METHODS AND DEVICES FOR AUTOMATED FUEL DISPENSING AUTHORIZATION IN SERVICE STATIONS

Disclosed are methods and devices useful for identifying vehicles for the purpose of fuel dispensing authorization, that in some embodiments save energy by reducing the amount of time that energy-using components of a vehicle identification tag reader are activated. Specifically, some energy-expensive processes in embodiments such as attempted reading of a vehicle identification tag and/or wireless transmission of a result of such an attempt are performed only under command of a service station controller. The feature that energy-using components used for reading a vehicle identification tag or for transmitting results are activated only upon command allows a significant saving in energy, allows for significantly cheaper implementation of automated fuel dispensing authorization. Disclosed are also devices useful in implementing the method.
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RELATED APPLICATIONS

The present application gains benefit of the filing date of US patent application No. 60/899,889 filed 7 February 2007 which is incorporated by reference as if fully set forth herein.

FIELD AND BACKGROUND OF THE INVENTION

The present invention, in some embodiments, relates to the fields of purchase authorization and vehicular refueling, and more particularly, to methods and devices useful for implementing automated fuel dispensing authorization. Some embodiments of the present invention are energy-efficient, allowing a reduction in cost of implementing automated fuel dispensing authorization in a service station.

In the past a gas station was primarily a location to purchase fuel for a vehicle and occasionally to purchase comestibles and products associated with vehicular operation. Increasingly, gas stations are transforming into service stations, becoming one of the most important retail venues in industrialized society. The reasons for the increasing importance of service stations as retail venues, as well as the nature of the purchases, result from the relative advantages of service stations which are dictated by the primary purpose of service stations: efficiently providing fuel to vehicles.

To be successful as a gas station, a service station must generally be located on a heavily traveled road with a large area available for both high speed entrance and egress, many fuel-dispensing locations (i.e., fuel pumps), arranged for high-throughput refueling of many continuously arriving vehicles.

One preferred method for increasing the attractiveness of a service station is through the use of automated fuel dispensing authorization. In such methods, a vehicle is equipped with a vehicle identification tag storing data relating to the vehicle identity and a payment method. Each fuel-dispensing location is provided with a vehicle identification tag-reader configured to wirelessly read the vehicle identification tag using a tag-reading transceiver provided with a vehicle identification tag reader antenna.
In order to reduce fuel theft and in order to reduce interference between any two vehicle identification tag readers, it is accepted to limit the range of the wireless communication (as measured between the vehicle identification tag and the vehicle identification tag reader antenna), typically to only a few centimeters. Thus, vehicle identification tags are generally located in proximity of a vehicle refueling port and vehicle identification tag reader antennas are generally secured to a fuel-dispensing nozzle associated with a specific fuel-dispensing location so that the vehicle identification tag reader is able to read the vehicle identification tag substantially only when the fuel-dispensing nozzle engages the vehicle refueling port.

Generally, associated with the vehicle identification tag reader is a tag reader station communication transmitter, configured to forward information read from a vehicle identification tag by the vehicle identification tag reader to a service station controller. A tag-reader station communication transmitter is usually in wired communication with the tag-reading transceiver itself and is usually physically associated with the fuel-dispensing nozzle or with the associated fuel dispensing location. The tag-reader station communication transmitter is generally also in wired communication with the service station controller, for example through the underground wired communication channels that exist in any case between the service station controller and the different fuel-dispensing locations. An advantage of the wired communication with the service station controller is that unlimited power for operating the vehicle identification tag reader is supplied through the wires of the wired communication system.

When it is desired to purchase fuel, a fuel dispensing nozzle of a fuel dispensing location is placed inside the refueling port of a vehicle, bringing the vehicle identification tag reader antenna of the vehicle identification tag reader in wireless communication range with the vehicle identification tag. Information (such as vehicle identity or payment means) read through the vehicle identification tag reader antenna is forwarded to the service station controller by the tag reader station communication transmitter along with the identity of the fuel-dispensing nozzle with which the respective vehicle identification tag reader is associated. Based on the applicable rules, the service station controller optionally communicates an
authorization signal including if, under what conditions and how much fuel to dispense to the identified vehicle through the fuel-dispensing nozzle.

Due in large part to the use of wired communication between the various subsystems, especially between a nozzle-mounted vehicle identification tag reader and a service station controller, installation, maintenance and upgrading of an automated fuel payment system is difficult. Once a service station has invested in purchasing and installing a given automated fuel dispensing authorization system, it is often prohibitively expensive to replace or upgrade the system.

In the art, a number of devices and methods for automated fuel dispensing authorization have been taught that in some embodiments overcome some of the disadvantages of systems having wired communication between subsystems.

In the PCT patent applications of the Applicant published as WO 2007/049273 and WO 2007/049274 are taught vehicle identification tag readers configured for wireless communication with a service station controller and also automated fuel dispensing authorization methods including wireless communication between a vehicle identification tag reader and a service station controller.

In Figure 1A, a wireless vehicle identification tag reader 10 such as taught in WO 2007/049274 is schematically depicted mounted on a fuel dispensing nozzle 12. Components of wireless tag reader 10 depicted include tag-reader controller 14, tag reading transceiver 16, vehicle identification tag reading antenna 18, wireless tag reader station communication transmitter 20 and autonomous power storage unit 22.

The use of wireless vehicle identification tag reader 10 for automated fuel dispensing authorization is schematically depicted in Figure 1B. A fuel dispensing nozzle 12 of a fuel dispensing location 24 is placed inside a refueling port 26 of a vehicle 28 so that a vehicle identification tag reader antenna 18 is within wireless communication range of a vehicle identification tag 30. Relevant information read by tag reading transceiver 16 of vehicle identification tag reader 10 through vehicle identification tag reader antenna 18 is forwarded to service station controller 32 using wireless tag reader station communication transmitter 20 along with the identity of fuel-dispensing location 24. Based on the applicable rules, service station controller 32 optionally communicates an authorization signal including if, under what conditions and how much fuel to dispense to vehicle 28 to a fuel dispensing controller.
which forwards the authorization signal to fuel dispensing location 24 through a wired communication channel 36.

