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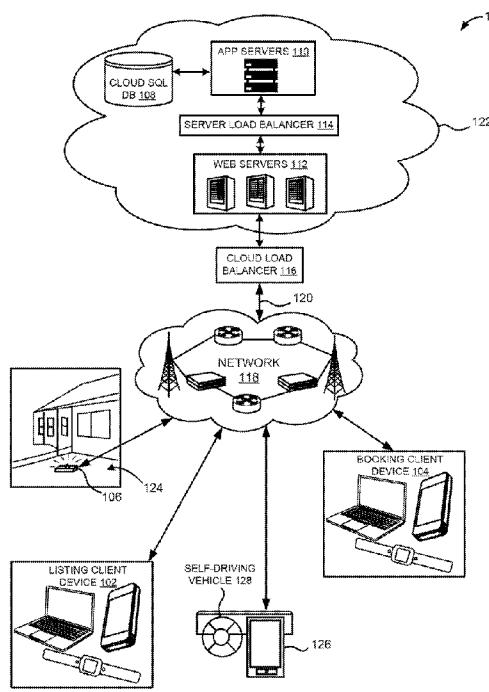
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[Continued on next page]

**(54) Title:** PARKING MANAGEMENT SYSTEM AND METHODS OF OPERATION THEREOF



**(57) Abstract:** A parking management system and methods of operation are disclosed. In one variation, a computer-implemented method comprises receiving positional data concerning a listing location from a listing client device; establishing a radius boundary based on the positional data; filtering one or more databases using the radius boundary to determine an amount of parking spaces listed and the amount of parking spaces reserved within a preset time period; calculating a location-specific transaction rate using the amount of parking spaces listed, the amount of parking spaces reserved, and the preset time period; determining a recommended listing price based on the location-specific transaction rate; and transmitting the recommended listing price to the listing client device.



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**TITLE OF THE INVENTION**  
**PARKING MANAGEMENT SYSTEM AND METHODS OF OPERATION**  
**THEREOF**

#### CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application No. 62/162,574 filed on May 15, 2015, the entirety of which is hereby incorporated by reference.

## TECHNICAL FIELD

[0002] This disclosure relates generally to the field of vehicle parking management and, more specifically, to an online parking marketplace and methods of operation thereof.

## BACKGROUND

[0003] Parking a vehicle in densely populated environments is often a frustrating experience due to the dearth of free parking spaces and the expense of private parking garages or lots. This is especially true in populated urban environments such as the downtowns of large municipalities (e.g., New York City, San Francisco, etc.). Moreover, parking is often in demand near destinations or event venues such as neighborhoods surrounding sports stadiums, concert halls, amusement parks, or beachfronts.

[0004] Additionally, the high price of real estate has motivated many property owners to seek out non-traditional ways for property owners to monetize their real property assets. For example, homeowners can often rent out rooms in their homes to tourists or travelers using an online home rental platform.

[0005] Therefore, a solution is needed for a parking management system to conveniently, securely and effectively allow property owners to rent out their available parking space(s) and for drivers seeking parking to reserve such parking spaces. In addition, such a solution should assist the property owner in determining an appropriate rental price for their parking spaces. Also, such a solution should be able to assist the property owner in maximizing their earning potential from such assets by ensuring

1 adequate turnover in parked vehicles and that empty parking spaces are occupied quickly  
2 and efficiently. Moreover, such a solution should also ensure that drivers vacate rented  
3 parking spaces in time so as not to inconvenience property owners who require such spaces  
4 and suggest appropriate penalty measures when drivers overstay their allotted parking  
5 times.

6

7 **SUMMARY**

8 **[0006]** A parking management system and methods of operation are disclosed. A  
9 computer-implemented method of managing parking reservations over a communications  
10 network can include receiving, in one or more databases stored in one or more memory  
11 units, positional data concerning a listing location. The method can also include  
12 establishing, using one or more processors of a computing system, a radius boundary based  
13 on the positional data stored in the one or more databases and filtering, using the one or  
14 more processors, the one or more databases using the radius boundary to determine an  
15 amount of parking spaces listed and the amount of parking spaces reserved within a preset  
16 time period. The method can also include calculating, using the one or more processors, a  
17 transaction rate using the amount of parking spaces listed, the amount of parking spaces  
18 reserved, and the preset time period and storing the transaction rate in the one or more  
19 databases. The method can also include determining, using the one or more processors, a  
20 recommended listing price based on the transaction rate and transmitting, over the  
21 communications network using one or more communication interfaces, the recommended  
22 listing price to a listing client device.

23 **[0007]** The method can also include receiving, over the communications network, one  
24 or more listing requests from one or more parking sensors. The method can also include  
25 receiving, over the communications network, one or more reservation requests from at least  
26 one of one or more booking client devices and one or more control units of a self-driving  
27 vehicle and updating, using the one or more processors, the amount of parking spaces listed  
28 and the amount of parking spaces reserved in the one or more databases using the one or  
29 more listing requests and the one or more reservation requests.

30 **[0008]** The one or more parking sensors can include a proximity detector, one or more  
31 sensor processors, a sensor communication interface, and a portable power supply. The one  
32 or more parking sensors can also include a positioning unit of a booking client device or  
33 the control unit of a self-driving vehicle.

1 [0009] The method can also include adding, using the one or more processors, a buffer  
2 period to a reservation period in response to receiving the reservation request from at least  
3 one of the booking client device and the control unit of the self-driving vehicle. The  
4 method can also include calculating, using the one or more processors, an average listing  
5 price based on listing prices stored in the one or more databases prior to determining the  
6 recommended listing price and determining, using the one or more processors, the  
7 recommended list price by calculating a listing multiplier using the transaction rate stored  
8 in the one or more databases and multiplying the listing multiplier by the average listing  
9 price.

10 [0010] The method can also include calculating the listing multiplier by applying, using  
11 the one or more processors, a logarithmic function to the transaction rate stored in the one  
12 or more databases when the transaction rate exceeds a rate threshold. The method can also  
13 include receiving timestamp data from one or more sensors in a vicinity of the listing  
14 location and storing the timestamp data in the one or more databases. The method can also  
15 include determining, using the one or more processors, an average park time using the  
16 timestamp data; and transmitting, over the communications network using the one or more  
17 communication interfaces, a recommended availability time calculated using the average  
18 park time to the listing client device. The one or more sensors can include a positioning  
19 unit of at least one of one or more booking client devices and one or more control units of a  
20 self-driving vehicle.

21 [0011] The method can also include receiving, over the communications network, a  
22 status update from a booking client device concerning an upcoming departure of a vehicle  
23 occupying a reserved parking space. The method can also include determining a real-time  
24 position of the booking client device in response to receiving the status update and  
25 querying a parking sensor in a vicinity of the reserved parking space in response to the  
26 status update received from the booking client device to confirm an occupancy status of the  
27 reserved parking space.

28 [0012] The method can also include calculating a penalty multiplier using the  
29 transaction rate based on the occupancy status of the reserved parking, calculating a penalty  
30 rate using the penalty multiplier and a listing price, and transmitting, over the  
31 communications network, the penalty rate to at least one of the booking client device and  
32 the listing client device.

33 [0013] A computing system to manage parking reservations over a communications  
34 network can include one or more communication interfaces, one or more memory units,

1 one or more processors executing computer-readable instructions stored in the one or more  
2 memory units to receive, in one or more databases stored in the one or more memory units,  
3 positional data concerning a listing location, establish a radius boundary based on the  
4 positional data stored in the one or more databases, and filter the one or more databases  
5 using the radius boundary to determine an amount of parking spaces listed and the amount  
6 of parking spaces reserved within a preset time period.

7 [0014] The computing system can also calculate a transaction rate using the amount of  
8 parking spaces listed, the amount of parking spaces reserved, and the preset time period  
9 and storing the transaction rate in the one or more databases, determine a recommended  
10 listing price based on the transaction rate, and transmit, over the communications network  
11 using the one or more communication interfaces, the recommended listing price to a listing  
12 client device.

13 [0015] A non-transitory computer readable medium can include computer executable  
14 instructions stored thereon executed by one or more processors, where the instructions  
15 include the steps of receiving, in one or more databases stored in one or more memory  
16 units, positional data concerning a listing location, establishing, using the one or more  
17 processors of a computing system, a radius boundary based on the positional data stored in  
18 the one or more databases, and filtering, using the one or more processors, the one or more  
19 databases using the radius boundary to determine an amount of parking spaces listed and  
20 the amount of parking spaces reserved within a preset time period. The instructions can  
21 also include the steps of calculating, using the one or more processors, a transaction rate  
22 using the amount of parking spaces listed, the amount of parking spaces reserved, and the  
23 preset time period and storing the transaction rate in the one or more databases,  
24 determining, using the one or more processors, a recommended listing price based on the  
25 transaction rate, and transmitting, over the communications network using one or more  
26 communication interfaces, the recommended listing price to a listing client device.

27 [0016] The methods, devices, or systems disclosed herein may be implemented in a  
28 variety of different ways. Certain variations have other steps or elements in addition to or  
29 in place of those mentioned above. The steps or elements will become apparent to those  
30 skilled in the art from the accompanying drawings or from the detailed description that  
31 follows.

32

#### 33 BRIEF DESCRIPTION OF THE DRAWINGS

34 [0017] Figure 1 illustrates a parking management system.

1 [0018] Figure 2A illustrates a variation of a server of the parking management system.

2 [0019] Figure 2B illustrates a variation of a client device of the parking management

3 system.

4 [0020] Figure 2C illustrates a variation of a parking sensor of the parking management

5 system.

6 [0021] Figure 3A illustrates a new listing graphical user interface (GUI) displayed on a

7 listing client device connected to the parking management system.

8 [0022] Figure 3B illustrates a listing information GUI displayed on a listing client

9 device connected to the parking management system.

10 [0023] Figure 4A illustrates a reservation request GUI displayed on a booking client

11 device connected to the parking management system.

12 [0024] Figure 4B illustrates a reservation status GUI displayed on a booking client

13 device connected to the parking management system.

14 [0025] Figure 5 illustrates a schematic of a booking vehicle detected by a parking

15 sensor at a listing location.

16 [0026] Figure 6A illustrates a variation of a listing database table stored in one or more

17 databases of the parking management system.

18 [0027] Figure 6B illustrates a variation of a reservation database table stored in one or

19 more databases of the parking management system.

20 [0028] Figure 7 illustrates examples of computer readable instructions and application

21 logic undertaken by the parking management system.

22 [0029] Figure 8 illustrates a variation of a map overview GUI displayed on a display

23 component connected to the parking management system.

24 [0030] Figure 9 illustrates a method of operation of the parking management system.

25

#### 26 DETAILED DESCRIPTION OF THE INVENTION

27 [0031] Figure 1 illustrates that a parking management system 100 can include one or

28 more listing client devices 102, booking client devices 104, parking sensors 106, or a

29 combination thereof communicatively coupled to one or more databases 108, application

30 servers 110, web servers 112, server load balancers 114, cloud load balancers 116, or a

31 combination thereof over a communications network 118.

32 [0032] The communications network 118 can be any multi-hop network that covers

33 regions, countries, continents, or a combination thereof. Examples of the communications

34 network 118 can include a cellular network such as a 3G network, a 4G network, a long-

1 term evolution (LTE) network; a sonic communication network; a satellite network; a wide  
2 area network such as the Internet, or a combination thereof. The web servers 112, the  
3 application servers 110, the server load balancers 114, the cloud load balancers 116, or a  
4 combination thereof can be communicatively coupled to the communications network 118  
5 through connections 120. The connections 120 can be wired connections, wireless  
6 connections, or a combination thereof.

7 [0033] The parking management system 100, or a portion therein, can include a web  
8 and/or mobile application hosted by a computing cloud 122 such as a Windows Azure™  
9 cloud, an Amazon Elastic Computer Cloud (Amazon EC2)™, a Google App Engine™, or  
10 a combination thereof. For example, the parking management system 100 can include a  
11 web and/or mobile application run on virtual machines hosted on the one or more  
12 application servers 110, web servers 112, or a combination thereof. In one variation, the  
13 computing cloud 122 can include the one or more application servers 110, web servers 112,  
14 databases 108, server load balancers 114, cloud load balancers, portions therein, or a  
15 combination thereof. The parking management system 100 can rely on processing and  
16 storage resources provided by the one or more application servers 110, web servers 112,  
17 databases 108, server load balancers 114, cloud load balancers 116, or a combination  
18 thereof.

