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- (71) **Applicant:** TRIMBLE NAVIGATION LIMITED
[US/US]; 935 Stewart Drive, Sunnyvale, CA 94085 (US).
- (72) **Inventor:** BOTTICELLI, Mark, Philip; 32 Bridle Ridge Drive, North Grafton, MA 01536 (US).
- (74) **Agent:** ASHLEY, William, B.; Hollingsworth Davis, LLC, 8000 W. 78th Street, Suite 450, Minneapolis, MN 55439 (US).
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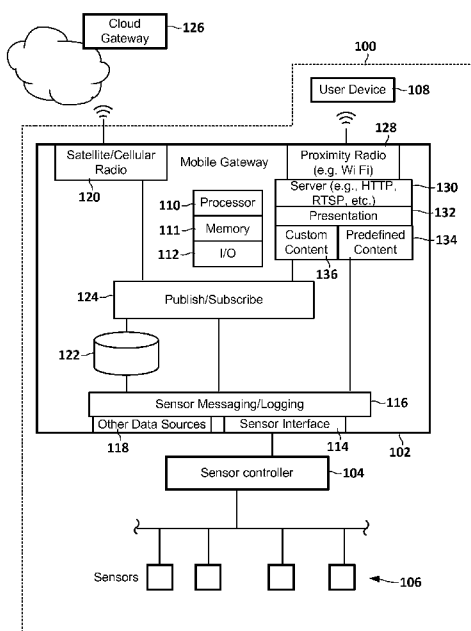


FIG. 1

- (57) **Abstract:** A new sensor is detected being added to a vehicle sensor bus. A publication topic is created based on the new sensor. The publication topic is made available via at least to a server component operating via the proximity networking radio. Data from the new sensor is added to the publication topic. In response to a subscription to the publication topic via a user device, the data is dynamically presented to the user device via the server component.

DYNAMICALLY PRESENTING VEHICLE SENSOR DATA VIA MOBILE GATEWAY PROXIMITY NETWORK

SUMMARY

[0001] The present disclosure is related to vehicle data systems. In one embodiment, method, systems, apparatuses, and a computer-readable medium facilitate detecting a new sensor added to a vehicle sensor bus. A publication topic is created based on the new sensor. The publication topic is made available via at least to a server component operating via the proximity networking radio. Data from the new sensor is added to the publication topic. In response to a subscription to the publication topic via a user device, the data is dynamically presented to the user device via the server component.

[0002] These and other features and aspects of various embodiments may be understood in view of the following detailed discussion and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] In the following diagrams, the same reference numbers may be used to identify similar/same components in multiple figures. The drawings are not necessarily to scale.

[0004] FIG. 1 is a block diagram of an in-vehicle system according to an example embodiment;

[0005] FIGS. 2-5 are user interface diagrams illustrating presentation of data to a user device according to example embodiments;

[0006] FIGS. 6-7 are sequence diagrams illustrating operation of an in-vehicle system according to example embodiments; and

[0007] FIG. 8 is a flowchart illustrating a method according to an example embodiment.

DETAILED DESCRIPTION

[0008] In general, the disclosure is directed to techniques for utilizing vehicle data. Such data, which may include any data generated by onboard sensors, may be used to manage operation of private or commercial vehicles. In some systems, motor vehicles are equipped with communication devices that communicate data to a data center

or other central office system. While the vehicles and/or drivers need not have any association with one another, the vehicles may be part of one or more fleets of vehicles, such as in the trucking industry. The central office may serve as a fleet management system (FMS) in which the trucks or other vehicles communicate, regardless of which fleet, if any, they may be associated with.

[0009] The solutions presented herein utilize the data gathered by vehicle sensor systems to provide information to the driver and other occupants of the vehicle. While some systems currently provide this ability, the systems are often specially built for particular purposes. For example, some in-vehicle fleet management systems provide in-cab display and controller units that interface with a particular controller/gateway unit that gathers the data. While these in-cab units can be built to a given specification, the cost can be significant. Further, such devices may need reconfiguration (e.g., new firmware) to handle new functionality provided by the controller/gateway unit and/or new sensors.

[0010] In embodiments described herein, a mobile gateway unit provides a wireless access point (e.g., Wi-Fi hotspot) and a server that provides sensor and other data via a network server. This server runs locally on the vehicle, and may utilize a known data access protocol, such as Hypertext Transport Protocol (HTTP). In this way, a commodity user device such as smartphone or tablet can be used to access the vehicle data and other fleet management-type data. This can reduce costs and leverage the development and improvements in general-purpose consumer and/or commercial mobile devices. For example, features such as voice recognition, biometric authentication, multiple applications and protocol compatibility, are available “out-of-the-box” with modern mobile devices, and these features can be useful for in-cab applications.

[0011] In reference now to FIG. 1, a block diagram illustrates an in-vehicle system according to an example embodiment. The confines of a vehicle are generally indicated by dashed line 100, which encompasses a mobile gateway 102, a sensor controller 104, sensors 106, and a user device 108. The mobile gateway 102 serves generally as a data collection and disbursement device, and may include special- or general-purpose computing hardware, as indicated by processor 110, memory 111, and input/output (I/O) circuitry 112. The mobile gateway 102 also includes a sensor interface 114 that may be coupled to external data gathering components such as sensor controller 104. The sensor interface 114 may include data transfer interfaces such as serial port (e.g., RS-232, RS-422, etc.), Ethernet, Universal Serial Bus (USB), etc.

[0012] The sensor controller 104 in this example may be configured to read data from vehicle type busses, such as Controller Area Network (CAN). Generally, CAN is a message-based protocol that couples nodes to a common data bus. The nodes utilize bit-wise arbitration to determine which node has priority to transmit onto the bus. The leading bits of the message determine which messages will win arbitration, and so relative ranking of message priorities is set by assigning message IDs that populate these leading bits. The embodiments need not be limited to CAN busses; the sensor controller 104 (or other sensor controllers) can be used to read data from other types sensor coupling standards, such as power-line communication, IP networking (e.g., Universal Plug and Play), I²C bus, Serial Peripheral Interface (SPI) bus, vehicle computer interface, etc. While the sensor controller 104 is shown as external to the mobile gateway 102, it may be incorporated within the mobile gateway 102, e.g., integrated with main board and/or as an expansion board/module.

[0013] The sensor controller 104 may act as a pass-through that detects and assembles messages, and queues them for transmission to the sensor interface 114. The sensor controller 104 may include additional capabilities such as determining a type of data encoded in the message, formatting the message data, and adding additional data (e.g., metadata, tags) that facilitate easily interpreting the message data. The sensor controller 104 may also have the ability to detect sensors being added or removed from the existing set of sensors 106. This can dynamically affect the types and amounts of data being transferred to the mobile gateway 102 via the sensor interface 114.

[0014] The mobile gateway 102 includes a sensor/messaging logging component 116 that receives sensor data via the sensor interface 114. The messaging logging component 116 processes various streams of data from the sensor interface 114 (which may include multiple interfaces) and other data sources 118. The other data sources 118 may include data generated/measured by the mobile gateway 102 itself, and the user device 108, and wireless networks, as indicated by satellite/cellular radio module 120. The messaging/logging component 116 at least classifies the messages and stores the message data in a persistent data store 122. The data store 122 may include a hard drive or flash memory, and the messaging/logging component 116 may process the messages (e.g., compression, discarding of old data) to ensure the data store 122 doesn't become full.