Two features that make a wireless vehicle identification tag reader such as 10 exceptionally useful are wireless communication and an autonomous (as opposed to external) power storage unit. Since there are no wires to be connected or disconnected, installation and removal is easy. These two features also render a wireless vehicle identification tag reader substantially self-contained, increasing robustness so that malfunction rarely occurs even under the difficult environmental conditions (exposure to the elements and gasoline) in which a vehicle identification tag reader is found. As a result, wireless vehicle identification tag readers make implementation of automated fuel dispensing authorization in a service station cheap and simple, allowing simple hardware upgrades and requiring little maintenance.

However, the electromagnetic environment of a service station is challenging for wireless radio-frequency communication due to the presence of many metal objects, including static objects such as fuel-dispensing locations and moving objects, such as automobiles and lorries. As a result, a wireless tag reader station communication transmitter of a vehicle identification tag-reader preferably transmits a relatively strong signal in order to provide robust communication with a service station controller. Further, in order to reduce costs of operating an automated fuel dispensing authorization system it is preferable that the vehicle identification tags be passive tags without an own source of power. The most useful type of passive vehicle identification tag is a passive RFID tag, a circuit that receives energy by induction from a vehicle identification tag-reading transceiver and then uses the energy to transmit identification information at radio-frequencies. Transmission of energy by induction to a vehicle identification tag by a tag-reading transceiver requires much energy, especially considering that the vehicle to which a vehicle identification tag is secured is usually made of metal. Consequently, wireless vehicle identification tag readers have a relatively high energy requirement.

The high energy requirements of a tag reader station communication transmitter and of a tag reading transceiver of a wireless vehicle identification tag reader make implementation of such tag readers challenging. Wireless tag readers having external power sources or autonomous power-generating power sources may
receive effectively unlimited power, but are complex and expensive to purchase, install and maintain. Wireless tag readers provided with an autonomous power storage unit require a relatively bulky and/or expensive autonomous power source (increasing costs) and/or require frequent maintenance (e.g., recharging or replacement).

SUMMARY OF THE INVENTION

The present invention, in some embodiments thereof, relates to methods and devices useful for identifying vehicles, for example for the purpose of automated fuel dispensing authorization, that in some embodiments save energy by reducing the amount of time that energy-using components of a vehicle identification tag reader are activated.

Specifically, in some embodiments of the present invention, a vehicle identification tag reader activates certain energy-using components only upon command from a service-station controller. In some embodiments, for example where the vehicle identification tag reader includes an autonomous power storage unit, the consequent reduction in energy-use reduces operation costs by reducing the frequency with which the power storage unit of the vehicle identification tag reader is recharged or replaced.

According to an aspect of some embodiments of the present invention there is provided a method for identifying a vehicle for the purpose of fuel dispensing authorization, comprising: a) providing at least one fuel-dispensing location including a fuel-dispensing nozzle having at least two states: a "NOZZLE-DOWN" state and a "NOZZLE-UP" state where the "NOZZLE-UP" state is suitable for dispensing fuel; b) for at least one of the fuel-dispensing locations, associating a vehicle identification tag reader therewith; and c) when the fuel-dispensing nozzle is in the "NOZZLE UP" state, periodically communicating with (in embodiments wirelessly) the vehicle identification tag reader, wherein the communication includes:

i. a command for the vehicle identification tag reader to attempt (preferably wirelessly) to read a vehicle identification tag (preferably using radio-frequency communication); and/or

ii. a command for the vehicle identification tag reader to (preferably wirelessly) transmit (preferably using a wireless radio-frequency transmitter)
results of an attempt by the vehicle identification tag reader to read a vehicle identification tag; and/or

iii. a reception time slot in which the vehicle-identification tag-reader is to expect further communication.

According to some embodiments, the method further comprises: upon receipt of the transmission from the vehicle identification tag reader associated with the fuel-dispensing location that an attempt to read a vehicle identification tag has succeeded, authorizing the dispensing of fuel from the fuel-dispensing location. In some embodiments, authorizing includes initiating the process of dispensing fuel from the fuel-dispensing location. In some embodiments, authorizing includes continuing an already-initiated process of dispensing fuel from the fuel-dispensing location.

According to some embodiments, the method further comprises: upon receipt of the transmission from the vehicle identification tag-reader associated with the fuel-dispensing location that an attempt to read a vehicle identification tag has failed, initiating a command to prevent the dispensing fuel from the fuel-dispensing location. In some embodiments, preventing includes preventing the initiation of a process of dispensing of fuel from the fuel-dispensing location. In some embodiments, preventing includes stopping an already-initiated process of dispensing fuel from the fuel-dispensing location.

According to some embodiments, the communication with the vehicle identification tag-reader occurs no less frequently than once every 5 seconds, no less frequently than once every 2.5 seconds, no less frequently than once every second, and even no less frequently than once every 0.5 second. According to some embodiments, the frequency of communication with the vehicle identification tag-reader is a predetermined constant time. In some embodiments, the frequency of communication is variable, for example dependent on the time of day.

According to some embodiments, the method further comprises: in response to a command to attempt to read a vehicle identification tag: the vehicle identification tag reader attempting to read a vehicle identification tag and the vehicle identification tag reader transmitting the results of the attempt to read a vehicle identification tag.
According to some embodiments, the transmitting of the results by the vehicle identification tag reader is periodic and occurs unrelated to receipt of a command to attempt to read the vehicle identification tag.

According to some embodiments, the transmitting of the results by the vehicle identification tag reader is in response to a command to transmit results of an attempt to read a vehicle identification tag.

According to some embodiments, the method further comprises:

the vehicle identification tag reader periodically attempting to read a vehicle identification tag; and

in response to a command to transmit results of an attempt to read a vehicle identification tag, transmitting results of the periodic attempt to read a vehicle identification tag.