19 [0034] The cloud load balancers 116 can provide traffic load balancing and distribute  
20 client requests among multiple web servers 112. The web servers 112 can include HTTP  
21 servers or rely on the computing cloud 122 to handle HTTP requests. The web servers 112  
22 can also be instantiated and managed by the computing cloud 122.

23 [0035] The server load balancer 114 can balance interactions between the web servers  
24 112 and the one or more application servers 110. The application servers 110 can handle  
25 application logic and interacts with the databases 108 to store data and application states.  
26 The web servers 112, the application servers 110, or a combination thereof can include rack  
27 mount servers, cluster servers, blade servers, main frames, dedicated desktops or laptops,  
28 or a combination thereof.

29 [0036] The databases 108 can be one or more SQL databases. The application servers  
30 110 can interface with one or more SQL servers managing the SQL databases. The  
31 application data and application states can be stored in a cloud managed SQL database. In  
32 other variations, the database 108 can be a document-oriented database including a NoSQL  
33 database such as a MongoDB® database.

1 [0037] The application servers 110, the web servers 112, the cloud load balancers 116, 2 the server load balancers 114, and the cloud SQL databases 108 can be any of the servers, 3 load balancers, and databases discussed in U.S. Patent No. 9,176,773, the content of which 4 is hereby incorporated by reference in its entirety.

5 [0038] The listing client devices 102, the booking client devices 104, or a combination 6 thereof can include a portable computing device such as a smartphone, a tablet, a laptop, a 7 smartwatch, a personal entertainment device, or a combination thereof. In other variations, 8 the listing client device 102, the booking client device 104, or a combination thereof can 9 include a desktop computer. The listing client device 102 can be used by a user of the 10 parking management system 100 to list a parking space for rental or lease by other users of 11 the parking management system 100. The booking client device 104 can be used by a user 12 of the parking management system 100 to book a parking space listed for rental or lease on 13 the parking management system 100.

14 [0039] The parking management system 100 can also include one or more parking 15 sensors 106. The parking sensors 106 can be located at a listing location 124. In one 16 variation, the parking sensor 106 can include the sensing components shown in Figure 2C. 17 In other variations, the parking sensor 106 can refer to a client device such as the listing 18 client device 102, the booking client device 104, or parts therein.

19 [0040] The parking management system 100 can be communicatively coupled to a 20 control unit 126 of a self-driving vehicle 128. For example, the parking management 21 system 100 can receive data or client requests from the control unit 126 of the self-driving 22 vehicle 128. The self-driving vehicle 128 can include motor vehicles or vessels having an 23 autonomous or semiautonomous driving mode. For example, the self-driving vehicle 128 24 can be vehicles disclosed or discussed in U.S. Patent No. 9,120,485, U.S. Patent No. 25 8,965,621, and U.S. Patent No. 8,954,217, the contents of which are hereby incorporated 26 by reference in their entireties.

27 [0041] Figure 2A illustrates that a server 200 of the parking management system 100 28 can have one or more processors 202, a memory 204, and a communication interface 206. 29 The processors 202 can be coupled to the memory 204 and the communication interface 30 206 through high-speed buses 208. The server 200 can represent any of the web servers 31 112, the application servers 110, or a combination thereof of Figure 1.

32 [0042] The processors 202 can include one or more central processing units (CPUs), 33 graphical processing units (GPUs), Application-Specific Integrated Circuits (ASICs), field- 34 programmable gate arrays (FPGAs), or a combination thereof. The processors 202 can

1 execute software or computer-readable instructions stored in the memory 204 to execute  
2 the methods or operations described herein. The processors 202 can be implemented in a  
3 number of different manners. For example, the processors 202 can include one or more  
4 embedded processors, processor cores, microprocessors, logic circuits, hardware finite state  
5 machines (FSMs), digital signal processors (DSPs), or a combination thereof. For example,  
6 the processors 202 can be 64-bit processors.

7 **[0043]** The memory 204 can store software, data, logs, or a combination thereof. The  
8 memory 204 can be an internal memory. Alternatively, the memory 204 can be an external  
9 memory, such as a memory residing on a storage node, a cloud server, or a storage server.  
10 The memory 204 can be a volatile memory or a non-volatile memory. For example, the  
11 memory 204 can be a nonvolatile storage such as non-volatile random access memory  
12 (NVRAM), Flash memory, disk storage, or a volatile storage such as static random access  
13 memory (SRAM). The memory 204 can be the main storage unit for the server 200.

14 **[0044]** The communication interface 206 can include one or more wired or wireless  
15 communication interfaces. For example, the communication interface 206 can be a network  
16 interface card of the server 200. The communication interface 206 can be a wireless  
17 modem or a wired modem. In one variation, the communication interface 206 can be a  
18 WiFi modem. In other variations, the communication interface 206 can be a 3G modem, a  
19 4G modem, an LTE modem, a Bluetooth® component, a radio receiver, an antenna, or a  
20 combination thereof. The server 200 can connect to or communicatively couple with the  
21 communications network 118 using the communication interface 206. The server 200 can  
22 transmit or receive packets or messages using the communication interface 206.

23 **[0045]** Figure 2B illustrates that a client device 210 of the parking management system  
24 100 can have a client processor 212, a client memory 214, a client communication unit 216,  
25 a locational unit 218 having a global positioning system (GPS) receiver, and a display 220.  
26 The client processor 212 can be coupled to the client memory 214, the client  
27 communication unit 216, and the locational unit 218 through high-speed buses 222.

28 **[0046]** The client processor 212 can include one or more CPUs, GPUs, ASICs, FPGAs,  
29 or a combination thereof. The client processor 212 can execute software stored in the client  
30 memory 214 to execute the methods described herein. The client processor 212 can be  
31 implemented in a number of different manners. For example, the client processor 212 can  
32 be an embedded processor, a processor core, a microprocessor, a logic circuit, a hardware  
33 FSM, a DSP, or a combination thereof. As a more specific example the client processor  
34 212 can be a 32-bit processor such as an ARM® processor.

1 [0047] The client memory 214 can store software, data, logs, or a combination thereof.  
2 In one variation, the client memory 214 can be an internal memory. In another variation,  
3 the client memory 214 can be an external storage unit. The client memory 214 can be a  
4 volatile memory or a non-volatile memory. For example, the client memory 214 can be a  
5 nonvolatile storage such as NVRAM, Flash memory, disk storage, or a volatile storage  
6 such as SRAM. The client memory 214 can be the main storage unit for the client device  
7 210.

8 [0048] The client communication unit 216 can be a wired or wireless communication  
9 interface. For example, the client communication unit 216 can be a network interface card  
10 of the client device 210. The client communication unit 216 can be a wireless modem or a  
11 wired modem. In one variation, the client communication unit 216 can be a WiFi modem.  
12 In other variations, the client communication unit 216 can be a 3G modem, a 4G modem,  
13 an LTE modem, a Bluetooth® component, a radio receiver, an antenna, or a combination  
14 thereof. The client device 210 can connect to or communicatively couple with the  
15 communications network 118 using the client communication unit 216. The client device  
16 210 can transmit or receive packets or messages using the client communication unit 216.

17 [0049] The locational unit 218 can include a GPS component such as the GPS receiver,  
18 an inertial unit, a magnetometer, a compass, or a combination thereof. The locational unit  
19 218 can receive GPS signals from a GPS satellite. The inertial unit can be implemented as  
20 a multi-axis accelerometer including a three-axis accelerometer, a multi-axis gyroscope  
21 including a three-axis MEMS gyroscope, or a combination thereof.

22 [0050] The display 220 can be a touchscreen display such as a liquid crystal display  
23 (LCD), a thin film transistor (TFT) display, an organic light-emitting diode (OLED)  
24 display, or an active-matrix organic light-emitting diode (AMOLED) display. In certain  
25 variations, the display 220 can be a retina display, a haptic touchscreen, or a combination  
26 thereof. For example, when the client device 210 is a smartphone, the display 220 can be  
27 the touchscreen display of the smartphone.

28 [0051] The client device 210 can refer to any of the listing client device 102, the  
29 booking client device 104, or a combination thereof. For purposes of the present disclosure,  
30 the client processor 212 can refer to a processor of the listing client device 102, the  
31 booking client device 104, or a combination thereof. Moreover, the client memory 214 can  
32 refer to a memory of the listing client device 102, the booking client device 104, or a  
33 combination thereof. In addition, the client communication unit 216 can refer to a  
34 communication unit of the listing client device 102, the booking client device 104, or a

1 combination thereof. Furthermore, the locational unit 218 can refer to a locational unit or  
2 GPS receiver of the listing client device 102, the booking client device 104, or a  
3 combination thereof. Additionally, the display 220 can refer to the display of the listing  
4 client device 102, the booking client device 104, or a combination thereof.

5 [0052] For example, the servers 200 and client devices 210 disclosed herein can  
6 include the type of computing systems and mobile computing devices disclosed or  
7 discussed in U.S. Patent No. 9,305,310, the content of which is hereby incorporated by  
8 reference in its entirety.

9 [0053] Figure 2C illustrates that the parking sensor 106 can include a sensor processor  
10 224, a sensor memory 226, a sensor communication interface 228, a proximity detector  
11 230, a portable power supply 232, or a combination thereof. In other variations, the parking  
12 sensor 106 can include a sensor locational unit 234 having a global positioning system  
13 (GPS) receiver, a camera unit 236, or a combination thereof. The sensor processor 224 can  
14 be coupled to the sensor memory 214, the sensor communication interface 228, the  
15 proximity detector 230, the portable power supply 232, or a combination thereof through  
16 high-speed buses 222.

17 [0054] The sensor processor 224 can include one or more CPUs, GPUs, ASICs,  
18 FPGAs, or a combination thereof. The sensor processor 224 can execute software stored in  
19 the sensor memory 226 to execute the methods or operations described herein. The sensor  
20 processor 224 can be implemented in a number of different manners. For example, the  
21 sensor processor 224 can include a processor core, a microprocessor, a logic circuit, a DSP,  
22 or a combination thereof. As a more specific example the sensor processor 224 can include  
23 a 16-bit or 32-bit processor such as an ARM™ processor.

24 [0055] The sensor memory 226 can store software, data, logs, or a combination thereof.  
25 In one variation, the sensor memory 226 can be an internal memory. In another variation,  
26 the sensor memory 226 can be an external storage unit. The sensor memory 226 can be a  
27 volatile memory or a non-volatile memory. For example, the sensor memory 226 can be a  
28 nonvolatile storage such as NVRAM, Flash memory, disk storage, or a volatile storage  
29 such as SRAM.

30 [0056] The sensor communication interface 228 can be a wired or wireless  
31 communication interface. For example, the sensor communication interface 228 can be a  
32 network interface card of the parking sensor 106. The sensor communication interface 228  
33 can be a wireless modem or a wired modem. In one variation, the sensor communication  
34 interface 228 can be a WiFi modem. In other variations, the sensor communication

1 interface 228 can be a 3G modem, a 4G modem, an LTE modem, a Bluetooth®  
2 component, a radio receiver, an antenna, or a combination thereof. The parking sensor 106  
3 can connect to or communicatively couple with the communications network 118 using the  
4 sensor communication interface 228. The parking sensor 106 can transmit or receive  
5 information or messages in the form of data packets using the sensor communication  
6 interface 228.

7 [0057] The proximity detector 230 can include an infrared (IR) light transceiver, an IR  
8 distance sensor, an ultrasonic transmitter and detector, or a combination thereof. The  
9 parking sensor 106 can use the proximity detector 230 to detect the presence of a vehicle in  
10 a certain vicinity of the parking sensor 106. For example, the parking sensor 106 can detect  
11 that a vehicle is near the parking sensor 106 when a portion of the vehicle, such as the  
12 chassis of the vehicle, covers or obscures the proximity detector 230 or a portion therein. In  
13 another variation, the parking sensor 106 can detect the presence of a vehicle when a part  
14 of the vehicle affects or interferes with a behavior of light or acoustic waves emitted,  
15 reflected, or received by the parking sensor 106.

