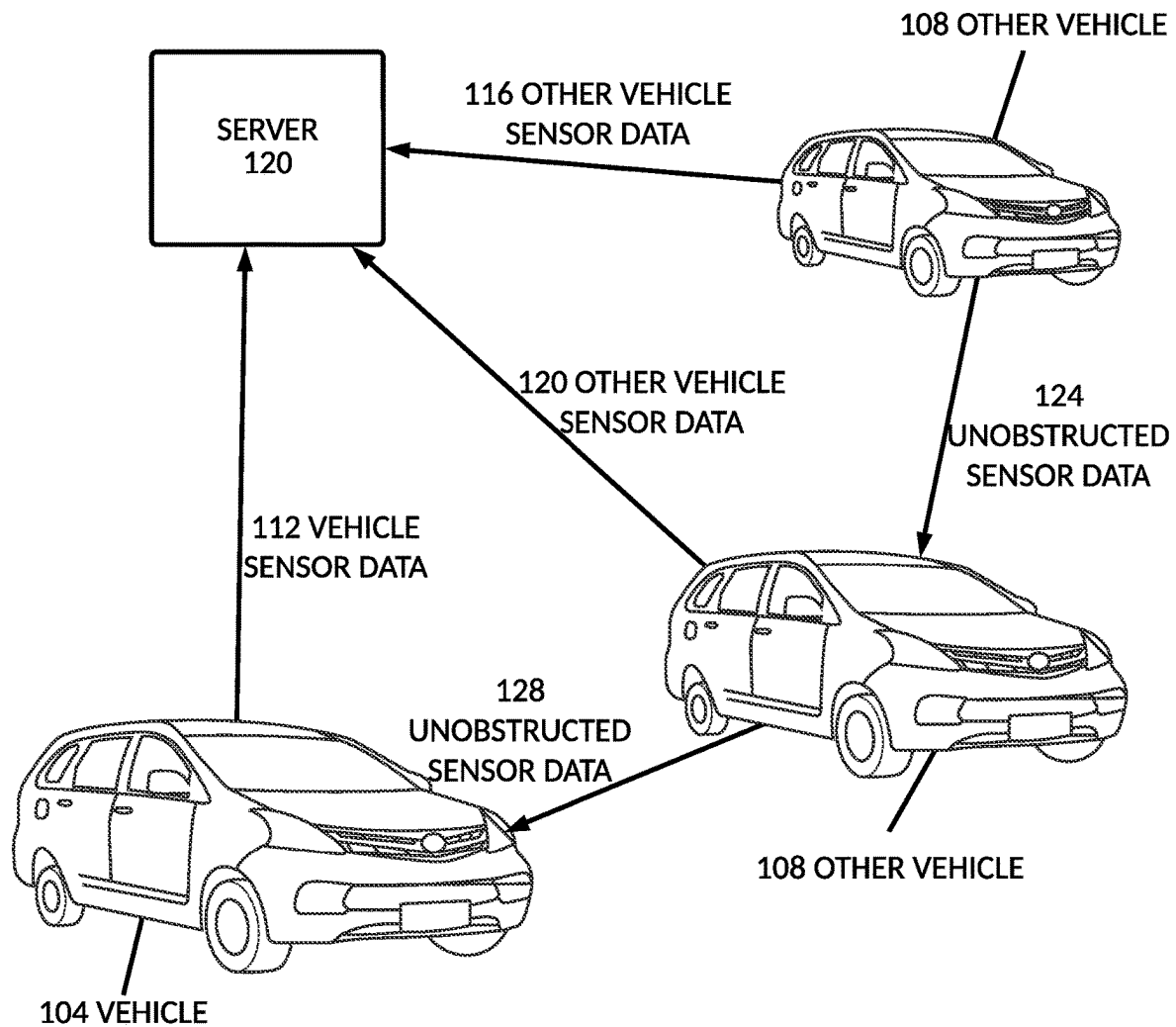
100

FIG. 1A

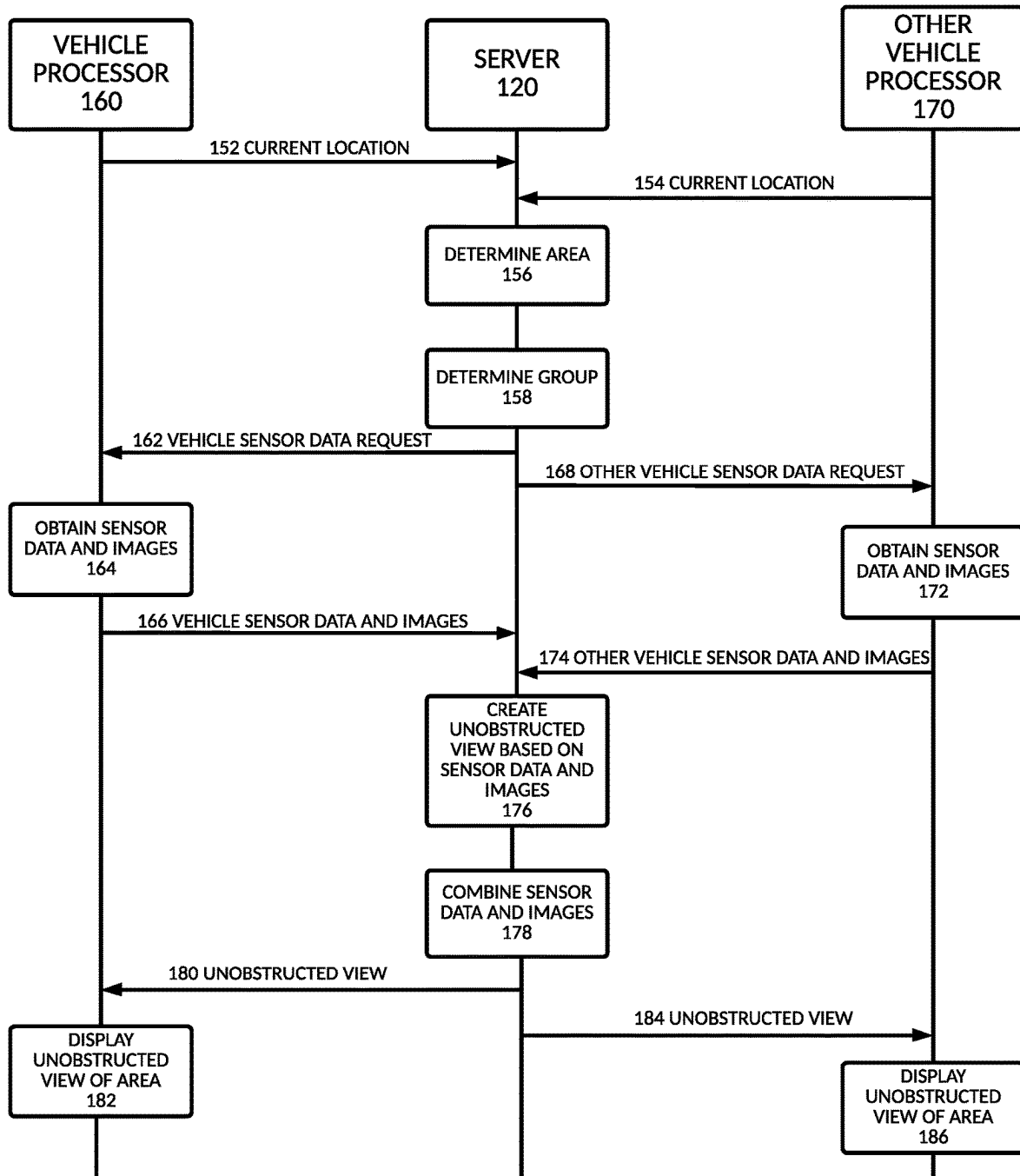
150

FIG. 1B

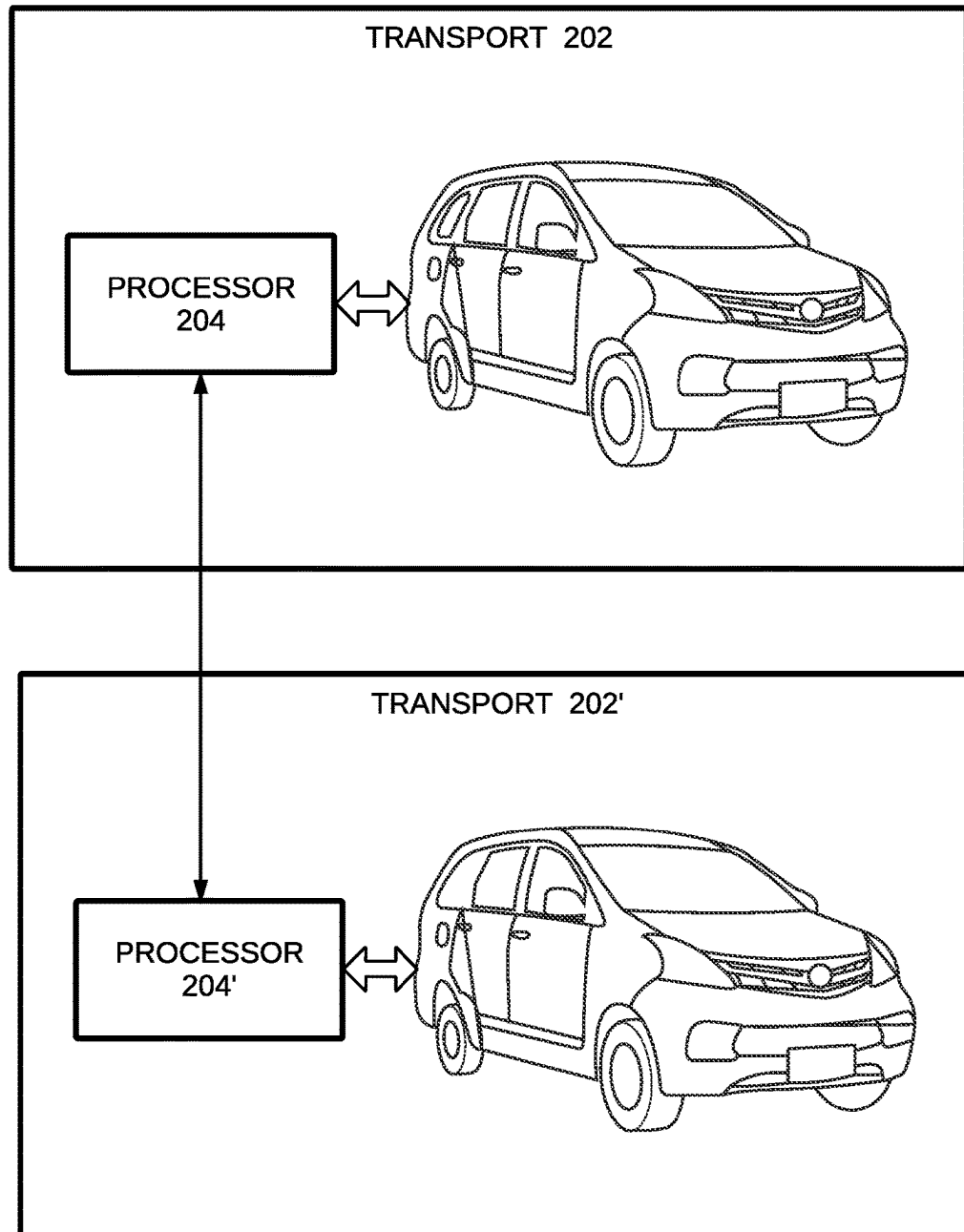
200

FIG. 2A

210

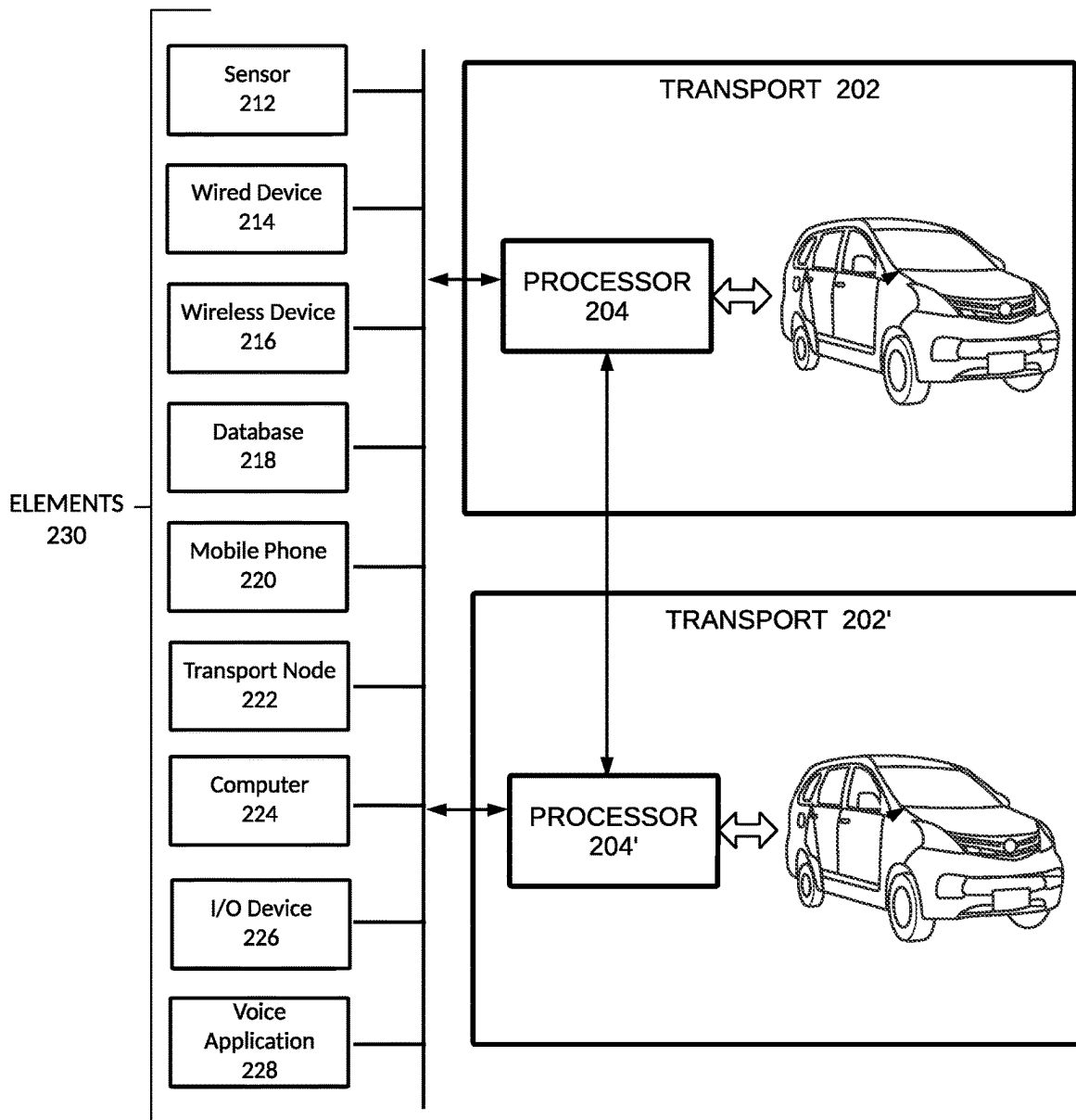


FIG. 2B

240

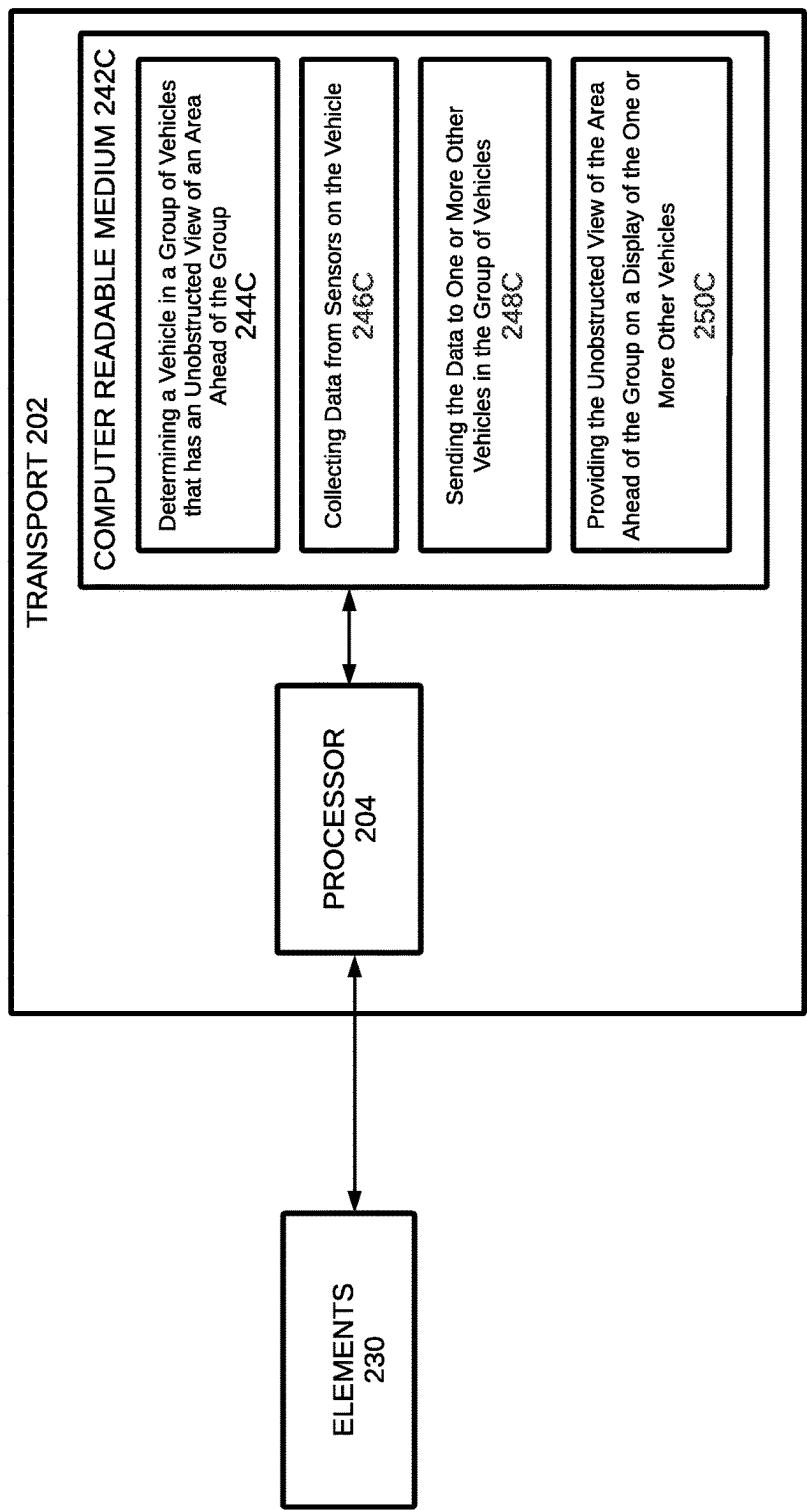


FIG. 2C

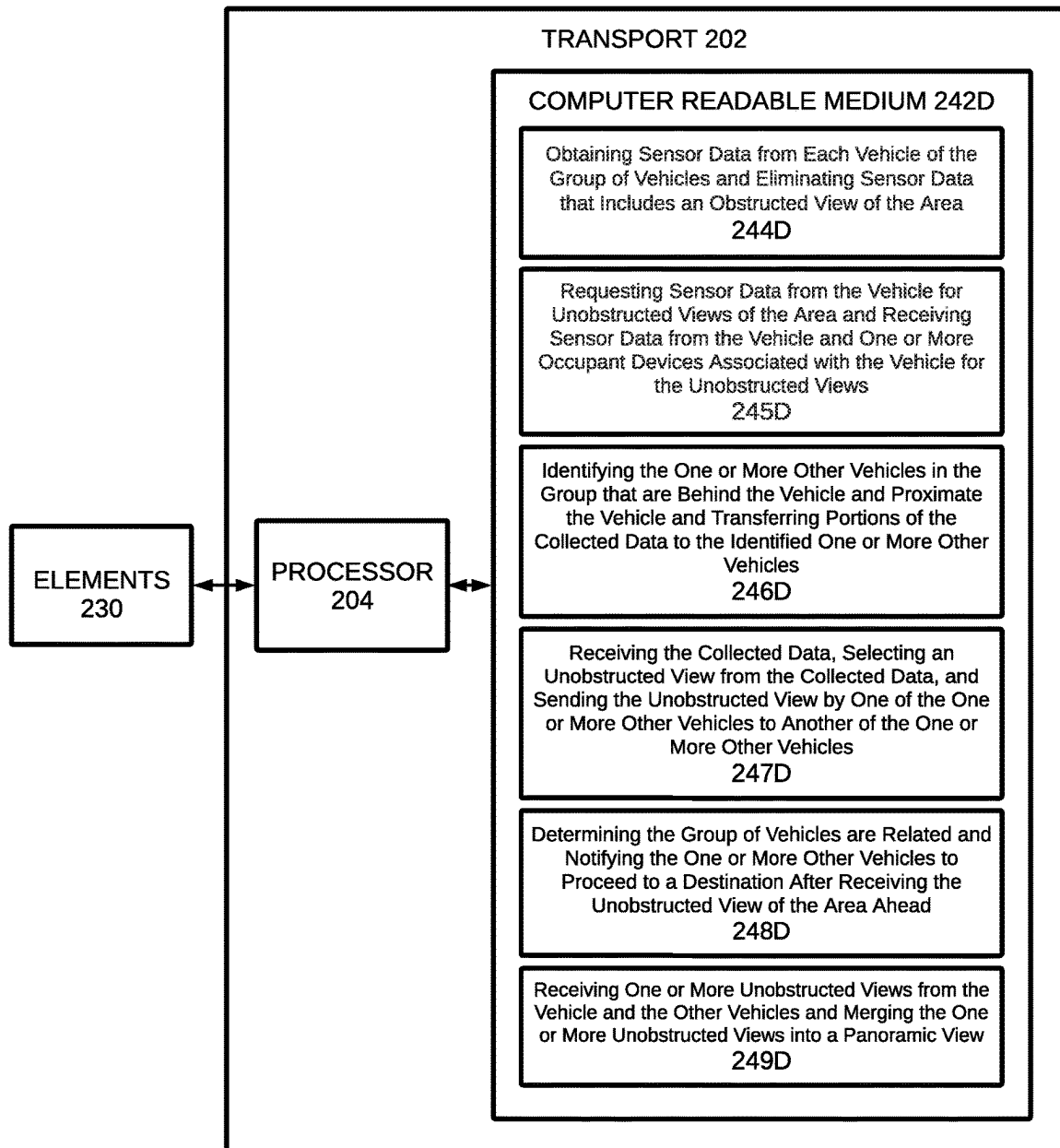
250

FIG. 2D

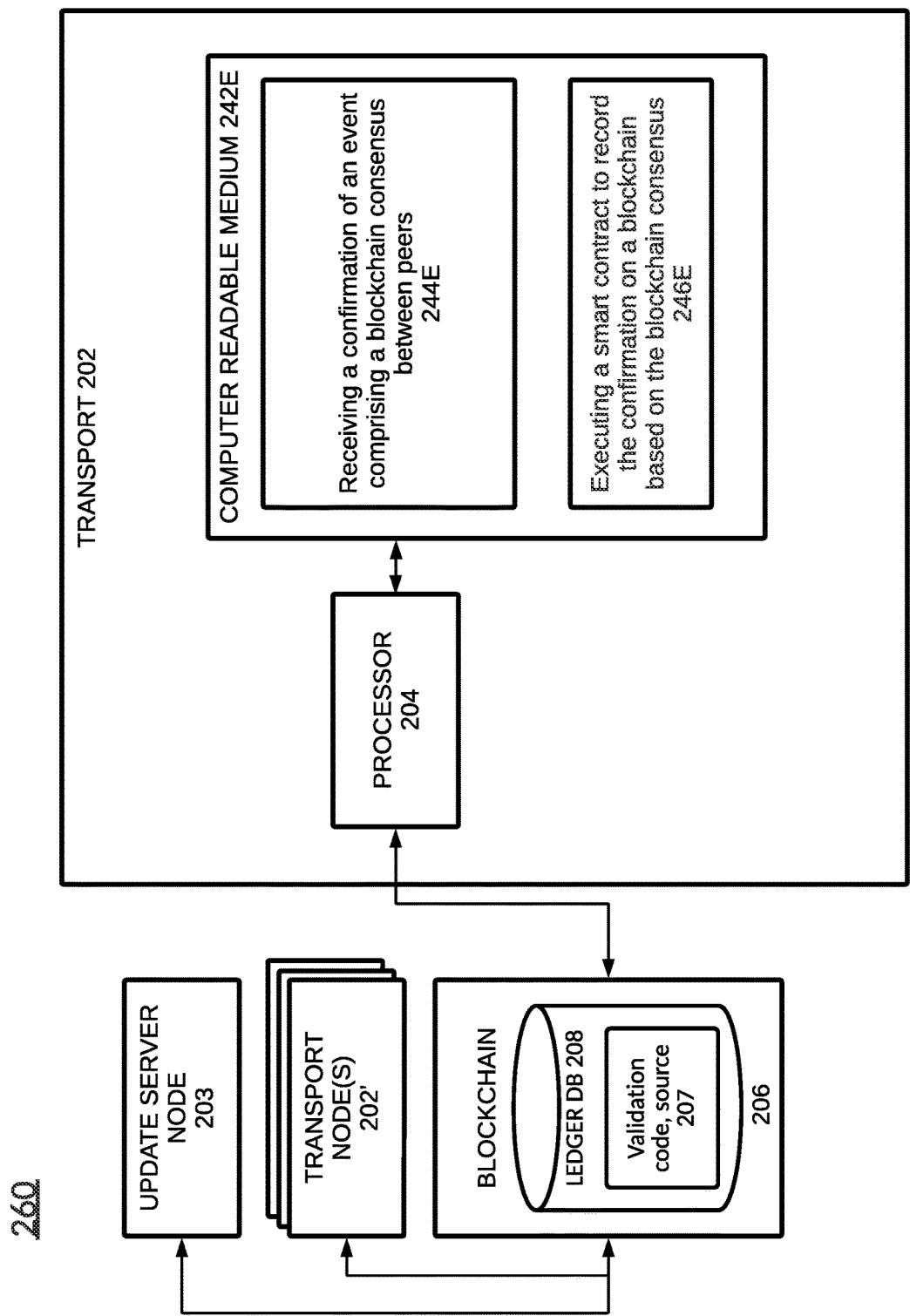


FIG. 2E



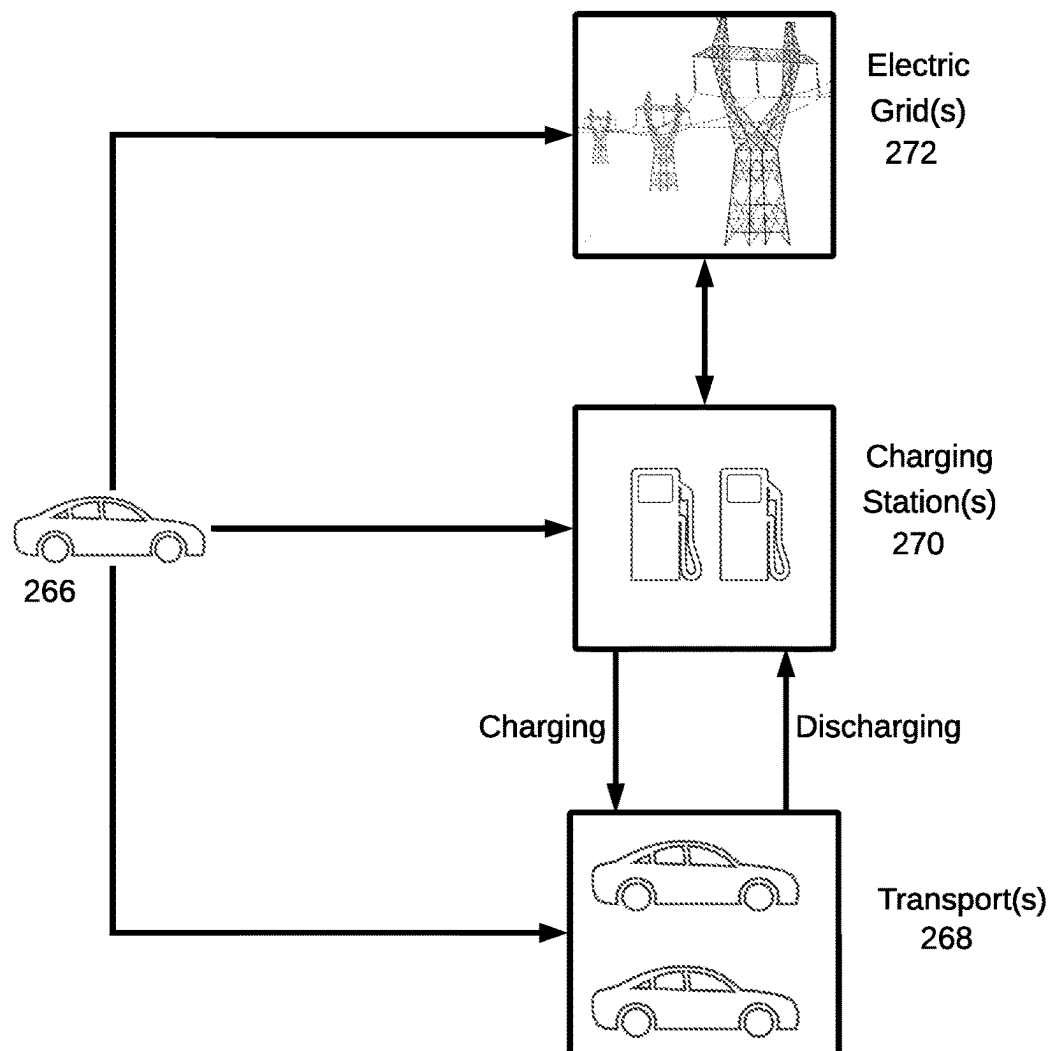
265

FIG. 2F

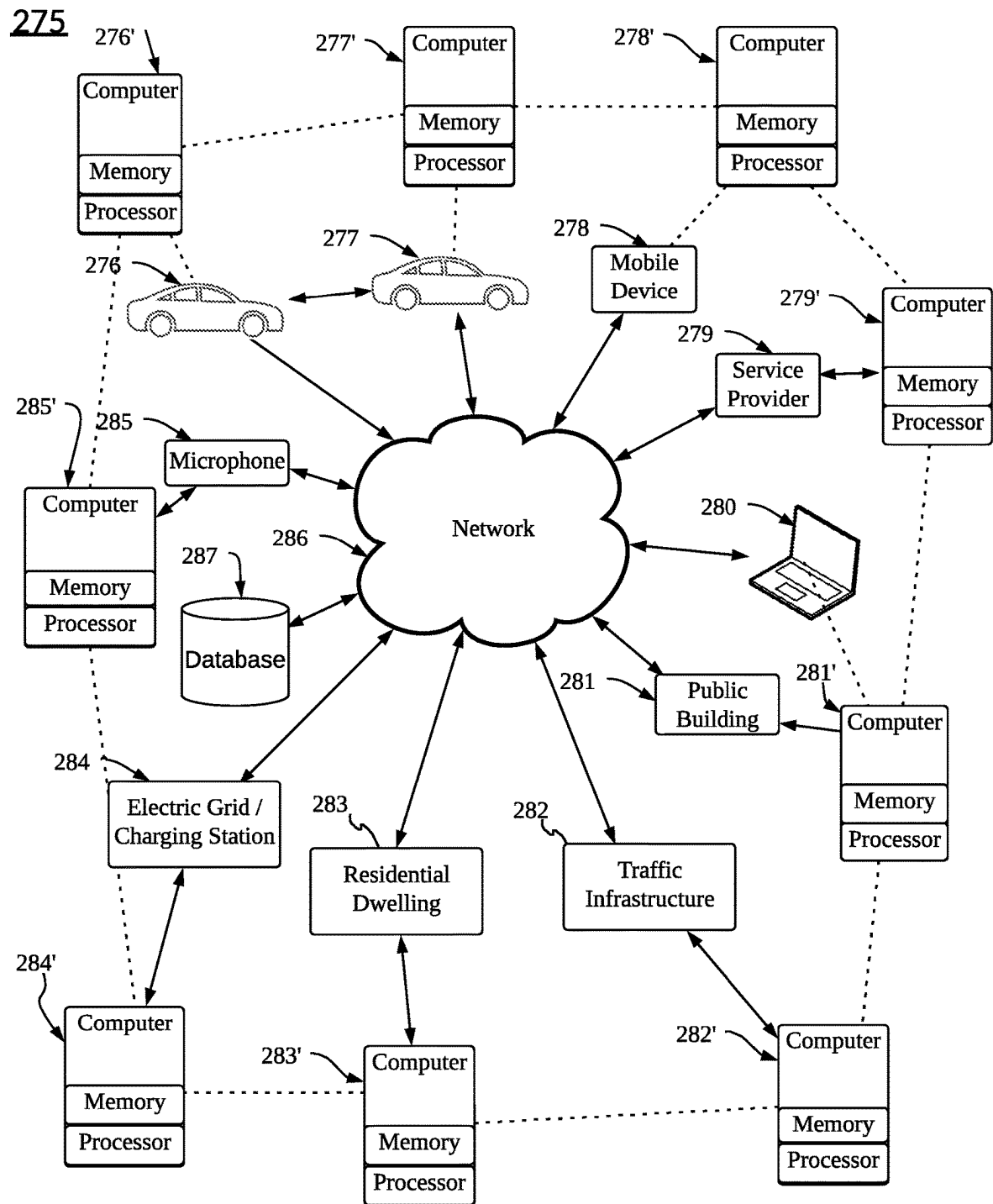