According to some embodiments, the at least one fuel-dispensing location is at least two fuel-dispensing locations, and a different (and identifiable) vehicle identification tag reader is associated with each of the at least two fuel-dispensing locations.

According to some embodiments, the communication with the vehicle-identification tag-reader includes allocation of a (preferably discrete) transmission time slot in which the communicated-with vehicle identification tag is to transmit the results of an attempt to read a vehicle identification tag. According to some embodiments, the transmission time slot has a duration of not more than about 100 milliseconds, not more than about 50 milliseconds, not more than about 20 milliseconds and even not more than about 10 milliseconds. In some embodiments, the duration of such a transmission time slot is variable, e.g., depends on the type of message to be transmitted or signal quality which changes with the occupancy of the service station. In some embodiments, the duration of such a transmission time slot is constant.

According to some embodiments, the communication with the vehicle identification tag-reader includes a reception time slot in which the communicated-with vehicle identification tag is to expect further communications. According to some embodiments, the vehicle identification tag-reader exits a reduced energy-usage state approximately during the reception time slot in order to be functional to receive
further communications. According to some embodiments, the reception time slot has a duration of not more than about 100 milliseconds, not more than about 50 milliseconds, not more than about 20 milliseconds and even not more than about 10 milliseconds. In some embodiments, the duration of such a reception time slot is variable, e.g., depends on the type of message to be transmitted or signal quality which changes with the occupancy of the service station. In some embodiments, the duration of such a reception time slot is constant.

According to some embodiments, a vehicle identification tag reader antenna through which a vehicle identification tag reader reads a vehicle identification tag is mounted on the fuel-dispensing nozzle of the fuel-dispensing location with which the vehicle identification tag reader is associated.

According to some embodiments, the vehicle identification tag reader includes an autonomous power storage unit.

According to some embodiments, the vehicle identification tag reader is configured to read an active vehicle identification tag.

According to some embodiments, the vehicle identification tag reader is configured to read a passive vehicle identification tag. According to some embodiments, the vehicle identification tag reader is configured to transmit power to a passive vehicle identification tag so that the passive vehicle identification tag receives (for example, by induction) and uses the power to affect the transmission from the vehicle identification tag reader, for example, an RFID tag, for example such as described in the PCT patent application published as WO 2007/049274 of the Applicant.

According to some embodiments, the vehicle identification tag reader is provided with a (preferably wireless, preferably radio-frequency) tag reader station communication transceiver configured for receiving the communication and for transmitting a response to the communication.

According to an aspect of some embodiments of the present invention there is also provided a service station controller, comprising: a) a service station controller processor configured to be functionally associated with a (preferably radio-frequency) transceiver for wirelessly receiving communication from and transmitting communications to at least one (identifiable) vehicle identification tag reader, each
vehicle identification tag reader associated with a different fuel-dispensing location; and b) an input channel configured to provide the service station controller processor with a "NOZZLE UP/NOZZLE DOWN" status of the fuel-dispensing locations; wherein the service station controller processor is configured to use the transceiver to periodically communicate with every vehicle identification tag-reader associated with a fuel-dispensing location which is in a "NOZZLE UP" status; wherein the communication includes:

i. a command for the vehicle identification tag reader to attempt to read a vehicle identification tag; and/or

ii. a command for the vehicle identification tag reader to transmit results of an attempt by the vehicle identification tag reader to read a vehicle identification tag; and/or

iii. a reception time slot in which the vehicle-identification tag-reader is to expect further communication from the service station controller.

According to some embodiments, the service station controller is further configured to authorize dispensing fuel from a fuel-dispensing location upon receipt of communication from a vehicle identification tag reader associated with the fuel-dispensing location that an attempt to read a vehicle identification tag has succeeded. In some embodiments, authorizing includes initiating the process of dispensing of fuel from the fuel-dispensing location. In some embodiments, authorizing includes continuing an already-initiated process of dispensing of fuel from the fuel-dispensing location.

According to some embodiments, the service station controller is further configured to initiate a command to prevent dispensing fuel from a fuel-dispensing location upon receipt of communication from a vehicle identification tag reader associated with the fuel-dispensing location that an attempt to read a vehicle identification tag has failed. In some embodiments, preventing includes preventing the initiation of a process of dispensing of fuel from the fuel-dispensing location. In some embodiments, preventing includes stopping an already-initiated process of dispensing of fuel from the fuel-dispensing location.

According to some embodiments, the service station controller is further configured so that communication with the vehicle identification tag-reader occurs no
less frequently than once every 5 seconds, no less frequently than once every 2.5 seconds, no less frequently than once every second and even no less frequently than once every 0.5 second. According to some embodiments, the service station controller is further configured so that the frequency of communication with the vehicle identification tag-reader is a predetermined constant time. In some embodiments, the service station controller is further configured so that the frequency of communication is variable.

According to some embodiment, the service station controller is configured to sequentially communicate with the vehicle identification tag-readers which are in a "NOZZLE-UP" status.

According to some embodiments, the service station controller is further configured to allocate a (preferably discrete) transmission time slot for each communicated-with vehicle identification tag reader during which the communicated-with vehicle identification tag reader is to transmit the results of an attempt to read a vehicle identification tag and further configured to communicate the allocated transmission time slot to the vehicle identification tag-reader. According to some embodiments, the transmission time slot has a duration of not more than about 100 milliseconds, not more than about 50 milliseconds, not more than about 20 milliseconds and even not more than about 10 milliseconds. In some embodiments, the duration of such a transmission time slot is variable, e.g., depends on the type of message to be transmitted or signal quality which changes with the occupancy of the service station. In some embodiments, the duration of such a transmission time slot is constant.