16 [0058] The sensor locational unit 234 can include a GPS component such as a GPS  
17 receiver, an inertial unit, a magnetometer, a compass, or a combination thereof. The sensor  
18 locational unit 234 can receive GPS signals from a GPS satellite. The inertial unit can be  
19 implemented as a multi-axis accelerometer including a three-axis accelerometer, a multi-  
20 axis gyroscope including a three-axis MEMS gyroscope, or a combination thereof. The  
21 parking sensor 106 can also include a camera unit 236. The camera unit 236 can capture  
22 static images, video images, or a combination thereof and store the images in the sensor  
23 memory 226.

24 [0059] The sensor processor 224 can be coupled to the sensor memory 226, the sensor  
25 communication interface 228, the sensor locational unit 234, the proximity detector 230,  
26 and the camera unit 236 through high-speed buses 238.

27 [0060] Figure 3A illustrates that a listing user of the parking management system 100  
28 can list a parking space for rent or lease by applying a user input to a new listing graphical  
29 user interface (GUI) 300 displayed on a listing client device 102. The listing user can list  
30 the parking space by applying a user input to a button or link displayed as part of the new  
31 listing GUI 300. The listing user can transmit a listing request 304 to the application  
32 servers 110 in response to applying the user input to the button or link.

33 [0061] The listing request 304 can be transmitted as one or more communication  
34 packets, such as transmission control protocol (TCP) packets, containing a header and a

1 payload. The listing request 304 can be received by the web servers 112, the application  
2 servers 110, or a combination thereof and stored in the database 108.

3 [0062] The new listing GUI 300 can be rendered through an application 302. In one  
4 variation, the application 302 can be written using the Xcode™ programming language, the  
5 Swift™ programming language, or a combination thereof. In other variations, the  
6 application 302 can be written using the Java™ programming language, the Objective-C  
7 programming language, or a C programming language.

8 [0063] Figure 3B illustrates that the listing user can input information concerning the  
9 parking space through a listing information GUI 306. The listing user can enter a type 308  
10 of parking space, a listing location 310, a listing price 312, an availability window 314, or a  
11 combination thereof. The type 308 of parking space can include a driveway space, a  
12 parking space in a residential or commercial garage, a parking space in a parking lot, a  
13 front yard or back yard space, a curb space, a metered space, or a combination thereof.

14 [0064] The listing location 310 can include an address of a residence, building, or other  
15 location providing the parking space. The listing user can manually enter a geographic  
16 address for the listing location 310 through the listing information GUI 306. In this case,  
17 the application server 110 can transmit the geographic address to a map database, such as a  
18 Geographic Information System (GIS) database or a Google Maps® database and query the  
19 map database for positional coordinates corresponding to the geographic address. The  
20 application server 110 can then store the positional coordinates in the database 108. In  
21 another variation, the user can use the locational unit 218 of the listing client device 102 to  
22 provide positional coordinates for the listing location 310 when the user is at the listing  
23 location 310.

24 [0065] The listing price 312 can include an hourly rate or price requested by the user  
25 for the parking space. The availability window 314 can be a time window when the parking  
26 space is available for rent or lease. For example, the availability window 314 can range  
27 from 30 minutes to 30 days. The listing request 304 can include data concerning the type  
28 308 of parking space, the listing location 310, the listing price 312, the availability window  
29 314, or a combination thereof.

30 [0066] In other variations, the listing request 304 can be transmitted directly from the  
31 parking sensor 106. The parking sensor 106 can automatically transmit the listing request  
32 304 to the application servers 110 when the parking sensor 106 detects a vehicle has  
33 departed a parking space in the vicinity of the parking sensor 106. For example, the parking  
34 sensor 106 can be configured to store information concerning the listing location 310, the

1 listing price 312, the availability window 314, and the type 308 of listing in the sensor  
2 memory 226. The parking sensor 106 can automatically transmit a listing request 304  
3 containing such data or information as soon as the space is vacant. As a more specific  
4 example, the parking sensor 106 can be a sensor embedded in a driveway of a residence  
5 and the parking sensor 106 can transmit the listing request 304 as soon as a vehicle  
6 previously occupying the driveway vacates the driveway.

7 [0067] Figure 4A illustrates that a booking user of the parking management system 100  
8 can reserve a parking space listed by a listing user through a reservation request GUI 400.  
9 The booking user can reserve a parking space in a desired booking location 402 by  
10 manually entering a geographic address. In addition, the booking user can apply an input to  
11 a current location icon 404 displayed on the reservation request GUI 400 to prompt the  
12 locational unit 218 of the booking client device 104 to transmit the current geographic  
13 coordinates of the booking client device 104 to the application servers 110, the cloud-  
14 managed database 108, or a combination thereof. Moreover, the booking user can draw a  
15 radius boundary around a portion of a map graphic 408 displayed on the reservation request  
16 GUI 400.

17 [0068] The reservation request GUI 400 can display parking space listings 406 in list  
18 form or overlaid on the map graphic 408. Each space listings 406 can include information  
19 concerning the listing location 310, the listing price 312, or the availability window 314  
20 associated with the space listing 406. Once the booking user has found a desired parking  
21 space, the booking user can select the space listing 406 to place a reservation request 410.  
22 For example, the booking user can apply a user input to an icon associated with the space  
23 listing 406 and then press a reservation button to place the reservation request 410.

24 [0069] Figure 4B illustrates that the booking user can view a current status of a  
25 reserved parking space 414 once a reservation has been placed using the parking  
26 management system 100. The booking user can view the current status of the reservation  
27 through a reservation status GUI 412. The reservation status GUI 412 can include a timer  
28 416 counting down a reservation period 418. In other variations, the reservation status GUI  
29 412 can display an accrued cost of the reservation. The booking user can apply a user input  
30 to a departure button to transmit a status update 420 to the parking management system 100  
31 that a booking vehicle 422 is either in the process of departing the reserved parking space  
32 414 or has departed the reserved parking space 414.

33 [0070] In another variation, the booking client device 104 can receive one or more  
34 messages or notifications from the parking management system 100 concerning the

1 expiration of the reservation period 418. For example, the messages can include a text  
2 messages, such as a Short Message Service (SMS) message, a Multimedia Messaging  
3 Service (MMS) message, or a combination thereof. The messages can include a link to  
4 prompt the booking client device 104 to open the application 302 and display the  
5 reservation status GUI 412. The link can be a deep linking uniform resource locator (URL)  
6 address directing the booking client device 104 to open a specific page of the application  
7 302.

8 [0071] In other variations, the booking vehicle 422 can be a self-driving vehicle 128  
9 and the control unit 126 of the self-driving vehicle 128 can automatically transmit the  
10 reservation request 410 without input from the booking user. The reservation request 410  
11 can include preset information or data concerning the parking space desired by an occupant  
12 or owner of the self-driving vehicle 128 including a listing location 310, the listing price  
13 312, the type 308 of listing, or a combination thereof. The parking management system 100  
14 can receive the reservation request 410 directly from the control unit 126 of the self-driving  
15 vehicle 128 and parse the reservation request 410 for data or information concerning the  
16 listing location 310, the listing price 312, the type 308 of listing, or a combination thereof.  
17 The parking management system 100 can then filter the one or more databases 108 to  
18 select a listing 406 matching the criteria included in the reservation request 410.

19 [0072] The parking management system 100 can also receive the status update 420  
20 directly from the control unit 126 of the self-driving vehicle 128 without input from the  
21 booking user. The status update 420 can indicate that the self-driving vehicle 128 is  
22 departing or has departed the reserved parking space 414.

23 [0073] The listing client device 102, the booking client device 104, the parking sensors  
24 106, or a combination thereof can encrypt requests, including a listing request 304 or a  
25 reservation request 410, before transmitting the request. The listing client device 102, the  
26 booking client device 104, the parking sensors 106, or a combination thereof can encrypt  
27 the requests using an encryption protocol such as a secure hash algorithm (SHA). The  
28 encryption protocol can be a SHA-256 hash function, a SHA-384 hash function, or any  
29 type of SHA-2 certificate or function. The listing client device 102, the booking client  
30 device 104, the parking sensors 106, or a combination thereof can securely transmit the  
31 encrypted request over the communications network 118 to servers or other devices in the  
32 computing cloud 122.

33 [0074] Figure 5 illustrates that the parking management system 100 can query a  
34 parking sensor 106 in a vicinity of the reserved parking space 414 in response to the status

1 update 420 received from the booking client device 104 to confirm an occupancy status of  
2 the booking vehicle 422. For example, the application server 110 can ping the parking  
3 sensor 106 and request the last proximity measurement from the sensor memory 226. The  
4 application server 100 can also ping the parking sensor 106 to activate the proximity  
5 detector 230 of the parking sensor 106 and query the parking sensor 106 for a real-time  
6 proximity measurement.

7 [0075] In another variation, the parking management system 100 can activate the  
8 camera unit 236 of the parking sensor 106 and instruct the camera unit 236 to capture  
9 images of the environment surrounding the reserved parking space 414. The parking sensor  
10 106 can then transmit the images to the one or more application servers 110 for analysis by  
11 an image recognition protocol executed by the one or more processors 202.

12 [0076] In variations where the parking sensor 106 refers to a listing client device 102 or  
13 portions therein, the application servers 110 can transmit one or more messages to the  
14 listing client device 102 to confirm that the booking vehicle 422 has departed the reserved  
15 parking space 414.

16 [0077] Figure 6A illustrates that the database 108 can store in one or more database  
17 tables 600 positional data 602 concerning a listing location 310. The one or more databases  
18 108 can include a cloud managed SQL database such as Microsoft Azure® database. The  
19 one or more databases 108 can be stored in a memory 204 of the computing cloud 122.

20 [0078] One or more servers responsible for managing the database 108 can receive the  
21 positional data 602 from a map database, such as a Google Maps® database, after querying  
22 the map database with a geographic address received from the booking client device 104.  
23 In other variations, the web servers 112, the application servers 110, or a combination  
24 thereof can receive the positional data 602 directly from the locational unit 218 of the  
25 booking client device 104.

26 [0079] The positional data 602 can include latitudinal and longitudinal coordinates. For  
27 example, the positional data 602 can include latitude and longitude coordinates in the  
28 Universal Traverse Mercator (UTM) coordinate system.

29 [0080] The database 108 can store the positional data 602 concerning the listing  
30 location 310 in one or more listing database tables 604. The application servers 110 can  
31 also parse the listing request 304 received from the booking client device 104, the control  
32 unit 126 of the self-driving vehicle 128, or a combination thereof and store data or  
33 information concerning the type 308 of parking space, the listing price 312, the availability  
34 window 314, or a combination thereof in the listing database tables 604.

1 [0081] Figure 6B illustrates that the database 108 can also include one or more  
2 reservation database tables 606. The reservation database tables 606 can include data or  
3 information obtained from the reservation request 410 including the type 308 of parking  
4 space, the reservation period 418, positional data 602 concerning the reserved parking  
5 space 414, or a combination thereof. The reservation database tables 606 can also include  
6 data or information concerning an occupancy status 608 of the reserved parking space 414,  
7 a buffer period 610, and/or an actual parking time 614 based on timestamps 612 received  
8 from the listing client device 102 or the parking sensors 106.

9 [0082] The parking management system 100 can determine the occupancy status 608  
10 of a reserved parking space 414 by querying or pinging one or more parking sensors 106 in  
11 a vicinity of the reserved parking space 414. In another variation, the parking management  
12 system 100 can determine the occupancy status 608 of a reserved parking space 414 by  
13 receiving a confirmation signal or message from a listing client device 102. For example,  
14 the parking management system 100 can transmit a text message to the listing client device  
15 102 containing a link directing the listing user to confirm that a booking vehicle 422 has  
16 vacated the reserved parking space 414.

17 [0083] The parking management system 100 can also add a buffer period 610 to the  
18 reservation period 418 of a reservation request 410 stored in the reservation database tables  
19 606. The parking management system 100 can set the buffer period 610 based on the length  
20 of the reservation period 418. For example, the parking management system 100 can set the  
21 buffer period 610 as half the length of the reservation period 418 initially requested by a  
22 booking user. In another variation, the parking management system 100 can automatically  
23 set a buffer period 610 of one hour for all reservations exceeding 30 minutes.