[0015] The messaging/logging component 116 may attempt to categorize the data received via the sources and store it appropriately in the data store 122. For

example, the data store 122 may include a relational database that stores numeric or text data, and one table of the database may have columns such as `TIMESTAMP`, `DATA_TYPE` and `DATA`, where `DATA_TYPE` is an enumerated type (e.g., temperature, geolocation, percentage, etc.). However, the `DATA_TYPE` column may be redundant for large data sets, and instead a different table may be formed for each type of data. Other types of data, such as images, audio, video, may use other storage conventions.

[0016] Generally, the messaging/logging component 116 may only need to interpret the incoming data so that it can be efficiently stored, and other components, such as the publish/subscribe component 124, may perform additional interpretations/transformations and/or create more sophisticated representations and categorizations of the data. An example of the former is converting temperature readings from a variety of sensors to a common format, e.g., degrees C. An example of the latter is using sensors that detect fuel flow and speed to derive fuel consumption, both instantaneous consumption and a running average. The running average fuel consumption can be combined with a fuel level sensor to derive a range in miles until fuel is empty. These derived values can also be stored in the data store 122 and/or dynamically calculated as needed.

[0017] Besides categorizing data, the publish/subscribe component 124 implements a pattern that is useful for providing customized views of data. In a publish/subscribe model, publishers of messages do not program the messages to be sent directly to subscribers. Instead, published messages are characterized into topics (or named logical channels), without knowledge of what, if any, subscribers there may be. Similarly, subscribers express interest in one or more topics, and only receive messages that are of interest, without knowledge of what, if any, publishers there are.

[0018] In the present example, the publish/subscribe component 124 categorizes the vehicle data into appropriate topics, such as telemetry data (e.g., geolocation, speed, altitude, direction.), engine data (e.g., coolant temperature, generator voltage, airflow, engine speed), cargo data (e.g., temperature, vibration), etc. The list of topics may expand or contract based on sensors detected via the sensor controller 104. For example, if a rear-view camera is added, the feed (either static images or video) can be added to one or more topics, such as telemetry data, and/or have its own topic created, e.g., “on-board video.” Subscribers in a topic-based system may receive some or all messages published to the topics to which they subscribe, and all subscribers to a topic

may receive the same messages. Customizations may be used (e.g., filters) that allow blocking certain messages on a particular topic. The publisher defines the classes of messages to which subscribers can subscribe, and associate those messages with the various topics as appropriate. Thereafter, a mechanism such as HTTP, syndication feed, email, etc., may be used to send out the messages. This results in dynamic presentation of the sensor data, e.g., a time varying view of data that may be in real-time or near-real time.

[0019] The publish/subscribe component 124 may be part of a wider publish/subscribe system of a fleet management system. For example, a cloud gateway 126 is an infrastructure service that subscribes to a set of messages from the mobile gateway 102. These messages are stored and may be further processed by the cloud gateway. Other subscribers such as fleet management services, customers, and third parties, and subscribe to the messages via a publish/subscribe service of the cloud gateway 126. The cloud gateway 126 may aggregate similar messages from a large number of vehicles, providing an overall picture of fleet activity, for example.

[0020] The publish/subscribe component 124 of the individual mobile gateways 102 assists in easily implementing features of the cloud gateway 126. For example, the publish/subscribe component 124, either automatically or with minimal configuration, can handle new types of sensor data (or new transformations and combinations of existing sensor data) by adding a new topic. The cloud gateway 126 can add this to its subscription from the mobile gateway 102 using well-establish subscription protocols, and similarly publish the information to other entities.

[0021] As noted above, the user device 108 may be able to provide user data as inputs to the sensor messaging/logging component 116. In particular, the user device 108 may have applications installed that include publish/subscribe functionality similar to the mobile gateway 102. For example, the user device 108 may be able to authenticate the driver and thereby assign the driver's identity to the vehicle. The user device 108 may include a log book application for recording hours of driving and resting. This data may be able to be published to the mobile gateway 102 and accessed elsewhere, e.g., to ensure the driver is compliant with regulations. In another case, the user device 108 may use a camera of the user device 108 to record cargo identifiers (e.g., barcodes), take pictures of the loaded cargo (e.g., for insurance purposes), and perform other actions related to the transport of cargo. This information can also be useful to fleet managers and others. Similarly, other applications such as vehicle maintenance records/requests,

checklists, bill of lading, etc., can gather data that is useful both to the driver and to FMS services.

[0022] Besides providing data sources, the publish/subscribe model also allows for flexible and extendable views of the data to vehicle occupants via the user device 108. The mobile gateway 102 includes a readily-available proximity radio 128 that may use standards such as Wi-Fi™ or Bluetooth™. The proximity radio 128 may provide general-purpose Internet access to the user device 108, e.g., by routing data packets via the wireless network used to communicate with the cloud gateway 126. A server component 130 provides local content (e.g., content produced within the mobile gateway 102) to the user device 108 over the proximity radio 128 via well-known protocols, such as HTTP, HTTPS, Real-Time Streaming Protocol (RTSP), File Transfer Protocol (FTP), Simple Mail Transfer Protocol (SMTP), etc. A commercially available application such as a browser or media player running on the user device 108 can utilize the services of the server component 130 without any customization of the user device 108.

[0023] The service component 130 may also be used without a high-level of customization. For example, if the service component 130 provides HTTP/HTTPS services, a widely available server such as Apache can be used. Such a server can be made secure and is frequently updated with fixes and features. The service component 130 can take advantage of a special-purpose presentation component 132 that provides functionality tailored for presenting data from the mobile gateway 102 to the user device 108. The presentation component 132 may utilize existing application technologies that extend the functionality of the server component 130. For example, technologies such as Common Gateway Interface (CGI), Java™ Enterprise Edition and Active Server Pages (ASP) allow dynamically generated content to be provided via HTTP and utilized in browsers.

[0024] The presentation component 132 provides services generally of interest to the occupants of the vehicle 100, which may include driver and/or passengers. Data such as engine status (e.g., temperature, speed, miles traveled) are already commonly including in instrument panels viewable by the driver. Other data, such as video from aftermarket cameras, can be viewed using customized displays. Other data may be provided from a fleet manager, such as messaging (e.g., dispatch, company notices, alerts), etc. Because the needs of fleets and other commercial entities may be highly-specialized,

additional data may be useful to the occupant, and this kind of flexibility can be provided via the presentation component 132.

[0025] Generally, the presentation component 132 provides a framework for visualizing data for presentation via the server component 130, as well as managing possibly changing data sources detected via the mobile gateway 102, such as via the sensor messaging/logging component 116. The available data sources are generally divided for purposes of discussion into predefined content 134 and custom content 136. The predefined content 134 may include content that is commonly available on vehicles, such as engine data, speed, direction, location, etc. The predefined content 134 may be made available using relatively static templates, such that the server can present useful default content without significant effort on behalf of the user.

[0026] The custom content 136 facilitates using content that is user specific, and may be defined by the user and/or fleet management systems after the system has been fielded. For example, if a type of sensor not normally associated with fleet management, e.g., a pH sensor, is coupled to the sensor controller 104, the sensor controller 104 may be able to read the messages from the sensor which can be sent to the sensor messaging/logging component 116. Even if the sensor messaging/logging component 116 or sensor controller 104 have not dealt with this type of sensor, they may be able to determine from a local or remote database that this sensor is TYPE_PH, and can create a database table (or other structure) for storing the sensor data in the data store. Or, if the type cannot be determined, a generic type may be used, e.g., TYPE_UNKNOWN_1. The sensor messaging/logging component 116 may convert the data to a recognizable format (e.g., floating point number or string) or store the binary representation as read by the sensor.

