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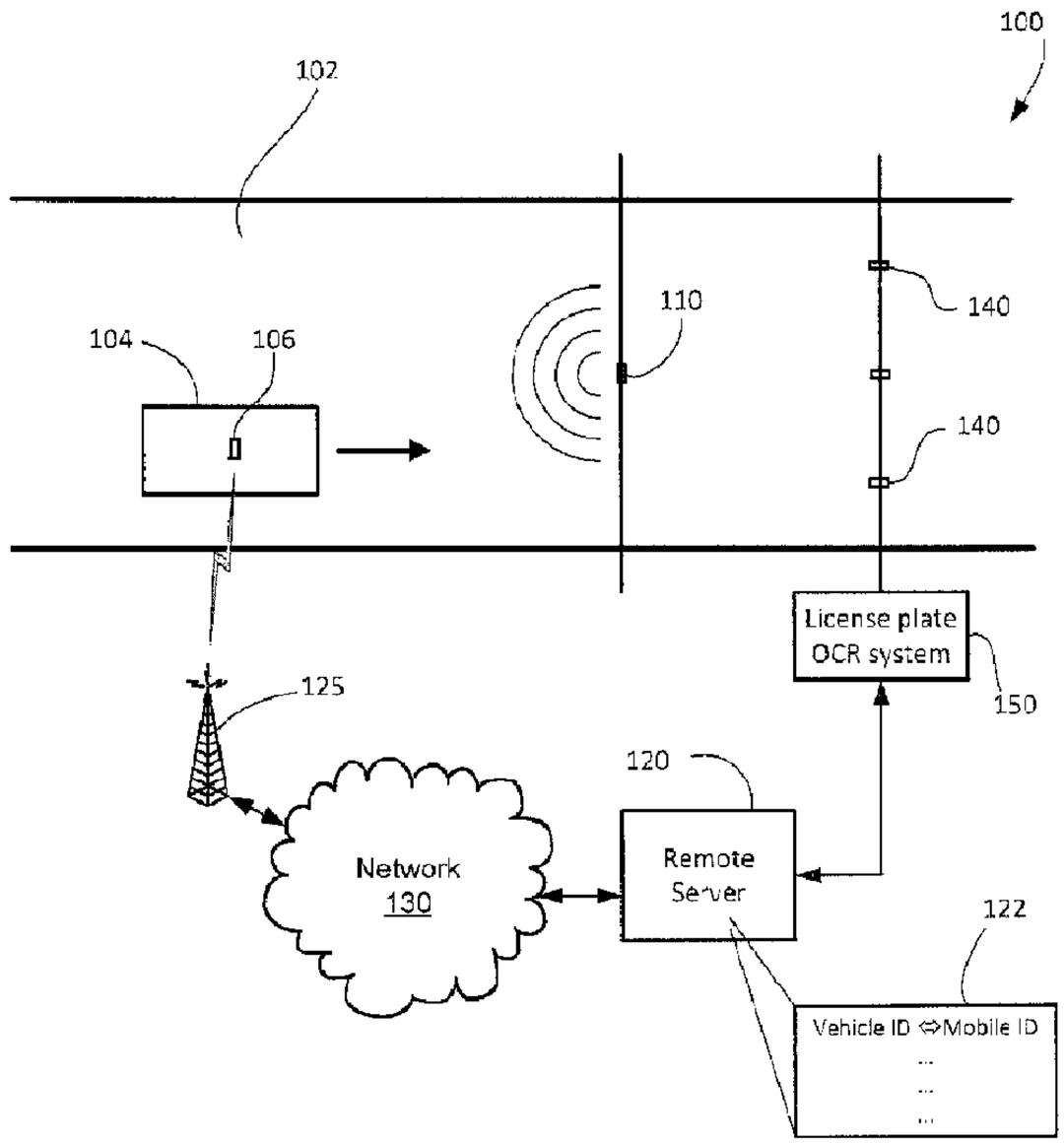
(54) **Titre : PAIEMENTS PAR APPAREIL MOBILE FONDES SUR UNE BALISE**
(54) **Title: BEACON-BASED MOBILE PAYMENTS**



(57) Abrégé/Abstract:
Electronic payment using a mobile device having a wireless data connection to a public mobile network. A location-specific low-energy beacon periodically broadcasts a beacon signal containing a unique location identifier. The mobile device receives the beacon signal and reports the location identifier to a remote server. The remote server identifies an associated vehicle based on identification data and an association with the vehicle. If a payment transaction is required, then an amount is determined based on the location identifier and a toll payment is processed using payment information linked to the mobile device or its user. The beacon signal may be a Bluetooth LE™ signal.

ABSTRACT

Electronic payment using a mobile device having a wireless data connection to a public mobile network. A location-specific low-energy beacon periodically broadcasts a beacon signal containing a unique location identifier. The mobile device receives the beacon signal and reports the location identifier to a remote server. The remote server identifies an associated vehicle based on identification data and an association with the vehicle. If a payment transaction is required, then an amount is determined based on the location identifier and a toll payment is processed using payment information linked to the mobile device or its user. The beacon signal may be a Bluetooth LE™ signal.

BEACON-BASED MOBILE PAYMENTS

TECHNICAL FIELD

[0001] The present disclosure relates to mobile electronic commerce systems and, in particular, to a system and method for location-based payments using mobile phones and relying on beacons to signal proximity to a payment area.

BACKGROUND

[0002] Vehicle-based RFID communications are commonly used to communicate with electronic toll collection (ETC) systems. In such cases, ETC systems conduct toll transactions based on radio frequency (RF) communications between a vehicle-mounted transponder (a "tag") and a stationary toll lane or toll plaza transceiver (a "reader"). An example of an electronic toll collection system is described in U.S. Patent No. 6,661,352 issued Dec. 9, 2003 to Tiernay et al.

[0003] In some cases, an ETC transponder may also be utilized to perform non-toll electronic commerce transactions. For example, a transponder may be utilized in a vendor location in order to purchase goods and services offered by a vendor (*i.e.* perform a sales transaction). For example, gas stations or parking lots may provide roadside readers for automatically communicating with a vehicle-mounted transponder in order to perform a sales transaction using RFID.

[0004] Conventional ETC and other RFID-based payment systems have the drawback of requiring a large upfront investment in the form of manufacturing and distributing transponders. Even if transponder technology is integrated into modern vehicles, there is a large investment required in roadside technology to build gantries, install and configure reader antennas, transceivers, and controllers, and associated communications infrastructure to reach a back office processing center.

[0005] It would be advantageous to have a method and system for mobile payments, like road tolls, that can leverage existing and ubiquitous mobile communications devices and systems, *e.g.* smartphones, to speed deployment and reduce cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Reference will now be made, by way of example, to the accompanying drawings which show an embodiment of the present application, and in which:

[0007] Figure 1 shows, in block diagram form, an example embodiment of an electronic payment system;

[0008] Figure 2 shows, in flowchart form, one example of a method of conducting an electronic toll transaction; and

[0009] Figure 3 shows, in flowchart form, for determining and reporting presence in an electronic toll transaction system.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

[0010] The present application discloses systems and methods for location-based payments using mobile phones and relying on beacons to signal proximity to a payment area.