24 [0084] The parking management system 100 can permit the booking user to extend the  
25 reservation period 418 up to the end of the buffer period 610. For example, when a booking  
26 user initially requests a reservation period 418 of one hour, the parking management  
27 system 100 can automatically set the buffer period 610 for this reservation as 30 minutes.  
28 In this case, the parking management system 100 can allow the booking user to park the  
29 user's vehicle in the reserved parking space 414 for up to 1.5 hours. The parking  
30 management system 100 can charge the booking user an additional fee for the extension.  
31 Upon reaching the end of the buffer period 610, the parking management system 100 can  
32 prevent the booking user from extending the reservation period 418 any longer and require  
33 the booking user to initiate a new reservation request 410.

1 [0085] When a buffer period 610 is added to a reservation period 418, the parking  
2 management system 100 can ensure the listing 406 does not appear as an entry in any  
3 database tables listing available or unoccupied parking spaces during the pendency of the  
4 reservation period 418 and the buffer period 610. The parking management system 100 can  
5 add a buffer period 610 to all reservation requests 410 received from booking client devices  
6 104 and/or the control units 126 of all self-driving vehicles 128.

7 [0086] The databases 108 can also store timestamps 612 received from listing client  
8 devices 102, booking client devices 104, parking sensors 106, or a combination thereof.  
9 The listing client devices 102, the parking sensors 106, or a combination thereof can  
10 transmit timestamps 612 in connection with the transmission of listing requests 304. The  
11 booking client devices 104 can transmit timestamps 612 in connection with the  
12 transmission of reservation requests 410. The parking sensors 106, the listing client devices  
13 102, or a combination thereof can also transmit timestamps 612 in connection with the  
14 transmission of status updates 420 or when the occupancy status 608 of a reserved parking  
15 space 414 changes.

16 [0087] The reservation database table 606 can also store actual parking times 614 based  
17 on the timestamps 612 received. The parking management system 100 can determine the  
18 actual parking times 614 based on timestamps 612 received when a booking vehicle 422  
19 occupies the reserved parking space 414 and the same booking vehicle 422 vacates the  
20 reserved parking space 414. The actual parking times 614 can differ from the reservation  
21 periods 418 included in the reservation requests 410.

22 [0088] The database tables 600 can also keep track of a listing count 616 and a  
23 reservation count 618. The listing count 616 can correspond to the number or amount of  
24 parking spaces listed using the parking management system 100 during a given time  
25 period. The reservation count 618 can correspond to the number or amount of parking  
26 spaces reserved using the parking management system 100 during a given time period. For  
27 example, the listing count 616 can correspond to the number of listing requests 304  
28 received by the parking management system 100 within a given time period. The  
29 reservation count 618 can correspond to the number of reservation requests 410 received  
30 by the parking management system 100 within a given time period. The parking  
31 management system 100 can continuously update the one or more database tables 600,  
32 including the listing count 616 and the reservation count 618, based on the number of  
33 listing requests 304 and the number of reservation requests 410 received.

1 [0089] Figure 7 illustrates that one or more processors 202 of the parking management  
2 system 100 can execute computer-readable instructions stored in a memory 204 of the  
3 computing cloud 122 in order to determine a recommended list price 700. The parking  
4 management system 100 can determine the recommended list price 700 in response to a  
5 listing request 304 received from a listing client device 102.

6 [0090] The parking management system 100 can determine the recommended list price  
7 700 by first establishing a radius boundary 702 based on the positional data 602 received  
8 from the listing client device 102. The parking management system 100 can retrieve the  
9 positional data 602 stored in the one or more databases 108 and establish the radius  
10 boundary 702 using the coordinates of the position data 602 as the center point. For  
11 example, the parking management system 100 can establish the radius boundary 702 as the  
12 boundary or demarcation of a one mile or one kilometer radius. The parking management  
13 system 100 can set the size of the radius boundary 702 based on a geographic criterion such  
14 as a size of the municipality or geographic region in which the positional data 602 is  
15 located. The parking management system 100 can also adjust the radius boundary 702  
16 based on a time-of-day, a day-of-the-week, a month, a season, or a combination thereof.

17 [0091] The parking management system 100 can then filter the one or more databases  
18 108 using the radius boundary 702 and a preset time period 704. The preset time period  
19 704 can range from 10 minutes to 10 days. In other variations, the preset time period 704  
20 can be more than 10 days. The preset time period 704 can be adjusted by an administrator  
21 of the parking management system 100. The parking management system 100 can filter the  
22 one or more listing database tables 604 using the radius boundary 702 and the positional  
23 data 602 of all other listing requests 304 received within the preset time period 704 to  
24 determine the listing count 616. The parking management system 100 can also filter the  
25 one or more reservation database tables 606 using the radius boundary 702 and the  
26 positional data 602 of all reservation requests 410 received within the preset time period  
27 704 to determine the reservation count 618.

28 [0092] The parking management system 100 can then calculate a transaction rate 706  
29 using the listing count 616 and the reservation count 618. The transaction rate 706 can be  
30 calculated by summing the listing count 616 and the reservation count 618. The transaction  
31 rate 706 can be calculated by summing the listing count 616 and the reservation count 618  
32 to yield a total count and then dividing the total count by the preset time period 704. The  
33 transaction rate 706 can also be equivalent to either the reservation count 618 or the listing  
34 count 616. The parking management system 100 can store the transaction rate 706 in one or

1 more database tables 600 and update the transaction rate 706 as new listing requests 304  
2 are received.

3 [0093] The transaction rate 706 can also be calculated by taking a ratio of the  
4 reservation count 618 and the listing count 616 and or by dividing the reservation count  
5 618 by the listing count 616. The parking management system 100 can also calculate the  
6 transaction rate 706 by adding the ratio of the reservation count 618 and the listing count  
7 616 to any of the listing count 616, the reservation count 618, or a sum thereof.

8 [0094] The parking management system 100 can then calculate a listing multiplier 708  
9 using the transaction rate 706. The parking management system 100 can calculate the  
10 listing multiplier 708 by applying a first logarithmic function 710 to the transaction rate  
11 706 when the transaction rate 706 exceeds a first rate threshold 712. For example, the first  
12 rate threshold 712 can be a rate of 10 listings and/or requests per minute and the parking  
13 management system 100 can apply a  $\log_{10}$  function to the transaction rate 706 when the  
14 transaction rate 706 exceeds the first rate threshold 712. When the transaction rate 706 does  
15 not exceed the first rate threshold 712, the parking management system 100 can apply a  
16 second logarithmic function 714 to the transaction rate 706 when the transaction rate 706  
17 exceeds a second rate threshold 716. The first rate threshold 712 can be different from the  
18 second rate threshold 716. For example, the first rate threshold 712 can be greater than the  
19 second rate threshold 716. The second logarithmic function 714 can be a natural log  
20 function.

21 [0095] The parking management system 100 can determine the recommended listing  
22 price 700 by multiplying the listing multiplier 708 by an average listing price 718. The  
23 parking management system 100 can calculate the average listing price 718 by taking an  
24 average of the listing prices 312 stored in the filtered instance of the listing database tables  
25 604. After calculating the recommended listing price 700, the application servers 110 can  
26 transmit the recommended listing price 700 to the listing client device 102 over the  
27 communications network 118.

28 [0096] The parking management system 100 can also determine an average park time  
29 720 based on the actual parking times 614 stored in the filtered instance of the reservation  
30 database table 606. The parking management system 100 can then transmit a recommended  
31 availability time 724 to the listing client device 102 equivalent to the average park time  
32 720. In other variations, the parking management system 100 can multiply the average park  
33 time 720 by a multiplier to yield the recommended availability time 724.

1 [0097] The parking management system 100 can also ensure a booking user does not  
2 abuse the system by occupying a reserved parking space 414 past the end of the reservation  
3 period 418. The parking management system 100 can receive, over the communications  
4 network 118, a status update 420 concerning a departure or upcoming departure of a  
5 booking vehicle 422 from a reserved parking space 414.

6 [0098] The parking management system 100 can determine a real-time position of the  
7 booking client device 104 associated with the booking vehicle 422 in response to receiving  
8 the status update 420. The parking management system 100 can determine a real-time  
9 position 724 of the booking client device 104 by querying a map database such as a Google  
10 Maps® database. In another variation, the parking management system 100 can determine  
11 a real-time position 724 of the booking client device 104 by directly tracking a locational  
12 unit 218 of the booking client device 104.

13 [0099] When the real-time position 724 of the booking client device 104 is not in a  
14 vicinity of the listing location 310 of the reserved parking space 414, such as when the  
15 booking client device 104 is outside the radius boundary 702, the parking management  
16 system 100 can query the parking sensor 106 in the vicinity of the reserved parking space  
17 414 to confirm the occupancy status 608 of the reserved parking space 414. In another  
18 variation, the parking management system 100 can query the listing client device 102 to  
19 confirm the occupancy status 608 of the reserved parking space 414 by requesting the  
20 listing user enter a user input to confirm the departure of the booking vehicle 422. In other  
21 variations, when the booking vehicle 422 is a self-driving vehicle 128, the parking  
22 management system 100 can ping the control unit 126 of the self-driving vehicle 128 for a  
23 real-time position of the self-driving vehicle 128.

24 [0100] The parking management system 100 can calculate a penalty rate 726 using a  
25 penalty multiplier 728. In one variation, the penalty multiplier 728 can be equivalent to the  
26 listing multiplier 708. In other variations, the penalty multiplier 728 can be greater than the  
27 listing multiplier 708, such as double the value of the listing multiplier 708. The parking  
28 management system 100 can calculate the penalty rate 726 by multiplying the listing price  
29 312 by the penalty multiplier 728. The parking management system 100 can transmit, over  
30 the communications network 118, the penalty rate 726 to the booking client device 104, the  
31 listing client device 102, or a combination thereof.

32 [0101] Figure 8 illustrates that the parking management system 100 can determine a  
33 causal point-of-interest (POI) 800 using the transaction rate 706 and positional data 602  
34 included in the listing requests 304 and reservation requests 410 received by the parking

1 management system 100 within a preset time period 704. The parking management system  
2 100 can determine the causal POI 800 when the transaction rate 706 within a certain radius  
3 boundary 702 exceeds a rate threshold such as five or ten listings and/or requests per  
4 minute. The radius boundary 702 can be established when the parking management system  
5 100 receives the first listing request 304 or reservation request 410.

6 [0102] The causal POI 800 can be a location or venue causing a surge or sudden  
7 increase in demand for parking within a vicinity of the causal POI 800. For example, the  
8 causal POI 800 can include a sports stadium, a concert hall, a nightclub, a movie theater, a  
9 museum, or a restaurant. The causal POI 800 can also include a location of an event such  
10 as a site of a farmer's market, a political gathering, or a parade route.

11 [0103] The parking management system 100 can determine the causal POI 800 by  
12 calculating a centroid of a polygon created by the positional coordinates of listing requests  
13 304 or reservation requests 410 received within a preset time period 704. For example,  
14 three reservation requests 410 can be received within a 60 second period and the parking  
15 management system 100 can calculate the centroid of a triangle having vertices at the three  
16 desired booking locations 402 included in the three reservation requests 410.

17 [0104] The parking management system 100 can also determine the causal POI 800  
18 using a request trajectory 802. The request trajectory 802 can be the trajectory or direction  
19 of travel of a vehicle or other mode of transportation carrying a booking client device 104.  
20 In other variations, the request trajectory 802 can be the trajectory or direction of travel of a  
21 self-driving vehicle 128 transmitting a reservation request 410.

22 [0105] When the parking management system 100 determines the location of the causal  
23 POI 800, the parking management system 100 can send one or more notifications,  
24 messages, or alerts to user client devices in the vicinity of the causal POI 800 to alert such  
25 users to list their parking spaces using the parking management system 100. The parking  
26 management system 100 can send notifications, messages, or alerts to client devices of  
27 users who have previously listed their parking spaces using the parking management  
28 system 100. The parking management system 100 can also send notifications, messages, or  
29 alerts to user client devices along the request trajectory 802 or along a route leading to the  
30 causal POI 800.