FIG. 2G

290

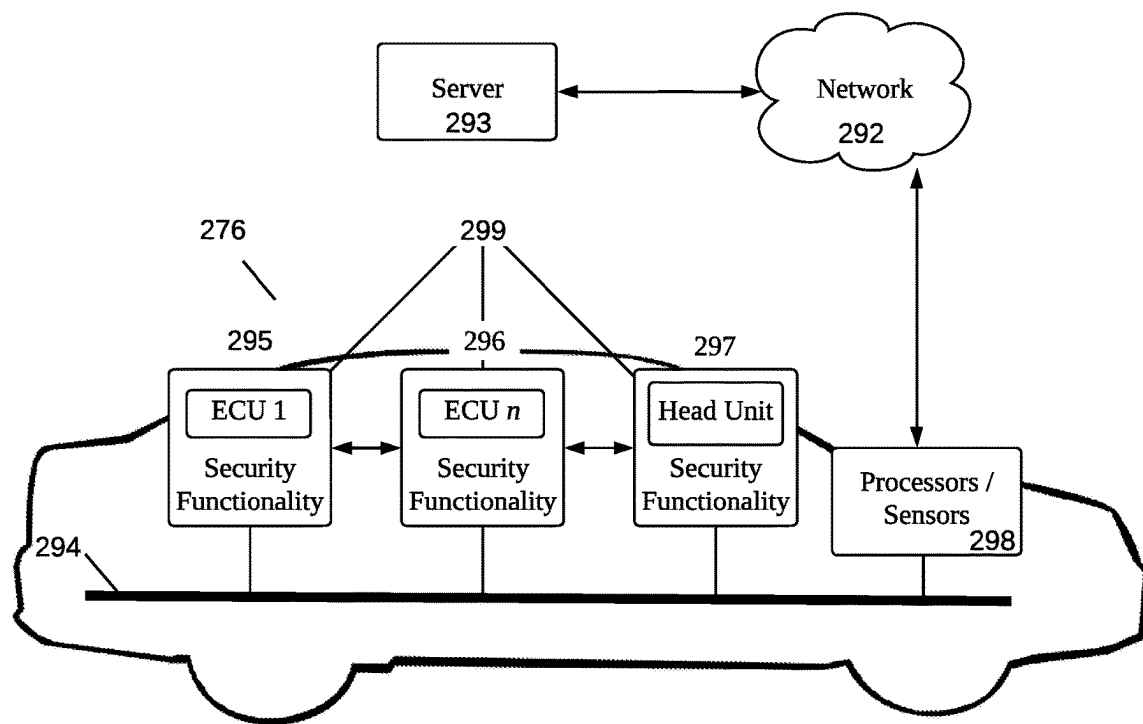


FIG. 2H

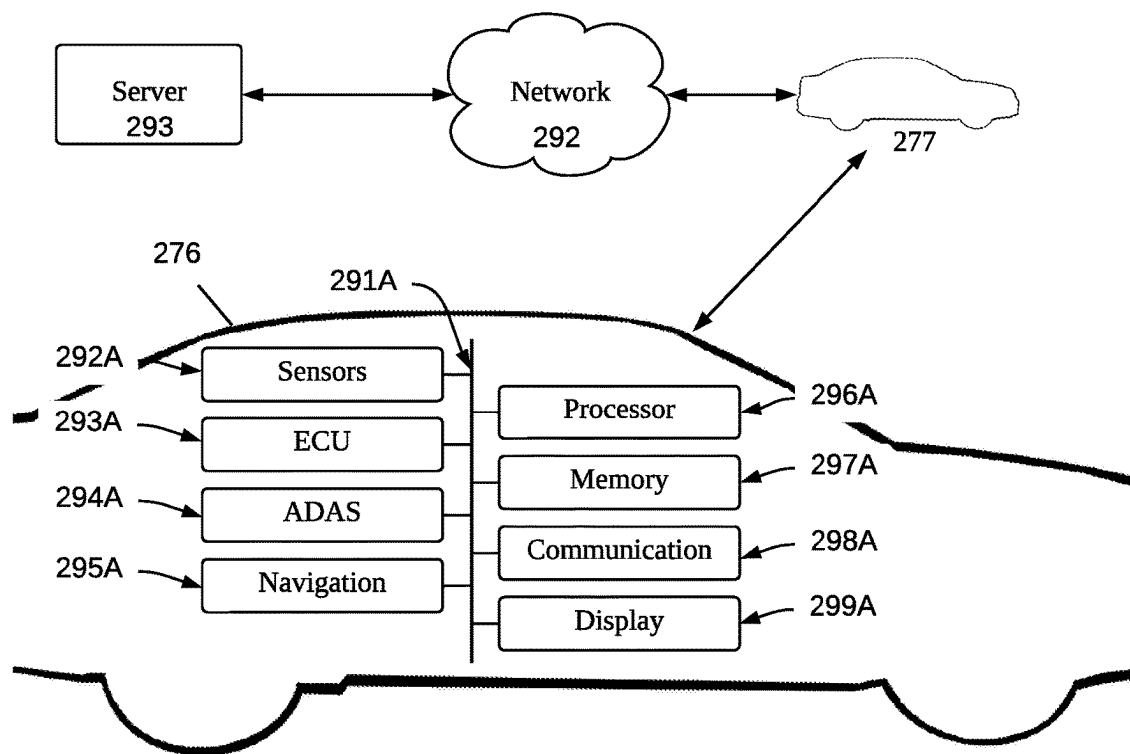
290A

FIG. 2I

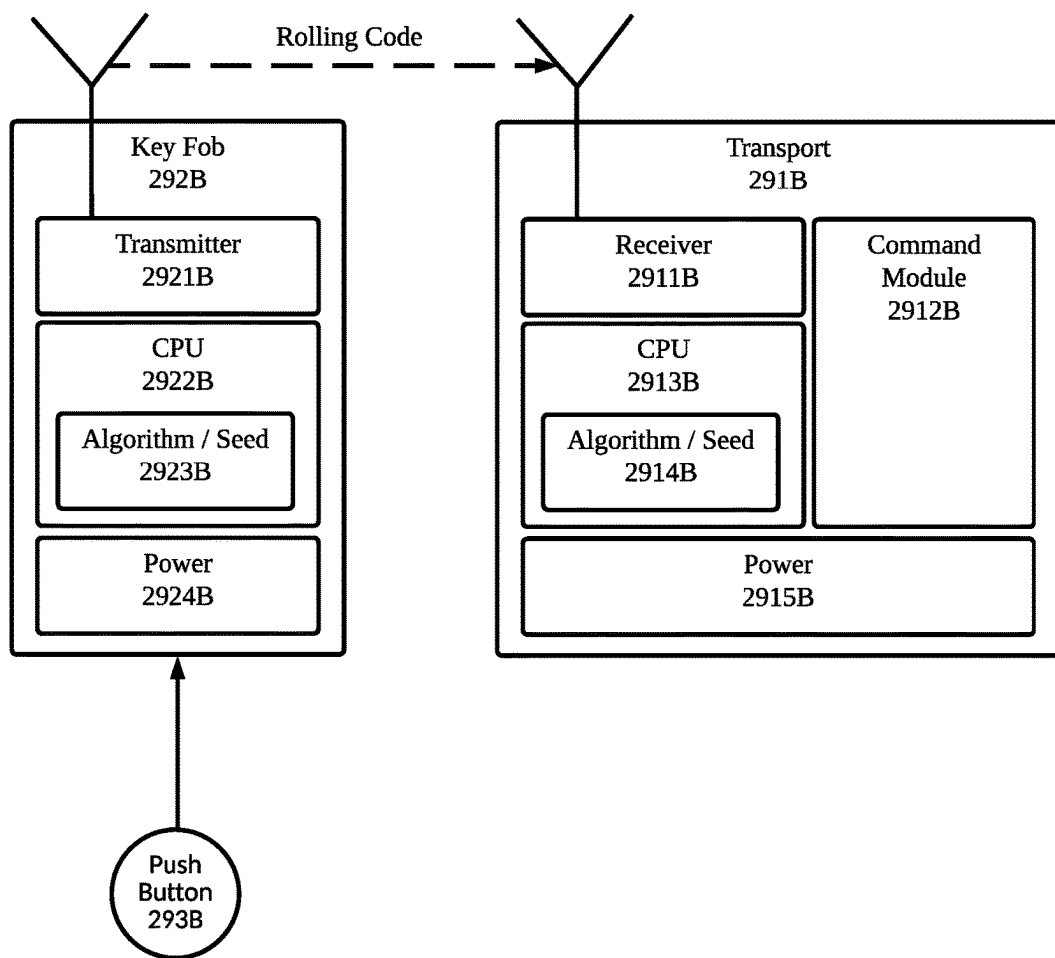
290B

FIG. 2J

290C

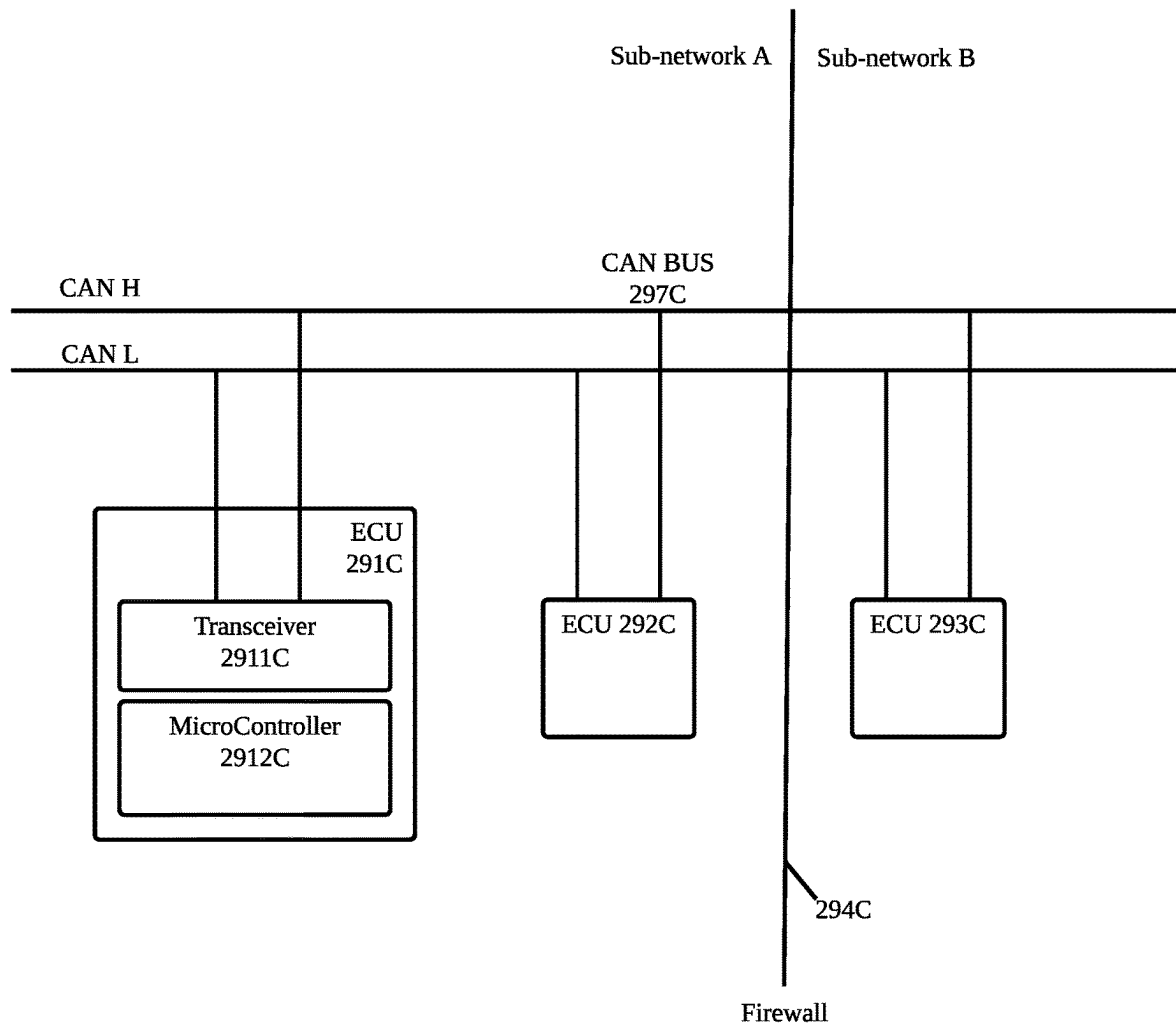


FIG. 2K

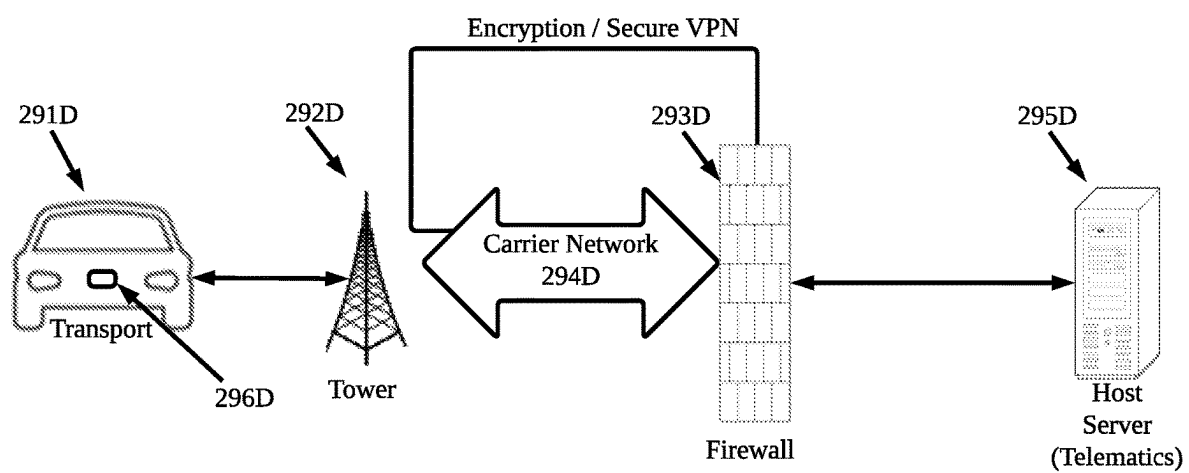
290D

FIG. 2L

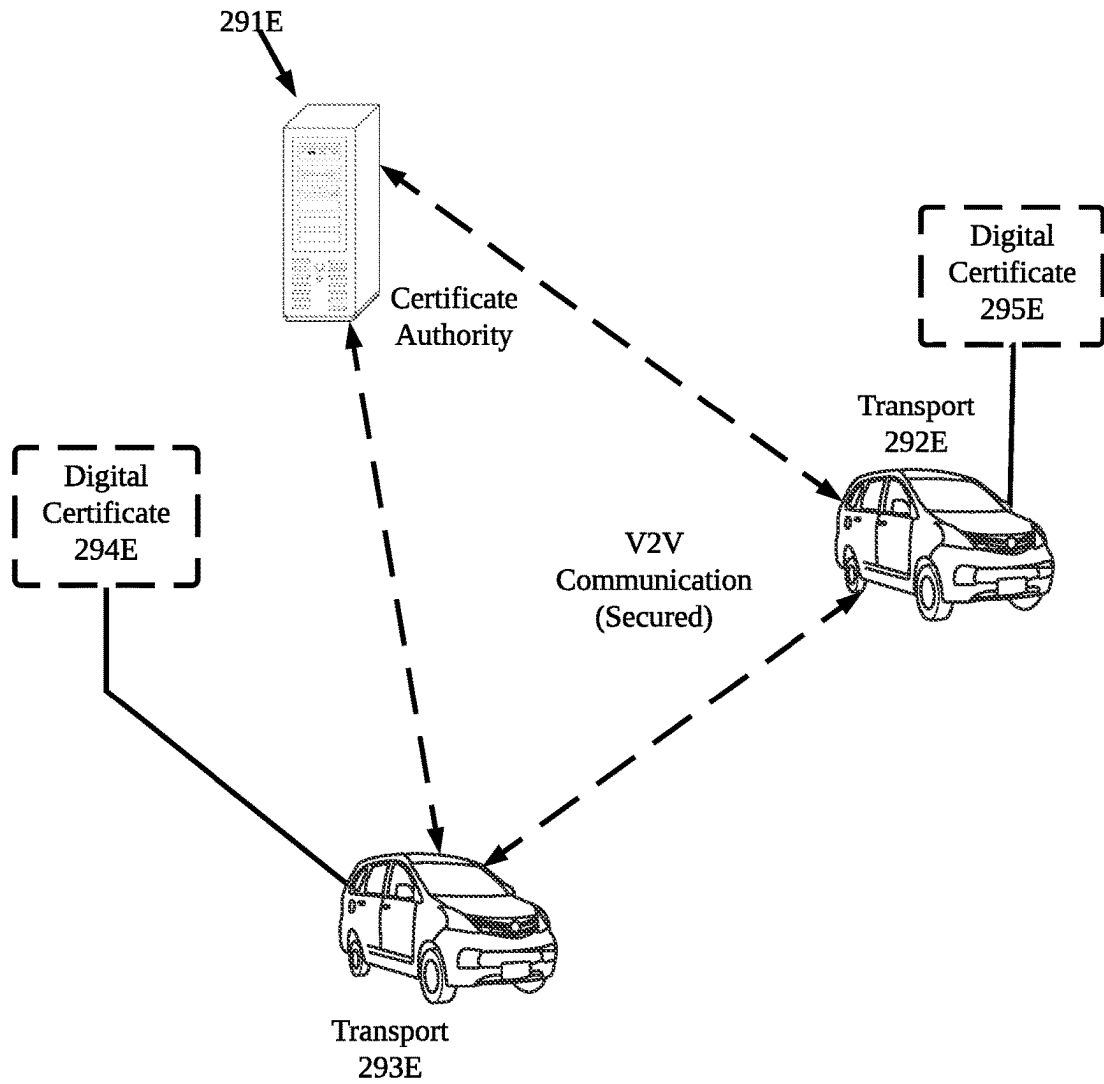
290E

FIG. 2M



290E

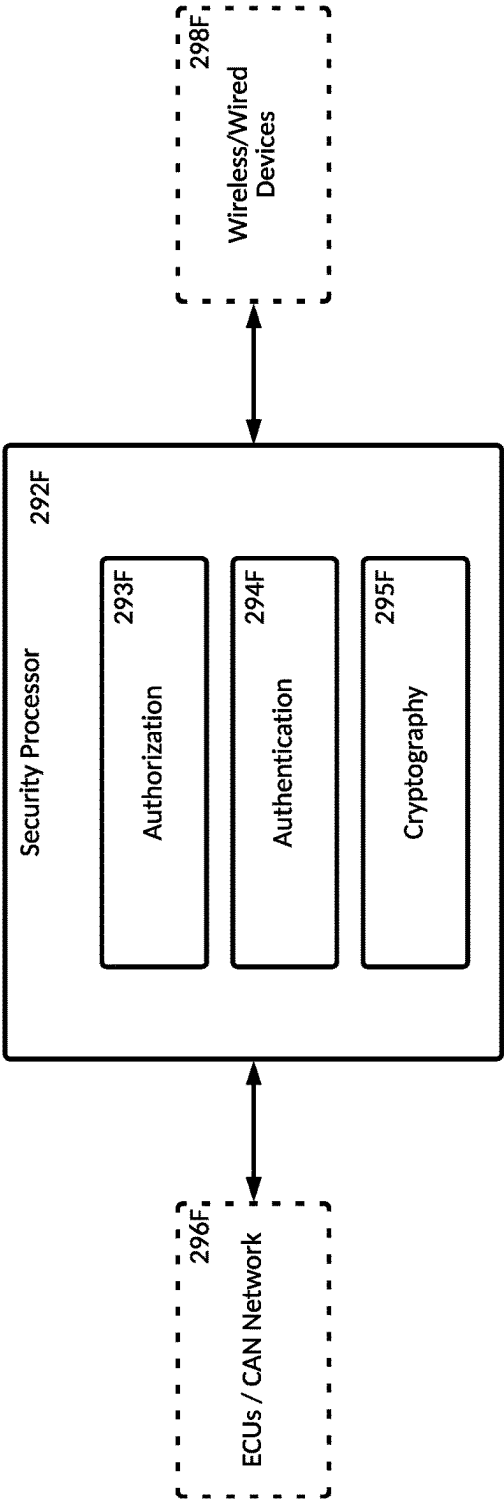


FIG. 2N

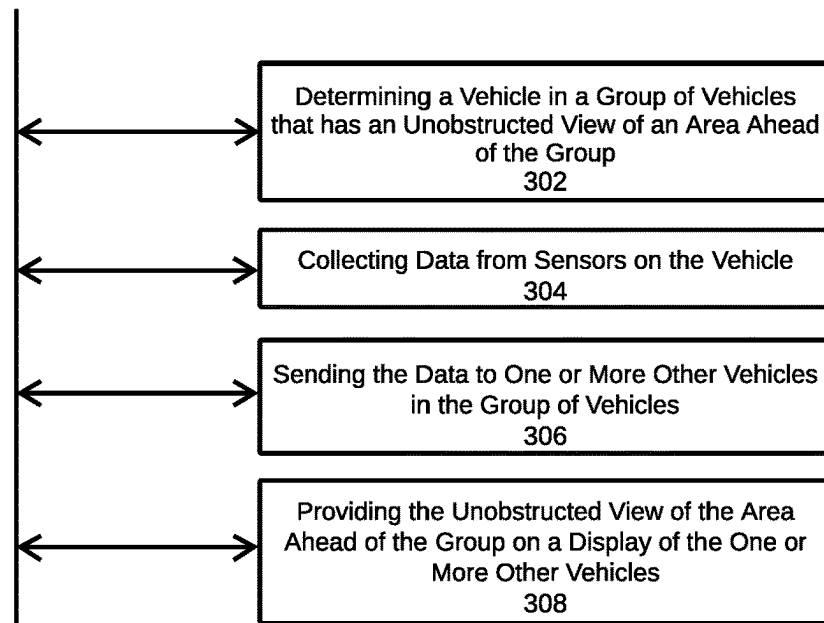
300

FIG. 3A