[0011] In one aspect, the present application discloses a method of electronic road toll payment using a mobile communications device having a wireless data connection to a public mobile network, the method being implemented by the mobile communications device, wherein a roadway includes a plurality of location-specific low energy beacons each periodically broadcasting a beacon signal containing a location identifier. The method includes detecting the beacon signal from one of the beacons; extracting the location identifier from the detected beacon signal; generating a passage report containing identification data and the extracted

location identifier; and transmitting the passage report to a remote server via the wireless data connection over the public mobile network.

[0012] In a further aspect, the present application discloses a method of electronic road toll payment using a mobile communications device having a wireless data connection to a public mobile network, the method being implemented by a server configured to receive communications from the mobile communications device via the public mobile network, wherein a roadway includes a plurality of location-specific low energy beacons each periodically broadcasting a beacon signal containing a location identifier. The method includes receiving from the mobile communications device, via the public mobile network, a passage report including identification data and one of the location identifiers; determining a vehicle identifier associated with the identification data; storing data noting detection of the vehicle identifier in association with said one of the location identifiers; and determining from said one of the location identifiers whether a toll transaction is required and, if so, then determining a toll amount based on said one of the location identifiers, and processing a toll payment using payment information linked to the identification data.

[0013] In another aspect, the present application discloses system for conducting toll payment transactions using a mobile communications device having a wireless data connection to a public mobile network. The system includes a plurality of location-specific low energy beacons each periodically broadcasting a beacon signal containing a location identifier and each positioned in proximity to a respective part of a roadway; a server having a processor, memory and a communications interface to receive communications from the mobile communications device via the public mobile network. The server further includes a toll processing application containing instructions, which, when executed, cause the processor to receive from the mobile communications device, via the public mobile network, a passage report including identification data and one of the location identifiers, determine a vehicle identifier associated with the identification data, store data noting detection of the vehicle identifier in association with said one of the location identifiers, and determine from said one of the location identifiers whether a toll transaction is required and, if so, then determine a toll amount based on said one of the location identifiers, and process a toll payment using payment information linked to the identification data.

[0014] In yet a further aspect, the present application discloses a mobile communications device for conducting an electronic toll transaction in connection with a roadway, the roadway having a plurality of location-specific low energy beacons each periodically broadcasting a beacon signal containing a location identifier. The mobile communications device includes memory; a processor; a communications interface to establish a wireless data connection to a public mobile network; and a toll application stored in the memory and containing processor-executable instructions, which, when executed, cause the processor to detect the beacon signal from one of the beacons, extract the location identifier from the detected beacon signal, generate a passage report containing identification data and the extracted location identifier, and transmit the passage report to a remote server via the wireless data connection over the public mobile network.

[0015] In one aspect, the present application excludes the use of GPS or other satellite navigation services for determining position.

[0016] In another aspect, the present application describes methods and system in which beacon signals are generated and detected using Bluetooth™ communications protocols.

[0017] Other aspects and features of the present application will be apparent to those of ordinary skill in the art from a review of the following detailed description when considered in conjunction with the drawings.

[0018] Although the embodiments described below focus upon electronic toll transactions in an intelligent vehicle highway system (IVHS), the present application is not limited to IVHS or electronic tolling in particular.

[0019] In accordance with one aspect of the present application relating to electronic tolling, a mobile device detects a beacon signal from a roadside beacon and extracts a location identifier from the beacon signal. The mobile device then transmits the extracted location identifier to a remote server over a mobile data connection, such as via a mobile telephony network, to report its presence in that location. The remote server identifies a stored correlation/association of the mobile device with a vehicle and thereby determines that the vehicle is present at that location. The remote server may process a toll event or transaction and

bill an account associated with the mobile device. When conducting enforcement in connection with vehicles detected in the roadway, the remote server is able to prevent enforcement and billing (*e.g.* via license plate recognition) against those vehicles that have a validly correlated passage report for which billing has already occurred.

[0020] In other words, instead of detecting the presence of vehicles using local RFID polling/response protocols within a capture zone, the present application proposes to broadcast a local beacon signal. A mobile phone detects the beacon signal and reports its presence to a remote server via a mobile wireless data channel, such as over the public land mobile network (PLMN).

[0021] Advantageously, this system permits low cost implementation of toll roads without requiring installation and configuration of expensive and cumbersome directional antennas and roadside reader equipment, and their associated gantries. In some instances, low-cost commercial off-the-shelf Bluetooth LE™ beacon devices may be used. The processing is largely centralized in a remote server system. The deployment of custom transponders (active or passive), with the associated logistical problems is also avoided by deploying a downloadable mobile device app that configures a mobile device to listen for the beacon signal and prepare and send passage reports to the remote server. A user interface in the app may provide the functionality for enabling/disabling features and associating the mobile device with a particular vehicle.

[0022] Reference is first made to Figure 1, which shows, in block diagram form, an example electronic payment system 100. In this example, the electronic payment system 100 is an electronic toll system associated with a roadway 102. The roadway 102 may be a single lane roadway, a multi-lane roadway, an entrance or on-ramp to a tolled road, or an exit or off-ramp to a tolled road, in some examples. Figure 1 depicts a vehicle 104 traveling in the roadway 102. At least one occupant of the vehicle 104 has a mobile device 106.

[0023] In a conventional open-road tolling system, the vehicle 104 would be equipped with an RFID transponder (either passive or active), perhaps attached to a windshield or license plate. The RFID transponder would communicate with local directional antennas and a roadside reader so that the tolling system detects the presence of the transponder-equipped vehicle. In

some cases, the tolling system would be configured to determine the lane in which the vehicle is likely located as well.

[0024] In the example system 100 shown in Figure 1, no roadside readers and associated antennas are needed. Instead, one or more beacons 110 broadcast a short-range RF beacon signal. In some embodiments, the beacon 110 employs Bluetooth™ low energy (Bluetooth LE™) technology and protocols to broadcast the signal over a coverage area in the roadway 102. The Bluetooth™ low energy protocol includes a proximity profile in which one device monitors for the presence of another device in its proximity. In this example, the mobile device 106 monitors for the presence of the beacon 110 in its proximity. The coverage area is sufficiently large that a mobile device within a vehicle traveling at roadway speed will successfully detect the beacon signal at least once while traversing the coverage area.

[0025] The beacon 110 broadcasts a beacon signal that includes at least a location identifier for the beacon 110. In some embodiments, the location identifier is a unique code or identifier associated with the beacon 110 and/or the portion of the roadway at which the beacon 110 is located. In the case of multiple beacons 110 at the same location, in some implementations each of them may broadcast a beacon signal containing the same location identifier, or in other implementations each beacon 110 may have a unique location identifier.