31 [0106] Figure 9 illustrates that a computer-implemented method 900 of managing  
32 parking reservations over the communications network 118 can include receiving, in one or  
33 more databases 108 stored in one or more memory units 204, positional data 602  
34 concerning a listing location 310. The positional data 602 or address of the listing location

1 310 can be transmitted by a listing client device 102 in step 902. The positional data 602 or  
2 address of the listing location 310 can also be transmitted by a parking sensor 106 in step  
3 904. When the listing client device 102 or parking sensor 106 transmits an address, the  
4 application servers 110 can query a map or GIS database for the positional coordinates of  
5 the address in step 906. The application servers 110 can interact with the map or GIS  
6 database through a map API such as the Google Maps® API.

7 [0107] The method 900 can also include establishing, using one or more processors  
8 202, a radius boundary 702 based on the positional data 602 stored in the one or more  
9 databases 108 in step 908. The method 900 can also include filtering, using the one or more  
10 processors 202, the one or more databases 108 using the radius boundary 702 to determine  
11 the listing count 616 representing an amount of parking spaces listed and the reservation  
12 count 618 representing the amount of parking spaces reserved within a preset time period  
13 704 in step 910.

14 [0108] The method 900 can also include calculating, using the one or more processors  
15 108, a transaction rate 706 using the listing count 616, the reservation count 618, and the  
16 preset time period 704 and storing the transaction rate 706 in the one or more databases 108  
17 in step 912. The method 900 can also include calculating an average listing price 718 in  
18 step 914. The method 900 can also include calculating a listing multiplier 708 in step 916.  
19 The method 900 can include determining, using the one or more processors 108, a  
20 recommended listing price 700 based on the average listing price 718 and the listing  
21 multiplier 708. The method 900 can include transmitting the recommended listing price  
22 700 to the listing client device 102 over the communications network 118 in step 920.

23 [0109] The method 900 can also include the application servers 110 receiving a status  
24 update 420 concerning the departure of a booking vehicle 422 from a reserved parking  
25 space 414. For example, a booking client device 104 can transmit the status update 420 in  
26 step 922. The method 900 can include determining a real-time position 724 of the booking  
27 client device 104 in response to receiving the status update 420 in step 924. The method  
28 900 can also include querying a parking sensor 106 in the vicinity of the reserved parking  
29 space 414 in response to the status update to confirm an occupancy status 608 of the  
30 reserved parking space 414 in step 926. The method 900 can also include calculating a  
31 penalty rate 726 using a penalty multiplier 728 when the system determines the booking  
32 vehicle 422 has overstayed the end of the reservation period 418 in step 928.

33 [0110] The system and methods described herein provides an improvement in the way  
34 parking data or information is managed and stored in a cloud managed database. In

1 addition, by calculating a recommended listing price 700 based on a transaction rate 706  
2 corresponding to the rate at which parking listings are added and reservation requests are  
3 received, the system provides an improvement in the field of parking management beyond  
4 recommending prices based on static inventory levels.

5 [0111] A number of variations have been described. Nevertheless, it will be understood  
6 by one of ordinary skill in the art that various modifications may be made without  
7 departing from the spirit and scope of the variations. In addition, the flowcharts or logic  
8 flows depicted in the figures do not require the particular order shown, or sequential order,  
9 to achieve desirable results. In addition, other steps or operations may be provided, or steps  
10 or operations may be eliminated, from the described flows, and other components may be  
11 added to, or removed from, the described systems. Accordingly, other variations are within  
12 the scope of the following claims.

13 [0112] It will be understood by one of ordinary skill in the art that the various methods  
14 disclosed herein may be embodied in a non-transitory readable medium, machine-readable  
15 medium, and/or a machine accessible medium comprising instructions compatible,  
16 readable, and/or executable by a processor or processing unit of a machine, device, or  
17 computing device. The structures and modules in the figures may be shown as distinct and  
18 communicating with only a few specific structures and not others. The structures may be  
19 merged with each other, may perform overlapping functions, and may communicate with  
20 other structures not shown to be connected in the figures. Accordingly, the specification  
21 and/or drawings may be regarded in an illustrative rather than a restrictive sense.

22

## CLAIMS

We claim:

1. A computer-implemented method of managing parking reservations over a communications network, the method comprising:
  - receiving, in one or more databases stored in one or more memory units, positional data concerning a listing location;
  - establishing, using one or more processors of a computing system, a radius boundary based on the positional data stored in the one or more databases;
  - filtering, using the one or more processors, the one or more databases using the radius boundary to determine an amount of parking spaces listed and the amount of parking spaces reserved within a preset time period;
  - calculating, using the one or more processors, a transaction rate using the amount of parking spaces listed, the amount of parking spaces reserved, and the preset time period and storing the transaction rate in the one or more databases;
  - determining, using the one or more processors, a recommended listing price based on the transaction rate; and
  - transmitting, over the communications network using one or more communication interfaces, the recommended listing price to a listing client device.
2. The computer-implemented method of claim 1, further comprising:
  - receiving, over the communications network, one or more listing requests from one or more parking sensors;
  - receiving, over the communications network, one or more reservation requests from at least one of one or more booking client devices and one or more control units of a self-driving vehicle; and
  - updating, using the one or more processors, the amount of parking spaces listed and the amount of parking spaces reserved in the one or more databases using the one or more listing requests and the one or more reservation requests.
3. The computer-implemented method of claim 2, wherein the one or more parking sensors comprise a proximity detector, one or more sensor processors, a sensor communication interface, and a portable power supply.
4. The computer-implemented method of claim 2, further comprising adding, using the one or more processors, a buffer period to a reservation period in response to receiving the reservation request from at least one of the booking client device and the control unit of the self-driving vehicle.

1        5. The computer-implemented method of claim 1, further comprising:  
2                calculating, using the one or more processors, an average listing price based on  
3                listing prices stored in the one or more databases prior to determining the  
4                recommended listing price; and  
5                determining, using the one or more processors, the recommended list price by  
6                calculating a listing multiplier using the transaction rate stored in the one or  
7                more databases and multiplying the listing multiplier by the average listing  
8                price.

9        6. The computer-implemented method of claim 5, wherein calculating the listing  
10        multiplier includes applying, using the one or more processors, a logarithmic function  
11        to the transaction rate stored in the one or more databases when the transaction rate  
12        exceeds a rate threshold.

13        7. The computer-implemented method of claim 1, further comprising:  
14                receiving timestamp data from one or more sensors in a vicinity of the listing  
15                location and storing the timestamp data in the one or more databases;  
16                determining, using the one or more processors, an average park time using the  
17                timestamp data; and  
18                transmitting, over the communications network using the one or more  
19                communication interfaces, a recommended availability time calculated using the  
20                average park time to the listing client device.

21        8. The computer-implemented method of claim 7, wherein the one or more sensors  
22        comprise a positioning unit of at least one of one or more booking client devices and  
23        one or more control units of a self-driving vehicle.

24        9. The computer-implemented method of claim 1, further comprising:  
25                receiving, over the communications network, a status update from a booking client  
26                device concerning an upcoming departure of a vehicle occupying a reserved  
27                parking space;  
28                determining a real-time position of the booking client device in response to  
29                receiving the status update; and  
30                querying a parking sensor in a vicinity of the reserved parking space in response to  
31                the status update received from the booking client device to confirm an  
32                occupancy status of the reserved parking space.

33        10. The computer-implemented method of claim 9, further comprising:

1 calculating a penalty multiplier using the transaction rate based on the occupancy  
2 status of the reserved parking;  
3 calculating a penalty rate using the penalty multiplier and a listing price; and  
4 transmitting, over the communications network, the penalty rate to at least one of  
5 the booking client device and the listing client device.

6 11. A computing system to manage parking reservations over a communications  
7 network, the system comprising:  
8 one or more communication interfaces;  
9 one or more memory units;  
10 one or more processors executing computer-readable instructions stored in the one  
11 or more memory units to:  
12 receive, in one or more databases stored in the one or more memory units,  
13 positional data concerning a listing location;  
14 establish a radius boundary based on the positional data stored in the one or  
15 more databases;  
16 filter the one or more databases using the radius boundary to determine an  
17 amount of parking spaces listed and the amount of parking spaces  
18 reserved within a preset time period;  
19 calculate a transaction rate using the amount of parking spaces listed, the  
20 amount of parking spaces reserved, and the preset time period and  
21 storing the transaction rate in the one or more databases;  
22 determine a recommended listing price based on the transaction rate; and  
23 transmit, over the communications network using the one or more  
24 communication interfaces, the recommended listing price to a listing  
25 client device.

26 12. The system of claim 11, further comprising:

27 one or more parking sensors;  
28 wherein the one or more processors further execute computer-readable instructions  
29 to:  
30 receive, over the communications network, one or more listing requests  
31 from the one or more parking sensors;  
32 receive, over the communications network, one or more reservation requests  
33 from at least one of one or more booking client devices and one or more  
34 control units of a self-driving vehicle; and

1 update the amount of parking spaces listed and the amount of parking lists  
2 reserved in the one or more databases using the one or more listing  
3 requests and the one or more reservation requests.

4 13. The system of claim 12, wherein the one or more parking sensors comprise:  
5 a proximity detector;  
6 one or more sensor processors;  
7 a sensor communication interface; and  
8 a portable power supply.

9 14. The system of claim 12, wherein the one or more processors further execute  
10 computer-readable instructions to add a buffer period to a reservation period in  
11 response to receiving the reservation request from at least one of the booking client  
12 device and the control unit of the self-driving vehicle.

13 15. The system of claim 11, wherein the one or more processors further execute  
14 computer-readable instructions to:

15 calculate an average listing price based on listing prices stored in the one or more  
16 databases prior to determining the recommended listing price; and  
17 determine the recommended list price by calculating a listing multiplier using the  
18 transaction rate stored in the one or more databases and multiplying the listing  
19 multiplier by the average listing price.

20 16. The system of claim 15, wherein the one or more processors further execute  
21 computer-readable instructions to calculate the listing multiplier by applying a  
22 logarithmic function to the transaction rate stored in the one or more databases when  
23 the transaction rate exceeds a rate threshold.

24 17. The system of claim 11, wherein the one or more processors further execute  
25 computer-readable instructions to:

26 receive timestamp data from one or more sensors in a vicinity of the listing location  
27 and storing the timestamp data in the one or more databases;  
28 determine an average park time using the timestamp data; and  
29 transmit, over the communications network using the one or more communication  
30 interfaces, a recommended availability time calculated using the average park  
31 time to the listing client device.

32 18. The system of claim 17, wherein the one or more sensors comprise a positioning  
33 unit of at least one of one or more booking client devices and one or more control units  
34 of a self-driving vehicle.

1        19. The system of claim 11, wherein the one or more processors further execute  
2        computer-readable instructions to:  
3            receive, over the communications network, a status update from a booking client  
4            device concerning a departure status of a vehicle occupying a reserved parking  
5            space;  
6            determine a real-time position of the booking client device in response to receiving  
7            the status update; and  
8            query a parking sensor in a vicinity of the reserved parking space in response to the  
9            status update received from the booking client device to confirm an occupancy  
10           status of the reserved parking space.

11        20. The system of claim 19, wherein the one or more processors further execute  
12        computer-readable instructions to:  
13            calculate a penalty multiplier using the transaction rate based on the occupancy  
14            status of the reserved parking;  
15            calculate a penalty rate using the penalty multiplier and a listing price; and  
16            transmit, over the communications network, the penalty rate to at least one of the  
17            booking client device and the listing client device.

18        21. A non-transitory computer readable medium comprising computer executable  
19        instructions stored thereon executed by one or more processors, wherein the  
20        instructions comprise:  
21            receiving, in one or more databases stored in one or more memory units, positional  
22            data concerning a listing location;  
23            establishing, using the one or more processors of a computing system, a radius  
24            boundary based on the positional data stored in the one or more databases;  
25            filtering, using the one or more processors, the one or more databases using the  
26            radius boundary to determine an amount of parking spaces listed and the  
27            amount of parking spaces reserved within a preset time period;  
28            calculating, using the one or more processors, a transaction rate using the amount of  
29            parking spaces listed, the amount of parking spaces reserved, and the preset  
30            time period and storing the transaction rate in the one or more databases;  
31            determining, using the one or more processors, a recommended listing price based  
32            on the transaction rate; and  
33            transmitting, over the communications network using one or more communication  
34            interfaces, the recommended listing price to a listing client device.