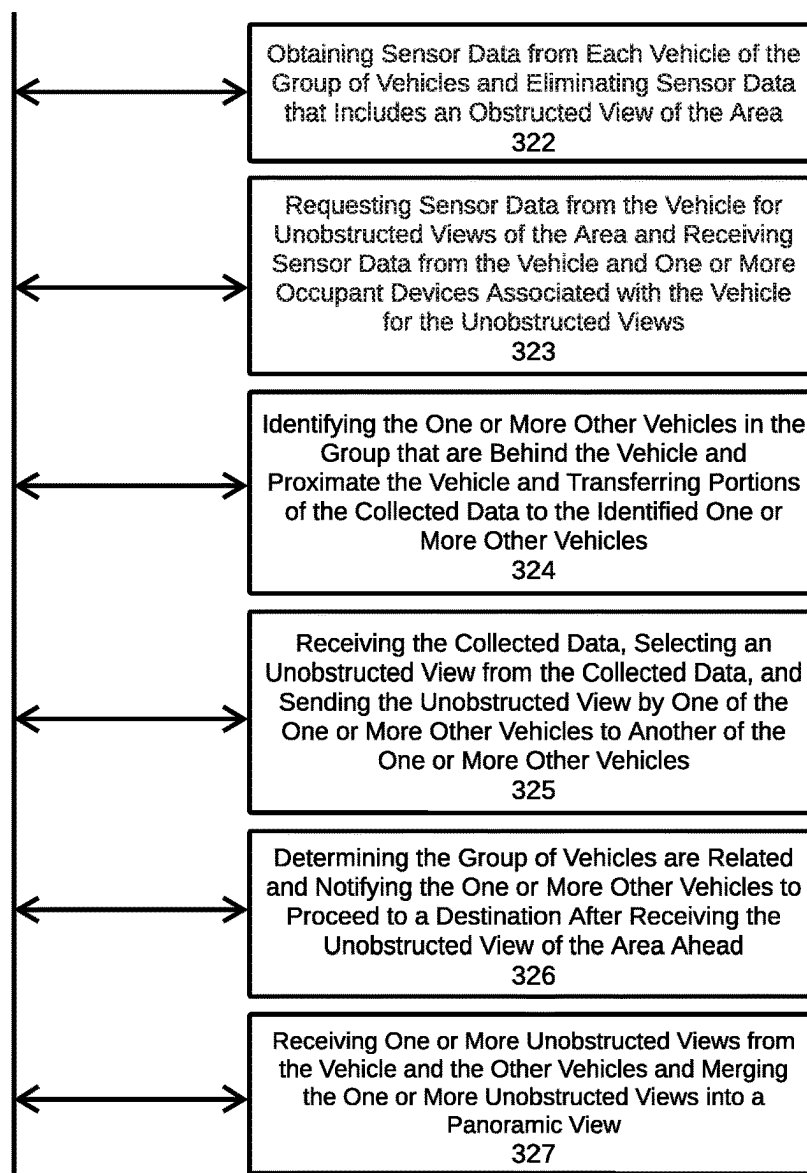
320

FIG. 3B

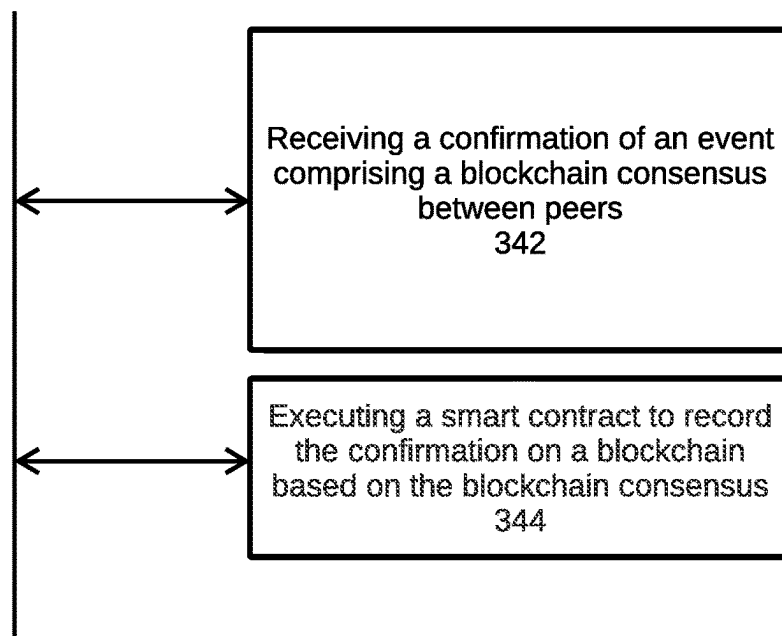
340

FIG. 3C

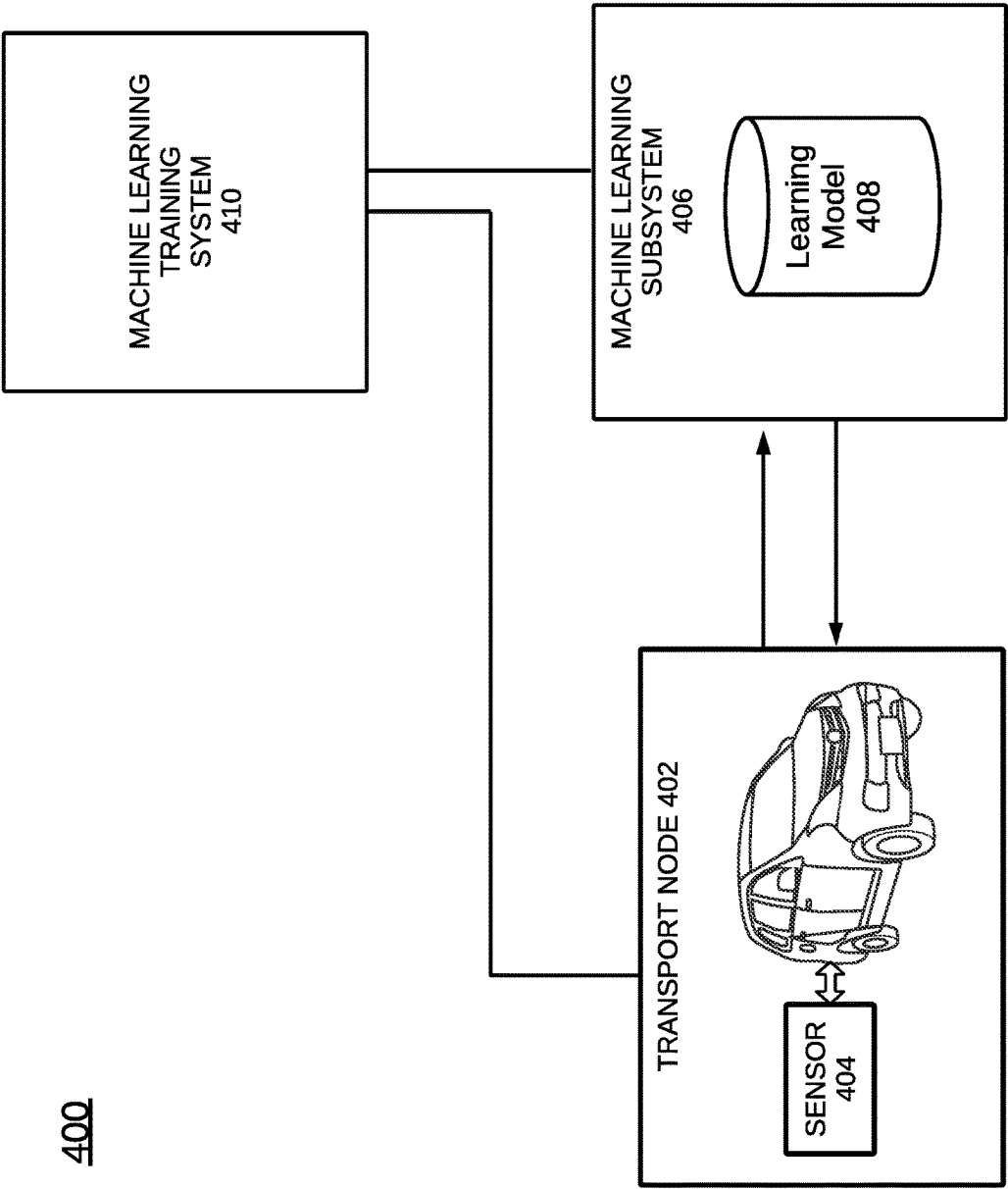


FIG. 4

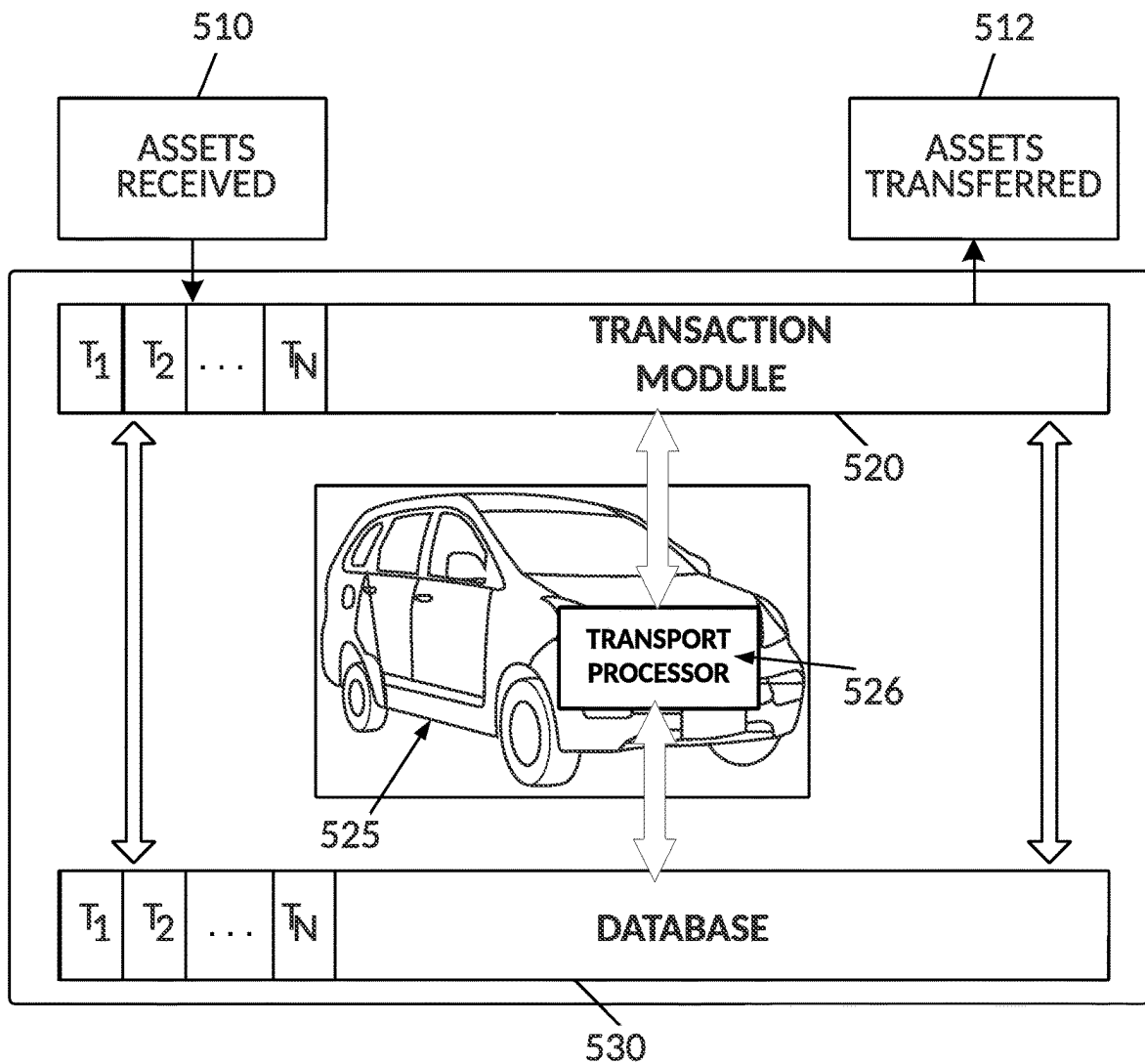
500

FIG. 5A

550

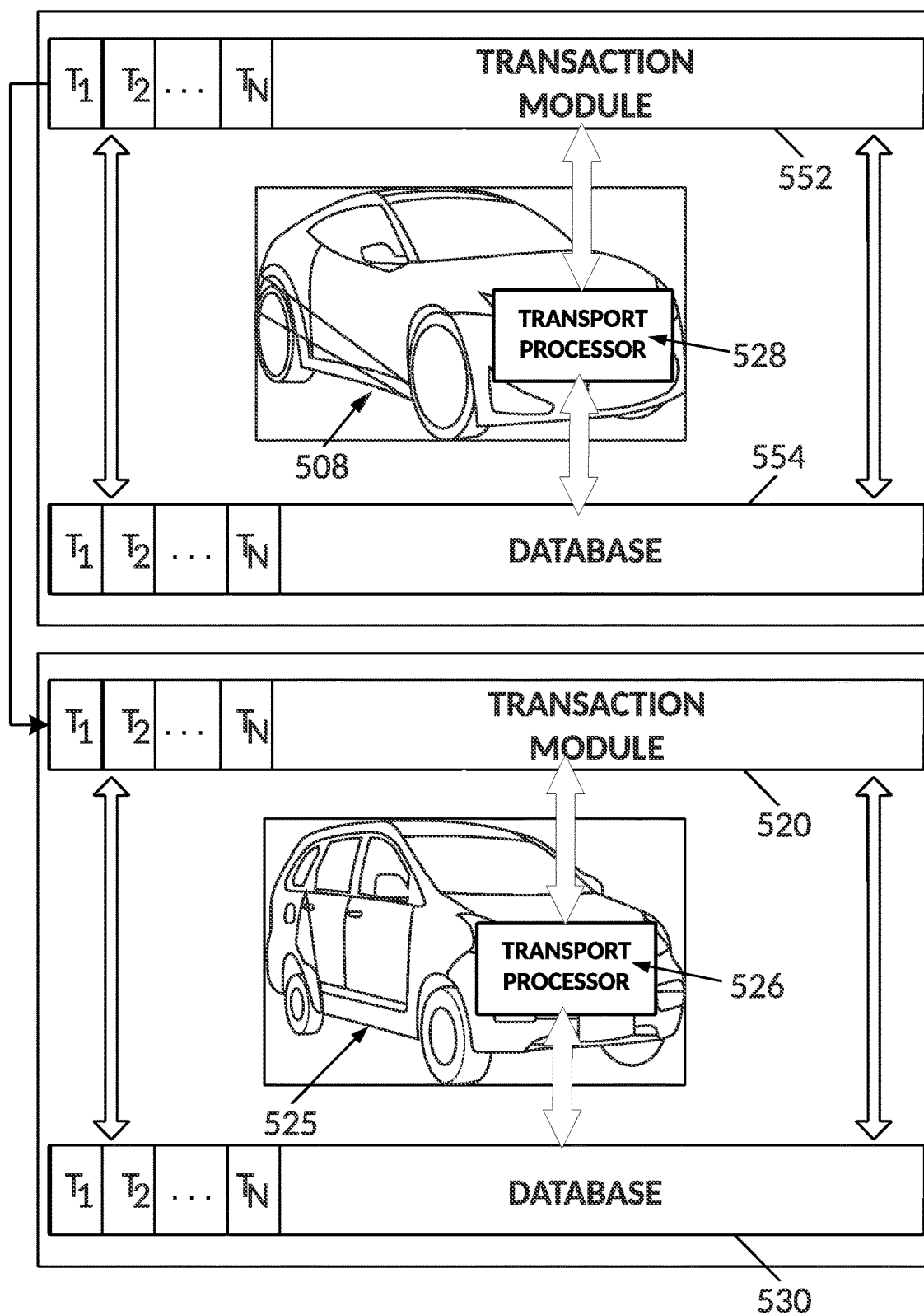


FIG. 5B

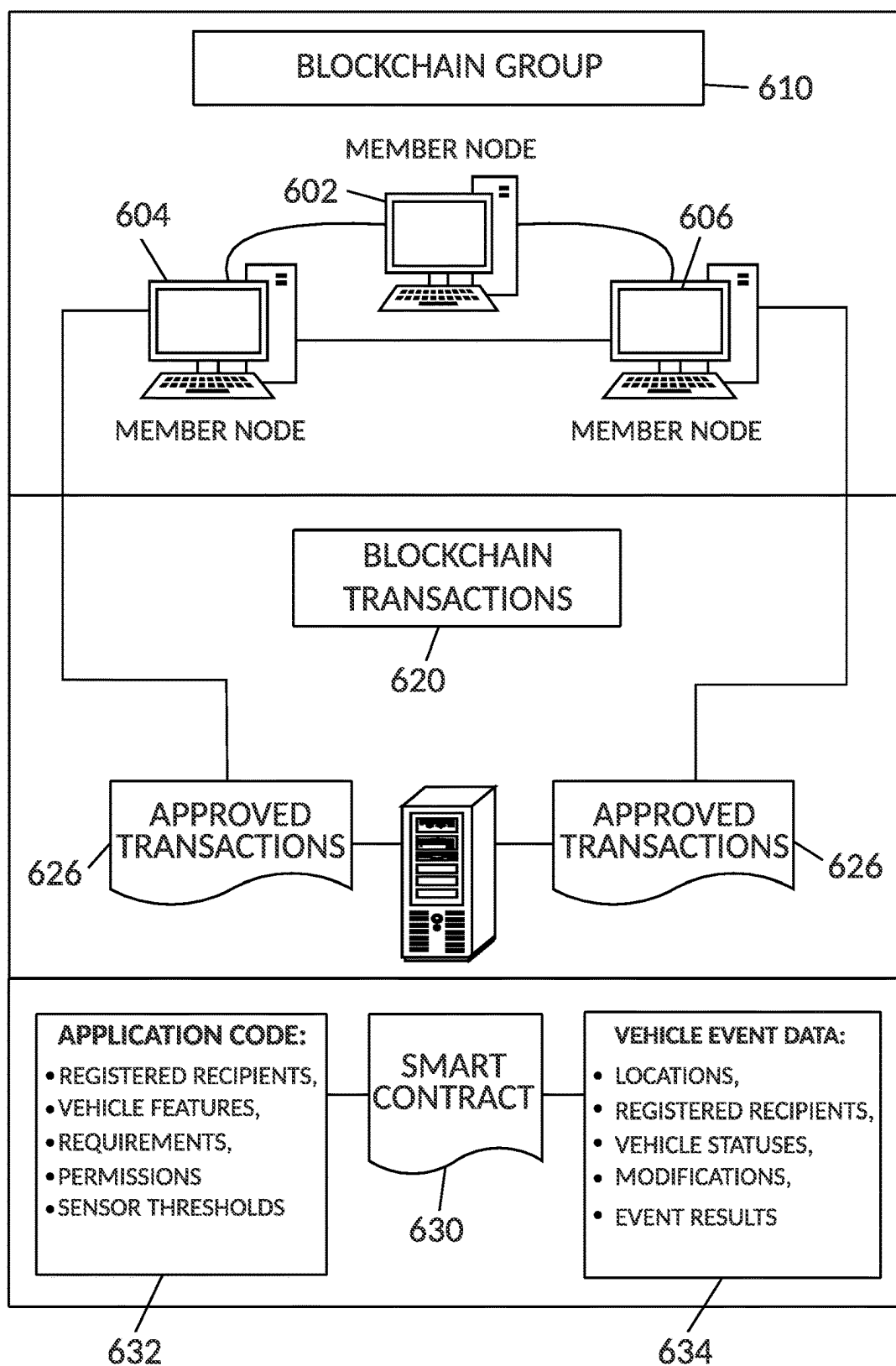
600

FIG. 6A



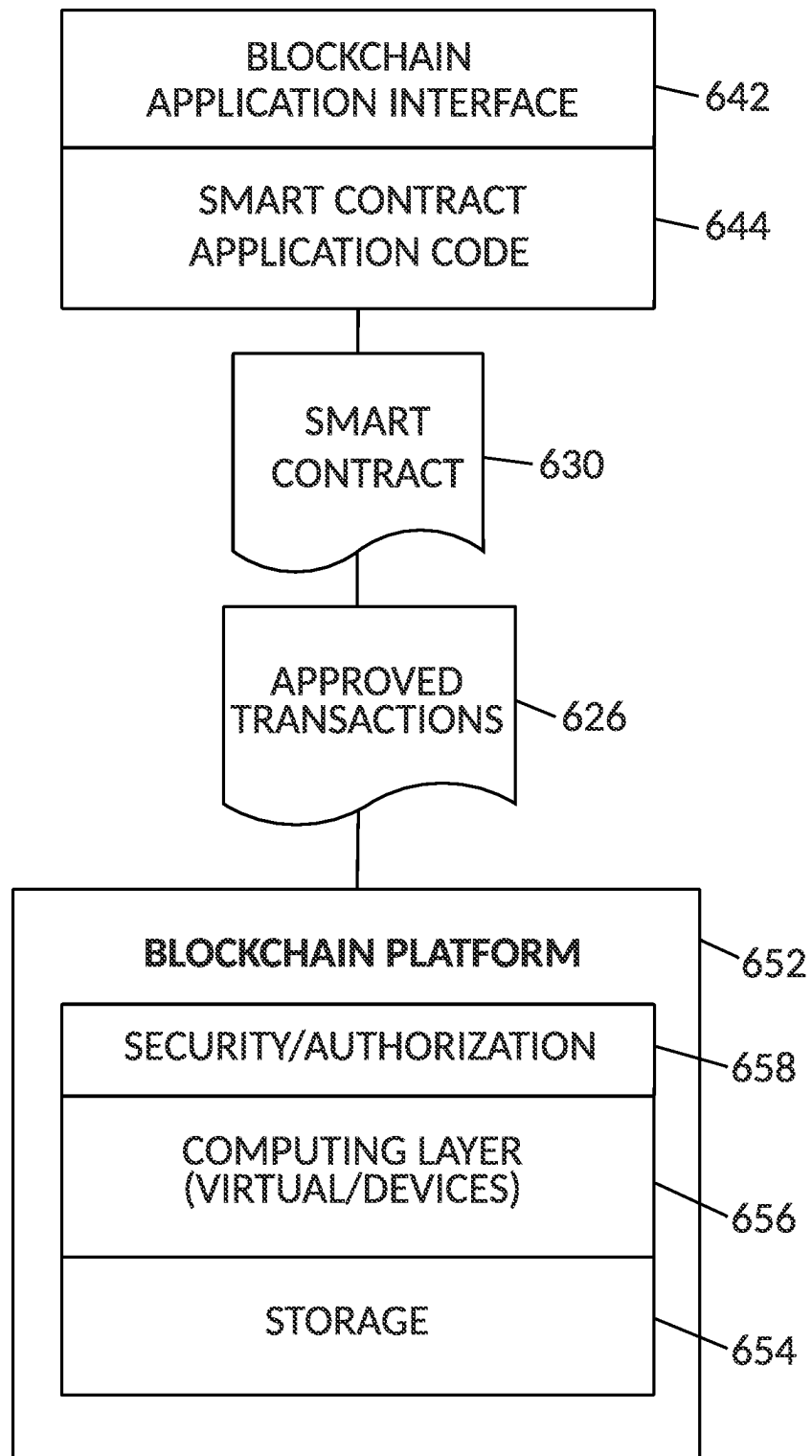
640

FIG. 6B

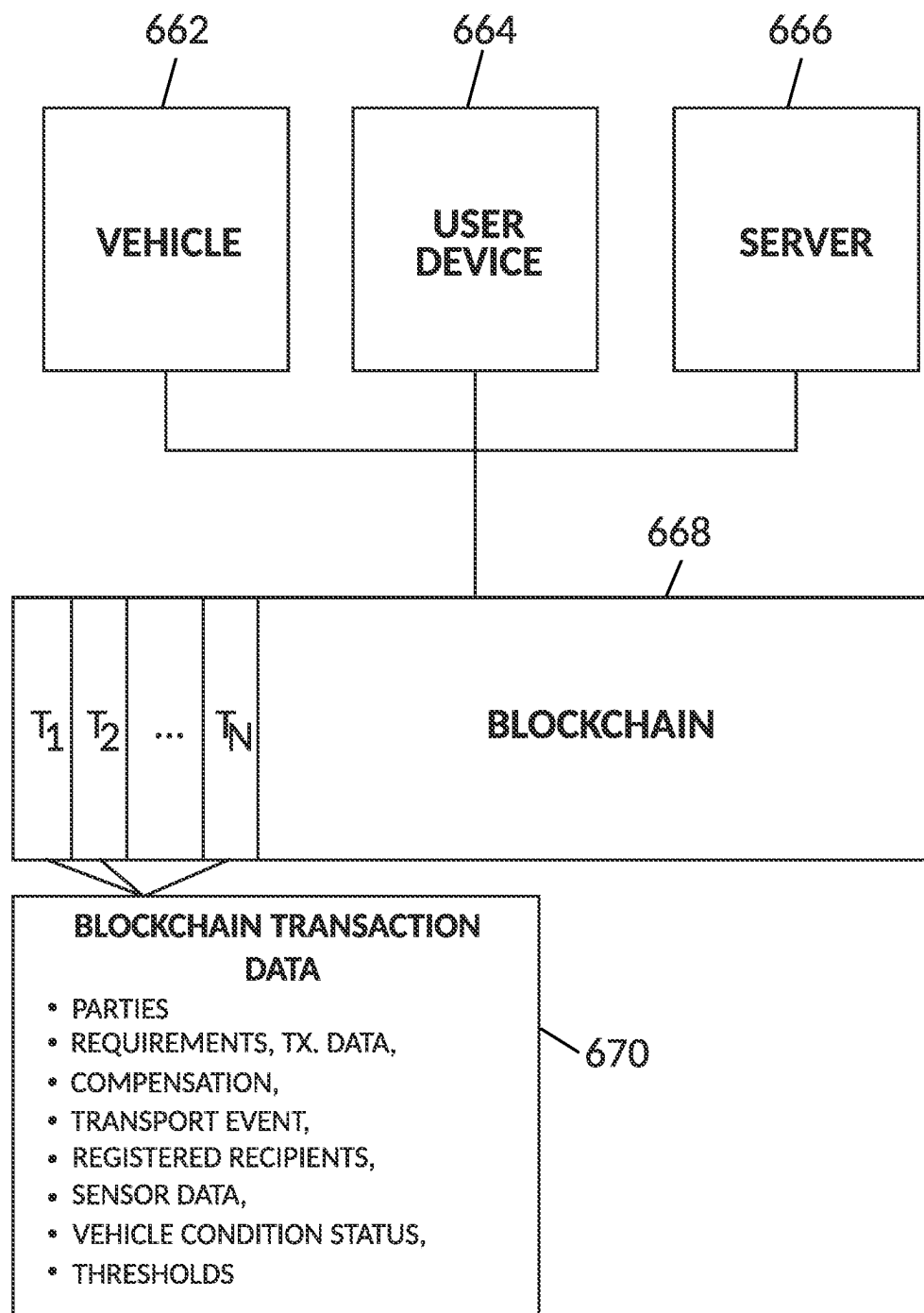
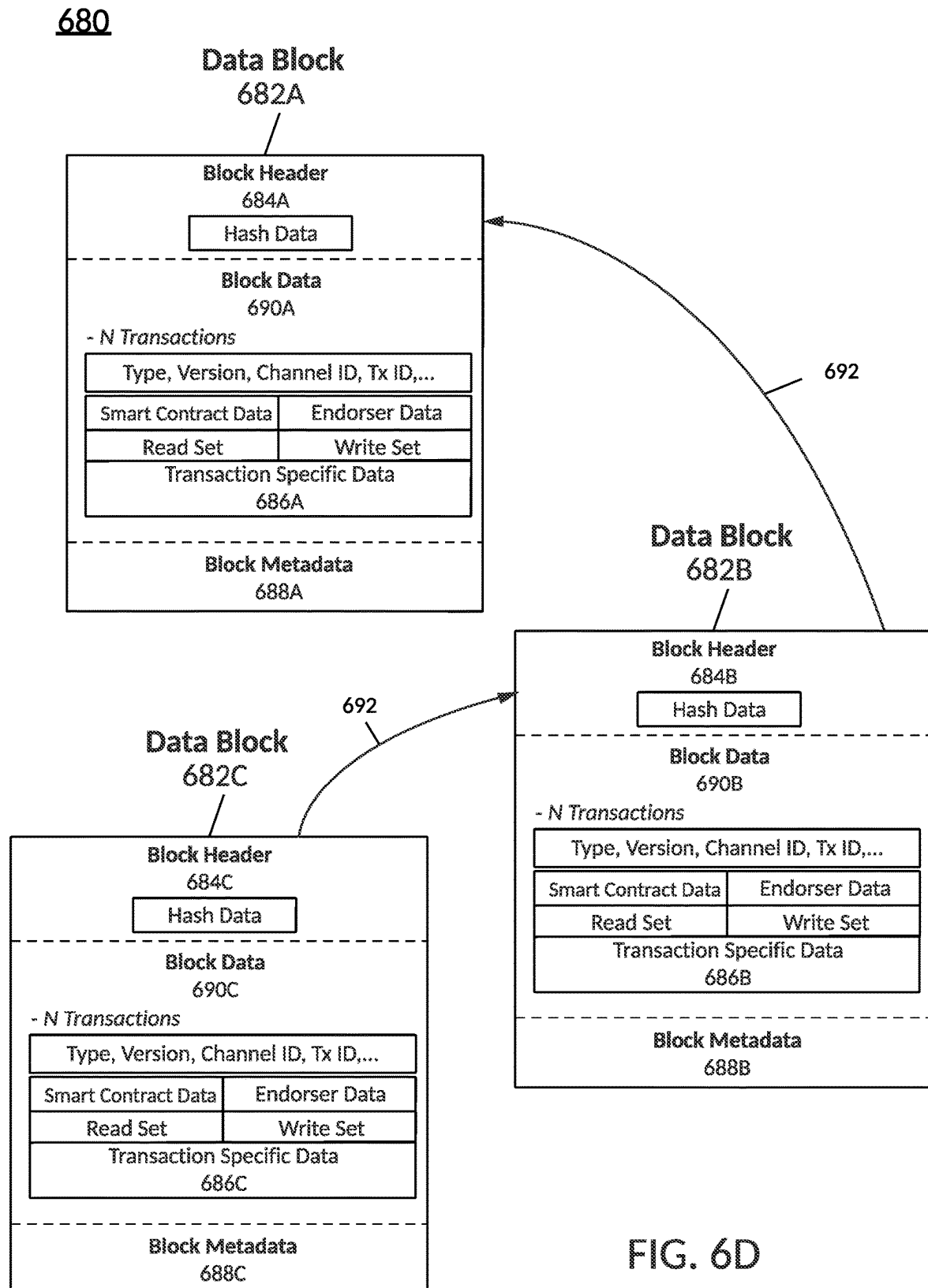
660