According to some embodiments, the service station controller is further configured to allocate a reception time slot for each communicated-with vehicle identification tag reader during which the communicated-with vehicle identification tag reader is to expect further communication from the service station controller and further configured to communicate the allocated reception time slot to the vehicle identification tag-reader. According to some embodiments, the reception time slot has a duration of not more than about 100 milliseconds, not more than about 50 milliseconds, not more than about 20 milliseconds and even not more than about 10 milliseconds. In some embodiments, the duration of such a reception time slot is
variable, e.g., depends on the type of message to be transmitted or signal quality which changes with the occupancy of the service station. In some embodiments, the duration of such a reception time slot is constant.

According to an aspect of some embodiments of the present invention there is also provided a vehicle identification tag reader, comprising: a) a tag-reader controller; b) functionally associated with the tag-reader controller, a vehicle identification tag-reading receiver configured to, upon activation by the tag-reader controller, attempt to (preferably wirelessly) read a vehicle identification tag; and c) a (preferably wireless radio-frequency) tag-reader station communication transceiver configured to:

i) (preferably wirelessly) receive communications from a service station controller (in embodiments upon activation by the tag-reader controller); and

ii) (preferably wirelessly) transmit communications to a service station controller (in embodiments upon activation by the tag-reader controller)

wherein the tag-reader controller is configured to:

activate the vehicle identification tag-reading receiver to attempt the reading of a vehicle identification tag upon receipt of a communication including a command for such from a service station controller; and/or

activate the tag-reader station communication transceiver to (preferably wirelessly) transmit results of an attempt of the vehicle identification tag-reading receiver to read a vehicle identification tag upon receipt of a communication including a command for such from a service station controller; and/or

switch the tag-reader station communication transceiver from a reduced energy-usage state to a state (preferably wirelessly) to receive communication from a service station controller during a reception time slot, the reception time slot allocated by a service station controller and subsequently place the tag-reader station communication transceiver back in the reduced energy-usage state.

According to some embodiments, the reception time slot has a duration of not more than about 100 milliseconds, not more than about 50 milliseconds, not more than about 20 milliseconds and even not more than about 10 milliseconds. In some
embodiments, the duration of such a reception time slot is variable, e.g., depends on the type of message to be transmitted or signal quality which changes with the occupancy of the service station. In some embodiments, the duration of such a reception time slot is constant.

According to some embodiments, the vehicle identification tag-reading receiver is a vehicle identification tag-reading transceiver.

According to some embodiments, the vehicle identification tag-reading receiver is configured to read an active vehicle identification tag.

According to some embodiments, the vehicle identification tag-reading receiver is configured to read a passive vehicle identification tag. According to some embodiments, the configuration of the vehicle identification tag-reading receiver to read a passive vehicle identification tag includes configuration to: i) wirelessly transmit energy to provide power to a passive vehicle identification tag upon the activation by the tag-reader controller; and ii) receive a signal transmitted by the passive vehicle identification tag. According to some embodiments, the configuration of the vehicle identification tag-reading receiver to read a vehicle identification tag includes configuration to read an RFID vehicle identification tag.

According to some embodiments, the tag-reader controller is further configured to implement a command to activate the vehicle identification tag-reading receiver, wherein the command includes a delay time, that is, a specific time between receipt of the command and activation of the vehicle identification tag-reading receiver.

According to some embodiments, the tag-reader controller is configured to implement a command to activate the tag-reader station communication transceiver to transmit the results, wherein the command includes a transmission time slot during which the results are to be transmitted. According to some embodiments, the transmission time slot has a duration of not more than about 100 milliseconds, not more than about 50 milliseconds, not more than about 20 milliseconds and even not more than about 10 milliseconds. In some embodiments, the duration of such a transmission time slot is variable, e.g., depends on the type of message to be transmitted or signal quality which changes with the occupancy of the service station. In some embodiments, the duration of such a transmission time slot is constant.
According to some embodiments, the vehicle identification tag-reading receiver is functionally associated with a vehicle identification tag reader antenna, the vehicle identification tag reader antenna configured for mounting on a fuel-dispensing nozzle.

According to some embodiments, the vehicle identification tag reader further comprises an autonomous power storage unit (e.g., a battery or the like) for providing power to the tag-reader controller, the vehicle identification tag-reading receiver and/or the tag-reader station communication transceiver. In some embodiments, the power source is rechargeable. In some embodiments, the power source is not-rechargeable and is configured to replaced when spent. In some embodiments, the power source is not-rechargeable and the vehicle identification tag is configured to be replaced when the power storage unit is spent.

According to an aspect of some embodiments of the present invention there is also provided a service station for dispensing fuel to vehicles and configured for implementing automated fuel dispensing authorization, comprising:

a) a service station controller substantially as described above; and

b) at least one vehicle identification tag reader substantially as described above.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, suitable methods and materials are described below. In case of conflict, the patent specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting.

As used herein, the terms "comprising" and "including" or grammatical variants thereof are to be taken as specifying the stated features, integers, steps or components but do not preclude the addition of one or more additional features, integers, steps, components or groups thereof. This term encompasses the terms "consisting of" and "consisting essentially of".
The phrase "consisting essentially of" or grammatical variants thereof when used herein are to be taken as specifying the stated features, integers, steps or components but do not preclude the addition of one or more additional features, integers, steps, components or groups thereof but only if the additional features, integers, steps, components or groups thereof do not materially alter the basic and novel characteristics of the claimed composition, device or method.

As used herein, the indefinite articles "a" and "an" mean "at least one" or "one or more".

Herein, the term “passive device” refers to a device that stores data (whether read-only or rewritable) that does not have an own power source. The term also encompasses data storage devices that receive an amount of power from a reader by induction and then use the received power to transmit the data, such as RFID tags and circuits.

Herein, the term “active device” refers to a device associated with a power source that stores data (whether read-only or rewritable) where the device is configured to transmit the data using power from the associated power source.

Herein, the term “fuel dispenser” refers to a device that dispenses fuel, for example to a vehicle, and generally includes a pump, at least one hose and at least one fuel-dispensing nozzle with a fuel dispensing actuator such as a trigger.