[0027] The publish/subscribe component 124 can be configured to automatically detect new sensor tables added to the data store, and can create a new topic, e.g., pH sensor or unknown sensor 1, which is published and available for subscription, either locally or remotely. In this case, the fleet management system and/or operator would already understand the reasons and uses for the pH sensor, and can subscribe to the new topic as part of creating the custom content 136. Another aspect of the custom content 136 is the ability to create new user interfaces, and the fleet management system and/or operator can further define user interface elements that provide the desired presentation of the pH data.

[0028] An example of how a mobile gateway may present data to a browser 200 of user device is shown in FIGS. 2-5. In FIG. 2, the browser 200 shows a portal screen, which may be displayed after establishing a connection to a gateway-integrated wireless network hotspot or other proximity connection. The portal page may include authentication controls 202 that verify credentials in order to access the data. Other means of authentication may be used, including a hardware key (e.g., RFID card) and biometrics (e.g., voice, face, fingerprint). One advantage of using a widely available user device is that a variety of authentication means may be already built in and verified on particular devices.

[0029] Content view controls 204 provide access to various types of content from the mobile gateway. The non-exhaustive categories shown include published Topics, Sensors, general-purpose Internet Access, customizable views (“My Views”), and Gateway Setup. Links to these categories may also be seen in the footer of the pages shown in FIGS. 2-5. The Topics categories represents published topics provided by a publish/subscribe component, such as component 124 shown in FIG. 1. The Topics may also include remotely published data, e.g., provided by the Cloud Gateway, that may originate from a centralized entity (e.g., fleet owner) and other vehicles. An example of a Topics view is shown in FIG. 3.

[0030] In FIG. 3, the browser 200 displays a hierarchical view of published topics. The first level 300 includes various broad categories such as Engine Data, Vehicle Data (e.g., non-engine sensors on the cab), Trailer Data (e.g., tires, brakes, refrigeration status), Trip Data (e.g., information about the current task, such as destination, origin, payee, tracking numbers, cargo), Route Data (e.g., navigation, traffic, weather), FMS Data (e.g., driver info, dispatch messages), and Other Data. The Vehicle Data control is shown as selected in FIG. 3, which presents a second hierarchal level of subtopics 302. One of the subtopics, Heading, is shown selected, and the heading data 304 is displayed, and can be dynamically updated. The units of display can be changed, as indicated by control 304.

[0031] The hierarchical view shown in FIG. 3 is just one example of how vehicle data may be displayed, and other view paradigms may be used. Generally, a hierarchical view allows for browsing through available data sets, and can be easily modified in response to addition and subtraction of sensors as described elsewhere herein. Similarly, the Sensor view, shown in FIG. 4, shows a hierarchical view based on busses

400 and individual sensors 402. The Sensor view may be more useful for uses such as troubleshooting technical problems. For example, in FIG. 4, the raw data from a wheel speed sensor (e.g., as used in anti-lock brake system) is shown. In contrast, the Topics view is more tailored toward end-users such as drivers and fleet managers. In either case, the views presented may be auto-generated based on data sets that are automatically detected, collected, and logged by the mobile gateway.

[0032] In FIG. 5, a user-customizable view is shown in the browser 200. The mobile gateway may include a tool that allows selecting various data sources (e.g., via the screens shown in FIGS. 3 and 4), associating the data source with a graphical element (e.g., VU-meter, bar meter, indicator light, digital readout, bar graph, pie chart, line graph, etc.). The user can arrange the graphical elements according to their own preferences, and create different view for different purposes (e.g., safety, dispatch, trip progress, traffic, weather, etc.). The illustrated view includes two air brake pressure meters 501-502, an air compressor temperature bar meter 504, and tire status lights 506. The mobile gateway may allow the use to combine different data sources to achieve the desired results. For example, if the cab or trailer tires include an auto-inflation system, then the tire indicators could turn red or yellow if either the pressure is below a threshold or if the auto-inflation systems associated with a group of tires is not working.

[0033] Even if a custom view as shown in FIG. 5 is redundant to other indicators available to the driver, the ability to customize the view may be useful. Further, the views may be made available as templates and pushed out to mobile gateways via the cloud gateway. In this way, a commercial fleet may be able to create a custom view tailored for the fleet owning company, including company-specific data, logos, and functionality. Such views may also accept data inputs to facilitate specific business practices of the company. For example, express input of rest times and drive times by the driver into the user device may help lower insurance rates without unduly inconveniencing the drivers, thereby facilitating compliance. Other aspects, such as effective use of gears, fuel efficiency, etc. could be reported in real-time to the driver if such factors, e.g., affect employee reviews or pay. This may help the driver to both better understand the policies and improve aspects of performance that are of interest to the company.

[0034] It will be understood that the views shown in FIGS. 3-5 may be user customizable and/or be based on a template that is remotely sent to the mobile gateway. The latter approach facilitates maintaining a common set of views that have been found

useful or necessary, e.g., due to risk mitigation, regulation, etc. Such templates may take the form of a markup language content page with special tags that can be filled in by a server-side component at run time. For example, technologies such as PHP, Java Server Faces, Rails, etc., allow defining layout and appearance of content via template pages. The template pages include placeholders where dynamically generated content can be inserted, in this case text or images based on sensor data.

[0035] In FIG. 6, a sequence diagram shows an example of how a newly added sensor 602 can be detected and added to the available data provided by a mobile gateway 600. The sensor 602 is coupled to a sensor controller 604 that inputs data to a logger 606 of the mobile gateway 600. The logger 606 coordinates with a publication/subscription interface 608, which coordinates with a web server 610. A user device 612 interacts with the web server 610 as is known in the art. In this example, the sensor 602 sends an initial message 620 to the sensor controller 604, e.g., after system initialization. The message 620 may include data, but for purposes of this example only shows a unique, numeric identifier of the sensor 602.

[0036] The sensor controller 604 may perform a lookup 621 for every message it receives, as all the messages may come over the same channel of the sensor bus. In this case, this is the first time this message identifier is detected, and so the new identifier is signaled 622 to the logger 606. The logger 606 in this example performs its own lookup 623, e.g., via a local or remote database. Such databases may be available for certain classes of devices, such as CAN sensors, network devices, peripheral bus devices, etc. The data obtained may at least indicate the type of device (e.g., temperature sensor, pressure sensor, etc.) and may include other data, such as part number, manufacturer, revision number, etc.

[0037] In this example, the lookup 623 determines that the numeric identifier is for a hydraulic pressure sensor, and this more detailed information (e.g., in the form of text and/or other structured data) is added 624 to a local database. For example, a new table Hyd_Pr may be created as part of the addition 624, with columns such as timestamp and numeric data value. Other information, such as how to interpret binary sensor data may also be determined at this level, or such information may be determined upstream via publication/subscription interface 608.