[0026] The system 100 further includes a remote server 120 connected via a mobile network 130 to a communications antenna 125, such as a cellular access point/antenna. The mobile device 106 is configured to communicate with the remote server 120 via the mobile network 130. In particular, the mobile device 106 is configured to report its presence in the roadway by sending a passage report to the remote server 120 upon detecting the beacon 110. The passage report contains the location identifier extracted by the mobile device 106 from the received beacon signal. The passage report may further contain an identifier for the mobile device 106, an identifier for a mobile payment account associated with the mobile device 106, an identifier of the vehicle with which the mobile device 106 is currently associated, or a combination thereof, all or any of which may be referred to herein as "identification data".

[0027] The mobile network 130 may be configured to use GPRS, CDMA2000, HSPA, LTE, or other 3G technologies, 4G technologies like LTE Advanced or WiMAX-Advanced, or

any other mobile data communications protocols. In some cases, the mobile network 130 may include WiFi networks and the like. The data format and type used in communications between the mobile device 106 and the remote server 120 may include SMS messaging, MMS messaging, email, IP-based messaging, or any other form or format for data transmission over the mobile network 130. It will be appreciated that although the network 130 is depicted as a single network and antenna 125, the system 100 may include a plurality of interconnected antennas and networks, with protocols for handoff of communications with the mobile device 106 as between antennas and amongst networks. The term "passage report" is intended to include any of the above forms or formats of communication between the mobile device 106 and remote server 120 for the purpose of reporting a detected location identifier.

[0028] In one embodiment, the remote server 120 may include a plurality of stored associations 122 between vehicle identifiers and identification data. The identification data may include a phone number, email address, SIP address, IMEI, IMSI, device serial number, user account identifier, or other unique code assigned or associated with the mobile device 106 or its user. The vehicle identifier may include a license plate number, vehicle identification number, or other unique code associated with the vehicle 104 and which may be correlated with the vehicle license plate.

[0029] The remote server 120 may store tracking information regarding vehicles from which it receives passage reports via the mobile network 130. This may assist the remote server 120 in determining when a vehicle has entered a toll road, exited a toll road, and the distance traveled in the toll road for the purpose of determining a toll amount.

[0030] The mobile device 106 may be configured to use a mobile app or other software to passively listen for beacon signals and to establish and/or maintain a data connection with the remote server 120 over the mobile network 130. The mobile app or other software may be further configured to provide a user interface to receive input (such as via keypad, touchscreen or microphone) enabling the app, disabling the app, creating or deleting an association between a specific vehicle and the mobile device 106 or user, and authorizing the sending of a passage report. The mobile app user interface may further output alerts or notifications. For example, when a beacon is detected, the user interface may be configured to output an auditory alert, a

visual alert, or both. The user interface may prompt the user (audibly or visually or both) to confirm that a passage report may be sent. Confirmation may be by auditory input from the user or by a button or key input, *e.g.* the app may receive input via the mobile device interfaces (keys or touchscreen) or via other input devices in the vehicle that are then connected to the mobile device via short range communications like Bluetooth™ or near-field communications.

[0031] It will be appreciated that multiple mobile devices 106 may be present in a vehicle at any one time. Moreover, some of those mobile devices 106 may be unassociated with a vehicle or may be associated with a different vehicle. Each mobile device 106 may output a prompt seeking confirmation that the mobile device 106 is to be used for toll transactions in connection with the roadway 102. The mobile devices 106 may further identify or announce the vehicle license plate or other identifier with which they are currently associated. The user then has an opportunity to change the association to link the mobile device 106 to the current vehicle or to disable the mobile app and prevent it from transmitting passage reports. A new association is reported by the mobile device 106 to the remote server 120 so that the remote server 120 may update its stored associations 122.

[0032] In some embodiments, the beacon signal may contain a type code that indicates whether the beacon is associated with an entrance, an exit, a billing point, or the like. For example, a first beacon location (*e.g.* at an entry point to a toll road) may include broadcast of a location identifier that includes a code or symbol that indicates that it is an entry point. Accordingly, the mobile device 106 may output prompts or alerts dependent upon the nature or type of beacon 110 detected. For example, if the beacon 110 corresponds to a billing point, the mobile device 106 may issue an alert or sound distinct from the sound or alert issued in connection with a non-billing point. If the beacon 110 corresponds to an entrance point then the mobile device 106 may seek confirmation that it is associated with the correct vehicle before sending a passage report.

[0033] In some cases, a vehicle 104 may contain two mobile devices 106 each associated with the vehicle 104. If both mobile devices 106 generate and send a passage report containing the same location identifier and associated with the same vehicle identifier, then the remote server 120 may detect the likelihood of double-billing. In such a situation, the remote server 120

may notify both mobile devices 106 and prompt them to confirm billing. The first mobile device 106 to respond may be associated with the vehicle 104 and used for billing purposes and the second mobile device 106 (or non-responsive one) is disassociated with the vehicle 104 and is not billed. In the case of no response, the remote server 120 may pick one of the two mobile devices 106 for association with the vehicle 104 and billing.

[0034] In one embodiment, the mobile device 106 may be configured to connect to the vehicle computer system, for example using short-range communications like Bluethooth™, in order to obtain the vehicle identifier. The mobile device 106 may then automatically update its association by reporting the new association to the remote server 120, or it may prompt the user to confirm the new association and, when confirmed, transmit the new association to the remote server 120.

[0035] In one example, the system 100 includes a vehicle detection system for enforcement of tolling. The vehicle detection system, in some embodiments, includes one or more cameras 140 and a license plate optical-character-recognition (OCR) system 150 connected to the cameras 140. In some embodiments, the OCR system 150 may be embedded in the cameras 140 themselves.

[0036] As vehicles are detected in the roadway (either via the cameras 140 or via another vehicle detection mechanism, such as a magnetic loop antenna or the like), the cameras 140 and OCR system 150 determine the vehicle license plate number from an image of the vehicle license plate area. If the plate is not automatically detected by the cameras 140 and OCR system 150, one or more images may be sent to a remote location for review by a human operator.

[0037] Identified vehicle license plate numbers are transmitted from the license plate OCR system 150 to the remote server 120. The remote server 120 then determines whether identified vehicle license plates from a given location correlate to passage reports received in connection with that location, *i.e.* whether a mobile device associated with that vehicle has reported its presence in that location. Any uncorrelated vehicles may be assessed a toll.

[0038] In one embodiment, vehicles that are detected by the vehicle license plate OCR system 150 that are correlated with a passage report from a mobile device are assessed a toll at a

regular rate and vehicles that are detected by the vehicle license plate OCR system 150 that are not correlated with a passage report from a mobile device are assessed a toll at a higher rate, or at a regular rate plus an excess processing fee.

[0039] In one embodiment, toll transactions are conducted based on passage reports from mobile devices without requiring correlation with identified vehicle license plates. In another embodiment, toll transactions are only conducted once an associated vehicle is identified by the license plate OCR system 150 and is correlated to the passage report so as to confirm the presence of the associated vehicle in the roadway 102 and avoid false passage reports or billing to mobile devices that are not associated with a vehicle in the roadway.