Implementation of the method and/or devices of embodiments of the invention can involve performing or completing selected tasks manually, automatically, or a combination thereof. Moreover, according to actual instrumentation and equipment of embodiments of the method and/or system of the invention, several selected tasks could be implemented by hardware, by software or by firmware or by a combination thereof using an operating system.

For example, hardware for performing selected tasks according to embodiments of the invention could be implemented as a chip or a circuit. As software, selected tasks according to embodiments of the invention could be implemented as a plurality of software instructions being executed by a computer using any suitable operating system. In an exemplary embodiment of the invention, one or more tasks according to exemplary embodiments of method and/or system as described herein are performed by a data processor, such as a computing platform for
executing a plurality of instructions. Optionally, the data processor includes a volatile memory for storing instructions and/or data and/or a non-volatile storage, for example, a magnetic hard-disk and/or removable media, for storing instructions and/or data. Optionally, a network connection is provided as well. A display and/or a user input device such as a keyboard or mouse are optionally provided as well.

BRIEF DESCRIPTION OF THE FIGURES

Some embodiments of the invention are herein described, by way of example only, with reference to the accompanying Figures. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of some embodiments of the invention. In this regard, the description taken with the Figures makes apparent to those skilled in the art how some embodiments of the invention may be practiced.

In the Figures:

FIG. 1A (prior art) depicts a wireless vehicle identification tag-reader secured to a fuel dispensing nozzle;

FIG. 1B (prior art) depicts a service station provided with a automated fuel dispensing authorization system using wireless vehicle identification tag-readers of FIG. 1A;

FIG. 2 depicts an embodiment of a service station controller suitable for implementing embodiments of the teachings of the present invention;

FIG. 3 depicts an embodiment of a vehicle identification tag-reader suitable for implementing embodiments of the teachings of the present invention secured to a fuel dispensing nozzle; and

FIG. 4 depicts a service station configured to implement the teachings of the present invention.

DESCRIPTION OF SPECIFIC EMBODIMENTS OF THE INVENTION

The present invention, in some embodiments, relates to methods and devices useful for implementing automated fuel dispensing authorization in service stations. Some embodiments, of the present invention are energy-efficient, allowing a
reduction in cost of implementing automated fuel dispensing authorization in a service station.

As discussed above, it is advantageous to implement automated fuel-dispensing authorization using vehicle identification tag-readers communicating with a service station controller, for example as described in the PCT patent applications published as WO 2007/049273 of the Applicant. Exceptionally useful is to use vehicle identification tag readers that are provided with an autonomous power storage unit and configured for wireless communication with a respective service station controller, as such are easy to install and replace for repair or hardware upgrade. However, wireless transmission (especially radio-frequency wireless transmission) from a vehicle identification tag reader to a service station controller requires a relatively large amount of energy due to the amount of metal found in a service station. Further, reading a vehicle identification tag, such as an RFID tag, positioned in proximity of a vehicle refueling port requires a relatively large amount of energy due to the proximity to the metal body of the vehicle.

Due to the high energy requirements of a typical vehicle identification tag reader, a vehicle identification tag reader is typically provided with an external power source or a power-generating power source rather than an autonomous storage unit. Manufacture, installation, maintenance and replacement of such power sources is difficult and expensive.

Some embodiments of the present invention provide methods and devices useful for automated fuel dispensing authorization that overcome challenges such as described above by allowing a service station controller to control, and thereby limit, the amount of time energy-using components of a vehicle identification tag reader are activated. Such control significantly reduces the power requirements of an appropriately configured vehicle identification tag reader. In some embodiments, the reduction is such that a relatively small (and therefore cheap and not bulky) power storage unit suffices for powering a vehicle identification tag reader for a long enough time to significantly reduce maintenance costs (e.g., by reducing the frequency of recharging for rechargeable autonomous power storage units or of replacement of non-rechargeable autonomous power storage units).
Specifically, the present invention, in some embodiments thereof, relates to a method useful for identifying vehicles, for example for the purpose of automated fuel dispensing authorization, that in some embodiments saves energy by reducing the amount of time that energy-using components of a vehicle identification tag reader are activated.

According to an aspect of some embodiments of the present invention, there is provided a method for identifying a vehicle the purpose of automated fuel dispensing authorization, comprising: a) providing at least one fuel-dispensing location including a fuel-dispensing nozzle having at least two states: a "NOZZLE-DOWN" state and a "NOZZLE-UP" state where the "NOZZLE-UP" state is suitable for dispensing fuel; b) for at least one of the fuel-dispensing locations, associating a vehicle identification tag reader therewith; and c) when the fuel-dispensing nozzle is in the "NOZZLE UP" state, periodically communicating with (in embodiments wirelessly) the vehicle identification tag reader, wherein the communication includes: i. a command for the vehicle identification tag reader to attempt (preferably wirelessly) to read a vehicle identification tag (preferably using radio-frequency communication); and/or ii. a command for the vehicle identification tag reader to (preferably wirelessly) transmit preferably using a wireless radio-frequency transmitter) results of an attempt by the vehicle identification tag reader to read a vehicle identification tag, and/or iii. a reception time slot in which the vehicle-identification tag-reader is to expect further communication.

Service Station Controller

In some embodiments, the teachings of the present invention are implemented where the periodic communication with the fuel-dispensing nozzles is performed using a service station controller of the present invention. An embodiment of a service station controller of the present invention, service station controller 38, is schematically depicted in Figure 2.

Service station controller 38 comprises a service station controller processor 40 configured to implement an embodiment of the method of the present invention as described herein and is configured to be functionally associated with a radio-frequency transceiver (in Figure 2, transceiver 42) for wirelessly receiving
communication from and transmitting communications to one or more appropriately configured vehicle identification tag readers and b) a communication line configured to act as a communication channel allowing a fuel-dispensing controller (in Figure 2, fuel-dispensing controller 32) to provide service station controller processor 40 with a "NOZZLE UP/NOZZLE DOWN" status of one or more fuel-dispensing locations under control of the fuel-dispensing controller.