FIG. 6C



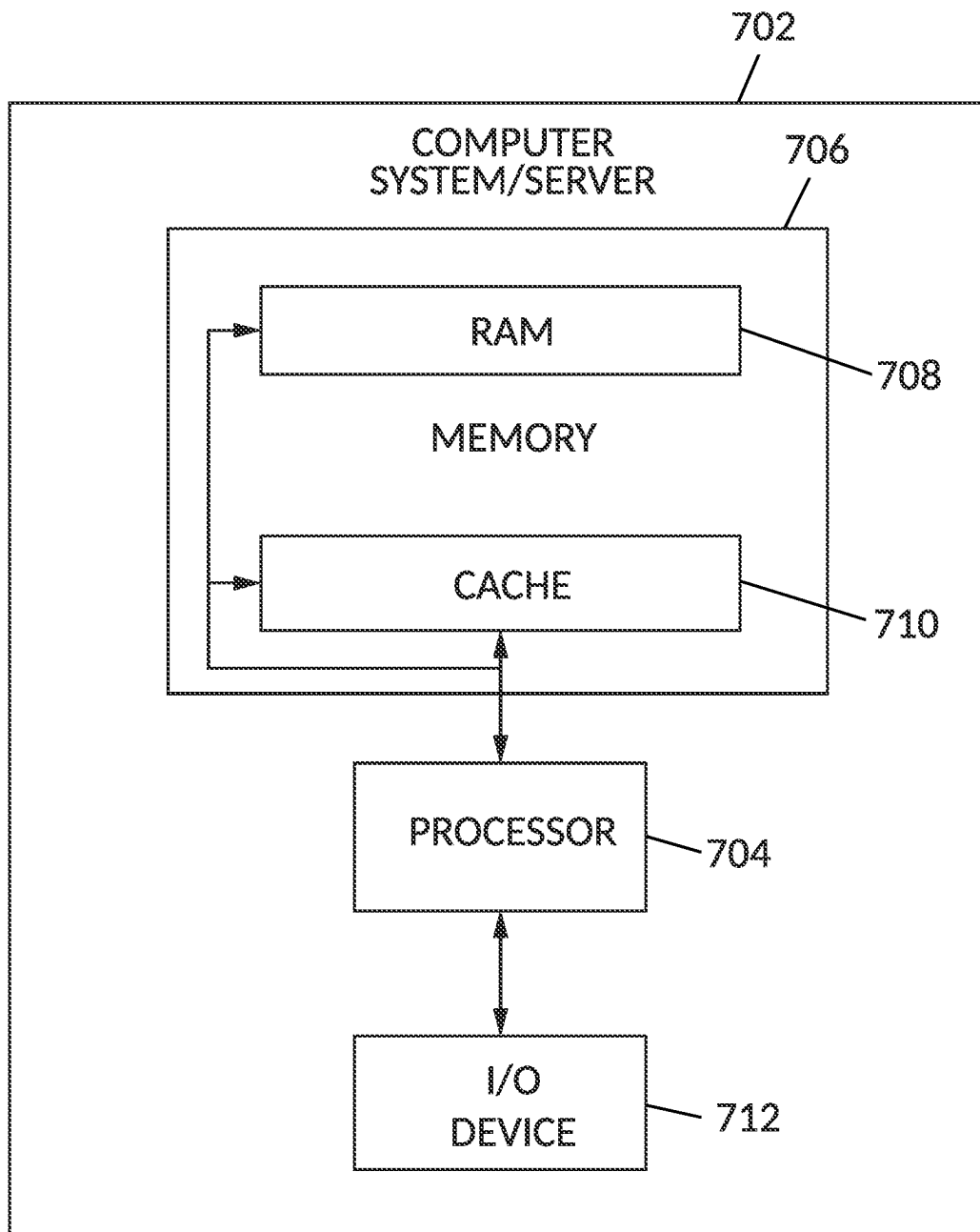
700

FIG. 7

## VEHICLE DETERMINATION FOR MEDIA COLLABORATION

### BACKGROUND

Vehicles or transports, such as cars, motorcycles, trucks, planes, trains, etc., generally provide transportation needs to occupants and/or goods in a variety of ways. Functions related to transports may be identified and utilized by various computing devices, such as a smartphone or a computer located on and/or off the transport.

### SUMMARY

One example embodiment provides a method that includes one or more of determining a vehicle in a group of vehicles that has an unobstructed view of an area ahead of the group, collecting data from sensors on the vehicle, sending the data to one or more other vehicles in the group of vehicles, and providing the unobstructed view of the area ahead of the group on a display of the one or more other vehicles.

Another example embodiment provides a system that includes a memory communicably coupled to a processor, where the processor performs one or more of determine a vehicle in a group of vehicles that has an unobstructed view of an area ahead of the group, collect data from sensors on the vehicle, send the data to one or more other vehicles in the group of vehicles, and provide the unobstructed view of the area ahead of the group on a display of the one or more other vehicles.

A further example embodiment provides a computer readable storage medium comprising instructions, that when read by a processor, cause the processor to perform one or more of determining a vehicle in a group of vehicles that has an unobstructed view of an area ahead of the group, collecting data from sensors on the vehicle, sending the data to one or more other vehicles in the group of vehicles, and providing the unobstructed view of the area ahead of the group on a display of the one or more other vehicles.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A illustrates an example diagram of vehicle determination for media collaboration, according to example embodiments.

FIG. 1B illustrates a flow diagram of vehicle determination for media collaboration, according to example embodiments.

FIG. 2A illustrates a transport network diagram, according to example embodiments.

FIG. 2B illustrates another transport network diagram, according to example embodiments.

FIG. 2C illustrates yet another transport network diagram, according to example embodiments.

FIG. 2D illustrates a further transport network diagram, according to example embodiments.

FIG. 2E illustrates yet a further transport network diagram, according to example embodiments.

FIG. 2F illustrates a diagram depicting electrification of one or more elements, according to example embodiments.

FIG. 2G illustrates a diagram depicting interconnections between different elements, according to example embodiments.

FIG. 2H illustrates a further diagram depicting interconnections between different elements, according to example embodiments.

FIG. 2I illustrates yet a further diagram depicting interconnections between elements, according to example embodiments.

FIG. 2J illustrates yet a further diagram depicting a keyless entry system, according to example embodiments.

FIG. 2K illustrates yet a further diagram depicting a CAN within a transport, according to example embodiments.

FIG. 2L illustrates yet a further diagram depicting an end-to-end communication channel, according to example embodiments.

FIG. 2M illustrates yet a further diagram depicting an example of transports performing secured V2V communications using security certificates, according to example embodiments.

FIG. 2N illustrates yet a further diagram depicting an example of a transport interacting with a security processor and a wireless device, according to example embodiments.

FIG. 3A illustrates a flow diagram, according to example embodiments.

FIG. 3B illustrates another flow diagram, according to example embodiments.

FIG. 3C illustrates yet another flow diagram, according to example embodiments.

FIG. 4 illustrates a machine learning transport network diagram, according to example embodiments.

FIG. 5A illustrates an example vehicle configuration for managing database transactions associated with a vehicle, according to example embodiments.

FIG. 5B illustrates another example vehicle configuration for managing database transactions conducted among various vehicles, according to example embodiments.

FIG. 6A illustrates a blockchain architecture configuration, according to example embodiments.

FIG. 6B illustrates another blockchain configuration, according to example embodiments.

FIG. 6C illustrates a blockchain configuration for storing blockchain transaction data, according to example embodiments.

FIG. 6D illustrates example data blocks, according to example embodiments.

FIG. 7 illustrates an example system that supports one or more of the example embodiments.

### DETAILED DESCRIPTION

It will be readily understood that the instant components, as generally described and illustrated in the figures herein, may be arranged and designed in a wide variety of different configurations. Thus, the following detailed description of the embodiments of at least one of a method, apparatus, computer readable storage medium and system, as represented in the attached figures, is not intended to limit the scope of the application as claimed but is merely representative of selected embodiments. Multiple embodiments depicted herein are not intended to limit the scope of the solution. The computer-readable storage medium may be a non-transitory computer readable medium or a non-transitory computer readable storage medium.

Communications between the transport(s) and certain entities, such as remote servers, other transports and local computing devices (e.g., smartphones, personal computers, transport-embedded computers, etc.) may be sent and/or received and processed by one or more 'components' which may be hardware, firmware, software or a combination thereof. The components may be part of any of these entities or computing devices or certain other computing devices. In one example, consensus decisions related to blockchain

transactions may be performed by one or more computing devices or components (which may be any element described and/or depicted herein) associated with the transport(s) and one or more of the components outside or at a remote location from the transport(s).

The instant features, structures, or characteristics described in this specification may be combined in any suitable manner in one or more embodiments. For example, the usage of the phrases “example embodiments,” “some embodiments,” or other similar language, throughout this specification refers to the fact that a particular feature, structure, or characteristic described in connection with the embodiment may be included in at least one example. Thus, appearances of the phrases “example embodiments,” “in some embodiments,” “in other embodiments,” or other similar language, throughout this specification do not necessarily all refer to the same group of embodiments, and the described features, structures, or characteristics may be combined in any suitable manner in one or more embodiments. In the diagrams, any connection between elements can permit one-way and/or two-way communication, even if the depicted connection is a one-way or two-way arrow. In the current solution, a vehicle or transport may include one or more of cars, trucks, walking area battery electric vehicle (BEV), e-Palette, fuel cell bus, motorcycles, scooters, bicycles, boats, recreational vehicles, planes, and any object that may be used to transport people and or goods from one location to another.

In addition, while the term “message” may have been used in the description of embodiments, other types of network data, such as, a packet, frame, datagram, etc. may also be used. Furthermore, while certain types of messages and signaling may be depicted in exemplary embodiments they are not limited to a certain type of message and signaling.

Example embodiments provide methods, systems, components, non-transitory computer readable medium, devices, and/or networks, which provide at least one of a transport (also referred to as a vehicle or car herein), a data collection system, a data monitoring system, a verification system, an authorization system, and a vehicle data distribution system. The vehicle status condition data received in the form of communication messages, such as wireless data network communications and/or wired communication messages, may be processed to identify vehicle/transport status conditions and provide feedback on the condition and/or changes of a transport. In one example, a user profile may be applied to a particular transport/vehicle to authorize a current vehicle event, service stops at service stations, to authorize subsequent vehicle rental services, and enable vehicle-to-vehicle communications.

Within the communication infrastructure, a decentralized database is a distributed storage system which includes multiple nodes that communicate with each other. A blockchain is an example of a decentralized database, which includes an append-only immutable data structure (i.e., a distributed ledger) capable of maintaining records between untrusted parties. The untrusted parties are referred to herein as peers, nodes, or peer nodes. Each peer maintains a copy of the database records, and no single peer can modify the database records without a consensus being reached among the distributed peers. For example, the peers may execute a consensus protocol to validate blockchain storage entries, group the storage entries into blocks, and build a hash chain via the blocks. This process forms the ledger by ordering the storage entries, as is necessary, for consistency. In public or permissionless blockchains, anyone can participate without

a specific identity. Public blockchains can involve cryptocurrencies and use consensus-based on various protocols such as proof of work (PoW). Conversely, a permissioned blockchain database can secure interactions among a group of entities, which share a common goal, but which do not or cannot fully trust one another, such as businesses that exchange funds, goods, information, and the like. The instant solution can function in a permissioned and/or a permissionless blockchain setting.

Smart contracts are trusted distributed applications which leverage tamper-proof properties of the shared or distributed ledger (which may be in the form of a blockchain) and an underlying agreement between member nodes, which is referred to as an endorsement or endorsement policy. In general, blockchain entries are “endorsed” before being committed to the blockchain while entries which are not endorsed are disregarded. A typical endorsement policy allows smart contract executable code to specify endorers for an entry in the form of a set of peer nodes that are necessary for endorsement. When a client sends the entry to the peers specified in the endorsement policy, the entry is executed to validate the entry. After validation, the entries enter an ordering phase in which a consensus protocol produces an ordered sequence of endorsed entries grouped into blocks.

Nodes are the communication entities of the blockchain system. A “node” may perform a logical function in the sense that multiple nodes of different types can run on the same physical server. Nodes are grouped in trust domains and are associated with logical entities that control them in various ways. Nodes may include different types, such as a client or submitting-client node, which submits an entry-invocation to an endorser (e.g., peer), and broadcasts entry proposals to an ordering service (e.g., ordering node). Another type of node is a peer node, which can receive client submitted entries, commit the entries and maintain a state and a copy of the ledger of blockchain entries. Peers can also have the role of an endorser. An ordering-service-node or orderer is a node running the communication service for all nodes and which implements a delivery guarantee, such as a broadcast to each of the peer nodes in the system when committing entries and modifying a world state of the blockchain. The world state can constitute the initial blockchain entry, which normally includes control and setup information.

A ledger is a sequenced, tamper-resistant record of all state transitions of a blockchain. State transitions may result from smart contract executable code invocations (i.e., entries) submitted by participating parties (e.g., client nodes, ordering nodes, endorser nodes, peer nodes, etc.). An entry may result in a set of asset key-value pairs being committed to the ledger as one or more operands, such as creates, updates, deletes, and the like. The ledger includes a blockchain (also referred to as a chain), which stores an immutable, sequenced record in blocks. The ledger also includes a state database, which maintains a current state of the blockchain. There is typically one ledger per channel. Each peer node maintains a copy of the ledger for each channel of which they are a member.

A chain is an entry log structured as hash-linked blocks, and each block contains a sequence of N entries where N is equal to or greater than one. The block header includes a hash of the blocks’ entries, as well as a hash of the prior block’s header. In this way, all entries on the ledger may be sequenced and cryptographically linked together. Accordingly, it is not possible to tamper with the ledger data without breaking the hash links. A hash of a most recently added

blockchain block represents every entry on the chain that has come before it, making it possible to ensure that all peer nodes are in a consistent and trusted state. The chain may be stored on a peer node file system (i.e., local, attached storage, cloud, etc.), efficiently supporting the append-only nature of the blockchain workload.

The current state of the immutable ledger represents the latest values for all keys that are included in the chain entry log. Since the current state represents the latest key values known to a channel, it is sometimes referred to as a world state. Smart contract executable code invocations execute entries against the current state data of the ledger. To make these smart contract executable code interactions efficient, the latest values of the keys may be stored in a state database. The state database may be simply an indexed view into the chain's entry log and can therefore be regenerated from the chain at any time. The state database may automatically be recovered (or generated if needed) upon peer node startup and before entries are accepted.

A blockchain is different from a traditional database in that the blockchain is not a central storage but rather a decentralized, immutable, and secure storage, where nodes must share in changes to records in the storage. Some properties that are inherent in blockchain and which help implement the blockchain include, but are not limited to, an immutable ledger, smart contracts, security, privacy, decentralization, consensus, endorsement, accessibility, and the like.

Example embodiments provide a service to a particular vehicle and/or a user profile applied to the vehicle. For example, a user may be the owner or operator of a vehicle owned by another party. The vehicle may require service at certain intervals, and the service needs may require authorization before permitting the services to be received. Also, service centers may offer services to vehicles in a nearby area based on the vehicle's current route plan and a relative level of service requirements (e.g., immediate, severe, intermediate, minor, etc.). The vehicle needs may be monitored via one or more vehicle and/or road sensors or cameras, which report sensed data to a central controller computer device in and/or apart from the vehicle. This data is forwarded to a management server for review and action. A sensor may be located on one or more of the interior of the transport, the exterior of the transport, on a fixed object apart from the transport, and on another transport proximate the transport. The sensor may also be associated with the transport's speed, the transport's braking, the transport's acceleration, fuel levels, service needs, the gear-shifting of the transport, the transport's steering, and the like. A sensor, as described herein, may also be a device, such as a wireless device in and/or proximate to the transport. Also, sensor information may be used to identify whether the vehicle is operating safely and whether an occupant has engaged in unexpected vehicle conditions, such as during a vehicle access and/or utilization period. Vehicle information collected before, during and/or after a vehicle's operation may be identified and stored in a transaction on a shared/distributed ledger, which may be generated and committed to the immutable ledger as determined by a permission-granting consortium, and thus in a "decentralized" manner, such as via a blockchain membership group.

Each interested party (i.e., owner, user, company, agency, etc.) may want to limit the exposure of private information, and therefore the blockchain and its immutability can be used to manage permissions for each particular user vehicle profile. A smart contract may be used to provide compensation, quantify a user profile score/rating/review, apply

vehicle event permissions, determine when service is needed, identify a collision and/or degradation event, identify a safety concern event, identify parties to the event and provide distribution to registered entities seeking access to such vehicle event data. Also, the results may be identified, and the necessary information can be shared among the registered companies and/or individuals based on a consensus approach associated with the blockchain. Such an approach could not be implemented on a traditional centralized database.

Various driving systems of the instant solution can utilize software, an array of sensors as well as machine learning functionality, light detection and ranging (Lidar) projectors, radar, ultrasonic sensors, etc., to create a map of terrain and road that a transport can use for navigation and other purposes. In some embodiments, GPS, maps, cameras, sensors and the like can also be used in autonomous vehicles in place of Lidar.

The instant solution includes, in certain embodiments, authorizing a vehicle for service via an automated and quick authentication scheme. For example, driving up to a charging station or fuel pump may be performed by a vehicle operator or an autonomous transport, and the authorization to receive charge or fuel may be performed without any delays provided the authorization is received by the service and/or charging station. A vehicle may provide a communication signal that provides an identification of a vehicle that has a currently active profile linked to an account that is authorized to accept a service, which can be later rectified by compensation. Additional measures may be used to provide further authentication, such as another identifier may be sent from the user's device wirelessly to the service center to replace or supplement the first authorization effort between the transport and the service center with an additional authorization effort.

Data shared and received may be stored in a database, which maintains data in one single database (e.g., database server) and generally at one particular location. This location is often a central computer, for example, a desktop central processing unit (CPU), a server CPU, or a mainframe computer. Information stored on a centralized database is typically accessible from multiple different points. A centralized database is easy to manage, maintain, and control, especially for purposes of security because of its single location. Within a centralized database, data redundancy is minimized as a single storing place of all data also implies that a given set of data only has one primary record. A blockchain may be used for storing transport-related data and transactions.

Any of the actions described herein may be performed by one or more processors (such as a microprocessor, a sensor, an Electronic Control Unit (ECU), a head unit, and the like), with or without memory, which may be located on-board the transport and/or off-board the transport (such as a server, computer, mobile/wireless device, etc.). The one or more processors may communicate with other memory and/or other processors on-board or off-board other transports to utilize data being sent by and/or to the transport. The one or more processors and the other processors can send data, receive data, and utilize this data to perform one or more of the actions described or depicted herein.

FIG. 1A illustrates an example diagram of vehicle determination for media collaboration according to example embodiments. A system 100 may include one or more vehicles 104, 108, and a server 120. Vehicles 104, 108 may include cars, trucks, recreational vehicles, construction vehicles, motorcycles, mopeds, powered bicycles, trains,

aircraft, and the like. In one embodiment, any of the vehicles **104**, **108** herein are at least partially powered by electric energy (i.e., hybrid vehicles (PHEVs) or electric vehicles (EVs), etc.). Vehicle **104** and other vehicles **108** may have one or more occupants associated with the vehicle **104** or other vehicles **108**. Occupants may have occupant devices such as smartphones, smartwatches, and the like. Occupant devices may include cameras and other sensors that may take pictures or videos of areas proximate the vehicle **104**, other vehicles **108**, or the occupant device.

In one embodiment, one or more of the vehicle **104** and the other vehicles **108** may be commonly owned, such as by a family, by a business, or by a government entity. The commonly owned vehicles may include vehicle processors that have contact information for other commonly-owned vehicles stored in an accessible memory device. In one embodiment, when a vehicle **104** or other vehicle **108** has sensor data or camera images to transmit, a vehicle processor associated with the vehicle **104** or other vehicle **108** may utilize the contact information to transmit the sensor data or camera images to the vehicle **104**, the other vehicles **108**, and/or the server **120**. For example, the vehicle **104** may have an internet protocol (IP) address of the server **120** or other commonly-owned other vehicles **108** stored in an accessible memory device, such as a memory device coupled to a vehicle processor, head unit processor, ECU, etc. of the vehicle **104**.

The server **120** may include one or more processors and memory devices for storing applications and data. In one embodiment, the server **120** may be associated with a vehicle manufacturer, a town or municipality, a government entity, a business or group of businesses, an organization, and the like. For example, the server **120** may be associated with a business that owns the vehicle **104** and the other vehicles **108**. In one embodiment, servers **120** may be located in a network or cloud, may be part of a vehicle **104** or other vehicle **108**, and/or in or connected to one or more vehicle charging stations. In one embodiment, the server **120** may represent any number of computing devices that may determine results and share data and determined results. The server **120** may communicate with one or more vehicles **104**, **108** in order to obtain various information including images related to areas proximate vehicles **104**, **108**, as discussed herein.

In one embodiment, the system **100** may include a number of vehicles **104** and other vehicles **108** that may be in a group, as discussed herein. The vehicle **104** and the other vehicles **108** may be within an area, such as within a distance from each other. In one embodiment, at least one vehicle **104** or other vehicle **108** is within an exterior camera image (i.e., line of sight) of the vehicle **104** or another vehicle **108**. For example, the vehicle **104** or other vehicles **108** may be in a same lane of a roadway, within a group of lanes of a roadway, and/or proceeding in a common direction of traffic flow on a roadway. In another embodiment, the vehicle **104** and the other vehicles **108** may be heading in different directions, such as the case where two vehicles are approaching a common point/area. The common point may be a destination for one or both vehicles, a building (e.g., a residence or business location), or an event location (e.g., an accident location where two or more emergency responder vehicles are approaching).

In one embodiment, each vehicle **104** or other vehicle **108** may provide data and information to the server **120** and other vehicles **108**. The vehicle **104** may provide vehicle sensor data **112** to the server **120** and receive unobstructed sensor data **128** from one or more other vehicles **108**. A first

other vehicle **108** may provide other vehicle sensor data **116** to the server **120** and unobstructed sensor data **124** to one or more other vehicles **108** and/or the vehicle **104**. A second other vehicle **108** may provide other vehicle sensor data **120** to the server **120** and unobstructed sensor data **128** to one or more other vehicles **108** and/or the vehicle **104**. In this way, the vehicle **104**, the other vehicles **108**, and/or the server **120** may intercommunicate sensor data and various camera images between them. Any number of other vehicles **108** may be included in the system **100**.

FIG. 1B illustrates an example flow diagram of vehicle determination for media collaboration according to example embodiments. A system **150** may include a vehicle processor **160**, a server **120**, and one or more other vehicle processors **170**. The server **120** was previously described with respect to FIG. 1A. The vehicle **104** may include a vehicle processor **160** and the other vehicles **108** may include one or more other vehicle processors **170** that communicate with the server **120** and each other. The vehicle processor **160** and/or the other vehicle processors **170** may include a navigation processor, a communication processor, a head unit processor, an ECU processor, a sensor processor, and the like. The vehicle processor **160**, the server **120**, and other vehicle processors **170** may communicate over wired and/or wireless communication media. For example, when a vehicle **104** and/or other vehicle **108** is receiving electrical charge at a charging location, the vehicle **104** or other vehicle **108** may be coupled to a charging station through a suitable charging cable, and the charging station may be communicably coupled to the server **120** through a wireless connection, such as a WI-FI or BLUETOOTH connection. The charging cable may include electrical pathway(s) to transfer electrical charge as well as one or more wired communication pathways (e.g., USB, Ethernet, etc.) to provide bidirectional communication to/from the vehicle processor **160** and/or the other vehicle processor **170**. As another example, the vehicle **104** and/or other vehicle **108** may not be coupled to a charging station, such as while traveling, and may communicate wirelessly with the server **120**, such as via WI-FI, BLUETOOTH, other wireless communication interfaces, and the like.

In one embodiment, the server **120** may receive a current location **152** from the vehicle processor **160** and current location(s) **154** from the other vehicle processors **170**. In one embodiment, the vehicle processor **160** and the other vehicle processors **170** may execute an application stored in an accessible memory device that periodically reports a current position (e.g., GPS coordinates, street address, etc.) to the server **120**. For example, the application may report the current position **152**, **154** to the server **120** every minute, every 10 minutes, every half hour, every hour, etc. From the received current locations **152**, **154**, the server **120** has up-to-date position information for all vehicles **104**, **108** within a group. For example, a server **120** associated with a package delivery company will have current position information for all delivery vans and trucks. In one embodiment, the current location **152**, **154** may include an identification of a corresponding vehicle **104** or other vehicle **108**, a destination of the vehicle **104** or current vehicle **108**, a current and/or remaining electrical charge level of the vehicle **104** or other vehicle **108**, and the like.