[0038] The addition of the new sensor 602 by the logger 606 is also signaled 625 to the publication/subscription interface 608. This may cause the

publication/subscription interface 608 to perform its own lookup 626. In this example, the general hardware details (e.g., type of sensor detected) are managed by the logger 606, while application details (e.g., in which vehicle system the sensor 602 is used) may be determined by the publication/subscription interface 608. For example, the hydraulic sensor 602 may be used for a number of systems, such as brakes, power take-off, suspension leveling, etc. A fleet management system may have the knowledge of the particular context in which this sensor 602 is being used, and can push that data out to the publication/subscription interface 608.

[0039] Based on application-level information determined from the lookup 626, the publication/subscription interface 608 adds 626 a topic (or updates and existing topic) called “Hydraulics,” and adds 628 (or updates) a topic “Accumulator Pressure” under which the sensor data is published. Thereafter, when sensor data 629 is received, the sensor controller 604 performs another lookup 630. This lookup 630 determines this is a known sensor identifier, and so passes the data 631 to the logger 606. In this example, the logger 606 logs the data via a Structured Query Language (SQL) insert statement. Note that the sensor data value 0x072 is converted to base 10 value of 114 and multiplied by 10, which represents 1140 pounds per square inch. Also note that, while not shown, other data may be inserted with the sensor data, such as a timestamp. This other data may also include the numeric sensor identifier, should multiple equivalent sensors be used to populate the same table. The logger 606 may inform the publication/subscription interface 608 of each new insertion, or the publication/subscription interface 608 may perform its own polling of incoming data, e.g., based on a particular publication schedule.

[0040] In FIG. 7, another example sequence is shown that follows that of FIG. 6. The user device 612 requests 701 a list of published topics, e.g., via an HTTP GET. The result 702 is returned in the form of a tagged/structured document, e.g., Hypertext Markup Language (HTML), eXtensible Markup Language (XML), JavaScript Object Notation (JSON), etc. In response, e.g., to a user selection via the user device 612, an HTTP POST command 703 causes the browser session to subscribe to the previously created topic and sub-topic of the accumulator data. This has the effect of adding a subscriber to this data at the publication/subscription interface 608, and causing a content page 704 to be returned. An initial value of the pressure may first be looked up before returning the content page 704, although is not shown here.

[0041] Thereafter, the sensor 602, sensor controller 604, and logger 606 receive and log new data via actions 705-708. In this example, the newly added data is signaled 709 to the publication/subscription interface 608. As described above, the publication/subscription interface 608 may have other ways of detecting new data, e.g., polling, detecting inserts into the database, etc. In response to the signal 709, the publication/subscription interface 608 determines 710 all subscribers for the data, of which at least the user device 612 is found. The latest data is selected 711 (e.g., via SQL query, although the signal 709 may have all the needed data) and used to form an updated document 712 that is sent to the user device 612. Other, more efficient, mechanisms may be used to update the browser on the user device 612, such as Asynchronous JavaScript and XML (AJAX), which allows asynchronously updating the displayed sensor data without reloading the page.

[0042] In reference now to FIG. 8, a flowchart shows a method according to an example embodiment. The method involves detecting 800 a sensor added to a vehicle sensor bus. A check is made to determine 802 if the sensor is a new sensor (i.e., not previously used on the vehicle sensor bus). If so, a publication topic is created 803 based on the new sensor and the topic is made available via a server component. The method also involves adding 804 data from the new sensor to the appropriate publication. If a user device has subscribed 805 to the publication topic, the data from the new sensor is dynamically presented 806 to the user device via the server component.

[0043] The various embodiments described above may be implemented using circuitry and/or software modules that interact to provide particular results. One of skill in the computing arts can readily implement such described functionality, either at a modular level or as a whole, using knowledge generally known in the art. For example, the flowcharts or other diagrams presented herein may be used to create computer-readable instructions/code for execution by a processor. Such instructions may be stored on a non-transitory computer-readable medium and transferred to the processor for execution as is known in the art.

[0044] The foregoing description of the example embodiments has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the inventive concepts to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. Any or all features of the disclosed embodiments can be applied individually or in any combination and are

not meant to be limiting, but purely illustrative. It is intended that the scope be limited not with this detailed description, but rather determined by the claims appended hereto.

WHAT IS CLAIMED IS:

1. A mobile gateway comprising:
 - a sensor interface configured to communicate via a vehicle sensor bus;
 - a proximity networking radio; and
 - a processor coupled to the sensor interface and the proximity networking radio, the processor configured to:
 - detect a new sensor added to the vehicle sensor bus;
 - create a publication topic based on the new sensor, the publication topic made available via at least to a server component operating via the proximity networking radio;
 - add data from the new sensor to the publication topic; and
 - in response to a subscription to the publication topic via a user device, dynamically present the data to the user device via the server component.
2. The mobile gateway of claim 1, wherein the sensor bus comprises a controller area network bus.
3. The mobile gateway of claim 1, wherein the server component comprises an HTTP server.
4. The mobile gateway of claim 1, wherein the proximity network comprises one of a Wi-Fi network and a Bluetooth network.
5. The mobile gateway of claim 1, wherein the processor is further configured to:
 - determine a numerical identifier of the new sensor; and
 - based on the numerical identifier, determine at least a type of the new sensor.
6. The mobile gateway of claim 5, wherein the publication topic is based on the type of the new sensor.
7. The mobile gateway of claim 1, wherein the processor is further configured to:

- facilitate user selection of multiple topics via the user device and the server component; and
- dynamically present data from the multiple topics via the server component.
8. The mobile gateway of claim 7, wherein the processor is further configured to:
- facilitate assignment of graphical components to the multiple topics via the user device and the server component;
- facilitate arrangement of the graphical components into a view, wherein the data from the multiple topics is presented via the graphical components in the view.
9. The mobile gateway of claim 1, wherein the processor is further configured to:
- facilitate selection of multiple topics via a template transmitted to the mobile gateway; and
- dynamically present data from the multiple topics via the server component.
10. The mobile gateway of claim 9, wherein presenting data from the multiple topics comprises combining data from at least two topics.
11. The mobile gateway of claim 9, wherein the processor is further configured to:
- facilitate assignment of graphical components to the multiple topics via the template; and
- facilitate arrangement of the graphical components into a view, wherein the data from the multiple topics is presented via the graphical components in the view.
12. The mobile gateway of claim 1, wherein the processor is further configured to:
- receive a second subscription to the publication topic via a cloud gateway; and
- in response to the second subscription, dynamically send the data to the cloud gateway.
13. A method comprising:
- detecting a new sensor added to a vehicle sensor bus;
- creating a publication topic based on the new sensor, the publication topic made available via at least to a server component operating via the proximity networking radio;

adding data from the new sensor to the publication topic; and
in response to a subscription to the publication topic via a user device, dynamically presenting the data to the user device via the server component.

14. The method of claim 13, further comprising:
determining a numerical identifier of the new sensor; and
based on the numerical identifier, determining at least a type of the new sensor.
15. The method of claim 14, wherein the publication topic is based on the type of the new sensor.
16. The method of claim 13, further comprising:
facilitating user selection of multiple topics via the user device and the server component; and
dynamically presenting data from the multiple topics via the server component.
17. The method of claim 16, further comprising:
facilitating assignment of graphical components to the multiple topics via the user device and the server component;
facilitating arrangement of the graphical components into a view, wherein the data from the multiple topics is presented via the graphical components in the view.
18. The method of claim 13, further comprising:
facilitating selection of multiple topics via a template transmitted to the mobile gateway; and
dynamically presenting data from the multiple topics via the server component, wherein presenting data from the multiple topics comprises combining data from at least two topics.
19. The method of claim 18, further comprising:
facilitating assignment of graphical components to the multiple topics via the template; and

facilitating arrangement of the graphical components into a view, wherein the data from the multiple topics is presented via the graphical components in the view.