Service station controller processor 40 is also configured to store an association between each of one or more fuel-dispensing location and a specific identifiable vehicle identification tag reader.

Service station controller processor 40 is configured to use transceiver 42 to periodically (e.g., once every second) sequentially communicate with every vehicle identification tag-reader associated with a fuel-dispensing location which is in a "NOZZLE-UP" status. The communication with each such vehicle-identification tag-reader includes a command for the vehicle identification tag reader to attempt to read a vehicle identification tag, a command allocating a discrete transmission time slot during which the vehicle identification tag reader is to transmit the results of an attempt to read a vehicle identification tag, and allocation of a following reception time slot where the vehicle identification tag is to expect additional communication from service station controller 38.

Allocation of a specific time slot for transmission of the results of an attempt to read a vehicle identification tag to service station controller 38 allows an appropriately configured vehicle identification tag to save energy by shutting down a tag reader station communication transmitter or by placing the transmitter in some other energy-reducing mode, and to transmit only when service station controller 38 is available to receive and process the results. Such allocation also prevents two or more vehicle identification tag readers from simultaneously transmitting. Service station controller 38 is configured to allocate a transmission time slot to a vehicle identification tag reader having a variable duration which is typically not more than about 100 milliseconds, not more than about 50 milliseconds, not more than about 20 milliseconds and even not more than about 10 milliseconds, e.g., depends on the type of message to be transmitted or signal quality which changes with the occupancy of the service station.
Allocation of a following reception time slot where the vehicle identification tag is to expect additional communication from service station controller 38 allows an appropriately configured vehicle identification tag to save energy by entering a reduced energy-usage state (e.g., to shut-down a receiver function) but to exit the reduced energy-usage state approximately during the reception time slot in order to be functional to receive further communications from service station controller 38.

Service station controller processor 40 is further configured to authorize dispensing fuel from a fuel-dispensing location upon receipt of communication from a vehicle identification tag reader associated with the fuel-dispensing location that an attempt to read a vehicle identification tag by that vehicle identification tag reader has succeeded. In some embodiments, authorizing includes initiating the process of dispensing of fuel from the fuel-dispensing location. In some embodiments, authorizing includes continuing an already-initiated process of dispensing of fuel from the fuel-dispensing location.

Service station controller processor 40 is further configured to initiate a command to prevent dispensing fuel from a fuel-dispensing location upon receipt of communication from a vehicle identification tag reader associated with the fuel-dispensing location that an attempt to read a vehicle identification tag by that vehicle identification tag reader has failed. In some embodiments, preventing includes preventing the initiation of a process of dispensing of fuel from the fuel-dispensing location. In some embodiments, preventing includes stopping an already-initiated process of dispensing of fuel from the fuel-dispensing location.

Service station controller processor 40 is configured to use transceiver 42 to communicate with a vehicle identification tag-reader, where the communication includes a command for the vehicle identification tag reader to attempt to read a vehicle identification tag, a command for the vehicle identification tag reader to transmit the results of the attempt and a reception time slot allocated by service station controller processor 40, the reception time slot being when the vehicle identification tag is to expect additional communication from service station controller 38.

In some embodiments, a communication includes a single command that triggers both an attempt to read vehicle identification tag and a transmission of the results of the attempt.
In some embodiments, a service station controller processor is configured to operate together with vehicle identification tag-readers that attempt to read a vehicle identification tag autonomously and not as a result of communication from the service station controller. In some such embodiments, the communication from the service station controller includes a command for the vehicle identification tag reader to transmit the results of the attempt.

Service station controller processor 40 is configured to periodically communicate with every vehicle identification tag-reader found in a "NOZZLE-UP" state. Service station controller processor 40 is configured to vary the frequency of communication in accordance with various parameters. Generally, communication with a vehicle identification tag-reader occurs no less frequently than once every 5 seconds, no less frequently than once every 2.5 seconds, no less frequently than once every second and even no less frequently than once every 0.5 second. In some embodiments, the frequency of communication with the vehicle identification tag is a predetermined constant time. In some embodiments, the frequency of communication is variable.

Service station controller processor 40 is configured to periodically sequentially communicate with every vehicle identification tag-reader in a "NOZZLE-UP" status, that is to say that every period service station controller processor 40 communicates with each one of the vehicle identification tag-reader, one after the other. In some embodiments, a service station controller processor is configured to communicate with vehicle identification tag-reader in a "NOZZLE-UP" status non-sequentially.

Vehicles Identification Tag Reader

In some embodiments, the teachings of the present invention are implemented using a vehicle identification tag-reader of the present invention. An embodiment of a vehicle identification tag-reader, vehicle identification tag-reader 46, configured for implementing the teachings of the present invention is depicted in Figure 3 secured to a fuel dispensing nozzle 12.

Vehicle identification tag-reader 46 comprises a tag-reader controller 48 of the present invention, a vehicle identification tag-reading transceiver 16 (a tag-reading
transceiver configured to read a passive RFID vehicle identification tag) functionally associated with a vehicle identification tag reader antenna 18 which is mounted on and encircles fuel-dispensing nozzle 12, a tag reader station communication transceiver 20 (a wireless radio-frequency transceiver) and an autonomous power storage unit, non-rechargeable battery 22. Vehicle identification tag-reading transceiver 16, vehicle identification tag reader antenna 18, tag reader station communication transceiver 20 and non-rechargeable battery 22 of vehicle identification tag-reader 46 are standard components similar to those used in implementing vehicle identification tag-reader 10 depicted in Figures 1A and 1B.

In vehicle identification tag reader 46, tag-reader controller 48 is an integrated circuit fashioned in the usual way. In some embodiments, a suitable tag-reader controller is fashioned using a different technology or combination of technologies with which a person having ordinary skill in the art is familiar.