1        22. The non-transitory computer readable medium of claim 21, wherein the instructions  
2        further comprise:

3            receiving, over the communications network, one or more listing requests from one  
4            or more parking sensors;  
5            receiving, over the communications network, one or more reservation requests from  
6            at least one of one or more booking client devices and one or more control units  
7            of a self-driving vehicle; and  
8            updating, using the one or more processors, the amount of parking spaces listed and  
9            the amount of parking lists reserved in the one or more databases using the one  
10           or more listing requests and the one or more reservation requests.

11        23. The non-transitory computer readable medium of claim 22, wherein the one or  
12        more parking sensors comprise a proximity detector, one or more sensor processors, a  
13        sensor communication interface, and a portable power supply.

14        24. The non-transitory computer readable medium of claim 22, wherein the instructions  
15        further comprise adding, using the one or more processors, a buffer period to a  
16        reservation period in response to receiving the reservation request from at least one of  
17        the booking client device and the control unit of the self-driving vehicle.

18        25. The non-transitory computer readable medium of claim 21, wherein the instructions  
19        further comprise:

20            calculating, using the one or more processors, an average listing price based on  
21            listing prices stored in the one or more databases prior to determining the  
22            recommended listing price; and

23            determining, using the one or more processors, the recommended list price by  
24            calculating a listing multiplier using the transaction rate stored in the one or  
25            more databases and multiplying the listing multiplier by the average listing  
26            price.

27        26. The non-transitory computer readable medium of claim 25, wherein the instructions  
28        further comprise calculating the listing multiplier includes applying, using the one or  
29        more processors, a logarithmic function to the transaction rate stored in the one or more  
30        databases when the transaction rate exceeds a rate threshold.

31        27. The non-transitory computer readable medium of claim 21, wherein the instructions  
32        further comprise:

33            receiving timestamp data from one or more sensors in a vicinity of the listing  
34            location and storing the timestamp data in the one or more databases;

1 determining, using the one or more processors, an average park time using the  
2 timestamp data; and  
3 transmitting, over the communications network using the one or more  
4 communication interfaces, a recommended availability time calculated using the  
5 average park time to the listing client device.

6 28. The non-transitory computer readable medium of claim 27, wherein the one or  
7 more sensors comprise a positioning unit of at least one of one or more booking client  
8 devices and one or more control units of a self-driving vehicle.

9 29. The non-transitory computer readable medium of claim 21, wherein the instructions  
10 further comprise:

11 receiving, over the communications network, a status update from a booking client  
12 device concerning an upcoming departure of a vehicle occupying a reserved  
13 parking space;

14 determining a real-time position of the booking client device in response to  
15 receiving the status update; and

16 querying a parking sensor in a vicinity of the reserved parking space in response to  
17 the status update received from the booking client device to confirm an  
18 occupancy status of the reserved parking space.

19 30. The non-transitory computer readable medium of claim 29, wherein the instructions  
20 further comprise:

21 calculating a penalty multiplier using the transaction rate based on the occupancy  
22 status of the reserved parking;

23 calculating a penalty rate using the penalty multiplier and a listing price; and  
24 transmitting, over the communications network, the penalty rate to at least one of  
25 the booking client device and the listing client device.

26

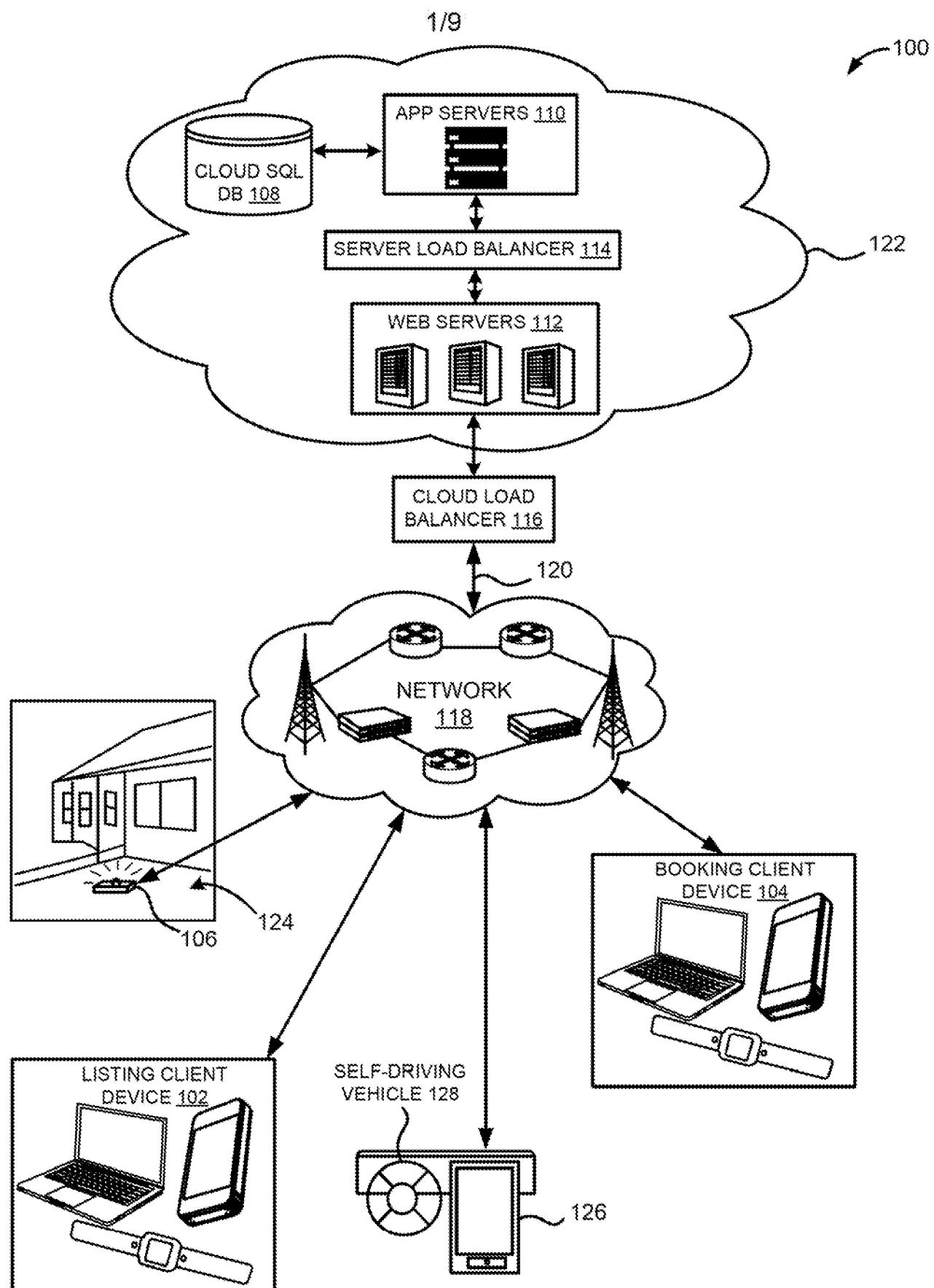
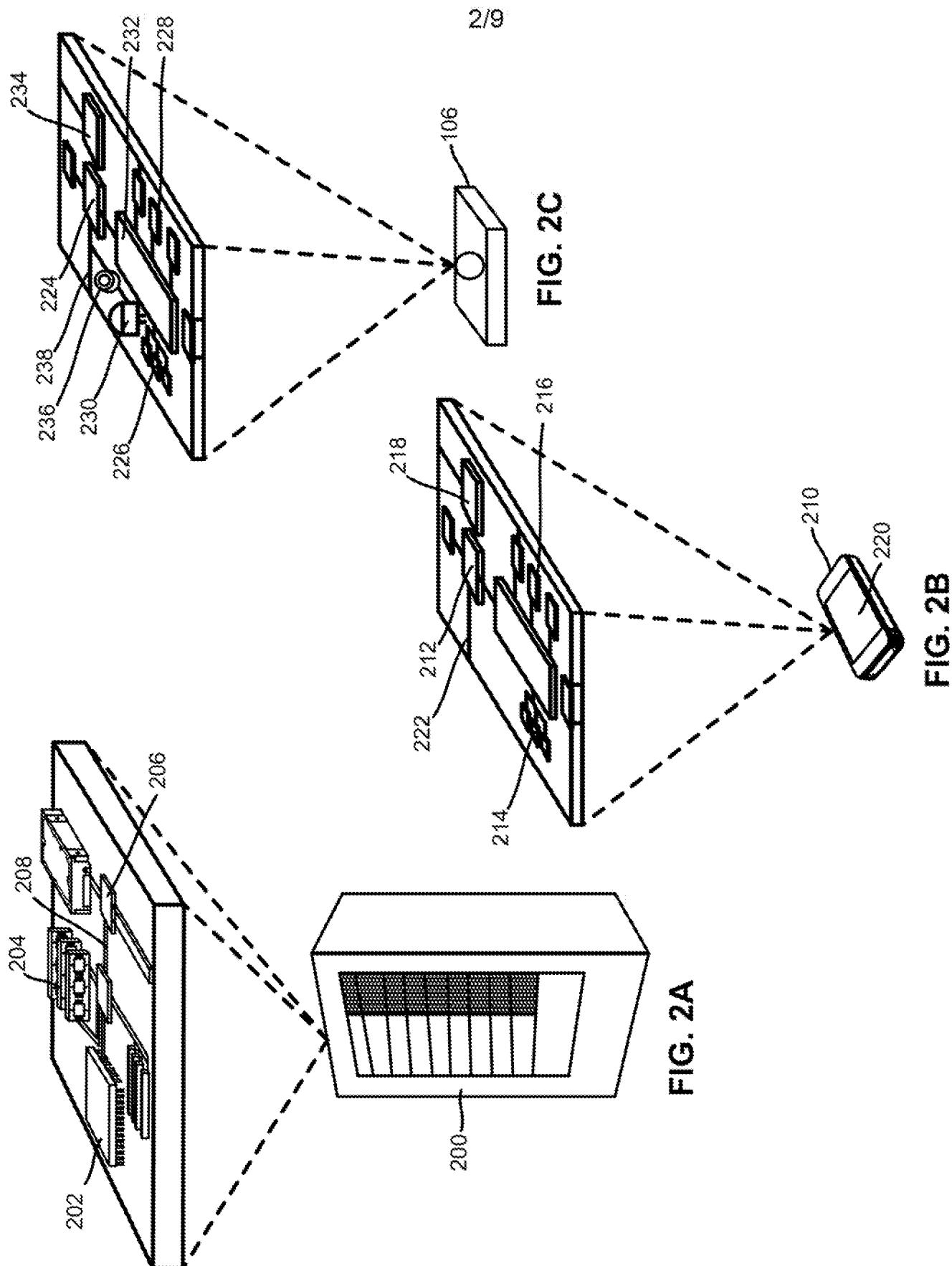