20. The method of claim 13, further comprising:
receiving a second subscription to the publication topic via a cloud gateway; and
in response to the second subscription, dynamically sending the data to the cloud gateway.

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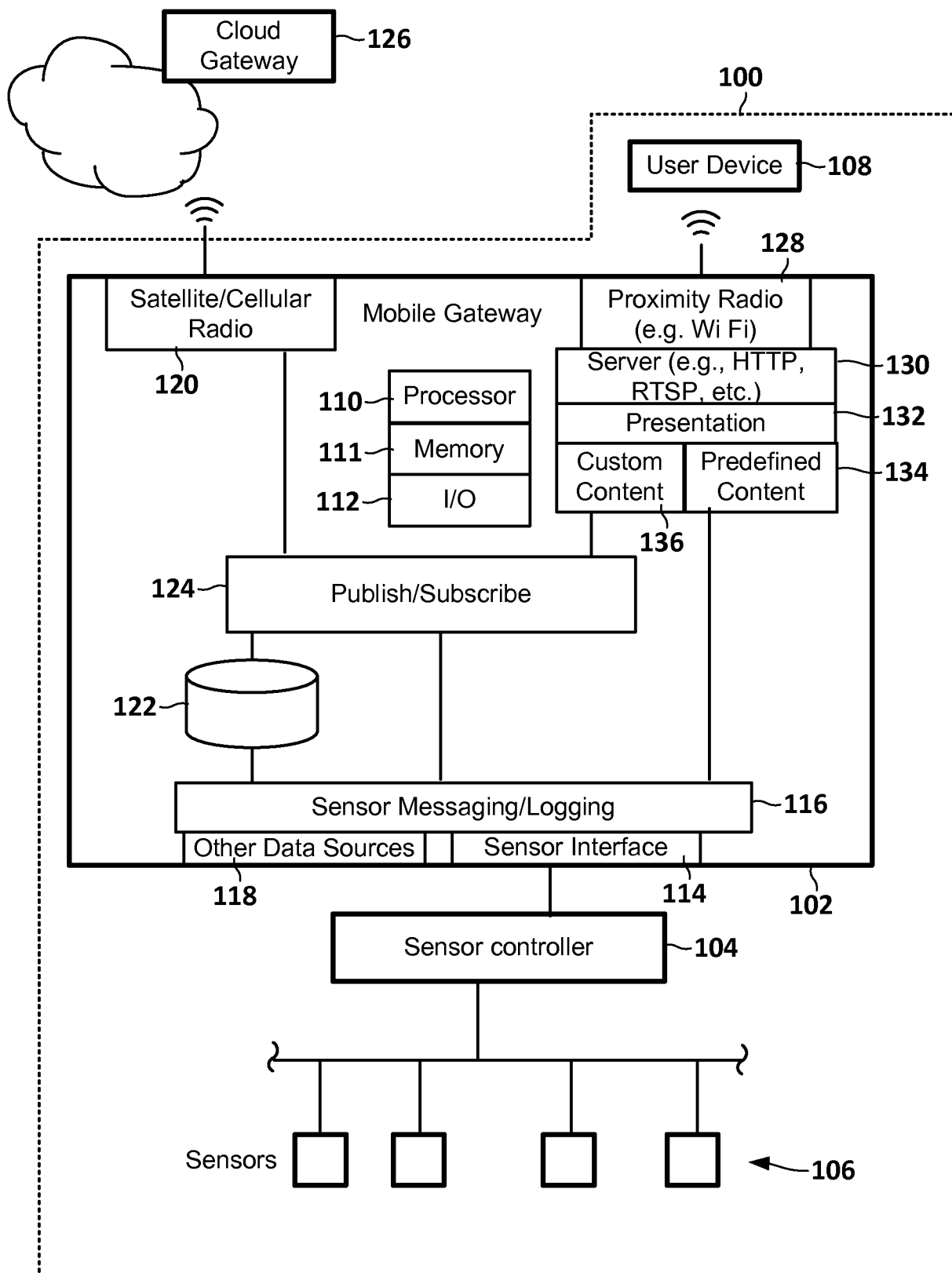


FIG. 1

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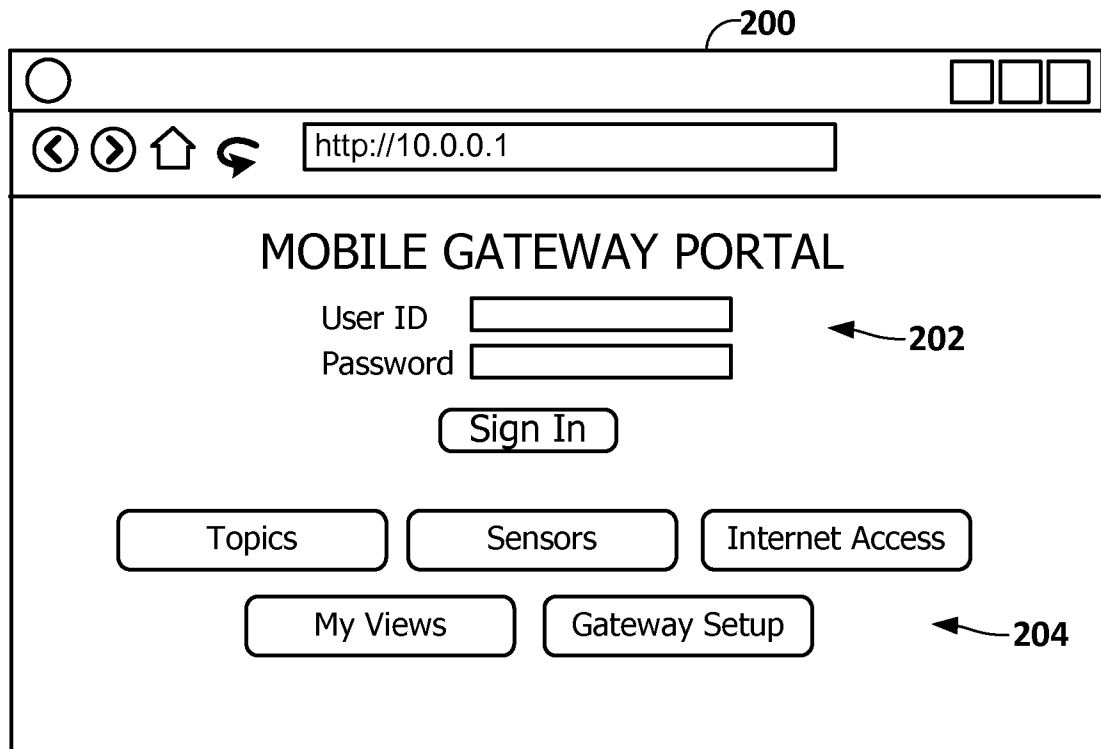