[0040] In another embodiment, if a mobile device/vehicle is billed a toll based on a passage report, but the associated vehicle is subsequently not identified at an enforcement location by the license place OCR system 150, for example within a certain period of time during which it would be expected to pass through the enforcement location, then a false billing alert may be generated. The false billing alert may flag the account for review by billing personnel to determine whether the passage reports were potentially erroneous or whether a mobile device present in a vehicle was incorrectly associated with another vehicle.

[0041] It will be understood that the remote server 120 may be implemented by a plurality of servers, server farms, or other processing resources, and that stored data at the remote server(s) 120 may be configured in any one of a number of data structures, including databases.

[0042] In one embodiment, upon detecting the beacon signal, the mobile device 106 may attempt to confirm the location identifier using one or more other sensors prior to transmitting a passage report to the remote server 120. For example, the mobile device 106 may use GPS to confirm that it is located within a roadway associated with the location identifier or known to be toll road. In some instances, the mobile device 106 may use other sensors, such as the gyroscope or accelerometer to confirm that it is present in a vehicle (*e.g.*by determining that it is in motion traveling at more than a minimum roadway speed). Other sensor data may be used in other implementations to verify, validate, or authenticate the mobile device's 106 presence in the roadway 102 or in a vehicle 104 prior to transmission of a passage report.

[0043] Reference is now made to Figure 2, which shows, in flowchart form, one example method 200 for conducting a toll transaction using a mobile payment service. The example method 200 may be implemented by a server(s) or other processing device by way of memory-stored computer-executable instructions which, when executed by one or more processors, carry out the operations of the method 200.

[0044] The method 200 includes, in operation 202, receiving and storing an association between a vehicle and a mobile device or mobile account or toll payment account. The association may be created through receipt of a vehicle identifier, like a license plate number, via a web interface provided for users to update associations. A login process may be used to obtain user account information such that the input data is associated with a particular mobile user account or mobile device. Subsequently entered license plate numbers or vehicle identifiers are then linked to the mobile user account or mobile device. In many implementations, a user's mobile account/device may only be linked to one vehicle at a time. In some implementations, a mobile user account or toll payment account may be linked to more than one mobile device, and each mobile device may only be linked to one vehicle at a time.

[0045] The vehicle identifier (*e.g.* license plate number) may be received via a web interface provided by a web server incorporated within or associated with the server. In some cases, an application, *i.e.* a mobile device app, specific to the mobile payment service is deployed and installed by users on their mobile devices in order to use the mobile payment service. Users may change the vehicle with which their device is associated via the app, and the app relays vehicle identifiers to the server to be stored as an association between the mobile device and the vehicle. In some instances, the mobile device may not pre-notify the remote server of the vehicle with which it is to be associated and, instead, sends the associated vehicle identifier in each passage report.

[0046] In operation 204, the server receives a passage report from a mobile device. The passage report contains a location identifier and identification data. The identification data may include a mobile device identifier, such as a mobile device IMEI, phone number, or other device-identifying data. In some embodiments, the identification data includes a user account identifier, such as user email address, mobile app code, mobile account number, payment account number,

or the like. In some cases, the passage report further includes the vehicle identifier with which the mobile device is presently associated. In some cases, the identification data is the vehicle identifier itself.

[0047] In operation 205, the server searches its stored associations to identify the vehicle associated with the identification data, *e.g.* the mobile device or user payment account. The search may be based upon the mobile identifier sent with the passage report. In the case where the vehicle identifier is included in the passage report, the server extracts or reads the vehicle identifier from the passage report in operation 205. In cases where the identification data is the vehicle identifier itself, then in operation 205 the server may search stored associations to identify the mobile device, user, and/or payment account currently associated with that vehicle.

[0048] In operation 206, the server may store the data regarding detection of the vehicle and/or the mobile device at the location associated with the location identifier.

[0049] In some cases the location is an entry point to a toll road. In some cases, the location is an exit. In operation 208, the server determines whether to process a toll transaction. The determination may be based upon whether the location identifier is an exit or not. If it is an exit, then a toll may be due, whereas if it is an entrance then the server may await exit of the vehicle from the toll road before processing the transaction. Note that in some embodiments, the toll transaction may occur upon entry into the toll road rather than exit from the toll road, depending on the pricing structure of the toll road. In some embodiments, further tolls may be processed as the vehicle travels further down the toll road past additional toll collection zones or billing points in the roadway.

[0050] If, in operation 208, it is determined that a toll is to be charged, then in operation 210 the amount of the toll is determined. In some cases, the toll may be a flat fee for all vehicles. In some cases, the toll may be partly dependent upon the vehicle identifier, *e.g.* license plate numbers associated with larger vehicles or commercial vehicles may be assessed different tolls than private standard-size vehicles. In some cases, the toll amount may be dependent upon the distance travelled in the roadway, *i.e.* at which location the vehicle entered the toll road. The location at which the vehicle entered the toll road may be determined by searching stored records

of passage reports for the passage report in which the mobile device reported a location identifier corresponding to an entry point to the toll road.

[0051] Once the toll amount is determined, then in operation 212 the toll transaction is processed. It will be appreciated that the transaction may be processed with respect to an account associated with the mobile device in some embodiments.

[0052] In one embodiment, the server does not store separate associations between mobile devices/accounts and vehicles; instead, the mobile device itself stores the vehicle identifier with which it is currently associated and includes the vehicle identifier in any passage reports transmitted to the remote server.

[0053] Reference will now be made to Figure 3, which shows, in flowchart form, one example method 300 for determining and reporting presence in an electronic toll transaction system. The method 300 is implemented on a mobile device, such as a tablet, smartphone, smartwatch, or other mobile device having an antenna for receiving short-range signals, such as Bluetooth LE™ signals, and a transceiver for wireless data communications over a mobile network, such as a 3G or 4G PLMN. The method 300 may be implemented natively in the operating system of the mobile device, using an app downloaded to the mobile device, or using any other software model by which computer-executable instructions may be stored and executed on the mobile device.

[0054] In operation 302, the mobile device listens for detection of a beacon signal using its short-range antenna. As noted above, the beacon signal may be a Bluetooth LE™ proximity profile beacon signal. If a beacon signal is detected in operation 304, then the mobile device extracts a location identifier from the beacon signal.

[0055] In this embodiment, the mobile device is configured to validate or authenticate the beacon signal. Accordingly, in operation 208 the mobile device determines whether validation/authentication is enabled/required. In some embodiments, the validation operation may be enabled only in some instances. For example, the user may configure the mobile device to validate or not validate via an options menu in a user interface.

[0056] If validation is required, then in operation 310, the mobile device obtains data from other sensors. Example sensors include a GPS chip or an accelerometer or gyroscope. In operation 312, the mobile device determines whether the sensor data is consistent with a valid ETC context, *i.e.* whether the sensors indicate that it is likely or unlikely that the mobile device is traveling in a vehicle entering or leaving a toll road. For example, in one implementation the GPS data may be compared to known locations of toll roads. In another example, the gyroscope or accelerometer data may be analyzed to determine if movement of the mobile device is consistent with travel in a vehicle.