FIG. 1



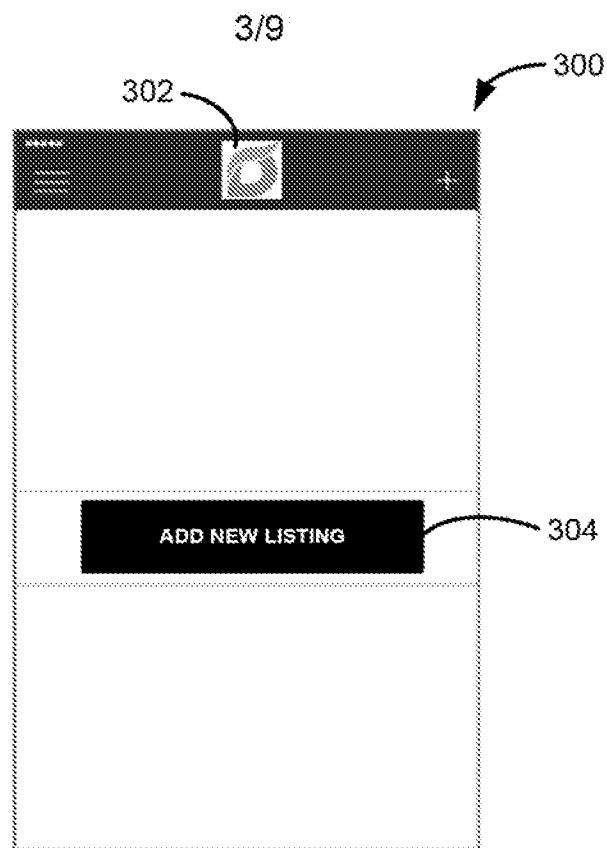


FIG. 3A

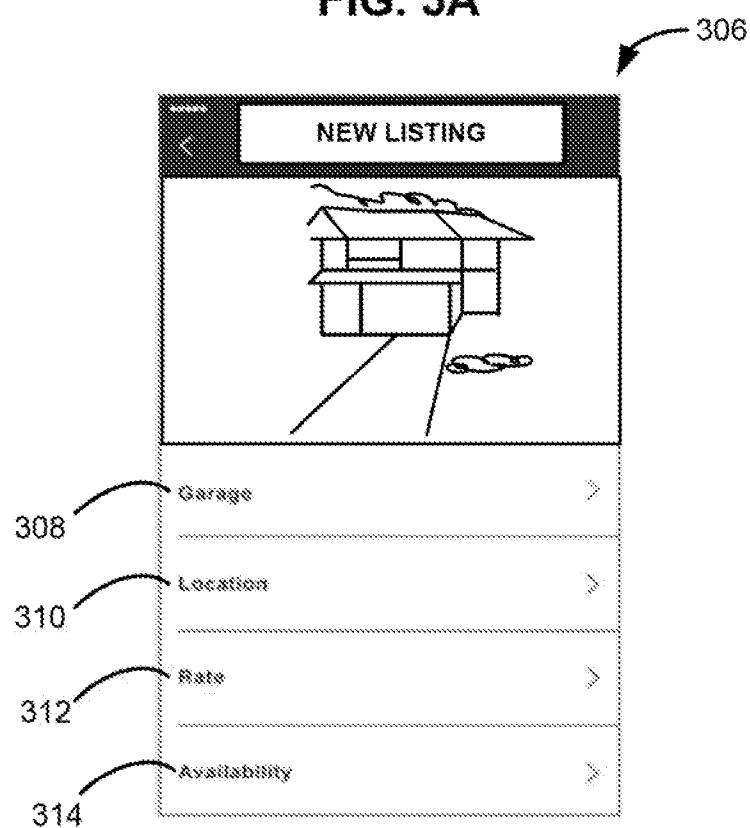


FIG. 3B

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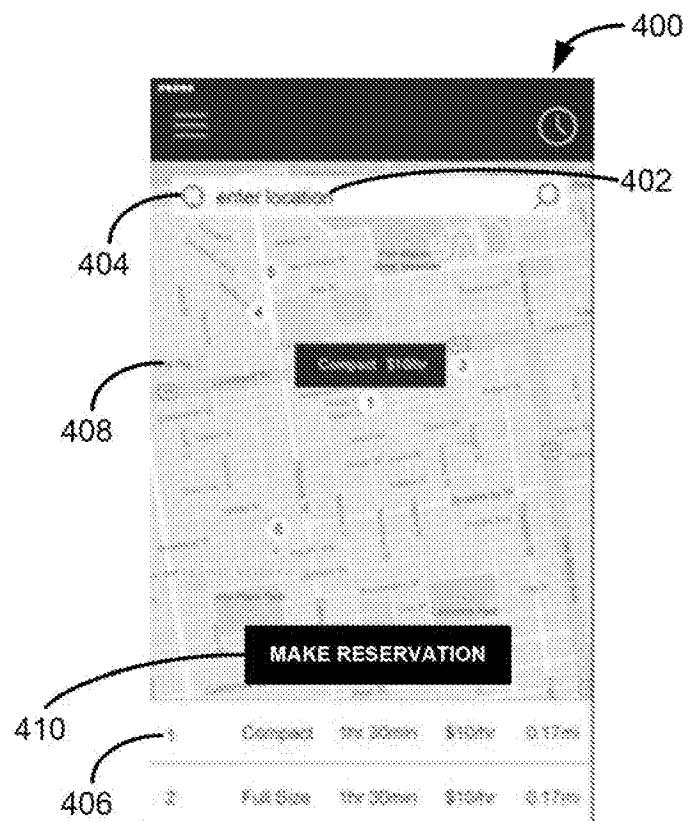


FIG. 4A

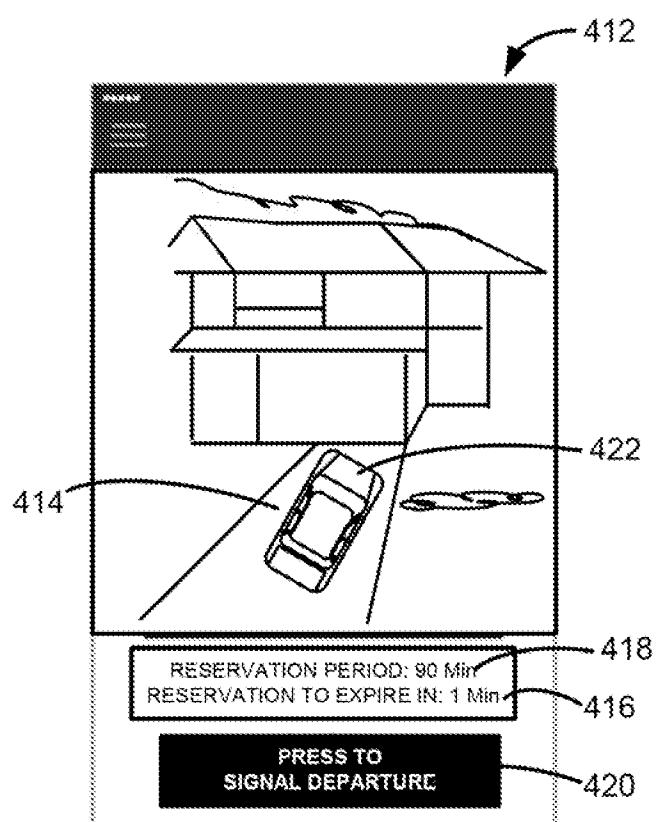
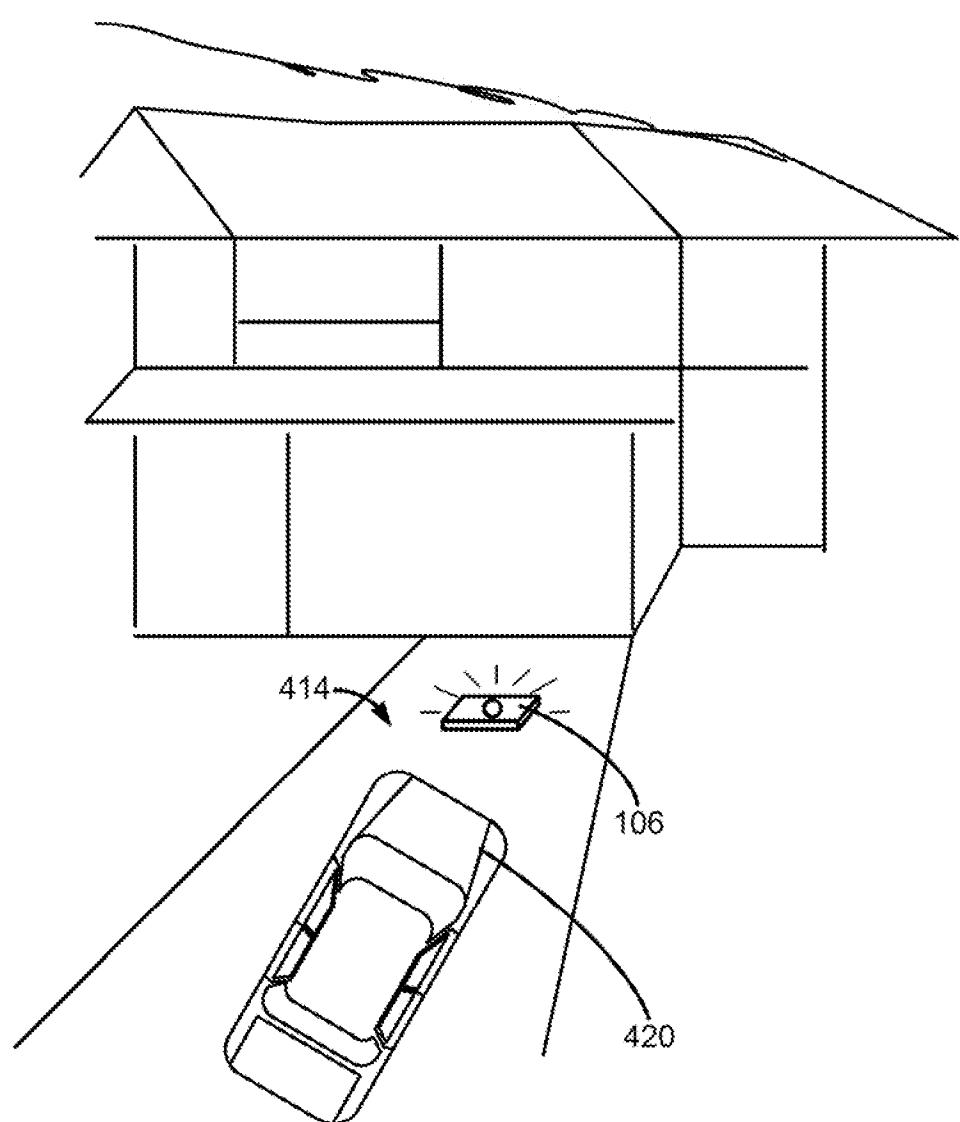


FIG. 4B

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**FIG. 5**

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600 → 308 → 602 → 604 → 612 → 312

#	USER ID	TYPE	LAT,LONG /UTM/GPS	STATUS	REQUEST SOURCE	• • •	LIST TIME	LIST PRICE
001	242345	GRG	37° 4' 31.3" N 122° 2' 38.3" W	RSVD	PARK SENSOR	• • •	2016-05-09 13:14:07 UTC	\$20/hr
002	262345	DWY	(24.2744, -100.405)	AVAIL	MOBILE DEVICE	• • •	2016-05-09 14:11:05 UTC	\$5/hr
003	134516	GRG	10 N 593353.6m E. 423034.8m N	OCCP	PARK SENSOR	• • •	2016-05-09 12:10:01 UTC	\$20/hr
004	538970	DWY	(39.3344, -121.405)	AVAIL	PARK SENSOR	• • •	2016-05-09 14:15:32 UTC	\$18/hr
005	346945	DWY	37° 4' 32.3" N 122° 2' 37.3" W	OCCP	MOBILE DEVICE	• • •	2016-05-09 12:41:02 UTC	\$16/hr
•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•
999	389712	GRG	(20.2744, -90.405)	AVAIL	PARK SENSOR	• • •	2016-05-09 12:23:41 UTC	\$12/hr

616

612



#	USER ID	TYPE	LAT,LONG /UTM/GPS	STATUS	REQUEST SOURCE	• • •	LIST TIME	LIST PRICE
001	242345	DWY	37° 4' 31.3" N 122° 2' 38.3" W	RSVD	PARK SENSOR	• • •	2016-05-09 13:14:07 UTC	\$20/hr
002	125467	GRG	37° 3' 30.3" N 122° 8' 31.3" W	RSVD	PARK SENSOR	• • •	2016-05-09 13:10:21 UTC	\$17/hr
003	346945	DWY	37° 4' 31.3" N 122° 2' 38.3" W	OCCP	MOBILE DEVICE	• • •	2016-05-09 12:41:02 UTC	\$16/hr