FIG. 2

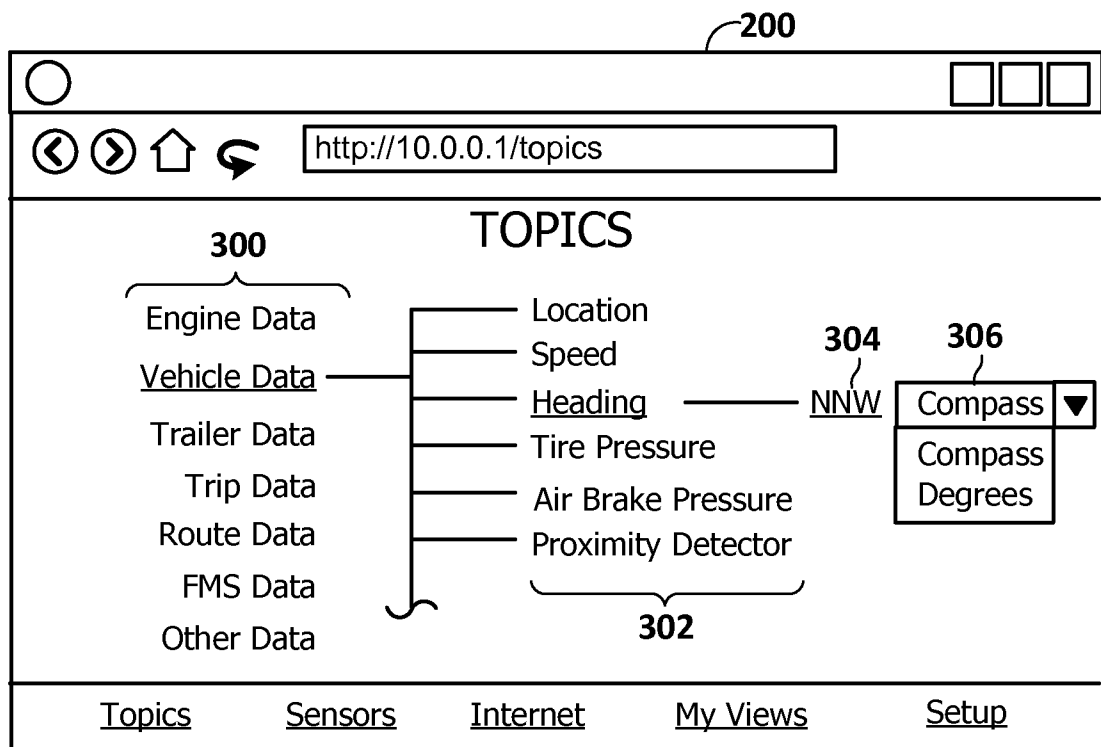
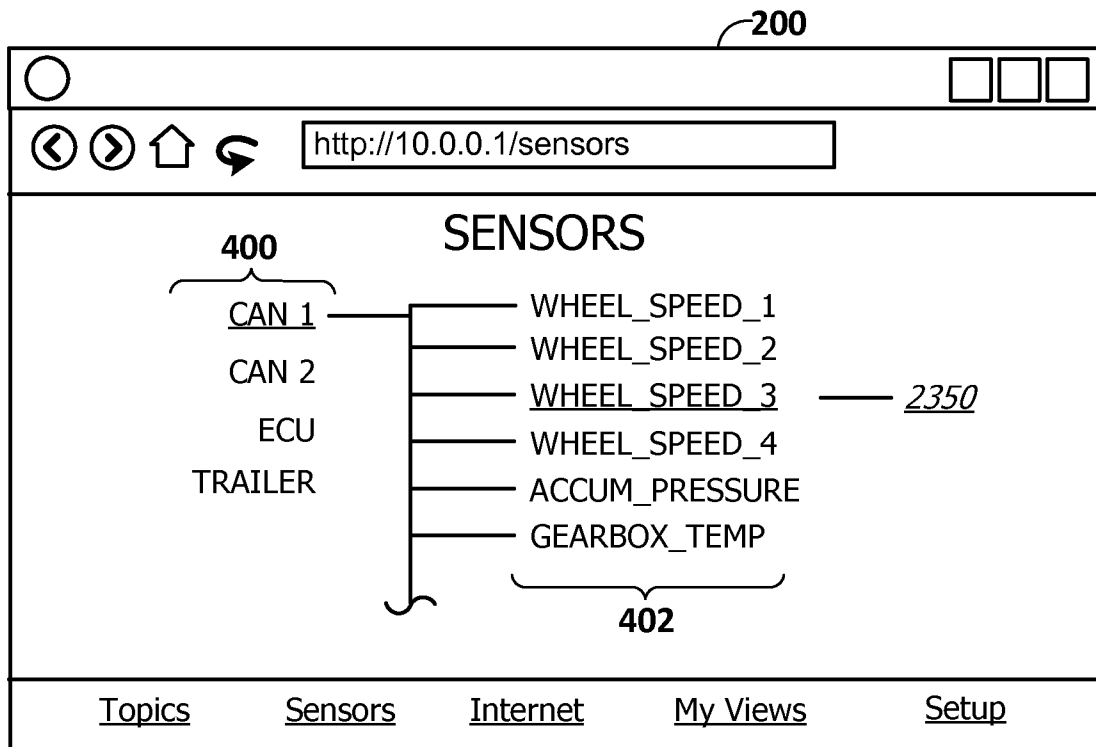
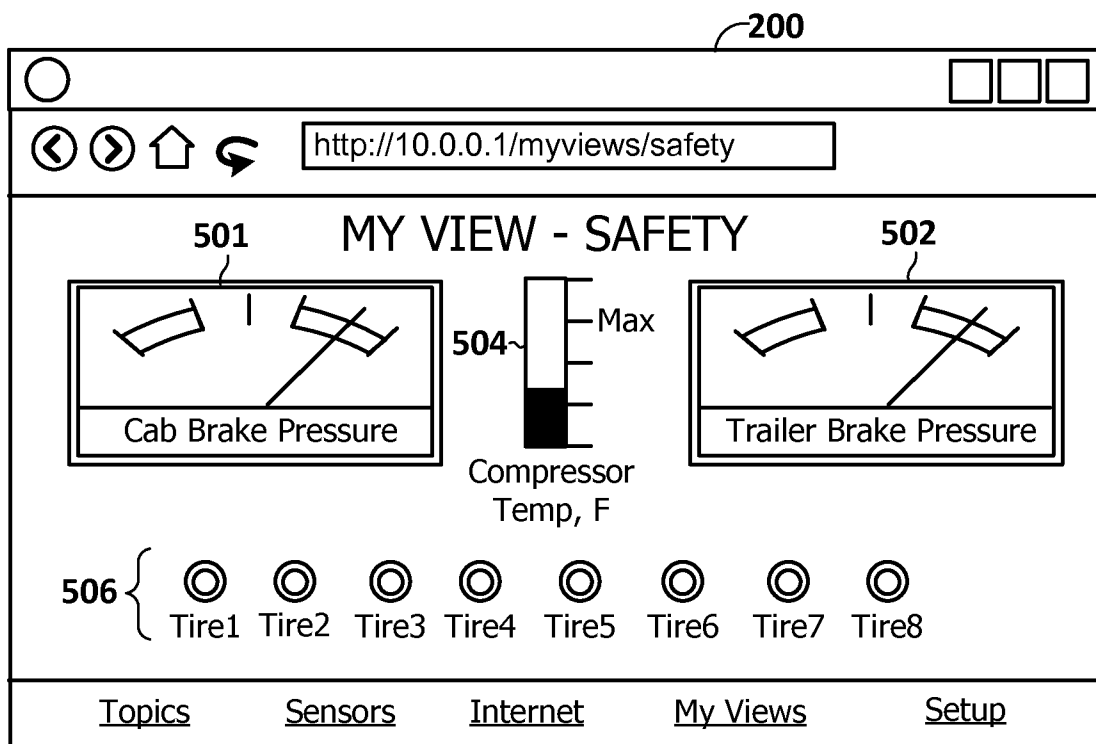