[0057] If the sensor data indicates, within some threshold of reliability, that the mobile device is not in a valid ETC context then the mobile device may issue an error signal, as indicated by operation 314. The error signal may include display of an error message, an audible tone or alert or message, transmission of an error report to a remote server, or any combination thereof. If, however, the sensor data validates (or conversely is unable to invalidate) the beacon signal, then the method 300 continues in operation 316.

[0058] In operation 316, the mobile device may output an auditory and/or visual notification indicating detection of a beacon signal from an ETC system so as to alert the user to the fact that the mobile device has detected a beacon and may transmit a passage report. In operation 318, the mobile device determines whether it is authorized or enabled to transmit the passage report without further input. If yes, then in operation 326 the mobile device generates and transmits the passage report to the remote server over the mobile network. The passage report includes the extracted location identifier from the beacon signal and identification data identifying the mobile device/account and/or vehicle.

[0059] If further authorization is required, then in operation 320 the mobile device outputs an authorization request. In some instances, the request may be a visually displayed message on a display screen; however, for vehicle safety in many embodiments the request may be an auditory message requesting an auditory response. The mobile device may then await auditory input via the microphone of the device, *e.g.* a "yes" response or the like. In operation 322 the mobile device assesses whether the response has been received and whether it is authorized. If so, then it sends the passage report in operation 326; otherwise, in operation 324,

it assesses whether it has timed out awaiting the authorization, in which case the mobile device may be configured to disable or end operation of the method 300. In some implementations, the receipt of a "no" or negative response ends the process in operation 322 and 324 rather than waiting for a time out.

[0060] It will be understood that the foregoing is one example method 300 and that many of the example operations may be omitted, rearranged, or modified in different implementations.

[0061] In some implementations, the mobile device and remote server employ encryption to securely communicate passage reports and other data communications.

[0062] In some implementations, the payment processing and toll transaction processing may be split amongst servers or amongst operators. For example, an extracted location identifier from the beacon signal may be sent over the mobile network to the remote server 120 where the user account is identified and the toll amount is determined. The remote server 120 then requests payment from a third party service provider (payment processor) for the toll transaction.

[0063] Although the foregoing examples are specific to electronic toll collection, it will be appreciated that the example methods and systems may be applied to other electronic payment transactions made using beacons and mobile devices. For example, parking payment may be based upon short range beacon sensing and a mobile device reporting the beacon location and an associated vehicle identifier. It may further be applied to other applications in which payment is made in association with a vehicle or user in connection with a detected location.

[0064] In another example, the system may be implemented in connection with controlled access to any restricted barrier based facilities. Such facilities may include, for example, parking at residential sites, including condominiums, town houses and other gated communities. In one example implementation, payment for access to such private parking facilities may be waived for registered residents whereas guests could be charged some fee with the approval of the host resident. In such an example, interactions between users and facilities may use the mobile device with beacons for position, and the mobile devices for payment and access approval.

[0065] In yet a further example, a beacon-based system may be used in connection with commuter rail. Commuter trains and/or stations may be equipped with a transmitting beacon and the mobile device records and reports the entrance to the train/station with location identification. On the basis of the reported train/station location, the remote server may process purchase of a train ticket for that train. In some example implementations, the remote server, having processed the purchase, may send the mobile device a code or other data confirming purchase of the applicable fare. During the ride a ticket collector may ask for proof of payment, whereupon the user of the mobile device may display a ticket or QR-code or other data received from the remote server to verify payment. In some instances, upon detecting the beacon signal, the mobile device may remind the patron that they are about to board a train and must procure a ticket, and may request confirmation before completing a purchase.

[0066] It will be understood that the beacon-based payment system may be implemented in other ticket or paid access applications.

[0067] Certain adaptations and modifications of the invention will be obvious to those skilled in the art when considered in light of this description. Therefore, the above discussed embodiments are considered to be illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

CLAIMS:

1. A method of electronic road toll payment using a mobile communications device having a wireless data connection to a public mobile network, the method being implemented by a server configured to receive communications from the mobile communications device via the public mobile network, wherein a roadway includes a plurality of location-specific low energy beacons each periodically broadcasting a beacon signal containing a location identifier, the method comprising:

receiving from the mobile communications device, via the public mobile network, a passage report including identification data and one of the location identifiers;

determining a vehicle identifier associated with the identification data;

storing data noting detection of the vehicle identifier in association with said one of the location identifiers; and

determining from said one of the location identifiers whether a toll transaction is required and, if so, then

determining a toll amount based on said one of the location identifiers, and

processing a toll payment using payment information linked to the identification data.

2. The method claimed in claim 1, further comprising initially receiving and storing an association between the vehicle identifier and the identification data, and wherein determining a vehicle identifier associated with the identification data comprises reading said stored association.

3. The method claimed in claim 1, wherein the passage report includes the vehicle identifier, and wherein determining a vehicle identifier comprises extracting the vehicle identifier from the passage report.

4. The method claimed in any one of claims 1 to 3, wherein determining from said one of the location identifiers whether a toll transaction is required comprises determining that the location identifier is associated with an exit, and wherein determining the toll amount includes retrieving stored data identifying a reported entrance location to the roadway associated with the identification data and determining the toll amount based on the reported entrance location and the exit.

5. The method claimed in any one of claims 1 to 4, further comprising

receiving a communication from an enforcement location on the roadway, the communication including a plurality of optically-detected vehicle license plate numbers;

with respect to a selected one of the locations identifiers associated with the enforcement location, correlating the stored data regarding vehicle identifiers with the optically-detected vehicle license plate numbers; and

processing a billing transaction with respect to any optically-detected vehicle license plate numbers not correlated with the stored data regarding vehicle identifiers.

6. The method claimed in any one of claims 1 to 5, further comprising:

deploying the plurality of location-specific low-energy beacons at selected entrance and exit locations for the roadway; and

configuring each beacon to periodically broadcast the beacon signal containing its respective location identifier.

7. The method claimed in any one of claims 1 to 6, wherein the beacons comprise electronic devices having a 2.4GHz transceiver and antenna and a controller configured to broadcast the beacon signal via the antenna using Bluetooth™ LE protocol.

8. The method claimed in any one of claims 1 to 7 wherein the identification data comprises one or more of a mobile device identifier, a mobile device user identifier, a payment account identifier, and the vehicle identifier.

9. A method of electronic road toll payment using a mobile communications device having a wireless data connection to a public mobile network, the method being implemented by the mobile communications device, wherein a roadway includes a plurality of location-specific low energy beacons each periodically broadcasting a beacon signal containing a location identifier, the method comprising:

detecting the beacon signal from one of the beacons;

extracting the location identifier from the detected beacon signal;

generating a passage report containing identification data and the extracted location identifier; and

transmitting the passage report to a remote server via the wireless data connection over the public mobile network.

10. The method claimed in claim 9, further comprising

outputting an audible prompt for confirmation;

receiving an auditory authorization response to the audible prompt;

transmitting the passage report based on received the auditory authorization.