In one embodiment, the server **120** may determine an area **156**. The area may be related to one or more of a weather event, roadway construction, an accident, a vehicle breakdown, or any other cause. For example, the server **120** may receive a notification from a state or county transportation department that may include a traffic advisory or road



condition, a time, a duration of the event, and a general or specific location of the event. Location may include a mile marker on a highway, a distance from an exit or entrance to the roadway, a cross street, and/or an identification of a public building or business location, and the like. In one embodiment, the server **120** may obtain a proximity to the location from an accessible memory device, such as  $\frac{1}{2}$  mile. Therefore, the server **120** may determine the area **156** is within  $\frac{1}{2}$  mile of the location. In another embodiment, the server **120** may obtain a travel time to the location from an accessible memory device, such as 5 minutes. Therefore, the server **120** may determine the area **156** is within 5 minutes travel time of the location.

In one embodiment, the server **120** may determine a group of vehicles **158**. In one embodiment, the group of vehicles may include those vehicles within the determined area **156**, but exclude vehicles not within the determined area **156**. For example, using the package delivery company example, the company may have a fleet of 35 delivery vehicles. From the received current locations **152**, **154**, the server **120** may identify 10 out of 35 specific vehicles are within the determined area **156**. Therefore, the determined group **156** is the 10 identified vehicles. The server **120** has current locations of the 10 vehicles and possibly other information about the identified vehicles, as discussed herein.

The server **120** may look up contact information for the vehicle **104** or other vehicles **108** of the group in an accessible memory device. From the contact information (e.g., IP address, email address, URL, Bluetooth address, etc), the server **120** may transmit a vehicle sensor data request **162** to the vehicle processor **160** and another vehicle sensor data request **168** to the other vehicle processors **170**. The vehicle processor **160** obtains sensor data and images **164** for the vehicle **104** and the other vehicle processors **170** obtain sensor data and images **172** for the other vehicles **108**. The vehicle processor **160** transmits the vehicle sensor data and images **166** and the other vehicle processors **170** transmit the other vehicle sensor data and images **174** to the server **120**.

The sensor data and images **164**, **172** may include Radar data, Lidar data, environmental data, and/or camera images and video from onboard sensors and cameras of the vehicle **104** or other vehicle **108**, respectively. The environmental data may include various forms of environmental data, such as temperature data, wind speed data, precipitation data, and the like. A vehicle **104** or other vehicle **108** may have multiple external cameras, which may include one or more front cameras, rear cameras, or side cameras. Vehicles **104** and other vehicles **108** may have different numbers of available cameras and sensors, depending on vehicle **104** or other vehicle **108** factors such as age, repair condition, etc.

In one embodiment, the vehicle processor **160** or other vehicle processor **170** may determine that one or more camera images are obstructed, as discussed herein. In one embodiment, obstructed may mean an associated camera is not able to provide a full image up to the capabilities or limits of the camera. For example, an external camera may have dirt or other foreign material covering a portion of a camera lens and only be able to view 52 degrees out of a horizontal field of view of 90 degrees. As another example, a camera image may be partially masked by an obstruction within the field of view of the camera, such as a tree trunk or other vehicle. In one embodiment, for each camera image, the vehicle processor **160** or other vehicle processor **170** may store other data with each image in an accessible memory device. The other data may include several parameters that may assist with understanding the camera image,

such as a time stamp, an identification of the vehicle **104** or other vehicle **108** that produced the image, an identification of which camera the image is from, a field of view of the camera image before obstruction (e.g., 135 degrees horizontally and 90 degrees vertically), a compass direction of a center of the camera image (e.g., 274 degrees), and/or an identification of a portion of obstruction or occlusion in the camera image (e.g. from 15 degrees through 65 degrees horizontally and from 45 degrees through 80 degrees vertically).

In one embodiment, the vehicle processor **160** and the other vehicle processor **170** may only transmit unobstructed camera images as part of the vehicle sensor data and images **166** and the other vehicle sensor data and images **174**, respectively. In another embodiment, the vehicle processor **160** and the other vehicle processor **170** may transmit obstructed and unobstructed camera images and the other data discussed herein as part of the vehicle sensor data and images **166** and the other vehicle sensor data and images **174**, respectively. This may allow the server **120** to determine which received camera images have obstructed portions and which do not (and what the obstructed portions are).

In one embodiment, the server **120** may create one or more unobstructed views based on sensor data and images **176** from the received vehicle sensor data and images **166** and the other vehicle sensor data and images **174**. Unobstructed views may be helpful where the data is either incomplete and/or camera images may be partially obstructed. For example, other vehicles **108** may be in a same lane and directly adjacent. A first other vehicle **108** may have a left side camera image that is partially obstructed by another vehicle next to the first other vehicle **108** such that only a right portion of the left side camera image is unobstructed. A second other vehicle **108** may have a left side camera image that is partially obstructed by a large tree next to the second other vehicle **108** such that only a right portion of the left side camera image is unobstructed. From the current locations **154** of the first and second other vehicles, the server **120** may determine the first and second other vehicles are adjacent in a same lane. From the other data received along with the camera images, the server **120** may determine the two camera images are from left side cameras facing in a same direction. From the identification of obstructed portions of the camera images, the server **120** may determine the left side of the camera image from the first other vehicle **108** and the right side of the camera image from the second other vehicle **108** may be combinable to create an unobstructed image. The server **120** may execute an application that is able to identify common objects and points between camera images in order to "stitch together" two or more camera images into an unobstructed view. Common objects may be identified by comparing for similarity the pixel dimensions, lean angles, relative height, and relative width.

In one embodiment, the server **120** may combine sensor data and images **178** from the received vehicle sensor data and images **166** and the other vehicle sensor data and images **174**. Combined data and images may be helpful where the data is either redundant and/or unusable. For example, multiple other vehicles **108** may provide identical or near-identical camera images and/or camera images including obstructed views that may not be combinable with other camera images. Camera images from two or more vehicles **104** or other vehicles **108** may include common areas of obstruction that provide no additional information if combined.

## 11

In one embodiment, after combining sensor data and images 178, the server 120 transmits a notification to the vehicle processor 160 with one or more unobstructed views 180 and a notification to one or more other vehicle processors 170 with one or more unobstructed views 184. The vehicle processor 160 displays the unobstructed view of the area 182 on a display device of the vehicle 104, such as a head unit display. The vehicle processor 170 may display the unobstructed view of the area 186 on a display device of the other vehicle 108.

Although FIG. 1B illustrates the perspective of the server 120 receiving the vehicle sensor data and images 166 from the vehicle processor 160, receiving the other vehicle sensor data and images 174 from the other vehicle processor 170, creating unobstructed views 176 and combining sensor data and images 178, it should be understood that the illustrated server 120 functions may alternately be performed by the vehicle processor 160 and/or the other vehicle processor 170. In one embodiment, the system 150 may not have a server 120 available, or access to the server 120 may be interrupted.

In one embodiment, determining the vehicle 108 in the group of vehicles that has an unobstructed view of the area ahead of the group may include obtaining sensor data from each vehicle 108 of the group of vehicles and eliminating sensor data that includes an obstructed view of the area. In one embodiment, obstructed views may have a portion of the field of view occluded in some way. For example, a stationary or moving object (e.g., another vehicle in proximity to the camera that captured the image), a tree or brush/bushes, dirt or other foreign object on a camera lens, etc.) may obstruct a camera view. Obstructed views may provide no value in finding an unobstructed view of an area. Therefore, the vehicle 104 or server 120 may obtain sensor data from all vehicles 108 in the group and eliminate sensor data that includes obstructed views. This may result in one or more unobstructed views. In one embodiment, a group of vehicles 108 may be in a row (one behind another), or in different lanes of a same roadway. In another embodiment, a group of vehicles 108 may be traveling in different directions, such as two vehicles 108 approaching a common point or area. In this case, vehicles 108 may only be able to provide an unobstructed view of a same area for a limited amount of time because the vehicles 108 will separate and move away from each other. In one embodiment, the server 120 may determine an arrival time for vehicles 108 at the same area, and may transfer a notification for the vehicles 108 to capture an image of the same area at a specific designated time. The vehicles 108 may capture one or more images of the same area at the designated time and transmit the captured images of the same area to the server 120. The server 120 may receive the images from the vehicles 108 and create an unobstructed view of the same area from the received images.

In another embodiment, collecting data from sensors on the vehicle 108 may include requesting sensor data from the vehicle 108 for unobstructed views of the area and receiving sensor data from the vehicle 108 and one or more occupant devices associated with the vehicle 108 for the unobstructed views. The server 120 may request sensor data from the vehicle 162 and request sensor data from the other vehicles 168. In one embodiment, the vehicle processor 160 or other vehicle processor 170 may capture sensor data, including camera images, of the requested area. The vehicle processor 160 or other vehicle processor 170 may review the sensor data and camera images to identify obstructed views or unusable sensor data. Unusable sensor data may include data

## 12

from a previously identified malfunctioning sensor or data that is outside an expected range for the sensor. In one embodiment, the vehicle processor 160 or other vehicle processor 170 may remove obstructed views and/or unusable sensor data from vehicle sensor data and images 166 transmitted by the vehicle processor 160 to the server 120 and from other vehicle sensor data and images transmitted from the other vehicle processor 170 to the server 120.

In one embodiment, it may be desirable for the vehicle processor 160 or other vehicle processor 170 to obtain and transmit additional data to make up for the obstructed views or unusable sensor data. For example, the vehicle processor 160 or other vehicle processor 170 may display a notification to a user associated with the vehicle 104 or other vehicle 108 to provide additional views of the area through an occupant device (e.g., smartphone, smartwatch, etc.) in their possession. The user may capture additional images with the occupant device and transmit them to the server 120 and/or the vehicle 104 or other vehicles 108 for interpretation and analysis. In another embodiment, the vehicle processor 160 or other vehicle processor 170 may determine that obstructed views or unusable data has been captured, and request that a proximate other vehicle 108 obtain and provide the image views and/or usable data to the server 120 or other vehicle processors 170. For example, the vehicle with obstructed views may capture a license plate number of a proximate vehicle and transmit the license plate number to the server 120 to request the proximate vehicle provide images and sensor data for the area. The server 120 may look up the license plate number (by querying another server, for example) to obtain contact information for the proximate vehicle and transmit another vehicle sensor data request 168 to the proximate vehicle. The proximate vehicle may provide the requested images and data to the server 120.

In one embodiment, sending the data to one or more other vehicles 108 in the group of vehicles may include identifying the one or more other vehicles 108 in the group that are behind the vehicle 104 and proximate the vehicle 104 and transferring portions of the collected data to the identified one or more other vehicles 108. In one embodiment, a vehicle 104 or other vehicle 108 may identify one or more other vehicles 108 behind the vehicle 104 or other vehicle 108 by transmitting GPS coordinates along with a notification to the server 120 to identify other vehicles 108 that are behind the vehicle 104 or other vehicle 108. The server 120 may respond with contact information for the other vehicles 108 that are behind.

The portions may include areas of the camera image that are obstructed for the identified other vehicles 108. Although the other vehicles 108 need to be fairly close to the vehicle 104 in order to capture images and sensor data that may be relevant to the same area as the vehicle 104, they also may need to be behind the vehicle 104 in order to take advantage of the collected data.

For example, an area may include four other vehicles 108. Other vehicle 1 108A may send different unobstructed portions of views to other vehicles 2 108B, 3 108C, and 4 108D. Each of those other vehicles 108 may have varying obstructed or unobstructed views of the area. When other vehicle 1 108A transmits to other vehicle 2 108B an obstructed view, other vehicle 2 108B may combine it with its own obstructed or unobstructed view. Other vehicle 2 108B may have a 20% unobstructed view of the area. Other vehicle 2 108B may obtain an 80% unobstructed from other vehicle 1 108A and replace the 80% unobstructed view from other vehicle 1 108A to produce a 100% unobstructed view of the area. Other vehicle 2 108 may receive, replace, add,

13

and render the new unobstructed view. In another embodiment, the obstructed views may be transmitted by the other vehicles 108A-108D to a server 120, which may combine the obstructed views to create an unobstructed view.

In one embodiment, the other vehicle processors 170 of the other vehicles 108A-D may review the captured images to identify obstructed portions of each image, and include the obstructed portions of each image along with each image. For example, other vehicle 3 108C may transfer to the server 120, vehicle processor 160, and/or other vehicle processor 170 an obstructed view of an area along with data that indicates one or more portions that may be obstructed. For example, the data may include information identifying a box between horizontal pixel values of 55 through 183 and vertical pixel values of 125 through 155 as being obstructed. The obstructed area may correspond to a location of another vehicle, a tree, etc as discussed herein. The server 120, vehicle processor 160, and/or other vehicle processor 170 (i.e. relevant processors) may replace the obstructed portion with an unobstructed portion of a received image that may correspond to a same area within the image.

In one embodiment, the vehicle processor 160, the other vehicle processor 170, and/or the server 120 may execute an application stored on an accessible memory device that automatically recognizes matching images or partially matching images. The application works from unordered collections of images, automatically finding matches between images using image processing algorithms. It then robustly aligns all images and uses advanced blending algorithms to form seamless panoramas in output images. For example, determining objects in an image may use the scale-invariant feature transform (SIFT) algorithm. Using SIFT, it is possible to first extract key points of objects from a set of reference images and store in a database. An object is determined to be a new image by individually comparing each feature from the new image to this database to find a candidate that may match features based on a Euclidean distance of their feature vectors. From the set of matches, good matches are filtered out by determining subsets of key points that agree on the object and its location, scale, and orientation in the new image. By using an efficient hash table implementation of a generalized Hough transformation, consistent clusters may be determined. Each cluster of a number (such as 3) or more features that agree on an object and its pose is then subject to further detailed model verification, discarding outliers. The system computes the probability that a particular set of features indicates the presence of an object, given the accuracy of fit and number of probable false matches. Object matches passing all these tests may be identified as correct with high confidence. Overlapping in the images may then be determined, which will later become panoramas. It may only be necessary to match each image to a small number of overlapping images in order to get a good solution for the image geometry. Random Sample Consensus (RANSAC) may be used to select a set of inliers that are compatible with a homography between the images. A probabilistic model may be applied to verify the match.

RANSAC is a robust estimation procedure using a minimal set of randomly sampled correspondences to estimate image transformation parameters which determines a solution that has the best consensus with the data. Sets of  $r=4$  feature correspondences are selected and compute the homography  $H$  between them using a direct linear transformation (DLT) method. This process may be repeated with  $n=500$  trials and the solution is selected that has the maximum number of inliers (whose projections are consistent

14

with  $H$  within a tolerance  $E$  pixels). Given a probability that a feature match is correct between a pair of matching images (the inlier probability) is  $p_i$ . After  $n$  trials, the probability of finding the correct transformation is  $p(H \text{ is correct}) = 1 - (1 - p_i)^n$ .

After a large number of trials the probability of finding the correct homography is very high. For example, for an inlier probability  $p_i=0.5$ , the probability that the correct homography is not found after 500 trials is approximately  $1 \times 10^{-14}$ . RANSAC is a sampling approach to estimating  $H$ . If instead of maximizing the number of inliers one maximizes the sum of the log-likelihoods, the result is referred to as the maximum likelihood estimation. Furthermore, if priors on the transformation parameters are available, one can compute a maximum posteriori estimate. These algorithms are referred to as MLESAC and MAPSAC respectively.

For each pair of potentially matching images a set of feature matches that are geometrically consistent (RANSAC inliers) are determined and features that are inside the area of overlap but not consistent (RANSAC outliers). The idea of the verification model is to compare the probabilities that this set of inliers/outliers was generated by a correct image match or by a false image match. Once pairwise matches have been established between images, panoramic sequences are determined as connected sets of matching images, allowing for recognizing multiple panoramas in a set of images, and rejecting noise images matching no other images.

In one embodiment, the server 120, vehicle processor 160, and/or other vehicle processor 170 may determine portions of images are obstructed by various means. In one embodiment, the server 120, vehicle processor 160, and/or other vehicle processor 170 may store in an accessible memory device various pixel patterns that identify a type of object in an image. For example, natural objects like trees and shrubs may include various pixel patterns for the trunk, branches, and leaves. When the server 120, vehicle processor 160, and/or other vehicle processor 170 detects a pixel pattern for a "tree trunk", the relevant processor searches adjacent pixels (both vertically and horizontally) in order to identify a primarily vertically-oriented sequence of pixel patterns with well-defined horizontal edges to different pixel patterns to the sides of the "tree trunk". The relevant processor may determine the size of the complete "tree trunk", and if the number of "tree trunk" pixel patterns is more than a percentage stored in an accessible memory device (e.g., 20%), the relevant processor may determine the image is obstructed where the "tree trunk" pixel patterns are present.

With respect to vehicles, the relevant processor may determine if more than a percentage stored in an accessible memory device is of a same vehicle, the image may be obstructed (e.g., 30%). The same vehicle would likely have a similar pixel pattern across many adjacent vertical and/or horizontal pixels. Although wheels and tires would likely have a different pixel pattern than the sides of a vehicle, it may be reasonable to ignore them with respect to the calculation. For other objects, the relevant processor may have a sample pixel pattern stored in an accessible memory device that may be compared with received images.

In one embodiment, once a server 120, vehicle processor 160, and/or other vehicle processor 170 has replaced obstructed portions of obstructed images with portions of other received images, and no other combinable images are available (e.g. same area, same compass direction, same time of day, etc.), the relevant processor may determine if the combined image is obstructed or unobstructed. First, the

15

relevant processor determines if more obstructed portions remain in an image after all combining operations are completed to replace obstructed portions. If one or more obstructed portions remain in an image, the relevant processor may determine if the sum of remaining obstructed portions is greater than a value stored in an accessible memory device (e.g., 10%). If the sum of remaining obstructed portions is greater than the value stored in the accessible memory device, the relevant processor may determine the image is still obstructed. If the sum of remaining obstructed portions are not greater than the value stored in the accessible memory device, the relevant processor may determine the image is now unobstructed. In one embodiment, if a relevant processor has one or more unobstructed view of an area, the relevant processor may distribute the unobstructed views by transmitting the unobstructed views to others of the server 120, the vehicle processor 160, and/or other vehicle processors 170. In another embodiment, if a relevant processor still has one or more obstructed views of an area after all combining operations, the relevant processor may transmit both obstructed and unobstructed views of the area to others of the server 120, the vehicle processor 160, and/or other vehicle processors 170. The receiving server 120, vehicle processor 160, and/or other vehicle processor 170 may have other obstructed views that may be combined with one or more received obstructed view to create one or more unobstructed views.

In one embodiment, providing the unobstructed view of the area ahead of the group may include receiving the collected data, selecting an unobstructed view from the collected data, and sending the unobstructed view by the vehicle 104 or one or more other vehicles 108 to another of the one or more other vehicles 108. In one embodiment, the unobstructed view may include a camera or video image from an occupant device of the vehicle 104, and the receiving other vehicle 108 may select an unobstructed view if multiple unobstructed views were received. The other vehicle 108 may display on a vehicle head unit or other display and/or on one or more occupant devices of the other vehicle 108. In one embodiment, a processor in the vehicle 104, such as the vehicle processor 160, may receive the collected data from sensors and cameras on other vehicles 108. In another embodiment, a server located apart from the vehicle (in a network), such as the server 120, may receive the collected data. In yet another embodiment, the one or more other vehicles 108 could receive the collected data.

Data collection may be sequenced one of several ways. In one embodiment, the collected data may be received and processed on the vehicle 104 before being sent to the server 120 or the one or more other vehicles 108. In another embodiment, the collected data may be received by the vehicle 104 and transmitted to the server 120 to be processed before the server 120 transmits the processed data to the one or more other vehicles 108. In yet another embodiment, the collected data may be received by the vehicle 104 and sent to the one or more other vehicles 108 to be processed. The processed data processed by the vehicle 104, the server 120, and/or the one or more other vehicle 108 may include some percentage of obstructed or unobstructed visual data with a field of view. For example, the vehicle 104 may have a portion of an image obstructed and replace the obstructed portion with an unobstructed portion of a similar or same image from another vehicle 108 and/or the server 120, as described herein. Unobstructed views may also be readily transmitted to the vehicle 104, other vehicles 108, or the server 120.

16

In one embodiment, a lead car (e.g. vehicle 104) may transmit all unobstructed views and sensor data to all following other vehicles 108 of the same group. Vehicle processors 170 of the following other vehicles 108 may process the received images as needed (i.e., by saving unobstructed images, using portions of unobstructed images to reconstruct obstructed images in the other vehicles 108, and by transmitting unobstructed images, whether received as unobstructed images or reconstructed from obstructed images, to other vehicles 108 and/or the server 120). In another embodiment, a vehicle processor 170 of a following other vehicle 108 may transmit a notification to a vehicle processor 160 of the vehicle 104 ahead. The notification may include a current position of the other vehicle 108 (e.g., GPS, etc.) and obstruction information for one or more images. The obstructed images may include a description of the obstructed image (e.g., external view, camera facing 57 degrees relative to North, vertical field of view 100 degrees, horizontal field of view 135 degrees, obstructed portion between 7 and 45 degrees horizontal and 10 to 25 degrees vertical). The vehicle processor 160 may receive the obstruction information and determine that it has an image, whether from an onboard camera or from another vehicle 108, that includes a view of the same area as the obstructed image. The vehicle processor 160 may determine the view of the same area does not include an obstructed area within the obstructed portion. The vehicle processor 160 may remove the (unobstructed) area that corresponds to the obstructed portion (i.e., obstructed portion between 7 and 45 degrees horizontal and 10 to 25 degrees vertical) and may transmit the data to the other vehicle processor 170. The other vehicle processor 170 receives the unobstructed portion and may replace the obstructed portion within the obstructed image with the unobstructed portion to create an unobstructed image.

In one embodiment, the server 120 may determine the group of vehicles are related and notify the one or more other vehicles to proceed to a destination after receiving the unobstructed view of the area ahead. The group of vehicles may include the vehicle 104 and the other vehicles 108 and may be owned by a family, a business, and/or a government entity. The vehicle 104 may be ahead of the other vehicles 108 along a same roadway. For example, the vehicle 104 may capture one or more unobstructed images of road construction around the vehicle 104 that has closed off lanes of the roadway or slowed traffic. Rather than allowing the other vehicles 108 to reach the construction area and be similarly delayed, the vehicle processor 160 may transmit one or more unobstructed images of the road construction to the other vehicles 108 along with a notification to proceed to a destination. The destination may be a common location for the vehicle 104 and the other vehicles 108, such as a warehouse for delivery vans or a post office location. By providing the unobstructed view(s) and direction to proceed to the destination, the vehicle processor 160 may allow the other vehicle processors 170 to route the other vehicles 108 off the roadway and avoid lost time waiting in the construction zone.

In one embodiment, the server 120 may receive one or more unobstructed views from the vehicle 104 and the other vehicles 108 and merge the one or more unobstructed views into a panoramic view. Panoramic view technology exists with actual or virtual panoramic cameras to "stitch together" views from multiple sources/cameras. This may be done with vehicle or occupant cameras as well.

Sometimes, the image field of view of different cameras on different vehicles 104 or other vehicles 108 may not be

17

exactly coincident. For example, a left-side camera image from two different vehicles, one in front of the other on a roadway, may not be truly coincident. The images may overlap to a degree and/or have different fields of view. Depending on source image divergence, the images may still be combinable by virtue of including one or more common objects. The combined results may be highly variable, but a panoramic view may beneficially allow a larger view of an area (e.g. large multi-vehicle collision, wildfire near a roadway, etc).

In one embodiment, the panoramic view may include a merging of a lead vehicle's forward unobstructed view with a following last vehicle's backward unobstructed view. Side camera views from other vehicles between the lead vehicle and the last vehicle may provide portions of the panoramic image that "connect" the forward view with the backward view. In some embodiments, the panoramic view may provide a 360-degree view around a group of vehicles.

In another embodiment, the merged image may be a panoramic view of the road and the sky from a vehicle that may not be the lead or rear vehicle of a group. This may beneficially distribute processing power requirements among multiple vehicles and vehicle processors.

In yet another embodiment, all of the processing may be performed by one vehicle, and all views may be combined to form a 360-degree, or near 360-degree, panoramic view.

Flow diagrams depicted herein, such as FIG. 1A, FIG. 1B, FIG. 2C, FIG. 2D, FIG. 2E, FIG. 3A, FIG. 3B and FIG. 3C are separate examples but may be the same or different embodiments. Any of the operations in one flow diagram could be adopted and shared with another flow diagram. No example operation is intended to limit the subject matter of any embodiment or corresponding claim.

It is important to note that all the flow diagrams and corresponding processes are derived from FIG. 1A, FIG. 1B, FIG. 2C, FIG. 2D, FIG. 2E, FIG. 3A, FIG. 3B and FIG. 3C may be part of a same process or may share sub-processes with one another, thus making the diagrams combinable into a single preferred embodiment that does not require any one specific operation but which performs certain operations from one example process and from one or more additional processes. All the example processes are related to the same physical system and can be used separately or interchangeably.

FIG. 2A illustrates a transport network diagram 200, according to example embodiments. The network comprises elements including a transport 202 including a processor 204, as well as a transport 202' including a processor 204'. The transports 202, 202' communicate with one another via the processors 204, 204', as well as other elements (not shown) including transceivers, transmitters, receivers, storage, sensors, and other elements capable of providing communication. The communication between the transports 202, and 202' can occur directly, via a private and/or a public network (not shown), or via other transports and elements comprising one or more of a processor, memory, and software. Although depicted as single transports and processors, a plurality of transports and processors may be present. One or more of the applications, features, steps, solutions, etc., described and/or depicted herein may be utilized and/or provided by the instant elements.

FIG. 2B illustrates another transport network diagram 210, according to example embodiments. The network comprises elements including a transport 202 including a processor 204, as well as a transport 202' including a processor 204'. The transports 202, 202' communicate with one another via the processors 204, 204', as well as other

18

elements (not shown), including transceivers, transmitters, receivers, storage, sensors, and other elements capable of providing communication. The communication between the transports 202, and 202' can occur directly, via a private and/or a public network (not shown), or via other transports and elements comprising one or more of a processor, memory, and software. The processors 204, 204' can further communicate with one or more elements 230 including sensor 212, wired device 214, wireless device 216, database 218, mobile phone 220, transport 222, computer 224, I/O device 226, and voice application 228. The processors 204, 204' can further communicate with elements comprising one or more of a processor, memory, and software.

Although depicted as single transports, processors and elements, a plurality of transports, processors and elements may be present. Information or communication can occur to and/or from any of the processors 204, 204' and elements 230. For example, the mobile phone 220 may provide information to the processor 204, which may initiate the transport 202 to take an action, may further provide the information or additional information to the processor 204', which may initiate the transport 202' to take an action, may further provide the information or additional information to the mobile phone 220, the transport 222, and/or the computer 224. One or more of the applications, features, steps, solutions, etc., described and/or depicted herein may be utilized and/or provided by the instant elements.

FIG. 2C illustrates yet another transport network diagram 240, according to example embodiments. The network comprises elements including a transport 202, a processor 204, and a non-transitory computer readable medium 242C. The processor 204 is communicably coupled to the computer readable medium 242C and elements 230 (which were depicted in FIG. 2B). The transport 202 could be a transport, server, or any device with a processor and memory.

The processor 204 performs one or more of determining a vehicle in a group of vehicles that has an unobstructed view of an area ahead of the group 244C, collecting data from sensors on the vehicle 246C, sending the data to one or more other vehicles in the group of vehicles 248C, and providing the unobstructed view of the area ahead of the group on a display of the one or more other vehicles 250C.

FIG. 2D illustrates a further transport network diagram 250, according to example embodiments. The network comprises elements including a transport 202 a processor 204, and a non-transitory computer readable medium 242D. The processor 204 is communicably coupled to the computer readable medium 242D and elements 230 (which were depicted in FIG. 2B). The transport 202 could be a transport, server or any device with a processor and memory.

The processor 204 performs one or more of obtaining sensor data from each vehicle of the group of vehicles and eliminating sensor data that includes an obstructed view of the area 244D, requesting sensor data from the vehicle for unobstructed views of the area and receiving sensor data from the vehicle and one or more occupant devices associated with the vehicle for the unobstructed views 245D, identifying the one or more other vehicles in the group that are behind the vehicle and proximate the vehicle and transferring portions of the collected data to the identified one or more other vehicles, wherein the portions comprise areas of the unobstructed view that are obstructed for respective one for the identified one or more other vehicles 246D, receiving the collected data, selecting an unobstructed view from the collected data, and sending the unobstructed view by one of the one or more other vehicles to another of the one or more other vehicles 247D, determining the group of vehicles are

19

related and notifying the one or more other vehicles to proceed to a destination after receiving the unobstructed view of the area ahead **248D**, and receiving one or more unobstructed views from the vehicle and the other vehicles and merging the one or more unobstructed views into a panoramic view **249D**.