FIG. 3

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**FIG. 4****FIG. 5**

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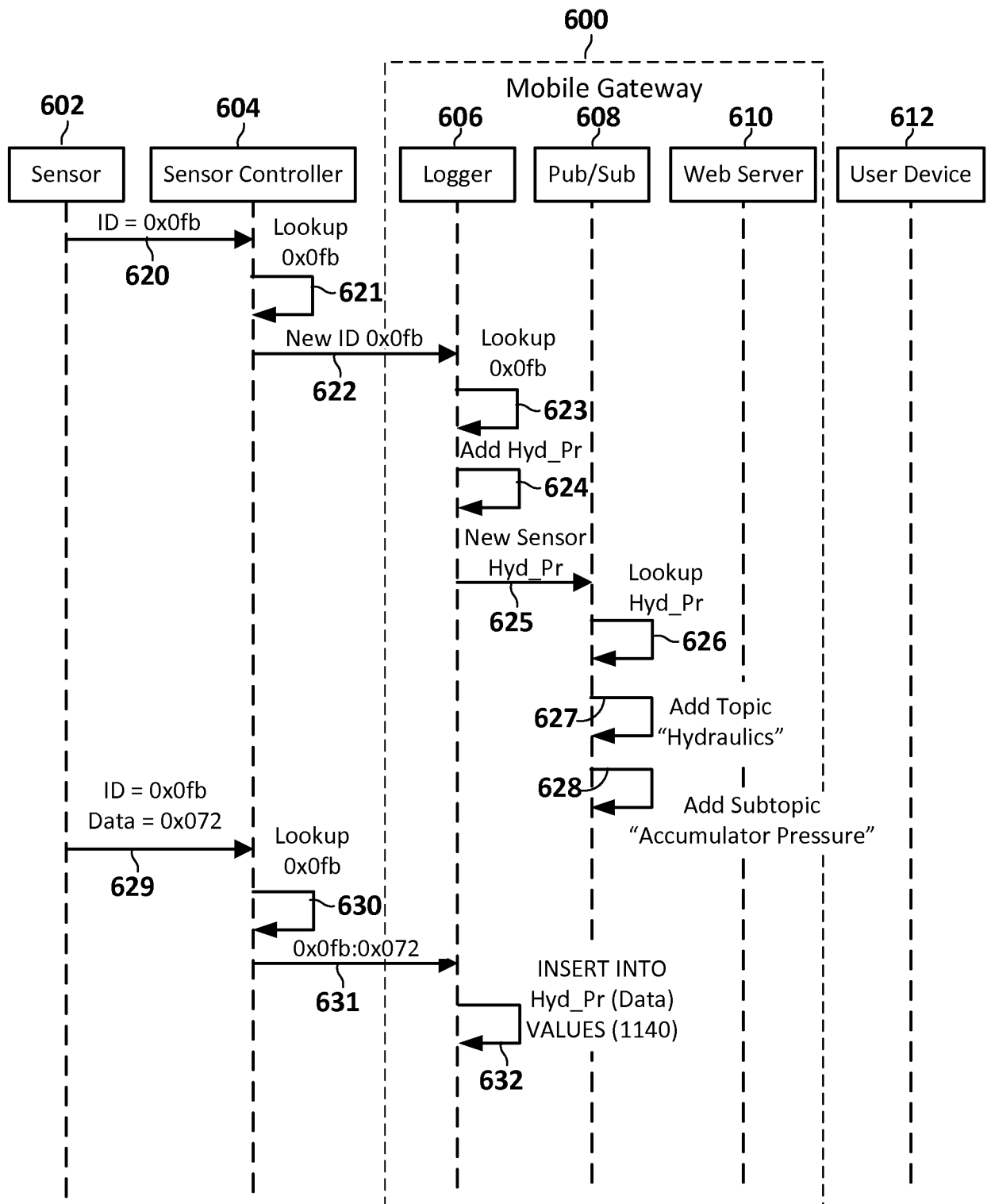