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FIG. 6A

308

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610

#	USER ID	TYPE	LAT,LONG /UTM/GPS	OCCUP. STATUS	RSV PERIOD	• • •	PARK TIME	BUFFER
001	462311	GRG	39° 4' 31.3" N 102° 2' 38.3" W	EMPTY	1 HR	• • •	IN: N/A OUT: N/A	0.5 HR
002	111567	DWY	37° 2' 24.3" N 122° 9' 30.3" W	EMPTY	2 HR	• • •	IN: N/A OUT: N/A	1 HR
003	302942	DWY	37° 4' 31.3" N 122° 2' 38.3" W	OCCP	1.5 HR	• • •	IN: 2016-05-09 12:55:08 UTC OUT: N/A	0.75 HR

618

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FIG. 6B

```

702 Longitude: 37.794434
    Latitude: -122.395243
    Radius: 1 km
    ***Filter park_listings DB TABLE***
    SELECT
        FROM park_listings
        WHERE (
704    POW( 69.1 * ( Longitude - 37.794434 ) * cos( -122.395243 / 57.3 ) ) , 2 ) + POW( ( 69.1 * ( Latitude - -122.395243 ) ) ,
2 )
    ) < ( 1 * 1 );
    WHEN ( DATEADD ( minute, -60, GETDATE () ) )
    :
    :
708    Recommend_Price = List_Multipl * Avg_Price
    List_Multipl = IF Tranct_Rate > Tranct_Thrshd_1, THEN
710        List_Multipl = LOG(Tranct_Rate), ELSE
712        Tranct_Rate > Tranct_Thrshd_2, THEN
714            List_Multipl = LN(Tranct_Rate), ELSE Tranct_Rate = List_Multipl
716
718        Tranct_Rate = COUNT(Park_List, < 60 min AND < 1km radius) + COUNT(Park_Rsv, < 60 min
        AND < 1 km radius) OR COUNT(Park_Rsv, < 60 min AND < 1 km radius) / COUNT(Park_List)
720        Avg_Price = SUM(List_Price, < 1 km radius) / COUNT(Park_List, 1 km radius)
722        Recommend_Prk_Window = Avg_Prk_Time
        Avg_Prk_Time = SUM(Prk_Time, < 10 hrs AND < 1km radius) / COUNT(Park_Rsv, < 10 hrs AND < 1km
        radius)
420
        :
        :
        IF OnTimeDepart_Status = TRUE, THEN
            CurrentPosition = getCurrentPosition(USER_ID), IF CurrentPosition > 1km radius,
724            var map = new google.maps.Map(document.getElementById('map'), {
                zoom: 25,
                mapTypeId: google.maps.MapTypeId.ROADMAP
            });
            var marker = null;
            function autoUpdate() {
                navigator.geolocation.getCurrentPosition(function(position) {
                    var newPoint = new google.maps.LatLng(position.coords.latitude,
                        position.coords.longitude);
                    if (marker) {
                        marker.setPosition(newPoint);
                    }
                    else {
                        marker = new google.maps.Marker({
                            position: newPoint,
                            map: map
                        });
                        map.setCenter(newPoint);
                    });
                    setTimeout(autoUpdate, 1000); } autoUpdate();
726
        THEN
            DISPLAY(Recommend_Penalty_Rate),
            Recommend_Penalty_Rate = Penalty_Multipl * Recommend_Price
            Penalty_Multipl = List_Multipl * LOG( Current_Time_sec - Exp_Rsvd_Time_sec )

```

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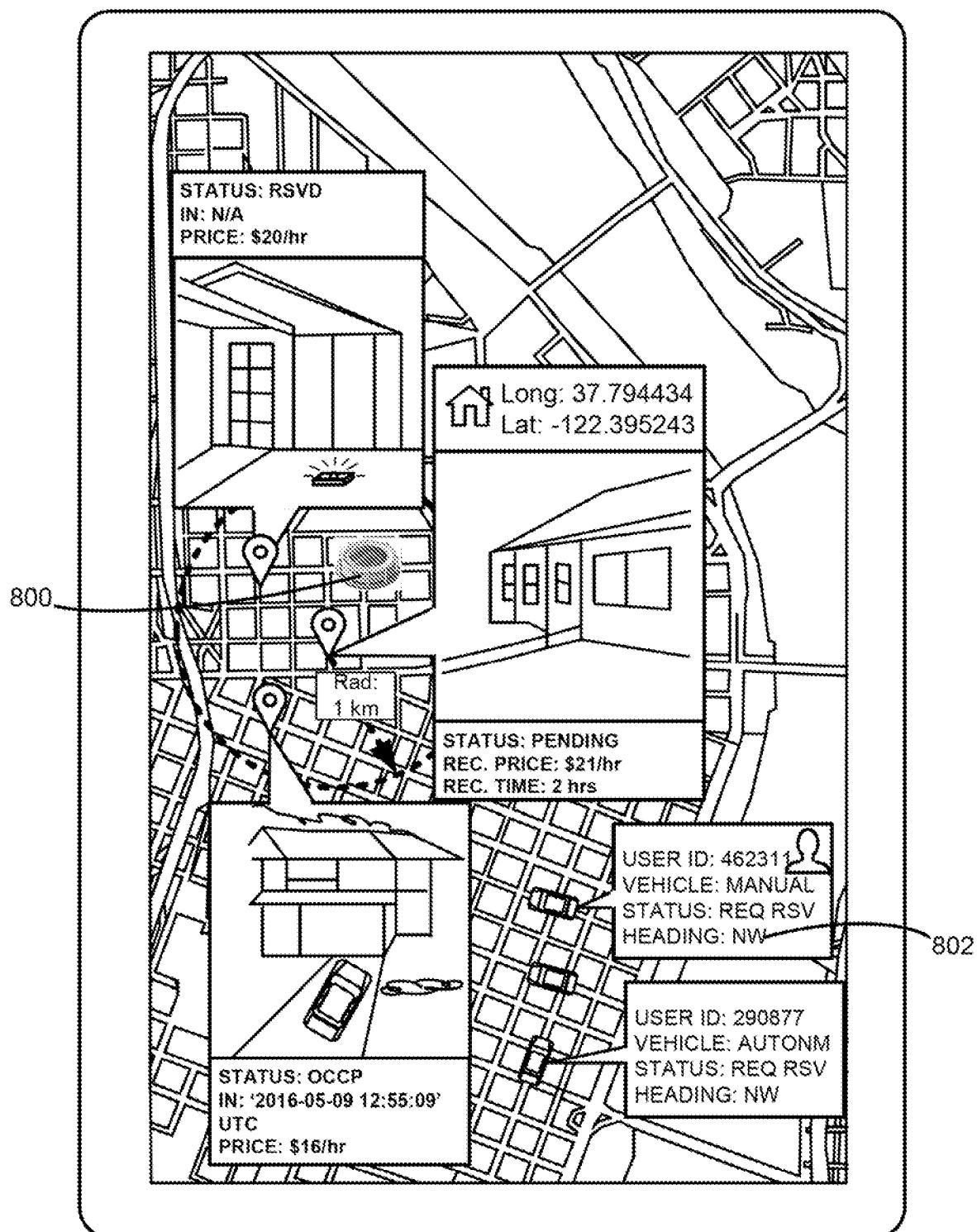


FIG. 8

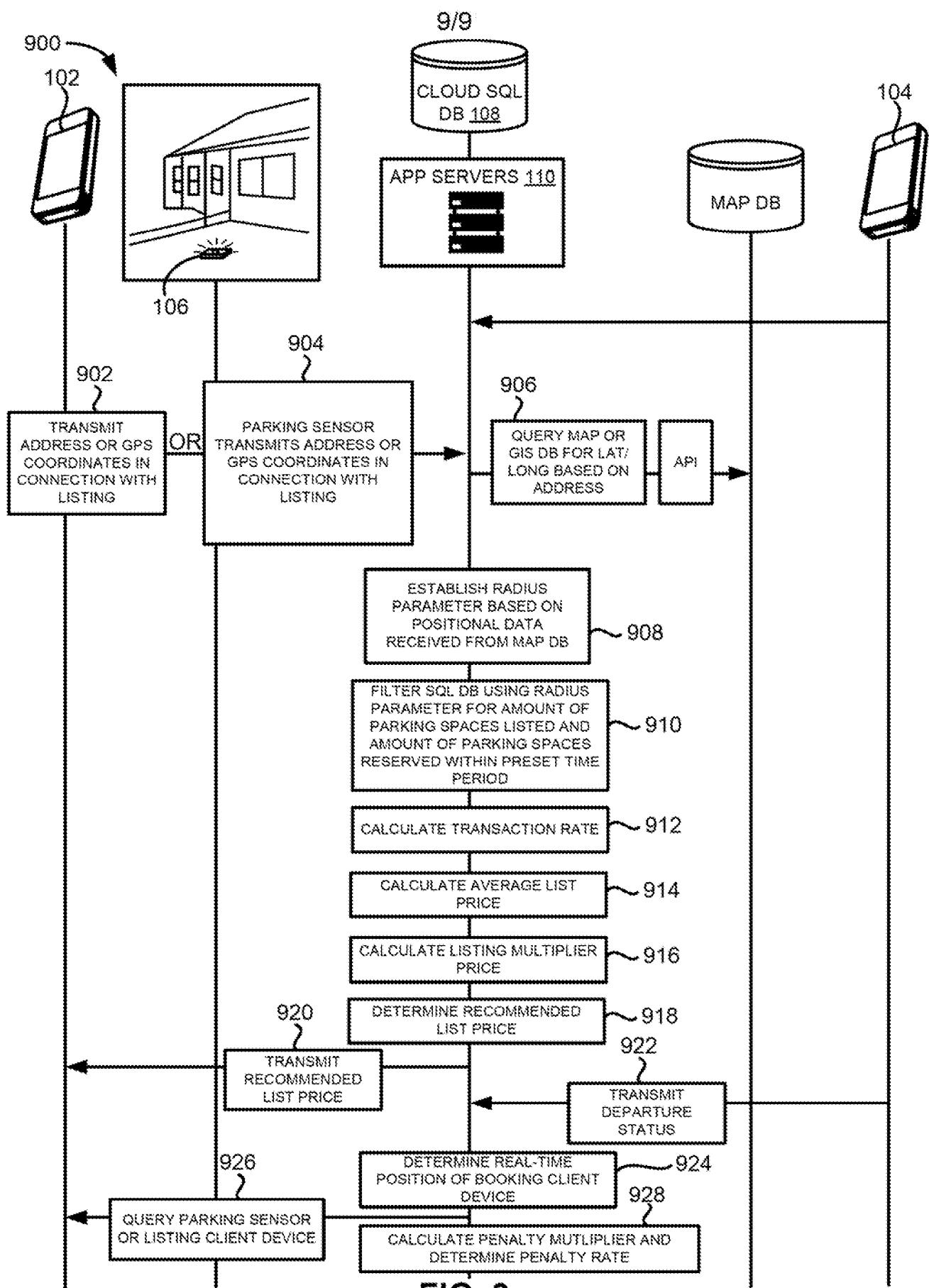


FIG. 9

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2016/032529

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G06F 17/30; G07B 15/02; G08G 1/14 (2016.01)

CPC - G07B 15/02; G07F 17/246; G08G 1/146 (2016.05)

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC - G06F 17/30; G07B 15/02; G08G 1/14

CPC - G07B 15/02; G07F 17/246; G08G 1/146

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
USPC - 340/932.200; 705/13.000; 705/32.000 (keyword delimited)

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

Orbit, Google Patents, Google Scholar, Google  
Search terms used: rate, parking, reservations

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/0310712 A1 (BAUGHMAN AARON K et al) 06 December 2012 (06.12.2012) entire document	1, 2, 4-12, 14-22, 24-30
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Y	US 2012/0293013 A1 (PARSONS KEVIN et al) 22 November 2012 (22.11.2012) entire document	3, 13, 23
A	US 2011/0022427 A1 (DAYAN) 27 January 2011 (27.01.2011) entire document	1-30
A	US 2014/0085109 A1 (PALO ALTO RESEARCH CENTER INC) 27 March 2014 (27.03.2014) entire document	1-30

 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	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

19 July 2016

Date of mailing of the international search report

16 AUG 2016

Name and mailing address of the ISA/

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