FIG. 2E illustrates yet a further transport network diagram **260**, according to example embodiments. Referring to FIG. 2E, the network diagram **260** includes a transport **202** connected to other transports **202'** and to an update server node **203** over a blockchain network **206**. The transports **202** and **202'** may represent transports/vehicles. The blockchain network **206** may have a ledger **208** for storing software update validation data and a source **207** of the validation for future use (e.g., for an audit).

While this example describes in detail only one transport **202**, multiple such nodes may be connected to the blockchain **206**. It should be understood that the transport **202** may include additional components and that some of the components described herein may be removed and/or modified without departing from a scope of the instant application. The transport **202** may have a computing device or a server computer, or the like, and may include a processor **204**, which may be a semiconductor-based microprocessor, a central processing unit (CPU), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA), and/or another hardware device. Although a single processor **204** is depicted, it should be understood that the transport **202** may include multiple processors, multiple cores, or the like without departing from the scope of the instant application. The transport **202** could be a transport, server or any device with a processor and memory.

The processor **204** performs one or more of receiving a confirmation of an event from one or more elements described or depicted herein, wherein the confirmation comprises a blockchain consensus between peers represented by any of the elements **244E** and executing a smart contract to record the confirmation on a blockchain-based on the blockchain consensus **246E**. Consensus is formed between one or more of any element **230** and/or any element described or depicted herein, including a transport, a server, a wireless device, etc. In another example, the transport **202** can be one or more of any element **230** and/or any element described or depicted herein, including a server, a wireless device, etc.

The processors and/or computer readable medium **242E** may fully or partially reside in the interior or exterior of the transports. The steps or features stored in the computer readable medium **242E** may be fully or partially performed by any of the processors and/or elements in any order. Additionally, one or more steps or features may be added, omitted, combined, performed at a later time, etc.

FIG. 2F illustrates a diagram **265** depicting the electrification of one or more elements. In one example, a transport **266** may provide power stored in its batteries to one or more elements, including other transport(s) **268**, charging station(s) **270**, and electric grid(s) **272**. The electric grid(s) **272** is/are coupled to one or more of the charging stations **270**, which may be coupled to one or more of the transports **268**. This configuration allows the distribution of electricity/power received from the transport **266**. The transport **266** may also interact with the other transport(s) **268**, such as via Vehicle to Vehicle (V2V) technology, communication over cellular, WiFi, and the like. The transport **266** may also interact wirelessly and/or wired with other transports **268**, the charging station(s) **270** and/or with the electric grid(s) **272**. In one example, the transport **266** is routed (or routes itself) in a safe and efficient manner to the electric grid(s)

20

**272**, the charging station(s) **270**, or the other transport(s) **268**. Using one or more embodiments of the instant solution, the transport **266** can provide energy to one or more of the elements depicted herein in various advantageous ways as described and/or depicted herein. Further, the safety and efficiency of the transport may be increased, and the environment may be positively affected as described and/or depicted herein.

The term 'energy' may be used to denote any form of energy received, stored, used, shared, and/or lost by the transport(s). The energy may be referred to in conjunction with a voltage source and/or a current supply of charge provided from an entity to the transport(s) during a charge/use operation. Energy may also be in the form of fossil fuels (for example, for use with a hybrid transport) or via alternative power sources, including but not limited to lithium-based, nickel-based, hydrogen fuel cells, atomic/nuclear energy, fusion-based energy sources, and energy generated on-the-fly during an energy sharing and/or usage operation for increasing or decreasing one or more transports energy levels at a given time.

In one example, the charging station **270** manages the amount of energy transferred from the transport **266** such that there is sufficient charge remaining in the transport **266** to arrive at a destination. In one example, a wireless connection is used to wirelessly direct an amount of energy transfer between transports **268**, wherein the transports may both be in motion. In one embodiment, wireless charging may occur via a fixed charger and batteries of the transport in alignment with one another (such as a charging mat in a garage or parking space). In one example, an idle vehicle, such as a vehicle **266** (which may be autonomous) is directed to provide an amount of energy to a charging station **270** and return to the original location (for example, its original location or a different destination). In one example, a mobile energy storage unit (not shown) is used to collect surplus energy from at least one other transport **268** and transfer the stored surplus energy at a charging station **270**. In one example, factors determine an amount of energy to transfer to a charging station **270**, such as distance, time, as well as traffic conditions, road conditions, environmental/weather conditions, the vehicle's condition (weight, etc.), an occupant(s) schedule while utilizing the vehicle, a prospective occupant(s) schedule waiting for the vehicle, etc. In one example, the transport(s) **268**, the charging station(s) **270** and/or the electric grid(s) **272** can provide energy to the transport **266**.

In one embodiment, a location such as a building, a residence, or the like (not depicted), communicably coupled to one or more of the electric grid **272**, the transport **266**, and/or the charging station(s) **270**. The rate of electric flow to one or more of the location, the transport **266**, the other transport(s) **268** is modified, depending on external conditions, such as weather. For example, when the external temperature is extremely hot or extremely cold, raising the chance for an outage of electricity, the flow of electricity to a connected vehicle **266/268** is slowed to help minimize the chance for an outage.

In one example, the solutions described and depicted herein can be utilized to determine load effects on the transport and/or the system, to provide energy to the transport and/or the system based on future needs and/or priorities, and provide intelligence between an apparatus containing a module and a vehicle allowing the processor of the apparatus to wirelessly communicate with a vehicle regarding an amount of energy store in a battery on the vehicle. In one example, the solutions can also be utilized to provide

21

charge to a location from a transport based on factors such as the temperature at the location, the cost of the energy, and the power level at the location. In one example, the solutions can also be utilized to manage an amount of energy remaining in a transport after a portion of the charge has been transferred to a charging station. In one example, the solutions can also be utilized to notify a vehicle to provide an amount of energy from batteries on the transport, wherein the amount of energy to transfer is based on the distance of the transport to a module to receive the energy.

In one example, the solutions can also be utilized to use a mobile energy storage unit that uses a determined path to travel to transports with excess energy and deposit the stored energy into the electric grid. In one example, the solutions can also be utilized to determine a priority of the transport's determination of the need to provide energy to grid and the priority of a current need of the transport, such as the priority of a passenger or upcoming passenger, or current cargo, or upcoming cargo. In one example, the solutions can also be utilized to determine that when a vehicle is idle, the vehicle decides to maneuver to a location to discharge excess energy to the energy grid, then return to the previous location. In one example, the solutions can also be utilized to determine an amount of energy needed by a transport to provide another transport with needed energy via transport to transport energy transfer based on one or more conditions such as weather, traffic, road conditions, car conditions, and occupants and/or goods in another transport, and instruct the transport to route to another transport and provide the energy. In one example, the solutions can also be utilized to transfer energy from one vehicle in motion to another vehicle in motion. In one example, the solutions can also be utilized to retrieve energy by a transport based on an expended energy by the transport to reach a meeting location with another transport, provide a service, and an estimated expended energy to return to an original location. In one example, the solutions can also be utilized to provide a remaining distance needed to a charging station and the charging station to determine an amount of energy to be retrieved from the transport wherein the amount of charge remaining is based on the remaining distance. In one example, the solutions can also be utilized to manage a transport that is concurrently charged by more than one point simultaneously, such as both a charging station via a wired connection and another transport via a wireless connection. In one example, the solutions can also be utilized to apply a priority to the dispensing of energy to transports wherein a priority is given to those transports that will provide a portion of their stored charge to another entity such as an electric grid, a residence, and the like.

In one embodiment, transports **266** and **268** may be utilized as bidirectional transports. Bidirectional transports are those that may serve as mobile microgrids that can assist in the supplying of electrical power to the grid **272** and/or reduce the power consumption when the grid is stressed. Bidirectional transports incorporate bidirectional charging, which in addition to receiving a charge to the transport, the transport can take energy from the transport and "push" the energy back into the grid **272**, otherwise referred to as "V2G". In bidirectional charging, the electricity flows both ways; to the transport and from the transport. When a transport is charged, alternating current (AC) electricity from the grid **272** is converted to direct current (DC). This may be performed by one or more of the transport's own converter or a converter on the charger **270**. The energy stored in the transport's batteries may be sent in an opposite direction back to the grid. The energy is converted from DC

22

to AC through a converter usually located in the charger **270**, otherwise referred to as a bidirectional charger. Further, the instant solution as described and depicted with respect to FIG. 2F can be utilized in this and other networks and/or systems.

FIG. 2G is a diagram showing interconnections between different elements **275**. The instant solution may be stored and/or executed entirely or partially on and/or by one or more computing devices **278'**, **279'**, **281'**, **282'**, **283'**, **284'**, **276'**, **285'**, **287'** and **277'** associated with various entities, all communicably coupled and in communication with a network **286**. A database **287** is communicably coupled to the network and allows for the storage and retrieval of data. In one example, the database is an immutable ledger. One or more of the various entities may be a transport **276**, one or more service provider **279**, one or more public buildings **281**, one or more traffic infrastructure **282**, one or more residential dwellings **283**, an electric grid/charging station **284**, a microphone **285**, and/or another transport **277**. Other entities and/or devices, such as one or more private users using a smartphone **278**, a laptop **280**, an augmented reality (AR) device, a virtual reality (VR) device, and/or any wearable device may also interwork with the instant solution. The smartphone **278**, laptop **280**, the microphone **285**, and other devices may be connected to one or more of the connected computing devices **278'**, **279'**, **281'**, **282'**, **283'**, **284'**, **276'**, **285'**, **287'**, and **277'**. The one or more public buildings **281** may include various agencies. The one or more public buildings **281** may utilize a computing device **281'**. The one or more service provider **279** may include a dealership, a tow truck service, a collision center or other repair shop. The one or more service provider **279** may utilize a computing apparatus **279'**. These various computer devices may be directly and/or communicably coupled to one another, such as via wired networks, wireless networks, blockchain networks, and the like. The microphone **285** may be utilized as a virtual assistant, in one example. In one example, the one or more traffic infrastructure **282** may include one or more traffic signals, one or more sensors including one or more cameras, vehicle speed sensors or traffic sensors, and/or other traffic infrastructure. The one or more traffic infrastructure **282** may utilize a computing device **282'**.

In one embodiment, anytime an electrical charge is given or received to/from a charging station and/or an electrical grid, the entities that allow that to occur are one or more of a vehicle, a charging station, a server, and a network communicably coupled to the vehicle, the charging station, and the electrical grid.

In one example, a transport **277/276** can transport a person, an object, a permanently or temporarily affixed apparatus, and the like. In one example, the transport **277** may communicate with transport **276** via V2V communication through the computers associated with each transport **276'** and **277'** and may be referred to as a transport, car, vehicle, automobile, and the like. The transport **276/277** may be a self-propelled wheeled conveyance, such as a car, a sports utility vehicle, a truck, a bus, a van, or other motor or battery-driven or fuel cell-driven transport. For example, transport **276/277** may be an electric vehicle, a hybrid vehicle, a hydrogen fuel cell vehicle, a plug-in hybrid vehicle, or any other type of vehicle with a fuel cell stack, a motor, and/or a generator. Other examples of vehicles include bicycles, scooters, trains, planes, boats, and any other form of conveyance that is capable of transportation. The transport **276/277** may be semi-autonomous or autonomous. For example, transport **276/277** may be self-manue-



vering and navigate without human input. An autonomous vehicle may have and use one or more sensors and/or a navigation unit to drive autonomously.

In one example, the solutions described and depicted herein can be utilized to determine an access to a transport via consensus of blockchain. In one example, the solutions can also be utilized to perform profile validation before allowing an occupant to use a transport. In one example, the solutions can also be utilized to have the transport indicate (visually, but also verbally in another example, etc.) on or from the transport for an action the user needs to perform (that could be pre-recorded) and verify that it is the correct action. In one example, the solutions can also be utilized to provide an ability to for a transport to determine, based on the risk level associated with data and driving environment, how to bifurcate the data and distribute a portion of the bifurcated data with a lower risk level during a safe driving environment, to the occupant, and later distributing a remaining portion of the bifurcated data, with a higher risk level, to the occupant after the occupant has departed the transport. In one example, the solutions can also be utilized to handle the transfer of a vehicle across boundaries (such as a country/state/etc.) through the use of blockchain and/or smart contracts and apply the rules of the new area to the vehicle.

In one example, the solutions can also be utilized to allow a transport to continue to operate outside a boundary when a consensus is reached by the transport based on the operation of the transport and characteristics of an occupant of the transport. In one example, the solutions can also be utilized to analyze the available data upload/download speed of a transport, size of the file, and speed/direction the transport is traveling to determine the distance needed to complete a data upload/download and assign a secure area boundary for the data upload/download to be executed. In one example, the solutions can also be utilized to perform a normally dangerous maneuver in a safe manner, such as when the system determines that an exit is upcoming and when the transport is seemingly not prepared to exit (e.g., in the incorrect lane or traveling at a speed that is not conducive to making the upcoming exit) and instruct the subject transport as well as other proximate transports to allow the subject transport to exit in a safe manner. In one example, the solutions can also be utilized to use one or more vehicles to validate diagnostics of another transport while both the one or more vehicles and the other transport are in motion.

In one example, the solutions can also be utilized to detect lane usage at a location and time of day to either inform an occupant of a transport or direct the transport to recommend or not recommend a lane change. In one example, the solutions can also be utilized to eliminate the need to send information through the mail and the need for a driver/occupant to respond by making a payment through the mail or in person. In one example, the solutions can also be utilized to provide a service to an occupant of a transport, wherein the service provided is based on a subscription and wherein the permission is acquired from other transports connected to the profile of the occupant. In one example, the solutions can also be utilized to record changes in the condition of a rented object. In one example, the solutions can also be utilized to seek a blockchain consensus from other transports that are in proximity to a damaged transport. In one example, the solutions can also be utilized to receive media, from a server such as an insurance entity server, from the transport computer, which may be related to an accident. The server accesses one or more media files to access the damage to the transport and stores the damage assessment

onto a blockchain. In one example, the solutions can also be utilized to obtain a consensus to determine the severity of an event from several devices over various times before the event related to a transport.

In one example, the solutions can also be utilized to solve a problem without video evidence for transport-related accidents. The current solution details the querying of media, by the transport involved in the accident, related to the accident from other transports that may have been proximate to the accident. In one example, the solutions can also be utilized to utilize transports and other devices (for example, a pedestrian's cell phone, a streetlight camera, etc.) to record specific portions of a damaged transport.

In one example, the solutions can also be utilized to warn an occupant when a transport is navigating toward a dangerous area and/or event, allowing for a transport to notify occupants or a central controller of a potentially dangerous area on or near the current transport route. In one example, the solutions can also be utilized to detect when a transport traveling at a high rate of speed, at least one other transport is used to assist in slowing down the transport in a manner that minimally affects traffic. In one example, the solutions can also be utilized to identify a dangerous driving situation where media is captured by the vehicle involved in the dangerous driving situation. A geofence is established based on the distance of the dangerous driving situation, and additional media is captured by at least one other vehicle within the established geofence. In one example, the solutions can also be utilized to send a notification to one or more occupants of a transport that that transport is approaching a traffic control marking on a road, then if a transport crosses a marking, receiving indications of poor driving from other, nearby transports. In one example, the solutions can also be utilized to make a transport partially inoperable by (in certain embodiments), limiting speed, limiting the ability to be near another vehicle, limiting speed to a maximum, and allowing only a given number of miles allowed per time period.

In one example, the solutions can also be utilized to overcome a need for reliance on software updates to correct issues with a transport when the transport is not being operated correctly. Through observing other transports on a route, a server will receive data from potentially multiple other transports observing an unsafe or incorrect operation of a transport. Through analysis, these observations may result in a notification to the transport when the data suggest an unsafe or incorrect operation. In one example, the solutions can also be utilized to notify between a transport and a potentially dangerous situation involving a person external to the transport. In one example, the solutions can also be utilized to send data to a server by devices either associated with an accident with a transport, or devices proximate to the accident. Based on the severity of the accident or near accident, the server notifies the senders of the data. In one example, the solutions can also be utilized to provide recommendations for operating a transport to either a driver or occupant of a transport based on the data analysis. In one example, the solutions can also be utilized to establish a geofence associated with a physical structure and determine payment responsibility to the transport. In one example, the solutions can also be utilized to coordinate the ability to drop off a vehicle at a location using both the current state at the location and a proposed future state using navigation destinations of other vehicles. In one example, the solutions can also be utilized to coordinate the ability to automatically arrange for the drop off of a vehicle at a location such as a transport rental entity.



25

In one example, the solutions can also be utilized to move transport to another location based on a user's event. More particularly, the system tracks a user's device and modifies the transport to be moved proximate to the user upon the conclusion of the original event or a modified event. In one example, the solutions can also be utilized to allow for the validation of available locations within an area through the existing transports within the area. The approximate time when a location may be vacated is also determined based on verifications from the existing transports. In one example, the solutions can also be utilized to move a transport to closer parking spaces as one becomes available and the elapsed time since initially parking is less than the average event time. Furthermore, moving the transport to a final parking space when the event is completed or according to a location of a device associated with at least one occupant of the transport. In one example, the solutions can also be utilized to plan for the parking before the upcoming crowd. The system interacts with the transport to offer some services at a less than full price and/or guide the transport to alternative parking locations based on a priority of the transport, increasing optimization of the parking situation before arriving.

In one example, the solutions can also be utilized to sell fractional ownership in transports or determine pricing and availability in ride-sharing applications. In one example, the solutions can also be utilized to provide accurate and timely reports of dealership sales activities well beyond what is currently available. In one example, the solutions can also be utilized to allow a dealership to request an asset over the blockchain. By using the blockchain, a consensus is obtained before any asset is moved. Additionally, the process is automated, and payment may be initiated over the blockchain. In one example, the solutions can also be utilized to arrange agreements that are made with multiple entities (such as service centers) wherein a consensus is acquired and an action performed (such as diagnostics). In one example, the solutions can also be utilized to associate digital keys with multiple users. A first user may be the transport operator, and a second user is a responsible party for the transport. These keys are authorized by a server where the proximity of the keys is validated against the location of a service provider. In one example, the solutions can also be utilized to determine a needed service on a transport destination. One or more service locations are located that can provide the needed service that is both within an area on route to the destination and has availability to perform the service. The navigation of the transport is updated with the determined service location. A smart contract is identified that contains a compensation value for the service, and a blockchain transaction is stored in a distributed ledger for the transaction.

In one example, the solutions can also be utilized to interfacing a service provider transport with a profile of an occupant of a transport to determine services and goods which may be of interest to occupants in a transport. These services and goods are determined by an occupant's history and/or preferences. The transport then receives offers from the service provider transport and, in another example, meets the transport to provide the service/good. In one example, the solutions can also be utilized to detect a transport within a range and send a service offer to the transport (such as a maintenance offer, a product offer, or the like). An agreement is made between the system and the transport, and a service provider is selected by the system to provide the agreement. In one example, the solutions can also be utilized to assign one or more transports as a

26

roadway manager, where the roadway manager assists in controlling traffic. The roadway manager may generate a roadway indicator (such as lights, displays, and sounds) to assist in the flow of traffic. In one example, the solutions can also be utilized to alert a driver of a transport by a device, wherein the device may be the traffic light or near an intersection. The alert is sent upon an event, such as when a light turns green, and the transport in the front of a list of transports does not move.

FIG. 2H is another block diagram showing interconnections between different elements in one example 290. A transport 276 is presented and includes ECUs 295, 296, and a Head Unit (otherwise known as an Infotainment System) 297. An Electrical Control Unit (ECU) is an embedded system in automotive electronics controlling one or more of the electrical systems or subsystems in a transport. ECUs may include but are not limited to the management of a transport's engine, brake system, gearbox system, door locks, dashboard, airbag system, infotainment system, electronic differential, and active suspension. ECUs are connected to the transport's Controller Area Network (CAN) bus 294. The ECUs may also communicate with a transport computer 298 via the CAN bus 294. The transport's processors/sensors (such as the transport computer) 298 can communicate with external elements, such as a server 293 via a network 292 (such as the Internet). Each ECU 295, 296, and Head Unit 297 may contain its own security policy. The security policy defines permissible processes that can be executed in the proper context. In one example, the security policy may be partially or entirely provided in the transport computer 298.

ECUs 295, 296, and Head Unit 297 may each include a custom security functionality element 299 defining authorized processes and contexts within which those processes are permitted to run. Context-based authorization to determine validity if a process can be executed allows ECUs to maintain secure operation and prevent unauthorized access from elements such as the transport's Controller Area Network (CAN Bus). When an ECU encounters a process that is unauthorized, that ECU can block the process from operating. Automotive ECUs can use different contexts to determine whether a process is operating within its permitted bounds, such as proximity contexts such as nearby objects, distance to approaching objects, speed, and trajectory relative to other moving objects, and operational contexts such as an indication of whether the transport is moving or parked, the transport's current speed, the transmission state, user-related contexts such as devices connected to the transport via wireless protocols, use of the infotainment, cruise control, parking assist, driving assist, location-based contexts, and/or other contexts.

In one example, the solutions described and depicted herein can be utilized to make a transport partially inoperable by (in certain embodiments), limiting speed, limiting the ability to be near another vehicle, limiting speed to a maximum, and allowing only a given number of miles allowed per time period. In one example, the solutions can also be utilized to use a blockchain to facilitate the exchange of vehicle possession wherein data is sent to a server by devices either associated with an accident with a transport, or devices proximate to the accident. Based on the severity of the accident or near accident, the server notifies the senders of the data. In one example, the solutions can also be utilized to help the transport to avoid accidents, such as when the transport is involved in an accident by a server that queries other transports that are proximate to the accident. The server seeks to obtain data from the other transports,

allowing the server to understand the nature of the accident from multiple vantage points. In one example, the solutions can also be utilized to determine that sounds from a transport are atypical and transmit data related to the sounds and a possible source location to a server wherein the server can determine possible causes and avoid a potentially dangerous situation. In one example, the solutions can also be utilized to establish a location boundary via the system when a transport is involved in an accident. This boundary is based on decibels associated with the accident. Multimedia content for a device within the boundary is obtained to assist in further understanding the scenario of the accident. In one example, the solutions can also be utilized to associate a vehicle with an accident, then capture media obtained by devices proximate to the location of the accident. The captured media is saved as a media segment. The media segment is sent to another computing device which builds a sound profile of the accident. This sound profile will assist in understanding more details surrounding the accident.

In one example, the solutions can also be utilized to utilize sensors to record audio, video, motion, etc. to record an area where a potential event has occurred, such as if a transport comes in contact or may come in contact with another transport (while moving or parked), the system captures data from the sensors which may reside on one or more of the transports and/or on fixed or mobile objects. In one example, the solutions can also be utilized to determine that a transport has been damaged by using sensor data to identify a new condition of the transport during a transport event and comparing the condition to a transport condition profile, making it possible to safely and securely capture critical data from a transport that is about to be engaged in a detrimental event.

In one example, the solutions can also be utilized to warn occupants of a transport when the transport, via one or more sensors, has determined that it is approaching or going down a one-way road the incorrect way. The transport has sensors/cameras/maps interacting with the system of the current solution. The system knows the geographic location of one-way streets. The system may audibly inform the occupants, "Approaching a one-way street," for example. In one example, the solutions can also be utilized to allow the transport to get paid, allowing autonomous vehicle owners to monetize the data their vehicle sensors collect and store, creating an incentive for vehicle owners to share their data and provide entities with additional data through which to improve the performance of future vehicles, provide services to the vehicle owners, etc.

In one example, the solutions can also be utilized to either increase or decrease a vehicle's features according to the action of the vehicle over a period of time. In one example, the solutions can also be utilized to assign a fractional ownership to a transport. Sensor data related to one or more transports and a device proximate to the transport are used to determine a condition of the transport. The fractional ownership of the transport is determined based on the condition, and a new transport responsibility is provided. In one example, the solutions can also be utilized to provide data to a replacement/upfitting component, wherein the data attempts to subvert an authorized functionality of the replacement/upfitting component, and responsive to a non-subversion of the authorized functionality, permitting, by the component, use of the authorized functionality of the replacement/upfitting component.

In one example, the solutions can also be utilized to provide individuals the ability to ensure that an occupant should be in a transport and for that occupant to reach a

particular destination. Further, the system ensures a driver (if a non-autonomous transport) and/or other occupants are authorized to interact with the occupant. Also, pickups, drop-offs and location are noted. All of the above are stored in an immutable fashion on a blockchain. In one example, the solutions can also be utilized to determine the characteristics of a driver via an analysis of driving style and other elements to take action if the driver is not driving in a normal manner, such as a manner in which the driver has previously driven in a particular condition, for example during the day, at night, in the rain, in the snow, etc. Further, the attributes of the transport are also taken into account. Attributes include weather, whether the headlights are on, whether navigation is being used, a HUD is being used, the volume of media being played, etc. In one example, the solutions can also be utilized to notify occupants in a transport of a dangerous situation when items inside the transport signify that the occupants may not be aware of the dangerous situation.

In one example, the solutions can also be utilized to mount calibration devices on a rig that is fixed to a vehicle, wherein the various sensors on the transport can automatically self-adjust based on what should be detected by the calibration devices as compared to what is actually detected. In one example, the solutions can also be utilized to use a blockchain to require consensus from a plurality of service centers when a transport needing service sends malfunction information allowing remote diagnostic functionality wherein a consensus is required from other service centers on what a severity threshold is for the data. Once the consensus is received, the service center may send the malfunction security level to the blockchain to be stored. In one example, the solutions can also be utilized to determine a difference in sensor data external to the transport and the transport's own sensor data. The transport requests, from a server, a software to rectify the issue. In one example, the solutions can also be utilized to allow for the messaging of transports that are either nearby or in the area when an event occurs (e.g., a collision).

Referring to FIG. 2I, an operating environment 290A for a connected transport, is illustrated according to some embodiments. As depicted, the transport 276 includes a Controller Area Network (CAN) bus 291A connecting elements 292A-299A of the transport. Other elements may be connected to the CAN bus and are not depicted herein. The depicted elements connected to the CAN bus include a sensor set 292A, Electronic Control Units 293A, autonomous features or Advanced Driver Assistance Systems (ADAS) 294A, and the navigation system 295A. In some embodiments, the transport 276 includes a processor 296A, a memory 297A, a communication unit 298A, and an electronic display 299A.

The processor 296A includes an arithmetic logic unit, a microprocessor, a general-purpose controller, and/or a similar processor array to perform computations and provide electronic display signals to a display unit 299A. The processor 296A processes data signals and may include various computing architectures, including a complex instruction set computer (CISC) architecture, a reduced instruction set computer (RISC) architecture, or an architecture implementing a combination of instruction sets. The transport 276 may include one or more processors 296A. Other processors, operating systems, sensors, displays, and physical configurations that are communicably coupled to one another (not depicted) may be used with the instant solution.

Memory 297A is a non-transitory memory storing instructions or data that may be accessed and executed by the processor 296A. The instructions and/or data may include code to perform the techniques described herein. The memory 297A may be a dynamic random-access memory (DRAM) device, a static random-access memory (SRAM) device, flash memory, or another memory device. In some embodiments, the memory 297A also may include non-volatile memory or a similar permanent storage device and media, which may include a hard disk drive, a floppy disk drive, a CD-ROM device, a DVD-ROM device, a DVD-RAM device, a DVD-RW device, a flash memory device, or some other mass storage device for storing information on a permanent basis. A portion of the memory 297A may be reserved for use as a buffer or virtual random-access memory (virtual RAM). The transport 276 may include one or more memories 297A without deviating from the current solution.

The memory 297A of the transport 276 may store one or more of the following types of data: navigation route data 295A, and autonomous features data 294A. In some embodiments, the memory 297A stores data that may be necessary for the navigation application 295A to provide the functions.