FIG. 6

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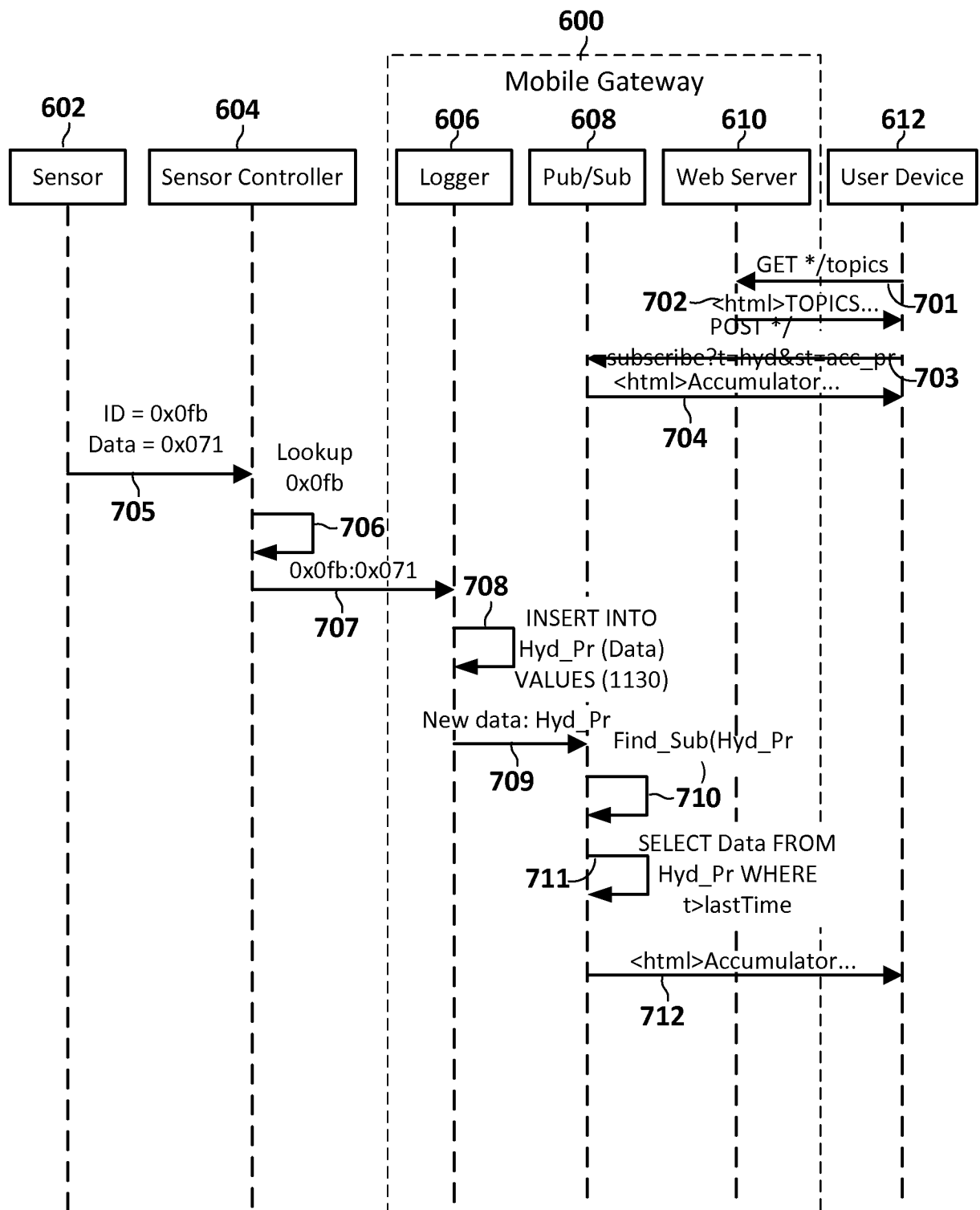
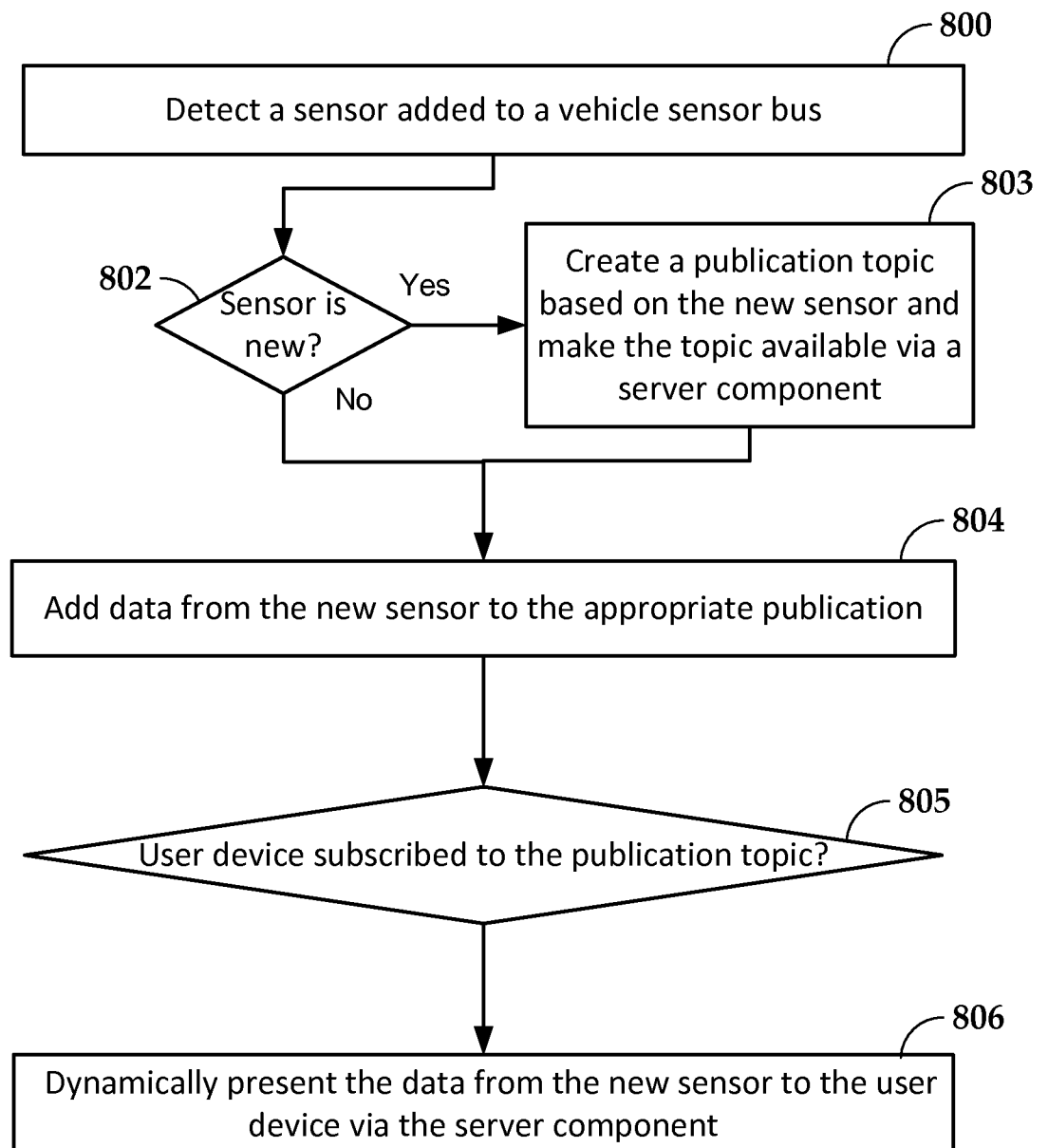


FIG. 7

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*FIG. 8*

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/045597

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L29/08 H04W8/20
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/027591 A1 (LENSER SCOTT [US] ET AL) 31 January 2008 (2008-01-31) the whole document -----	1-6, 12-15,20
A	US 2014/185516 A1 (RUBIN HARVEY [US] ET AL) 3 July 2014 (2014-07-03) the whole document -----	1-6, 12-15,20
A	US 2012/149353 A1 (HELFRICH MICHAEL [US]) 14 June 2012 (2012-06-14) the whole document -----	1-6, 12-15,20
A	WO 2009/079036 A1 (VIALOGY LLC [US]; GULATI SANDEEP [US]; HILL ROBIN ANTHONY [US]; DAGGUM) 25 June 2009 (2009-06-25) the whole document ----- -/--	1-6, 12-15,20

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

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

14 October 2015

Date of mailing of the international search report

18/01/2016

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Ghidini, Mario

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2015/045597

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2013/072925 A2 (TATA CONSULTANCY SERVICES LTD [IN]; MISRA PRATEEP [IN]; PAL ARPAN [IN]) 23 May 2013 (2013-05-23) the whole document	1-6, 12-15,20
A	----- US 2007/265866 A1 (FEHLING RONNY [CA] ET AL) 15 November 2007 (2007-11-15) the whole document -----	1-6, 12-15,20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/045597

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of Item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-6, 12-15, 20

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-6, 12-15, 20

Sensor management

2. claims: 7-11, 16-19

Presentation of information

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2015/045597

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008027591 A1	31-01-2008	NONE	
US 2014185516 A1	03-07-2014	NONE	
US 2012149353 A1	14-06-2012	US 2012149353 A1	14-06-2012
		US 2013252586 A1	26-09-2013
		US 2014155087 A1	05-06-2014
		WO 2012078983 A2	14-06-2012
WO 2009079036 A1	25-06-2009	NONE	
WO 2013072925 A2	23-05-2013	AU 2012338372 A1	27-03-2014
		AU 2012338373 A1	27-03-2014
		CA 2848988 A1	23-05-2013
		CA 2848995 A1	23-05-2013
		CN 103890730 A	25-06-2014
		CN 103891201 A	25-06-2014
		EP 2758879 A2	30-07-2014
		EP 2759093 A2	30-07-2014
		JP 2014534487 A	18-12-2014
		JP 2015501459 A	15-01-2015
		TW 201328921 A	16-07-2013
		TW 201333731 A	16-08-2013
		US 2014359552 A1	04-12-2014
		US 2014380264 A1	25-12-2014
		WO 2013072925 A2	23-05-2013
		WO 2013072926 A2	23-05-2013
US 2007265866 A1	15-11-2007	NONE	