Tag-reader controller 48 is functionally associated with and configured to control vehicle identification tag-reading transceiver 16. Upon activation by tag-reader controller 48, vehicle identification tag-reading transceiver 16 attempts to wirelessly read a RFID vehicle identification tag. If the attempt fails and no vehicle identification tag is successfully read, vehicle identification tag-reading transceiver 16 returns a "NO TAG FOUND" message to tag-reader controller 48. If the attempt succeeds and a vehicle identification tag is successfully read, vehicle identification tag-reading transceiver 16 returns the identity of the read vehicle identification tag ("ID=XXXX" message) to tag-reader controller 48.

Tag-reader controller 48 is also functionally associated with and configured to control tag reader station communication transceiver 20. Tag reader station communication transceiver 20 has a number of modes including an energy-saving "sleep mode", a communication-reception mode for reception of wireless communication from a service station controller and a transmission mode for wirelessly transmitting communications to a service station controller. Tag reader station communication transceiver 20 is configured to enter or exit a mode under control of tag-reader controller 48.

Tag-reader controller 48 is configured to activate vehicle identification tag-reading transceiver 16 to attempt the reading of a vehicle identification tag upon
receipt of a communication including a command to do so from a service station controller. Such configuration leads to the energy-intensive action of reading a vehicle identification tag occurring only when a service station controller is ready to process the results of such an attempt. Tag-reader controller 48 is also configured to implement a command to activate vehicle identification tag-reading transceiver 16, wherein the command includes a delay time, that is, a specific time between receipt of the command and activation of vehicle identification tag-reading receiver 16. Upon receipt of such a command, tag-reader controller 48 waits the delay time and only then activates vehicle identification tag-reading receiver 16.

Tag-reader controller 48 is also configured to activate tag-reader station communication transceiver 20 to receive communications from a service station controller (in the communication-reception mode) or to transmit communications to a service station controller (in the transmission mode) upon receipt of a communication including a command to do so from a service station controller. Such configuration leads to the energy-intensive actions of receiving communications from a service station controller only when a service station controller is transmitting communications directed to that vehicle identification tag-reader. Such configuration leads to the energy-intensive actions of transmitting communications (such as the results of an attempt by vehicle identification tag-reading transceiver 16 to read a vehicle identification tag) to a service station controller only when a service station controller is ready to receive and process the results of such a transmission.

Tag-reader controller 48 is also configured to implement a command to activate tag-reader station communication transceiver 20 to transmit the results of an attempt to read a vehicle identification tag, wherein the command includes an allocated transmission time slot during which the results are to be transmitted. Upon receipt of such a command, tag-reader controller 48 activates vehicle identification tag-reading transceiver 16 to attempt the reading of a vehicle identification tag and transmits the results of the attempt using tag-reader station communication transceiver 20 during the allocated transmission time slot.

In vehicle identification tag reader 46, tag-reader controller 48 is configured to activate tag reader station communication transceiver 20 to wirelessly receive communications from a service station controller during time slots allocated by and
received from a service station controller. In some embodiments, a vehicle identification tag reader station communication transceiver is configured to continuously wirelessly receive communications from a service station controller. In some embodiments, a tag-reader controller is configured to activate a tag reader station communication transceiver to wirelessly receive communications from a service station controller continuously only when an associated fuel-dispensing nozzle is in a "NOZZLE-UP" state. A tag-reader controller may be configured to determine a "NOZZLE UP" status, for example, by receipt of a communication from a service station controller or by functional association with a sensor.

In vehicle identification tag reader 46, tag-reader controller 48 is configured to transmit results of an attempt to read a vehicle identification tag during a transmission time slot designated by a service station controller, where the duration of the transmission time slot is variable. In some embodiments, the duration of such a transmission time slot is fixed.

In vehicle identification tag reader 46, tag-reader controller 48 is configured to: a) activate vehicle identification tag-reading transceiver 16 to attempt the reading of a vehicle identification tag, b) activate tag-reader station communication transceiver 20 to receive communications from a service station controller; and c) to transmit communications to a service station controller, all three a, b and c upon receipt of a communication including a command to do so from a service station controller. In some embodiments, a tag-reader controller of a vehicle identification tag reader is configured to perform only one or only two of the three actions a, b and c upon receipt of a communication to do so from a service station controller.

For example, in some embodiments, a tag-reader controller is configured to continuously activate a tag-reader transceiver or a tag-reader receiver to attempt to read a vehicle identification tag as well as to continuously activate a tag reader station communication transceiver to receive communications from a service station controller, but to activate a tag reader station communication transceiver to transmit the results of an attempt to read a vehicle identification tag only upon receipt of a command from a service station controller.

For example, in some embodiments, a tag-reader controller is configured to continuously activate a tag-reader transceiver or a tag-reader receiver to attempt to
read a vehicle identification tag, but to activate a tag reader station communication
transceiver to receive communications from a service station controller and to
transmit the results of an attempt to read a vehicle identification tag only upon receipt
of a command from a service station controller.

For example, in some embodiments, a tag-reader controller is configured to
continuously activate a tag reader station communication transceiver to continuously
receive communications from a service station controller, but to activate a tag-reader
transceiver or a tag-reader receiver to attempt to read a vehicle identification tag as
well as to activate a tag reader station communication transceiver to transmit the
results of an attempt to read a vehicle identification tag only upon receipt of a
command from a service station controller. In some embodiments, a tag-reader controller is configured to receive a single command from a service station controller
to activate both the tag-reading and the transmission to the service-station controller.
In some embodiments, a tag-reader controller is configured to receive one command
from a service station controller to activate the tag-reading and a separate command to
activate the transmission to the service-station controller.