11. The method claimed in claim 10, wherein the audible prompt includes announcement of a vehicle identifier with which the mobile device is presently associated.

12. The method claimed in any one of claims 9 to 11, further comprising receiving and storing selection of a vehicle identifier to be associated with the mobile device, and transmitting the selected vehicle identifier to the remote server.

13. The method claimed in claim 12, wherein transmitting the selected vehicle identifier comprises including the vehicle identifier in the passage report.

14. The method claimed in any one of claims 9 to 13, wherein the identification data comprises one or more of a mobile device identifier, a mobile device user identifier, a payment account identifier, and the vehicle identifier.

15. A system for conducting toll payment transactions using a mobile communications device having a wireless data connection to a public mobile network, the system comprising:

a plurality of location-specific low energy beacons each periodically broadcasting a beacon signal containing a location identifier and each positioned in proximity to a respective part of a roadway;

a server having a processor, memory and a communications interface to receive communications from the mobile communications device via the public mobile network,

wherein the server further includes a toll processing application containing instructions, which, when executed, cause the processor to:

receive from the mobile communications device, via the public mobile network, a passage report including identification data and one of the location identifiers,

determine a vehicle identifier associated with the identification data,

store data noting detection of the vehicle identifier in association with said one of the location identifiers, and

determine from said one of the location identifiers whether a toll transaction is required and, if so, then

determine a toll amount based on said one of the location identifiers, and

process a toll payment using payment information linked to the identification data.

16. The system claimed in claim 15, further comprising initially receiving and storing an association between the vehicle identifier and the identification data, and wherein determining a vehicle identifier associated with the identification data comprises reading said stored association.

17. The system claimed in claim 15, wherein the passage report includes the vehicle identifier, and wherein the processor determines the vehicle identifier by extracting the vehicle identifier from the passage report.

18. The system claimed in any one of claims 15 to 17, wherein the processor determines from said one of the location identifiers whether a toll transaction is required by determining that the location identifier is associated with an exit, and wherein the processor determines the toll amount by retrieving stored data identifying a reported entrance location to the roadway associated with the identification data and determining the toll amount based on the reported entrance location and the exit.

19. The system claimed in any one of claims 15 to 18, wherein the application, when executed, further causes the processor to:

receive a communication from an enforcement location on the roadway, the communication including a plurality of optically-detected vehicle license plate numbers;

with respect to a selected one of the locations identifiers associated with the enforcement location, correlate the stored data regarding vehicle identifiers with the optically-detected vehicle license plate numbers; and

process a billing transaction with respect to any optically-detected vehicle license plate numbers not correlated with the stored data regarding vehicle identifiers.

20. The system claimed in any one of claims 15 to 19, wherein the beacons comprise electronic devices having a 2.4GHz transceiver and antenna and a controller configured to broadcast the beacon signal via the antenna using Bluetooth™ LE protocol.

21. The system claimed in any one of claims 15 to 20, wherein the identification data comprises one or more of a mobile device identifier, a mobile device user identifier, a payment account identifier, and the vehicle identifier.

22. A mobile communications device for conducting an electronic toll transaction in connection with a roadway, the roadway having a plurality of location-specific low energy beacons each periodically broadcasting a beacon signal containing a location identifier, the device comprising:

memory;

a processor;

a communications interface to establish a wireless data connection to a public mobile network; and

a toll application stored in the memory and containing processor-executable instructions, which, when executed, cause the processor to:

detect the beacon signal from one of the beacons,

extract the location identifier from the detected beacon signal,

generate a passage report containing identification data and the extracted location identifier, and

transmit the passage report to a remote server via the wireless data connection over the public mobile network.

23. The mobile communications device claimed in claim 22, wherein the instructions further cause the processor to:

output an audible prompt for confirmation;

receive an auditory authorization response to the audible prompt; and

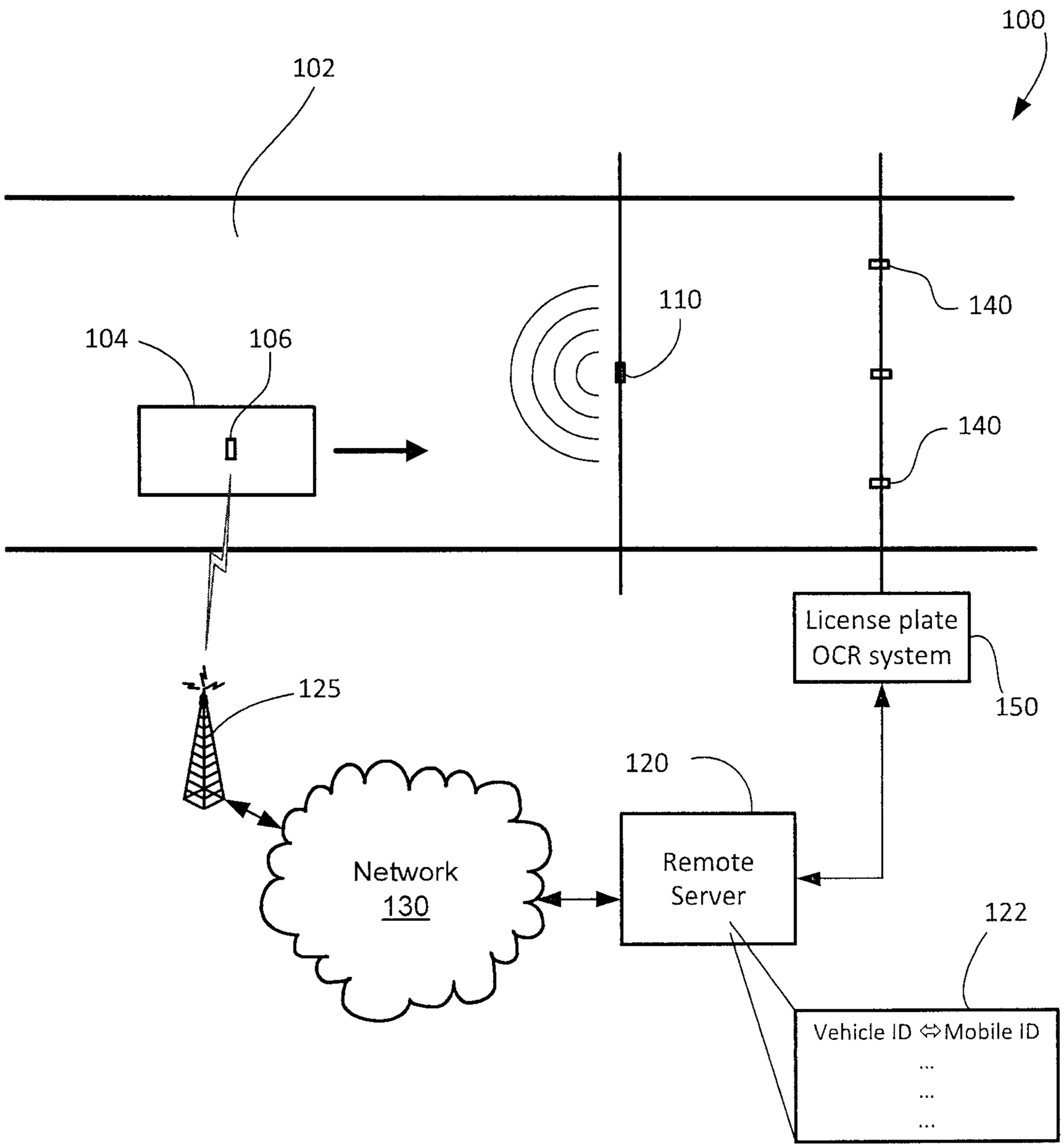
transmit the passage report based on received the auditory authorization.