The navigation system 295A may describe at least one navigation route including a start point and an endpoint. In some embodiments, the navigation system 295A of the transport 276 receives a request from a user for navigation routes wherein the request includes a starting point and an ending point. The navigation system 295A may query a real-time data server 293 (via a network 292), such as a server that provides driving directions, for navigation route data corresponding to navigation routes, including the start point and the endpoint. The real-time data server 293 transmits the navigation route data to the transport 276 via a wireless network 292, and the communication system 298A stores the navigation data 295A in the memory 297A of the transport 276.

The ECU 293A controls the operation of many of the systems of the transport 276, including the ADAS systems 294A. The ECU 293A may, responsive to instructions received from the navigation system 295A, deactivate any unsafe and/or unselected autonomous features for the duration of a journey controlled by the ADAS systems 294A. In this way, the navigation system 295A may control whether ADAS systems 294A are activated or enabled so that they may be activated for a given navigation route.

The sensor set 292A may include any sensors in the transport 276 generating sensor data. For example, the sensor set 292A may include short-range sensors and long-range sensors. In some embodiments, the sensor set 292A of the transport 276 may include one or more of the following vehicle sensors: a camera, a Lidar sensor, an ultrasonic sensor, an automobile engine sensor, a radar sensor, a laser altimeter, a manifold absolute pressure sensor, an infrared detector, a motion detector, a thermostat, a sound detector, a carbon monoxide sensor, a carbon dioxide sensor, an oxygen sensor, a mass airflow sensor, an engine coolant temperature sensor, a throttle position sensor, a crankshaft position sensor, a valve timer, an air-fuel ratio meter, a blind spot meter, a curb feeler, a defect detector, a Hall effect sensor, a parking sensor, a radar gun, a speedometer, a speed sensor, a tire-pressure monitoring sensor, a torque sensor, a transmission fluid temperature sensor, a turbine speed sensor (TSS), a variable reluctance sensor, a vehicle speed sensor (VSS), a water sensor, a wheel speed sensor, a GPS sensor,

a mapping functionality, and any other type of automotive sensor. The navigation system 295A may store the sensor data in the memory 297A.

The communication unit 298A transmits and receives data to and from the network 292 or to another communication channel. In some embodiments, the communication unit 298A may include a DSRC transceiver, a DSRC receiver, and other hardware or software necessary to make the transport 276 a DSRC-equipped device.

The transport 276 may interact with other transports 277 via V2V technology. V2V communication includes sensing radar information corresponding to relative distances to external objects, receiving GPS information of the transports, setting areas as areas where the other transports 277 are located based on the sensed radar information, calculating probabilities that the GPS information of the object vehicles will be located at the set areas, and identifying transports and/or objects corresponding to the radar information and the GPS information of the object vehicles based on the calculated probabilities, in one example.

In one example, the solutions described and depicted herein can be utilized to manage emergency scenarios and transport features when a transport is determined to be entering an area without network access. In one example, the solutions can also be utilized to manage and provide features in a transport (such as audio, video, navigation, etc.) without network connection. In one example, the solutions can also be utilized to determine when a profile of a person in proximity to the transport matches profile attributes of a profile of at least one occupant in the transport. A notification is sent from the transport to establish communication.

In one example, the solutions can also be utilized to analyze the availability of occupants in respective transports that are available for a voice communication based on an amount of time remaining in the transport and context of the communication to be performed. In one example, the solutions can also be utilized to determine two levels of threat of roadway obstruction and receiving a gesture that may indicate that the obstruction is not rising to an alert above a threshold, and proceeding, by the transport along the roadway. In one example, the solutions can also be utilized to delete sensitive data from a transport when the transport has had damage such that it is rendered unable to be used.

In one example, the solutions can also be utilized to verify that the customer data to be removed has truly been removed from all of the required locations within the enterprise, demonstrating GDPR compliance. In one example, the solutions can also be utilized to provide consideration from one transport to another transport in exchange for data related to safety, important notifications, etc. to enhance the autonomous capabilities of the lower-level autonomous vehicle. In one example, the solutions can also be utilized to provide an ability for a transport to receive data based on a first biometric associated with an occupant. Then the transport unencrypts the encrypted data based on a verification of a second biometric, wherein the second biometric is a continuum of the first biometric. The transport provides the unencrypted data to the occupant when only the occupant can receive the unencrypted data and deletes a sensitive portion of the unencrypted data as the sensitive portion is being provided and a non-sensitive portion after a period of time associated with the biometric elapses. In one example, the solutions can also be utilized to provide an ability for a transport to validate an individual based on a weight and grip pressure applied to the steering wheel of the transport. In one example, the solutions can also be utilized to provide a feature to a car that exists but is not currently enabled,

presenting features to an occupant of the automobile that reflects the occupant's characteristics.

In one example, the solutions can also be utilized to allow for the modification of a transport, particularly the interior of the transport and the exterior of the transport to reflect and assist at least one occupant, in one example. In another example, recreating an occupant's work and/or home environment is disclosed. The system may attempt to "recreate" the user's work/home environment while the user is in the transport if it determines that the user is in "work mode" or "home mode". All data relating to the interior and exterior of the transport as well as the various occupants utilizing the transport are stored on a blockchain and executed via smart contracts. In one example, the solutions can also be utilized to detect occupant gestures to assist in communicating with nearby transports wherein the transport may maneuver accordingly. In one example, the solutions can also be utilized to provide the ability for a transport to detect intended gestures using a gesture definition datastore. In one example, the solutions can also be utilized to provide an ability for a transport to take various actions based on a gait and a user's gesture. In one example, the solutions can also be utilized to ensure that a driver of a transport that is currently engaged in various operations (for example, driving while talking with navigation on, etc.) does not exceed an unsafe number of operations before being permitted to gesture.

In one example, the solutions can also be utilized to assign a status to each occupant in a transport and validating a gesture from an occupant based on the occupant's status. In one example, the solutions can also be utilized to collect details of sound related to a collision (in what location, in what direction, rising or falling, from what device, data associated with the device such as type, manufacturer, owner, as well as the number of contemporaneous sounds, and the times the sounds were emanated, etc.) and provide to the system where analysis of the data assists in determining details regarding the collision. In one example, the solutions can also be utilized to determine whether a transport is unsafe to operate. The transport includes multiple components that interoperate to control the transport, and each component is associated with a separate component key. A cryptographic key is sent to the transport to decrease transport functionality. In response to receiving the cryptographic key, the transport disables one or more of the component keys. Disabling the one or more component keys results in one or more of limiting the transport to not move greater than a given speed, limiting the transport to not come closer than a distance to another transport, and limiting the transport to not travel greater than a threshold distance.

In one example, the solutions can also be utilized to provide an indication from one specific transport (that is about to vacate a location) to another specific transport (that is seeking to occupy a location), a blockchain is used to perform authentication and coordination. In one example, the solutions can also be utilized to determine a fractional responsibility for a transport. Such as the case where multiple people own a single transport, and the use of the transport, which may change over a period of time, is used by the system to update the fractional ownership. Other embodiments will be included in the application, including a minimal ownership of a transport based on not the use of the transport but the availability of the transport, and the determination of the driver of the transport as well as others.

In one example, the solutions can also be utilized to permit in a transport a user to his/her subscriptions with a closed group of people such as family members or friends.

For example, a user might want to share a membership, and if so, associated transactions are stored in a blockchain or traditional database. When the subscribed materials are requested by a user, who is not a primary subscriber, a blockchain node (i.e., a transport) can verify that a person requesting a service is an authorized person with whom the subscriber has shared the profile. In one example, the solutions can also be utilized to allow a person to utilize supplemental transport(s) to arrive at an intended destination. A functional relationship value (e.g., value that indicates the various parameters and their importance in determining what type of alternate transport to utilize) is used in determining the supplemental transport. In one example, the solutions can also be utilized to allow the occupants in an accident to access other transports to continue to their initial destination.

In one example, the solutions can also be utilized to propagate a software/firmware upload to a first subset of transports. This first set of transports tests the update, and when the test is successful, the update is propagated to a further set of transports. In one example, the solutions can also be utilized to propagate software/firmware updates to vehicles from a master transport where the update is propagated through the network of vehicles from a first subset, then a larger subset, etc. A portion of the update may be first sent, then the remaining portion sent from the same or another vehicle. In one example, the solutions can also be utilized to provide an update for a transport's computer to the transport and a transport operator's/occupant's device. The update is maybe authorized by all drivers and/or all occupants. The software update is provided to the vehicle and the device(s). The user does not have to do anything but go proximate to the vehicle and the functionality automatically occurs. A notification is sent to the device(s) indicating that the software update is completed. In one example, the solutions can also be utilized to validate that an OTA software update is performed by a qualified technician and generation, by the one or more transport components, of a status related to an originator of the validation code, a procedure for wirelessly receiving the software update, information contained in the software update, and results of the validation.

In one example, the solutions can also be utilized to provide the ability to parse a software update located in a first component by a second component. Then verifying the first portion of critical updates and a second portion of non-critical updates, assigning the verified first portion to one process in the transport, running the verified first portion with the one process for a period of time, and responsive to positive results based on the period of time, running the verified first portion with other processes after the period of time. In one example, the solutions can also be utilized to provide a selection of services to an occupant where the services are based on a profile of an occupant of the transport, and a shared profile that is shared with the profile of the occupant. In one example, the solutions can also be utilized to store user profile data in a blockchain and intelligently present offers and recommendations to a user based on the user's automatically gathered history of purchases and preferences acquired from the user profile on the blockchain.

For a transport to be adequately secured, the transport must be protected from unauthorized physical access as well as unauthorized remote access (e.g., cyber-threats). To prevent unauthorized physical access, a transport is equipped with a secure access system such as a keyless entry in one example. Meanwhile, security protocols are added to a

transport's computers and computer networks to facilitate secure remote communications to and from the transport in one example.

Electronic Control Units (ECUs) are nodes within a transport that control tasks such as activating the windshield wipers to tasks such as an anti-lock brake system. ECUs are often connected to one another through the transport's central network, which may be referred to as a controller area network (CAN). State-of-the-art features such as autonomous driving are strongly reliant on implementing new, complex ECUs such as advanced driver-assistance systems (ADAS), sensors, and the like. While these new technologies have helped improve the safety and driving experience of a transport, they have also increased the number of externally-communicating units inside of the transport, making them more vulnerable to attack. Below are some examples of protecting the transport from physical intrusion and remote intrusion.

FIG. 2J illustrates a keyless entry system **290B** to prevent unauthorized physical access to a transport **291B**, according to example embodiments. Referring to FIG. 2J, a key fob **292B** transmits commands to a transport **291B** using radio frequency signals in one example. In this example, the key fob **292B** includes a transmitter **2921B** with an antenna that is capable of sending short-range wireless radio signals. The transport **291B** includes a receiver **2911B** with an antenna that is capable of receiving the short-range wireless signal transmitted from the transmitter **2921B**. The key fob **292B** and the transport **291B** also include CPUs **2922B** and **2913B**, respectively, which control the respective devices. Here, a memory of the CPUs **2922B** and **2913B** (or accessible to the CPUs). Each of the key fob **292B** and the transport **291B** includes power supplies **2924B** and **2915B** for powering the respective devices in one example.

When the user presses a button **293B** (or otherwise actuates the fob, etc.) on the key fob **292B**, the CPU **2922B** wakes up inside the key fob **292B** and sends a data stream to the transmitter **2921B**, which is output via the antenna. In other embodiments, the user's intent is acknowledged on the key fob **292B** via other means, such as via a microphone that accepts audio, a camera that captures images and/or video, or other sensors that are commonly utilized in the art to detect intent from a user including receiving gestures, motion, eye movements, and the like. The data stream may be a 64-bit to 128-bit long signal, which includes one or more of a preamble, a command code, and a rolling code. The signal may be sent at a rate between 2 KHz and 20 KHz, but embodiments are not limited thereto. In response, the receiver **2911B** of the transport **291B** captures the signal from the transmitter **2921B**, demodulates the signal, and sends the data stream to the CPU **2913B**, which decodes the signal and sends commands (e.g., lock the door, unlock the door, etc.) to a command module **2912B**.

If the key fob **292B** and the transport **291B** use a fixed code between them, replay attacks can be performed. In this case, if the attacker can capture/sniff the fixed code during the short-range communication, the attacker could replay this code to gain entry into the transport **291B**. To improve security, the key fob and the transport **291B** may use a rolling code that changes after each use. Here, the key fob **292B** and the transport **291B** are synchronized with an initial seed **2923B** (e.g., a random number, pseudo-random number, etc.) This is referred to as pairing. The key fob **292B** and the transport **291B** also include a shared algorithm for modifying the initial seed **2914B** each time the button **293B** is pressed. The following keypress will take the result of the previous keypress as an input and transform it into the next

number in the sequence. In some cases, the transport **291B** may store multiple next codes (e.g., **255** next codes) in case the keypress on the key fob **292B** is not detected by the transport **291B**. Thus, a number of keypress on the key fob **292B** that are unheard by the transport **291B** do not prevent the transport from becoming out of sync.

In addition to rolling codes, the key fob **292B** and the transport **291B** may employ other methods to make attacks even more difficult. For example, different frequencies may be used for transmitting the rolling codes. As another example, two-way communication between the transmitter **2921B** and the receiver **2911B** may be used to establish a secure session. As another example, codes may have limited expirations or timeouts. Further, the instant solution as described and depicted with respect to FIG. 2J can be utilized in this and other networks and/or systems, including those that are described and depicted herein.

FIG. 2K illustrates a controller area network (CAN) **290C** within a transport, according to example embodiments. Referring to FIG. 2K, the CAN **290C** includes a CAN bus **297C** with a high and low terminal and a plurality of electronic control units (ECUs) **291C**, **292C**, **293C**, etc. which are connected to the CAN bus **297C** via wired connections. The CAN bus **297C** is designed to allow microcontrollers and devices to communicate with each other in an application without a host computer. The CAN bus **297C** implements a message-based protocol (i.e., ISO 11898 standards) that allows ECUs **291C-293C** to send commands to one another at a root level. Meanwhile, the ECUs **291C-293C** represent controllers for controlling electrical systems or subsystems within the transport. Examples of the electrical systems include power steering, anti-lock brakes, air-conditioning, tire pressure monitoring, cruise control, and many other features.

In this example, the ECU **291C** includes a transceiver **2911C** and a microcontroller **2912C**. The transceiver may be used to transmit and receive messages to and from the CAN bus **297C**. For example, the transceiver **2911C** may convert the data from the microcontroller **2912C** into a format of the CAN bus **297C** and also convert data from the CAN bus **297C** into a format for the microcontroller **2912C**. Meanwhile, the microcontroller **2912C** interprets the messages and also decide what messages to send using ECU software installed therein in one example.

To protect the CAN **290C** from cyber threats, various security protocols may be implemented. For example, sub-networks (e.g., sub-networks A and B, etc.) may be used to divide the CAN **290C** into smaller sub-CANs and limit an attacker's capabilities to access the transport remotely. In the example of FIG. 2K, ECUs **291C** and **292C** may be part of a same sub-network, while ECU **293C** is part of an independent sub-network. Furthermore, a firewall **294C** (or gateway, etc.) may be added to block messages from crossing the CAN bus **297C** across sub-networks. If an attacker gains access to one sub-network, the attacker will not have access to the entire network. To make sub-networks even more secure, the most critical ECUs are not placed on the same sub-network, in one example.

Although not shown in FIG. 2K, other examples of security controls within a CAN include an intrusion detection system (IDS) which can be added to each sub-network and read all data passing to detect malicious messages. If a malicious message is detected, the IDS can notify the automobile user. Other possible security protocols include encryption/security keys that can be used to obscure mes-

sages. As another example, authentication protocols are implemented that enables a message to authenticate itself, in one example.

In addition to protecting a transport's internal network, transports may also be protected when communicating with external networks such as the Internet. One of the benefits of having a transport connection to a data source such as the Internet is that information from the transport can be sent through a network to remote locations for analysis. Examples of transport information include GPS, onboard diagnostics, tire pressure, and the like. These communication systems are often referred to as telematics because they involve the combination of telecommunications and informatics. Further, the instant solution as described and depicted with respect to FIG. 2K can be utilized in this and other networks and/or systems, including those that are described and depicted herein.

FIG. 2L illustrates a secure end-to-end transport communication channel according to example embodiments. Referring to FIG. 2L, a telematics network 290D includes a transport 291D and a host server 295D that is disposed at a remote location (e.g., a web server, a cloud platform, a database, etc.) and connected to the transport 291D via a network such as the Internet. In this example, a device 296D associated with the host server 295D may be installed within the network inside the transport 291D. Furthermore, although not shown, the device 296D may connect to other elements of the transport 291D, such as the CAN bus, an onboard diagnostics (OBDII) port, a GPS system, a SIM card, a modem, and the like. The device 296D may collect data from any of these systems and transfer the data to the server 295D via the network.

Secure management of data begins with the transport 291D. In some embodiments, the device 296D may collect information before, during, and after a trip. The data may include GPS data, travel data, passenger information, diagnostic data, fuel data, speed data, and the like. However, the device 296D may only communicate the collected information back to the host server 295D in response to transport ignition and trip completion. Furthermore, communication may only be initiated by the device 296D and not by the host server 295D. As such, the device 296D will not accept communications initiated by outside sources in one example.

To perform the communication, the device 296D may establish a secured private network between the device 296D and the host server 295D. Here, the device 296D may include a tamper-proof SIM card that provides secure access to a carrier network 294D via a radio tower 292D. When preparing to transmit data to the host server 295D, the device 296D may establish a one-way secure connection with the host server 295D. The carrier network 294D may communicate with the host server 295D using one or more security protocols. As a non-limiting example, the carrier network 294D may communicate with the host server 295D via a VPN tunnel which allows access through a firewall 293D of the host server 295D. As another example, the carrier network 294D may use data encryption (e.g., AES encryption, etc.) when transmitting data to the host server 295D. In some cases, the system may use multiple security measures such as both a VPN and encryption to further secure the data.

In addition to communicating with external servers, transports may also communicate with each other. In particular, transport-to-transport (V2V) communication systems enable transports to communicate with each other, roadside infrastructures (e.g., traffic lights, signs, cameras, parking meters, etc.), and the like, over a wireless network. The wireless

network may include one or more of Wi-Fi networks, cellular networks, dedicated short-range communication (DSRC) networks, and the like. Transports may use V2V communication to provide other transports with information about a transport's speed, acceleration, braking, and direction, to name a few. Accordingly, transports can receive insight into the conditions ahead before such conditions become visible, thus greatly reducing collisions. Further, the instant solution as described and depicted with respect to FIG. 2L can be utilized in this and other networks and/or systems, including those that are described and depicted herein.

FIG. 2M illustrates an example 290E of transports 293E and 292E performing secured V2V communications using security certificates, according to example embodiments. Referring to FIG. 2M, the transports 293E and 292E may communicate via V2V communications over a short-range network, a cellular network, or the like. Before sending messages, the transports 293E and 292E may sign the messages using a respective public key certificate. For example, the transport 293E may sign a V2V message using a public key certificate 294E. Likewise, the transport 292E may sign a V2V message using a public key certificate 295E. The public key certificates 294E and 295E are associated with the transports 293E and 292E, respectively, in one example.

Upon receiving the communications from each other, the transports may verify the signatures with a certificate authority 291E or the like. For example, the transport 292E may verify with the certificate authority 291E that the public key certificate 294E used by transport 293E to sign a V2V communication is authentic. If the transport 292E successfully verifies the public key certificate 294E, the transport knows that the data is from a legitimate source. Likewise, the transport 293E may verify with the certificate authority 291E that the public key certificate 295E used by the transport 292E to sign a V2V communication is authentic. Further, the instant solution as described and depicted with respect to FIG. 2M can be utilized in this and other networks and/or systems including those that are described and depicted herein.

FIG. 2N illustrates yet a further diagram 290F depicting an example of a transport interacting with a security processor and a wireless device, according to example embodiments. In some embodiments, the computer 224 shown in FIG. 2B may include security processor 292F as shown in the process 290F of the example of FIG. 2N. In particular, the security processor 292F may perform authorization, authentication, cryptography (e.g., encryption), and the like, for data transmissions that are sent between ECUs and other devices on a CAN bus of a vehicle, and also data messages that are transmitted between different vehicles.

In the example of FIG. 2N, the security processor 292F may include an authorization module 293F, an authentication module 294F, and a cryptography module 295F. The security processor 292F may be implemented within the transport's computer and may communicate with other transport elements, for example, the ECUs/CAN network 296F, wired and wireless devices 298F such as wireless network interfaces, input ports, and the like. The security processor 292F may ensure that data frames (e.g., CAN frames, etc.) that are transmitted internally within a transport (e.g., via the ECUs/CAN network 296F) are secure. Likewise, the security processor 292F can ensure that messages transmitted between different transports and devices attached or connected via a wire to the transport's computer are also secured.

37

For example, the authorization module **293F** may store passwords, usernames, PIN codes, biometric scans, and the like for different transport users. The authorization module **293F** may determine whether a user (or technician) has permission to access certain settings such as a transport's computer. In some embodiments, the authorization module may communicate with a network interface to download any necessary authorization information from an external server. When a user desires to make changes to the transport settings or modify technical details of the transport via a console or GUI within the transport or via an attached/connected device, the authorization module **293F** may require the user to verify themselves in some way before such settings are changed. For example, the authorization module **293F** may require a username, a password, a PIN code, a biometric scan, a predefined line drawing or gesture, and the like. In response, the authorization module **293F** may determine whether the user has the necessary permissions (access, etc.) being requested.

The authentication module **294F** may be used to authenticate internal communications between ECUs on the CAN network of the vehicle. As an example, the authentication module **294F** may provide information for authenticating communications between the ECUs. As an example, the authentication module **294F** may transmit a bit signature algorithm to the ECUs of the CAN network. The ECUs may use the bit signature algorithm to insert authentication bits into the CAN fields of the CAN frame. All ECUs on the CAN network typically receive each CAN frame. The bit signature algorithm may dynamically change the position, amount, etc., of authentication bits each time a new CAN frame is generated by one of the ECUs. The authentication module **294F** may also provide a list of ECUs that are exempt (safe list) and that do not need to use the authentication bits. The authentication module **294F** may communicate with a remote server to retrieve updates to the bit signature algorithm and the like.

The encryption module **295F** may store asymmetric key pairs to be used by the transport to communicate with other external user devices and transports. For example, the encryption module **295F** may provide a private key to be used by the transport to encrypt/decrypt communications, while the corresponding public key may be provided to other user devices and transports to enable the other devices to decrypt/encrypt the communications. The encryption module **295F** may communicate with a remote server to receive new keys, updates to keys, keys of new transports, users, etc., and the like. The encryption module **295F** may also transmit any updates to a local private/public key pair to the remote server.

FIG. 3A illustrates a flow diagram **300**, according to example embodiments. Referring to FIG. 3A, the flow diagram **300** includes one or more of determining a vehicle in a group of vehicles that has an unobstructed view of an area ahead of the group **302**, collecting data from sensors on the vehicle **304**, sending the data to one or more other vehicles in the group of vehicles **306**, and providing the unobstructed view of the area ahead of the group on a display of the one or more other vehicles **308**.

FIG. 3B illustrates another flow diagram **320**, according to example embodiments. Referring to FIG. 3B, the flow diagram **320** includes one or more of obtaining sensor data from each vehicle of the group of vehicles and eliminating sensor data that includes an obstructed view of the area **322**, requesting sensor data from the vehicle for unobstructed views of the area and receiving sensor data from the vehicle and one or more occupant devices associated with the

38

vehicle for the unobstructed views **323**, identifying the one or more other vehicles in the group that are behind the vehicle and proximate the vehicle and transferring portions of the collected data to the identified one or more other vehicles, wherein the portions comprise areas of the unobstructed view that are obstructed for respective one for the identified one or more other vehicles **324**, receiving the collected data, selecting an unobstructed view from the collected data, and sending the unobstructed view by one of the one or more other vehicles to another of the one or more other vehicles **325**, determining the group of vehicles are related and notifying the one or more other vehicles to proceed to a destination after receiving the unobstructed view of the area ahead **326**, and receiving one or more unobstructed views from the vehicle and the other vehicles and merging the one or more unobstructed views into a panoramic view **327**.

FIG. 3C illustrates yet another flow diagram **340**, according to example embodiments. Referring to FIG. 3C, the flow diagram includes one or more of receiving a confirmation of an event from one or more elements described or depicted herein, wherein the confirmation comprises a blockchain consensus between peers represented by any of the elements **342** and executing a smart contract to record the confirmation on a blockchain-based on the blockchain consensus **344**.

FIG. 4 illustrates a machine learning transport network diagram **400**, according to example embodiments. The network **400** includes a transport **402** that interfaces with a machine learning subsystem **406**. The transport includes one or more sensors **404**.

The machine learning subsystem **406** contains a learning model **408**, which is a mathematical artifact created by a machine learning training system **410** that generates predictions by finding patterns in one or more training data sets. In some embodiments, the machine learning subsystem **406** resides in the transport **402**. In other embodiments, the machine learning subsystem **406** resides outside of the transport **402**.

The transport **402** sends data from the one or more sensors **404** to the machine learning subsystem **406**. The machine learning subsystem **406** provides the one or more sensor **404** data to the learning model **408**, which returns one or more predictions. The machine learning subsystem **406** sends one or more instructions to the transport **402** based on the predictions from the learning model **408**.

In a further embodiment, the transport **402** may send the one or more sensor **404** data to the machine learning training system **410**. In yet another example, the machine learning subsystem **406** may send the sensor **404** data to the machine learning subsystem **410**. One or more of the applications, features, steps, solutions, etc., described and/or depicted herein may utilize the machine learning network **400** as described herein.

FIG. 5A illustrates an example vehicle configuration **500** for managing database transactions associated with a vehicle, according to example embodiments. Referring to FIG. 5A, as a particular transport/vehicle **525** is engaged in transactions (e.g., vehicle service, dealer transactions, delivery/pickup, transportation services, etc.), the vehicle may receive assets **510** and/or expel/transfer assets **512** according to a transaction(s). A transport processor **526** resides in the vehicle **525** and communication exists between the transport processor **526**, a database **530**, a transport processor **526** and the transaction module **520**. The transaction module **520** may record information, such as assets, parties, credits, service descriptions, date, time, location, results, notifica-



tions, unexpected events, etc. Those transactions in the transaction module **520** may be replicated into a database **530**. The database **530** can be one of a SQL database, an RDBMS, a relational database, a non-relational database, a blockchain, a distributed ledger, and may be on board the transport, may be off-board the transport, may be accessed directly and/or through a network, or be accessible to the transport.

FIG. 5B illustrates an example vehicle configuration **550** for managing database transactions conducted among various vehicles, according to example embodiments. The vehicle **525** may engage with another vehicle **508** to perform various actions such as to share, transfer, acquire service calls, etc. when the vehicle has reached a status where the services need to be shared with another vehicle. For example, the vehicle **508** may be due for a battery charge and/or may have an issue with a tire and may be in route to pick up a package for delivery. A transport processor **528** resides in the vehicle **508** and communication exists between the transport processor **528**, a database **554**, and the transaction module **552**. The vehicle **508** may notify another vehicle **525**, which is in its network and which operates on its blockchain member service. A transport processor **526** resides in the vehicle **525** and communication exists between the transport processor **526**, a database **530**, the transport processor **526** and a transaction module **520**. The vehicle **525** may then receive the information via a wireless communication request to perform the package pickup from the vehicle **508** and/or from a server (not shown). The transactions are logged in the transaction modules **552** and **520** of both vehicles. The credits are transferred from vehicle **508** to vehicle **525** and the record of the transferred service is logged in the database **530/554** assuming that the blockchains are different from one another, or are logged in the same blockchain used by all members. The database **554** can be one of a SQL database, an RDBMS, a relational database, a non-relational database, a blockchain, a distributed ledger, and may be on board the transport, may be off-board the transport, may be accessible directly and/or through a network.