24. The mobile communications device claimed in claim 23, wherein the audible prompt includes announcement of a vehicle identifier with which the mobile communications device is presently associated.

25. The mobile communications device claimed in any one of claims 22 to 24, wherein the instructions further cause the processor to receive and store selection of a vehicle identifier to be associated with the mobile device, and to transmit the selected vehicle identifier to the remote server.

26. The mobile communications device claimed in claim 25, wherein transmitting the selected vehicle identifier comprises including the vehicle identifier in the passage report.

27. The mobile communications device claimed in any one of claims 22 to 26, wherein the identification data comprises one or more of a mobile device identifier, a mobile device user identifier, a payment account identifier, and the vehicle identifier.


100
102
104
106
110
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140
125
License plate
OCR system
150
120
Network
130
Remote
Server
122
Vehicle ID ⇔ Mobile ID
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Fig. 1

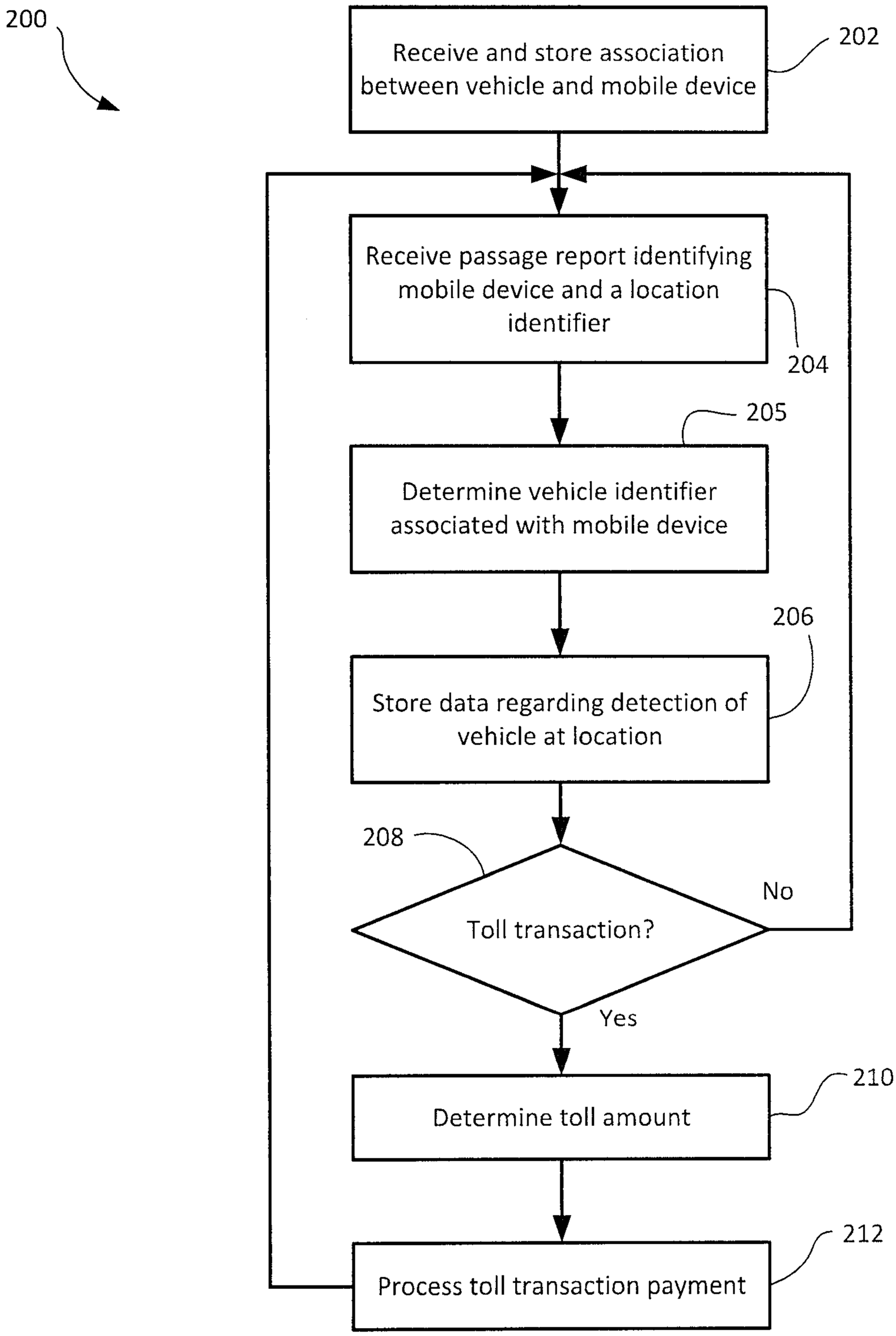

200
Receive and store association between vehicle and mobile device
202
Receive passage report identifying mobile device and a location identifier
204
205
Determine vehicle identifier associated with mobile device
206
Store data regarding detection of vehicle at location
208
Toll transaction?
No
Yes
Determine toll amount
210
Process toll transaction payment
212

Fig. 2

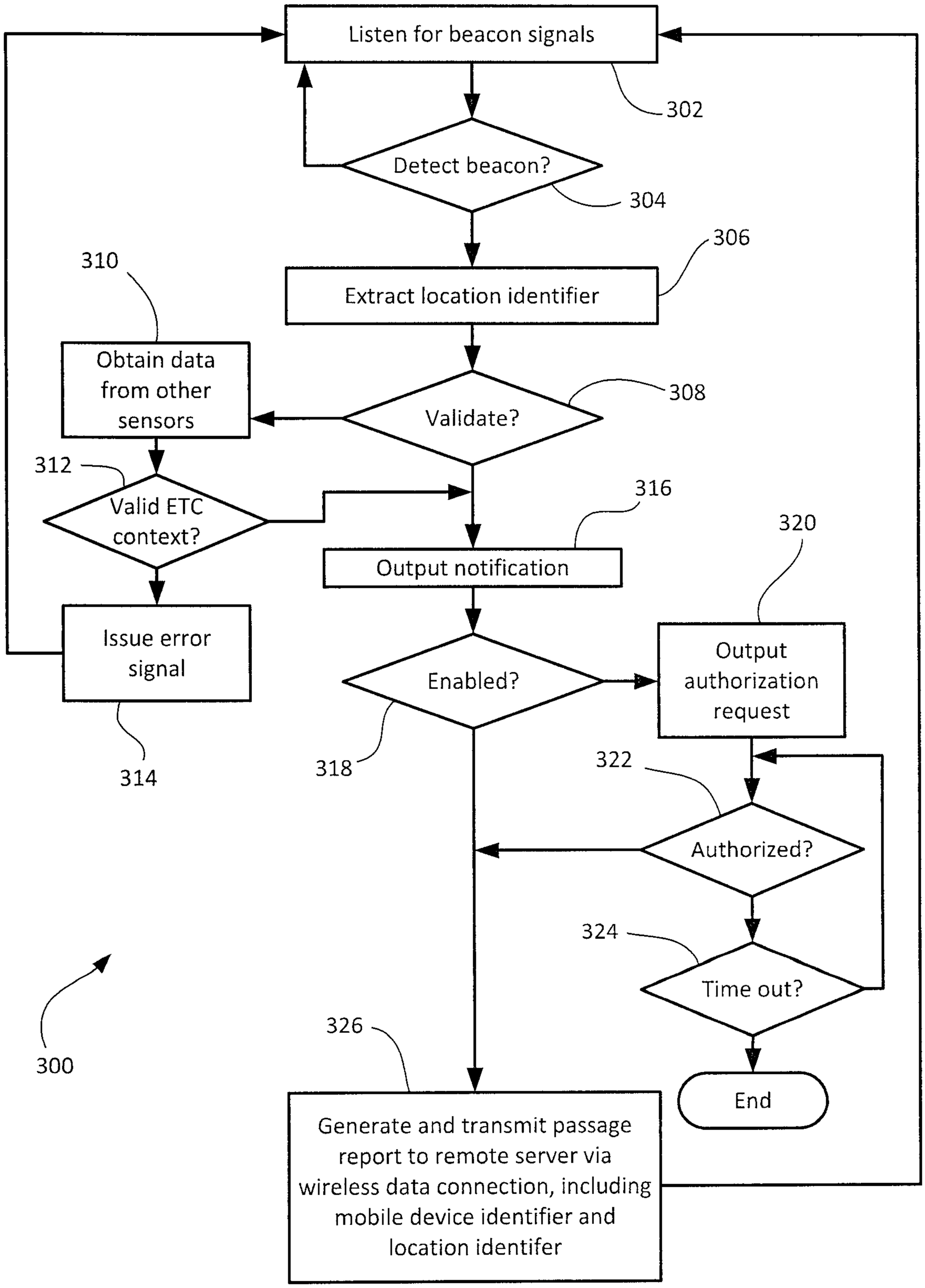
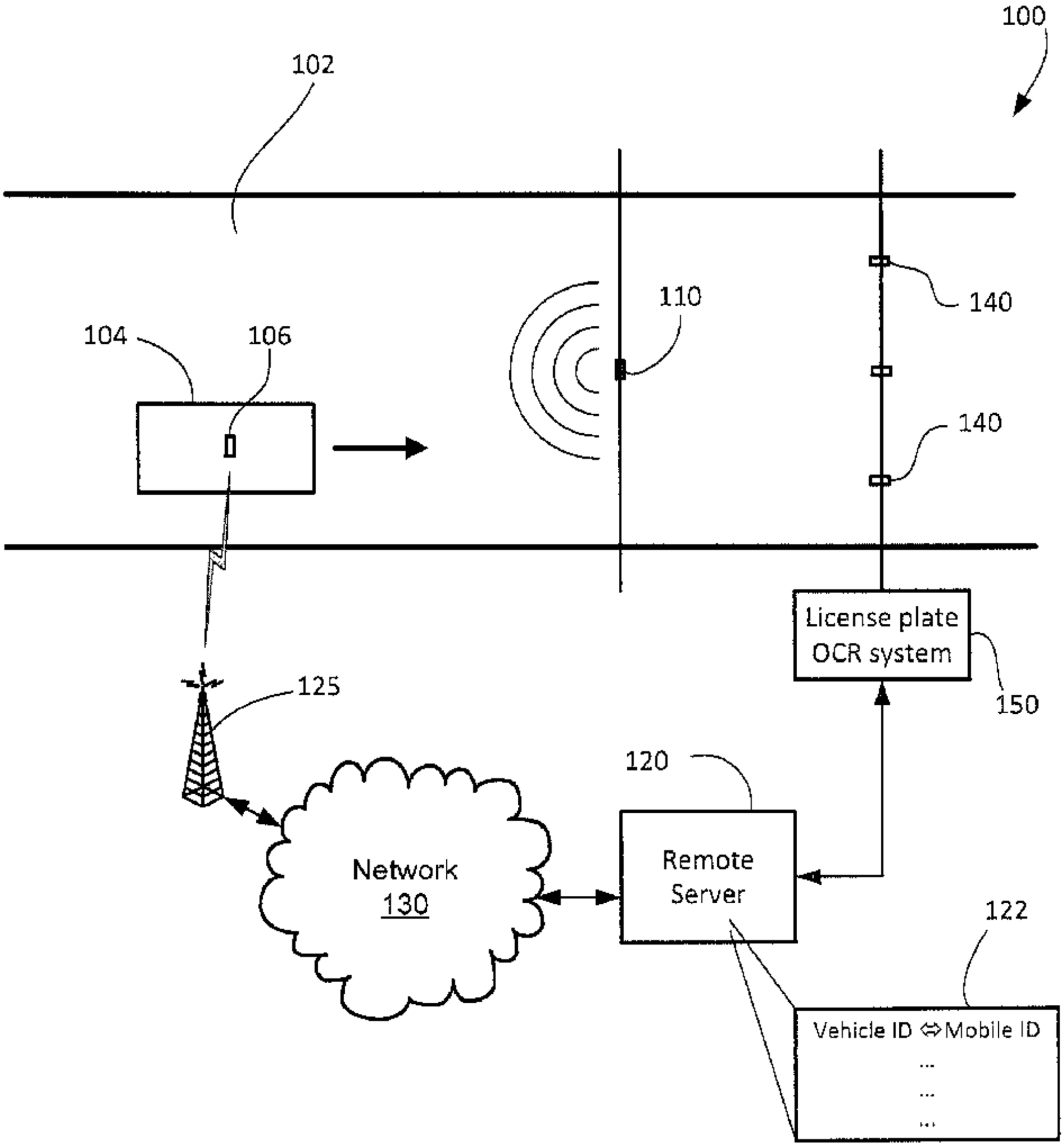

Listen for beacon signals
302
Detect beacon?
304
306
Extract location identifier
310
Obtain data from other sensors
308
Validate?
312
Valid ETC context?
316
Output notification
320
Issue error signal
Output authorization request
314
318
322
Authorized?
324
Time out?
326
End
300
Generate and transmit passage report to remote server via wireless data connection, including mobile device identifier and location identifer

Fig. 3


100
102
104
106
110
140
140
125
License plate
OCR system
150
120
Network
130
Remote
Server
122
Vehicle ID ⇔ Mobile ID
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