FIG. 6A illustrates a blockchain architecture configuration **600**, according to example embodiments. Referring to FIG. 6A, the blockchain architecture **600** may include certain blockchain elements, for example, a group of blockchain member nodes **602-606** as part of a blockchain group **610**. In one example embodiment, a permissioned blockchain is not accessible to all parties but only to those members with permissioned access to the blockchain data. The blockchain nodes participate in a number of activities, such as blockchain entry addition and validation process (consensus). One or more of the blockchain nodes may endorse entries based on an endorsement policy and may provide an ordering service for all blockchain nodes. A blockchain node may initiate a blockchain action (such as an authentication) and seek to write to a blockchain immutable ledger stored in the blockchain, a copy of which may also be stored on the underpinning physical infrastructure.

The blockchain transactions **620** are stored in memory of computers as the transactions are received and approved by the consensus model dictated by the members' nodes. Approved transactions **626** are stored in current blocks of the blockchain and committed to the blockchain via a committal procedure, which includes performing a hash of the data contents of the transactions in a current block and referencing a previous hash of a previous block. Within the blockchain, one or more smart contracts **630** may exist that define the terms of transaction agreements and actions

included in smart contract executable application code **632**, such as registered recipients, vehicle features, requirements, permissions, sensor thresholds, etc. The code may be configured to identify whether requesting entities are registered to receive vehicle services, what service features they are entitled/required to receive given their profile statuses and whether to monitor their actions in subsequent events. For example, when a service event occurs and a user is riding in the vehicle, the sensor data monitoring may be triggered, and a certain parameter, such as a vehicle charge level, may be identified as being above/below a particular threshold for a particular period of time, then the result may be a change to a current status, which requires an alert to be sent to the managing party (i.e., vehicle owner, vehicle operator, server, etc.) so the service can be identified and stored for reference. The vehicle sensor data collected may be based on types of sensor data used to collect information about vehicle's status. The sensor data may also be the basis for the vehicle event data **634**, such as a location(s) to be traveled, an average speed, a top speed, acceleration rates, whether there were any collisions, was the expected route taken, what is the next destination, whether safety measures are in place, whether the vehicle has enough charge/fuel, etc. All such information may be the basis of smart contract terms **630**, which are then stored in a blockchain. For example, sensor thresholds stored in the smart contract can be used as the basis for whether a detected service is necessary and when and where the service should be performed.

FIG. 6B illustrates a shared ledger configuration, according to example embodiments. Referring to FIG. 6B, the blockchain logic example **640** includes a blockchain application interface **642** as an API or plug-in application that links to the computing device and execution platform for a particular transaction. The blockchain configuration **640** may include one or more applications, which are linked to application programming interfaces (APIs) to access and execute stored program/application code (e.g., smart contract executable code, smart contracts, etc.), which can be created according to a customized configuration sought by participants and can maintain their own state, control their own assets, and receive external information. This can be deployed as an entry and installed, via appending to the distributed ledger, on all blockchain nodes.

The smart contract application code **644** provides a basis for the blockchain transactions by establishing application code, which when executed causes the transaction terms and conditions to become active. The smart contract **630**, when executed, causes certain approved transactions **626** to be generated, which are then forwarded to the blockchain platform **652**. The platform includes a security/authorization **658**, computing devices, which execute the transaction management **656** and a storage portion **654** as a memory that stores transactions and smart contracts in the blockchain.

The blockchain platform may include various layers of blockchain data, services (e.g., cryptographic trust services, virtual execution environment, etc.), and underpinning physical computer infrastructure that may be used to receive and store new entries and provide access to auditors, which are seeking to access data entries. The blockchain may expose an interface that provides access to the virtual execution environment necessary to process the program code and engage the physical infrastructure. Cryptographic trust services may be used to verify entries such as asset exchange entries and keep information private.

The blockchain architecture configuration of FIGS. 6A and 6B may process and execute program/application code via one or more interfaces exposed, and services provided,



by the blockchain platform. As a non-limiting example, smart contracts may be created to execute reminders, updates, and/or other notifications subject to the changes, updates, etc. The smart contracts can themselves be used to identify rules associated with authorization and access requirements and usage of the ledger. For example, the information may include a new entry, which may be processed by one or more processing entities (e.g., processors, virtual machines, etc.) included in the blockchain layer. The result may include a decision to reject or approve the new entry based on the criteria defined in the smart contract and/or a consensus of the peers. The physical infrastructure may be utilized to retrieve any of the data or information described herein.

Within smart contract executable code, a smart contract may be created via a high-level application and programming language, and then written to a block in the blockchain. The smart contract may include executable code that is registered, stored, and/or replicated with a blockchain (e.g., distributed network of blockchain peers). An entry is an execution of the smart contract code, which can be performed in response to conditions associated with the smart contract being satisfied. The executing of the smart contract may trigger a trusted modification(s) to a state of a digital blockchain ledger. The modification(s) to the blockchain ledger caused by the smart contract execution may be automatically replicated throughout the distributed network of blockchain peers through one or more consensus protocols.

The smart contract may write data to the blockchain in the format of key-value pairs. Furthermore, the smart contract code can read the values stored in a blockchain and use them in application operations. The smart contract code can write the output of various logic operations into the blockchain. The code may be used to create a temporary data structure in a virtual machine or other computing platform. Data written to the blockchain can be public and/or can be encrypted and maintained as private. The temporary data that is used/generated by the smart contract is held in memory by the supplied execution environment, then deleted once the data needed for the blockchain is identified.

A smart contract executable code may include the code interpretation of a smart contract, with additional features. As described herein, the smart contract executable code may be program code deployed on a computing network, where it is executed and validated by chain validators together during a consensus process. The smart contract executable code receives a hash and retrieves from the blockchain a hash associated with the data template created by use of a previously stored feature extractor. If the hashes of the hash identifier and the hash created from the stored identifier template data match, then the smart contract executable code sends an authorization key to the requested service. The smart contract executable code may write to the blockchain data associated with the cryptographic details.

FIG. 6C illustrates a blockchain configuration for storing blockchain transaction data, according to example embodiments. Referring to FIG. 6C, the example configuration 660 provides for the vehicle 662, the user device 664 and a server 666 sharing information with a distributed ledger (i.e., blockchain) 668. The server may represent a service provider entity inquiring with a vehicle service provider to share user profile rating information in the event that a known and established user profile is attempting to rent a vehicle with an established rated profile. The server 666 may be receiving and processing data related to a vehicle's service requirements. As the service events occur, such as

the vehicle sensor data indicates a need for fuel/charge, a maintenance service, etc., a smart contract may be used to invoke rules, thresholds, sensor information gathering, etc., which may be used to invoke the vehicle service event. The blockchain transaction data 670 is saved for each transaction, such as the access event, the subsequent updates to a vehicle's service status, event updates, etc. The transactions may include the parties, the requirements (e.g., 18 years of age, service eligible candidate, valid driver's license, etc.), compensation levels, the distance traveled during the event, the registered recipients permitted to access the event and host a vehicle service, rights/permissions, sensor data retrieved during the vehicle event operation to log details of the next service event and identify a vehicle's condition status, and thresholds used to make determinations about whether the service event was completed and whether the vehicle's condition status has changed.

FIG. 6D illustrates blockchain blocks 680 that can be added to a distributed ledger, according to example embodiments, and contents of block structures 682A to 682N. Referring to FIG. 6D, clients (not shown) may submit entries to blockchain nodes to enact activity on the blockchain. As an example, clients may be applications that act on behalf of a requester, such as a device, person or entity to propose entries for the blockchain. The plurality of blockchain peers (e.g., blockchain nodes) may maintain a state of the blockchain network and a copy of the distributed ledger. Different types of blockchain nodes/peers may be present in the blockchain network including endorsing peers, which simulate and endorse entries proposed by clients and committing peers which verify endorsements, validate entries, and commit entries to the distributed ledger. In this example, the blockchain nodes may perform the role of endorser node, committer node, or both.

The instant system includes a blockchain that stores immutable, sequenced records in blocks, and a state database (current world state) maintaining a current state of the blockchain. One distributed ledger may exist per channel and each peer maintains its own copy of the distributed ledger for each channel of which they are a member. The instant blockchain is an entry log, structured as hash-linked blocks where each block contains a sequence of N entries. Blocks may include various components such as those shown in FIG. 6D. The linking of the blocks may be generated by adding a hash of a prior block's header within a block header of a current block. In this way, all entries on the blockchain are sequenced and cryptographically linked together preventing tampering with blockchain data without breaking the hash links. Furthermore, because of the links, the latest block in the blockchain represents every entry that has come before it. The instant blockchain may be stored on a peer file system (local or attached storage), which supports an append-only blockchain workload.

The current state of the blockchain and the distributed ledger may be stored in the state database. Here, the current state data represents the latest values for all keys ever included in the chain entry log of the blockchain. Smart contract executable code invocations execute entries against the current state in the state database. To make these smart contract executable code interactions extremely efficient, the latest values of all keys are stored in the state database. The state database may include an indexed view into the entry log of the blockchain, it can therefore be regenerated from the chain at any time. The state database may automatically get recovered (or generated if needed) upon peer startup, before entries are accepted.

Endorsing nodes receive entries from clients and endorse the entry based on simulated results. Endorsing nodes hold smart contracts, which simulate the entry proposals. When an endorsing node endorses an entry, the endorsing nodes creates an entry endorsement, which is a signed response from the endorsing node to the client application indicating the endorsement of the simulated entry. The method of endorsing an entry depends on an endorsement policy that may be specified within smart contract executable code. An example of an endorsement policy is “the majority of endorsing peers must endorse the entry.” Different channels may have different endorsement policies. Endorsed entries are forward by the client application to an ordering service.

The ordering service accepts endorsed entries, orders them into a block, and delivers the blocks to the committing peers. For example, the ordering service may initiate a new block when a threshold of entries has been reached, a timer times out, or another condition. In this example, blockchain node is a committing peer that has received a data block **682A** for storage on the blockchain. The ordering service may be made up of a cluster of orderers. The ordering service does not process entries, smart contracts, or maintain the shared ledger. Rather, the ordering service may accept the endorsed entries and specifies the order in which those entries are committed to the distributed ledger. The architecture of the blockchain network may be designed such that the specific implementation of ‘ordering’ (e.g., Solo, Kafka, BFT, etc.) becomes a pluggable component.

Entries are written to the distributed ledger in a consistent order. The order of entries is established to ensure that the updates to the state database are valid when they are committed to the network. Unlike a cryptocurrency blockchain system (e.g., Bitcoin, etc.) where ordering occurs through the solving of a cryptographic puzzle, or mining, in this example the parties of the distributed ledger may choose the ordering mechanism that best suits that network.

Referring to FIG. 6D, a block **682A** (also referred to as a data block) that is stored on the blockchain and/or the distributed ledger may include multiple data segments such as a block header **684A** to **684n**, transaction-specific data **686A** to **686n**, and block metadata **688A** to **688n**. It should be appreciated that the various depicted blocks and their contents, such as block **682A** and its contents are merely for purposes of an example and are not meant to limit the scope of the example embodiments. In some cases, both the block header **684A** and the block metadata **688A** may be smaller than the transaction-specific data **686A**, which stores entry data; however, this is not a requirement. The block **682A** may store transactional information of N entries (e.g., **100**, **500**, **1000**, **2000**, **3000**, etc.) within the block data **690A** to **690n**. The block **682A** may also include a link to a previous block (e.g., on the blockchain) within the block header **684A**. In particular, the block header **684A** may include a hash of a previous block’s header. The block header **684A** may also include a unique block number, a hash of the block data **690A** of the current block **682A**, and the like. The block number of the block **682A** may be unique and assigned in an incremental/sequential order starting from zero. The first block in the blockchain may be referred to as a genesis block, which includes information about the blockchain, its members, the data stored therein, etc.

The block data **690A** may store entry information of each entry that is recorded within the block. For example, the entry data may include one or more of a type of the entry, a version, a timestamp, a channel ID of the distributed ledger, an entry ID, an epoch, a payload visibility, a smart contract executable code path (deploy tx), a smart contract execut-

able code name, a smart contract executable code version, input (smart contract executable code and functions), a client (creator) identify such as a public key and certificate, a signature of the client, identities of endorsers, endorser signatures, a proposal hash, smart contract executable code events, response status, namespace, a read set (list of key and version read by the entry, etc.), a write set (list of key and value, etc.), a start key, an end key, a list of keys, a Merkel tree query summary, and the like. The entry data may be stored for each of the N entries.

In some embodiments, the block data **690A** may also store transaction-specific data **686A**, which adds additional information to the hash-linked chain of blocks in the blockchain. Accordingly, the data **686A** can be stored in an immutable log of blocks on the distributed ledger. Some of the benefits of storing such data **686A** are reflected in the various embodiments disclosed and depicted herein. The block metadata **688A** may store multiple fields of metadata (e.g., as a byte array, etc.). Metadata fields may include signature on block creation, a reference to a last configuration block, an entry filter identifying valid and invalid entries within the block, last offset persisted of an ordering service that ordered the block, and the like. The signature, the last configuration block, and the orderer metadata may be added by the ordering service. Meanwhile, a committer of the block (such as a blockchain node) may add validity/invalidity information based on an endorsement policy, verification of read/write sets, and the like. The entry filter may include a byte array of a size equal to the number of entries in the block data **610A** and a validation code identifying whether an entry was valid/invalid.

The other blocks **682B** to **682n** in the blockchain also have headers, files, and values. However, unlike the first block **682A**, each of the headers **684A** to **684n** in the other blocks includes the hash value of an immediately preceding block. The hash value of the immediately preceding block may be just the hash of the header of the previous block or may be the hash value of the entire previous block. By including the hash value of a preceding block in each of the remaining blocks, a trace can be performed from the Nth block back to the genesis block (and the associated original file) on a block-by-block basis, as indicated by arrows **692**, to establish an auditable and immutable chain-of-custody.

The above embodiments may be implemented in hardware, in a computer program executed by a processor, in firmware, or in a combination of the above. A computer program may be embodied on a computer readable medium, such as a storage medium. For example, a computer program may reside in random access memory (“RAM”), flash memory, read-only memory (“ROM”), erasable programmable read-only memory (“EPROM”), electrically erasable programmable read-only memory (“EEPROM”), registers, hard disk, a removable disk, a compact disk read-only memory (“CD-ROM”), or any other form of storage medium known in the art.

An exemplary storage medium may be coupled to the processor such that the processor may read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an application-specific integrated circuit (“ASIC”). In the alternative, the processor and the storage medium may reside as discrete components. For example, FIG. 7 illustrates an example computer system architecture **700**, which may represent or be integrated in any of the above-described components, etc.

FIG. 7 is not intended to suggest any limitation as to the scope of use or functionality of embodiments of the application described herein. Regardless, the computing node 700 is capable of being implemented and/or performing any of the functionality set forth hereinabove.

In computing node 700 there is a computer system/server 702, which is operational with numerous other general purpose or special purpose computing system environments or configurations. Examples of well-known computing systems, environments, and/or configurations that may be suitable for use with computer system/server 702 include, but are not limited to, personal computer systems, server computer systems, thin clients, thick clients, hand-held or laptop devices, multiprocessor systems, microprocessor-based systems, set-top boxes, programmable consumer electronics, network PCs, minicomputer systems, mainframe computer systems, and distributed cloud computing environments that include any of the above systems or devices, and the like.

Computer system/server 702 may be described in the general context of computer system-executable instructions, such as program modules, being executed by a computer system. Generally, program modules may include routines, programs, objects, components, logic, data structures, and so on that perform particular tasks or implement particular abstract data types. Computer system/server 702 may be practiced in distributed cloud computing environments where tasks are performed by remote processing devices that are linked through a communications network. In a distributed cloud computing environment, program modules may be located in both local and remote computer system storage media including memory storage devices.

As shown in FIG. 7, computer system/server 702 in cloud computing node 700 is shown in the form of a general-purpose computing device. The components of computer system/server 702 may include, but are not limited to, one or more processors or processing units 704, a system memory 706, and a bus that couples various system components including system memory 706 to processor 704.

The bus represents one or more of any of several types of bus structures, including a memory bus or memory controller, a peripheral bus, an accelerated graphics port, and a processor or local bus using any of a variety of bus architectures. By way of example, and not limitation, such architectures include Industry Standard Architecture (ISA) bus, Micro Channel Architecture (MCA) bus, Enhanced ISA (EISA) bus, Video Electronics Standards Association (VESA) local bus, and Peripheral Component Interconnects (PCI) bus.

Computer system/server 702 typically includes a variety of computer system readable media. Such media may be any available media that is accessible by computer system/server 702, and it includes both volatile and non-volatile media, removable and non-removable media. System memory 706, in one example, implements the flow diagrams of the other figures. The system memory 706 can include computer system readable media in the form of volatile memory, such as random-access memory (RAM) 708 and/or cache memory 710. Computer system/server 702 may further include other removable/non-removable, volatile/non-volatile computer system storage media. By way of example only, memory 706 can be provided for reading from and writing to a non-removable, non-volatile magnetic media (not shown and typically called a "hard drive"). Although not shown, a magnetic disk drive for reading from and writing to a removable, non-volatile magnetic disk (e.g., a "floppy disk"), and an optical disk drive for reading from or writing to a removable, non-volatile optical disk such as a

CD-ROM, DVD-ROM or other optical media can be provided. In such instances, each can be connected to the bus by one or more data media interfaces. As will be further depicted and described below, memory 706 may include at least one program product having a set (e.g., at least one) of program modules that are configured to carry out the functions of various embodiments of the application.

Program/utility, having a set (at least one) of program modules, may be stored in memory 706 by way of example, and not limitation, as well as an operating system, one or more application programs, other program modules, and program data. Each of the operating system, one or more application programs, other program modules, and program data or some combination thereof, may include an implementation of a networking environment. Program modules generally carry out the functions and/or methodologies of various embodiments of the application as described herein.

As will be appreciated by one skilled in the art, aspects of the present application may be embodied as a system, method, or computer program product. Accordingly, aspects of the present application may take the form of an entirely hardware embodiment, an entirely software embodiment (including firmware, resident software, micro-code, etc.) or an embodiment combining software and hardware aspects that may all generally be referred to herein as a "circuit," "module" or "system." Furthermore, aspects of the present application may take the form of a computer program product embodied in one or more computer readable medium(s) having computer readable program code embodied thereon.

Computer system/server 702 may also communicate with one or more external devices via an I/O device 712 (such as an I/O adapter), which may include a keyboard, a pointing device, a display, a voice recognition module, etc., one or more devices that enable a user to interact with computer system/server 702, and/or any devices (e.g., network card, modem, etc.) that enable computer system/server 702 to communicate with one or more other computing devices. Such communication can occur via I/O interfaces of the device 712. Still yet, computer system/server 702 can communicate with one or more networks such as a local area network (LAN), a general wide area network (WAN), and/or a public network (e.g., the Internet) via a network adapter. As depicted, device 712 communicates with the other components of computer system/server 702 via a bus. It should be understood that although not shown, other hardware and/or software components could be used in conjunction with computer system/server 702. Examples, include, but are not limited to: microcode, device drivers, redundant processing units, external disk drive arrays, RAID systems, tape drives, and data archival storage systems, etc.

Although an exemplary embodiment of at least one of a system, method, and non-transitory computer readable medium has been illustrated in the accompanied drawings and described in the foregoing detailed description, it will be understood that the application is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications, and substitutions as set forth and defined by the following claims. For example, the capabilities of the system of the various figures can be performed by one or more of the modules or components described herein or in a distributed architecture and may include a transmitter, receiver or pair of both. For example, all or part of the functionality performed by the individual modules, may be performed by one or more of these modules. Further, the functionality described herein may be performed at various times and in relation to various events, internal or external

to the modules or components. Also, the information sent between various modules can be sent between the modules via at least one of: a data network, the Internet, a voice network, an Internet Protocol network, a wireless device, a wired device and/or via plurality of protocols. Also, the messages sent or received by any of the modules may be sent or received directly and/or via one or more of the other modules.

One skilled in the art will appreciate that a “system” could be embodied as a personal computer, a server, a console, a personal digital assistant (PDA), a cell phone, a tablet computing device, a smartphone or any other suitable computing device, or combination of devices. Presenting the above-described functions as being performed by a “system” is not intended to limit the scope of the present application in any way but is intended to provide one example of many embodiments. Indeed, methods, systems and apparatuses disclosed herein may be implemented in localized and distributed forms consistent with computing technology.

It should be noted that some of the system features described in this specification have been presented as modules to more particularly emphasize their implementation independence. For example, a module may be implemented as a hardware circuit comprising custom very-large-scale integration (VLSI) circuits or gate arrays, off-the-shelf semiconductors such as logic chips, transistors, or other discrete components. A module may also be implemented in programmable hardware devices such as field-programmable gate arrays, programmable array logic, programmable logic devices, graphics processing units, or the like.

A module may also be at least partially implemented in software for execution by various types of processors. An identified unit of executable code may, for instance, comprise one or more physical or logical blocks of computer instructions that may, for instance, be organized as an object, procedure, or function. Nevertheless, the executables of an identified module need not be physically located together but may comprise disparate instructions stored in different locations that, when joined logically together, comprise the module and achieve the stated purpose for the module. Further, modules may be stored on a computer-readable medium, which may be, for instance, a hard disk drive, flash device, random access memory (RAM), tape, or any other such medium used to store data.

Indeed, a module of executable code could be a single instruction, or many instructions, and may even be distributed over several different code segments, among different programs, and across several memory devices. Similarly, operational data may be identified and illustrated herein within modules and may be embodied in any suitable form and organized within any suitable type of data structure. The operational data may be collected as a single data set or may be distributed over different locations, including over different storage devices, and may exist, at least partially, merely as electronic signals on a system or network.

It will be readily understood that the components of the application, as generally described and illustrated in the figures herein, may be arranged and designed in a wide variety of different configurations. Thus, the detailed description of the embodiments is not intended to limit the scope of the application as claimed but is merely representative of selected embodiments of the application.

One having ordinary skill in the art will readily understand that the above may be practiced with steps in a different order and/or with hardware elements in configurations that are different from those which are disclosed. Therefore, although the application has been described

based upon these preferred embodiments, it would be apparent to those of skill in the art that certain modifications, variations, and alternative constructions would be apparent.

While preferred embodiments of the present application have been described, it is to be understood that the embodiments described are illustrative only and the scope of the application is to be defined solely by the appended claims when considered with a full range of equivalents and modifications (e.g., protocols, hardware devices, software platforms etc.) thereto.

What is claimed is:

1. A method, comprising:

determining a vehicle in a group of vehicles that has an unobstructed view of an area ahead of the group; collecting data from sensors on the vehicle; sending the data to one or more other vehicles in the group of vehicles; and

providing the unobstructed view of the area ahead of the group on a display of the one or more other vehicles, wherein sensor data from each vehicle of the group of vehicles is collected, wherein sensor data that includes an obstructed view of the area is eliminated.

2. The method of claim 1, wherein collecting data from sensors on the vehicle comprises:

requesting sensor data from the vehicle for unobstructed views of the area; and

receiving sensor data from the vehicle and one or more occupant devices associated with the vehicle for the unobstructed views.

3. The method of claim 1, wherein sending the data to one or more other vehicles in the group of vehicles comprises:

identifying the one or more other vehicles in the group that are behind the vehicle and proximate the vehicle; and

transferring portions of the collected data to the identified one or more other vehicles, wherein the portions comprise areas of the unobstructed view that are obstructed for respective one for the identified one or more other vehicles.

4. The method of claim 1, wherein providing the unobstructed view of the area ahead of the group comprises:

receiving the collected data; selecting an unobstructed view from the collected data; and

sending the unobstructed view by one of the one or more other vehicles to another of the one or more other vehicles.

5. The method of claim 1, comprising:

determining the group of vehicles are related; and notifying the one or more other vehicles to proceed to a destination after receiving the unobstructed view of the area ahead.

6. The method of claim 1, comprising:

receiving one or more unobstructed views from the vehicle and the one or more other vehicles; and merging the one or more unobstructed views into a panoramic view.

7. A system, comprising:

a processor; and

a memory, coupled to the processor, comprising instructions that when executed by the processor are configured to:

determine a vehicle in a group of vehicles that has an unobstructed view of an area ahead of the group;

49

collect data from sensors on the vehicle;  
 send the data to one or more other vehicles in the group  
 of vehicles; and  
 provide the unobstructed view of the area ahead of the  
 group on a display of the one or more other vehicles,  
 wherein sensor data from each vehicle of the group of  
 vehicles is collected,  
 wherein sensor data that includes an obstructed view of  
 the area is eliminated.

8. The system of claim 7, wherein the processor collects  
 data from sensors on the vehicle comprises the instructions  
 are configured to:  
 request sensor data from the vehicle for unobstructed  
 views of the area; and  
 receive sensor data from the vehicle and one or more  
 occupant devices associated with the vehicle for the  
 unobstructed views.

9. The system of claim 7, wherein the processor sends the  
 data to one or more other vehicles in the group of vehicles  
 comprises the instructions are configured to:  
 identify the one or more other vehicles in the group that  
 are behind the vehicle and proximate the vehicle; and  
 transfer portions of the collected data to the identified one  
 or more other vehicles, wherein the portions comprise  
 areas of the unobstructed view that are obstructed for  
 respective one for the identified one or more other  
 vehicles.

10. The system of claim 7, wherein the processor provides  
 the unobstructed view of the area ahead of the group  
 comprises the instructions are configured to:  
 receive the collected data;  
 select an unobstructed view from the collected data; and  
 send the unobstructed view by one of the one or more  
 other vehicles to another of the one or more other  
 vehicles.

11. The system of claim 7, wherein the instructions are  
 configured to:  
 determine the group of vehicles are related; and  
 notify the one or more other vehicles to proceed to a  
 destination after the one or more other vehicles receive  
 the unobstructed view of the area ahead.

12. The system of claim 7, wherein the instructions are  
 configured to:  
 receive one or more unobstructed views from the vehicle  
 and the one or more other vehicles; and  
 merge the one or more unobstructed views into a pan-  
 oramic view.

13. A non-transitory computer readable storage medium  
 comprising instructions, that when read by a processor,  
 cause the processor to perform:

50

determining a vehicle in a group of vehicles that has an  
 unobstructed view of an area ahead of the group;  
 collecting data from sensors on the vehicle;  
 sending the data to one or more other vehicles in the group  
 of vehicles; and  
 providing the unobstructed view of the area ahead of the  
 group on a display of the one or more other vehicles,  
 wherein sensor data from each vehicle of the group of  
 vehicles is collected,  
 wherein sensor data that includes an obstructed view of  
 the area is eliminated.

14. The non-transitory computer readable storage medium  
 of claim 13, wherein collecting data from sensors on the  
 vehicle comprises the instructions cause the processor to  
 perform:  
 requesting sensor data from the vehicle for unobstructed  
 views of the area; and  
 receiving sensor data from the vehicle and one or more  
 occupant devices associated with the vehicle for the  
 unobstructed views.

15. The non-transitory computer readable storage medium  
 of claim 13, wherein sending the data to one or more other  
 vehicles in the group of vehicles comprises the instructions  
 cause the processor to perform:  
 identifying the one or more other vehicles in the group  
 that are behind the vehicle and proximate the vehicle;  
 and  
 transferring portions of the collected data to the identified  
 one or more other vehicles, wherein the portions com-  
 prise areas of the unobstructed view that are obstructed  
 for respective one for the identified one or more other  
 vehicles.

16. The non-transitory computer readable storage medium  
 of claim 13, wherein providing the unobstructed view of the  
 area ahead of the group comprises the instructions cause the  
 processor to perform:  
 receiving the collected data;  
 selecting an unobstructed view from the collected data;  
 and  
 sending the unobstructed view by one of the one or more  
 other vehicles to another of the one or more other  
 vehicles.

17. The non-transitory computer readable storage medium  
 of claim 13, wherein the instructions cause the processor to  
 perform:  
 determining the group of vehicles are related; and  
 notifying the one or more other vehicles to proceed to a  
 destination after receiving the unobstructed view of the  
 area ahead.

\* \* \* \* \*