In vehicle identification tag reader 46, vehicle identification tag-reading
transceiver 16 is a tag-reading transceiver configured to read a passive RFID vehicle
identification tag, such as described in PCT patent application published as WO
2007/049274 of the Applicant. In some embodiments, when such a tag-reading
transceiver is activated, the tag-reading transceiver wirelessly transmits energy
through an antenna (e.g., vehicle identification tag reader antenna 18) to provide
power to a passive vehicle identification tag which is being read. The passive vehicle
identification tag absorbs the transmitted energy and uses the energy to transmit an
identification signal which is read by the vehicle identification tag-reading transceiver
through an antenna (e.g., vehicle identification tag reader antenna 18). Although
vehicle identification tag reader 46 is configured to read passive vehicle identification
tags, in embodiments a vehicle identification tag reader is configured to read active
vehicle identification tags. In some such embodiments, a vehicle identification tag
reader 46 is provided with a vehicle identification tag-reading receiver, and not a
transceiver, which is configured to read signals transmitted by an appropriately
configured vehicle identification tag. Although vehicle identification tag reader 46 is
configured to read vehicle identification tags using radio-frequency electromagnetic radiation, in embodiments, a vehicle identification tag reader is configured to read vehicle identification tags with some other suitable technology, for example using a different wavelength of electromagnetic radiation.

In vehicle identification tag reader 46, vehicle identification tag reader antenna 18 is configured to encircle fuel-dispensing nozzle 12. In some embodiments, a tag reader antenna is otherwise configured.

In vehicle identification tag reader 46, tag reader station communication transceiver 20 is a wireless radio–frequency transceiver. In some embodiments, a tag reader station communication transceiver is implemented using another suitable technology or combination of technologies.

In vehicle identification tag reader 46, power for tag-reader controller 48, vehicle identification tag-reading transceiver 16 and tag-reader station communication transceiver 20 is provided by an autonomous power storage unit, non-rechargeable battery 22. When the battery is spent, vehicle identification tag reader 46 is disconnected from fuel-dispensing nozzle 12 and discarded. In some embodiments, a vehicle identification tag reader is provided with some other power supply. In some embodiments, a vehicle identification tag reader is configured to allow a spent battery or other power storage unit to be replaced. In some embodiments, a vehicle identification tag reader is provided with a rechargeable power storage unit and is configured to allow recharging thereof. In some embodiments, the power supply is not autonomous but rather power is supplied from an external source. In some embodiments, the power supply comprises an autonomous power generating component, for example as described in the PCT patent application published as WO 2007/049274 of the Applicant.

Service Station

In Figure 4 is depicted an embodiment of a service station configured for implementing the teachings of the present invention, a service station 50 with a vehicle 52 in the process of being refueled.
In building 54 are located a service station controller 38 (similar to service station controller 38 described above) and a fuel dispensing controller 32 in wired communication through communication line 44.

Fuel dispensing controller 32 is in wired communication 36 (in the usual way as is known to one skilled in the art) with three fuel dispensing locations 24a, 24b and 24c. Each fuel dispensing location 24 includes an associated fuel dispensing nozzle 12a, 12b and 12c. Each fuel dispensing location 24 is configured to dispense fuel upon receipt of an authorization signal from fuel dispensing controller 32 through wired communication 36 and to report to fuel dispensing controller 34 whether a respective fuel dispensing nozzle 12 is in a cradle (NOZZLE DOWN state) or not (NOZZLE UP state).

Secured to each fuel dispensing nozzle 12a, 12b and 12c is a wireless vehicle identification tag reader 46a, 46b and 46c, respectively. Wireless vehicle identification tag readers 46 are substantially similar to vehicle identification tag reader 46 depicted in Figure 3. Each wireless vehicle identification tag reader 46 comprises a tag-reader controller 48, a vehicle identification tag-reading transceiver 16, a vehicle identification tag reading antenna 18, a wireless station communication transceiver 20 and an autonomous power storage unit 22. Each vehicle identification tag reader 46 is in wireless communication with service station controller 38 through transceiver 42 using the respective wireless station communication transceiver 20. Service station controller 38 stores the association between each of fuel-dispensing locations 24 and a respective associated vehicle identification tag reader 46.

Service station controller 38 communicates a command to each vehicle identification tag reader 46 associated with a fuel dispensing nozzle 12 in a "NOZZLE DOWN" state (e.g., vehicle identification tag reader 46a in Figure 4) to periodically (e.g., every 3 seconds) exit an energy-saving mode during which a respective station communication transceiver 20 is activated for a reception time slot of a specified duration (e.g., 5 milliseconds) to receive communications from service station controller 38. During the reception time slot, service station controller 38 transmits a following 5 millisecond reception time slot in which the vehicle identification tag reader 46 is to expect further communication.
Intermittently (e.g., once a minute or once every 5 minutes), during one of the reception time slots service station controller 38 sends a monitoring query including a transmission time slot having a specified duration (e.g., 20 milliseconds). In response to the monitoring query, tag reader controller 48 of vehicle identification tag reader 46a activates a respective station communication transceiver 20 to return a status report to service station controller 38 during the allocated 20 millisecond transmission time slot, allowing service station controller 38 to continuously determine whether or not the vehicle identification tag reader 46a is fully functioning.

During the time that a fuel-dispensing nozzle 12 is in a "NOZZLE DOWN" state the associated vehicle identification tag reader such as 46a is mostly in an energy-saving mode. The respective vehicle identification tag reading transceiver 16 is not activated and uses little, if any, energy. The respective station communication transceiver 20 is activated to receive communications rarely (5 milliseconds in every 3 seconds, about 0.17% of the time) and activated to transmit a status report even more rarely (20 milliseconds in every 5 minutes, about 0.01% of the time) and therefore also uses very little energy.

A person desiring to dispense fuel to a vehicle removes a fuel-dispensing nozzle 12 from a respective cradle of a fuel dispensing location 24 and places the nozzle 12 in the refueling port of a vehicle, for example nozzle 12b in refueling port 26 of vehicle 50. The specific fuel dispensing location 24 (e.g., 24b) reports a "NOZZLE UP" state to fuel dispensing controller 34 through wired communication 36 which forwards the "NOZZLE UP" state of the specific fuel dispensing nozzle to service station controller 38 through communication line 44.

Periodically (e.g., once every second) service station controller 38 serially communicates with each vehicle identification tag reader 46 which is associated with a fuel-dispensing nozzle 12 in a "NOZZLE UP" state, which in the situation depicted in Figure 4 includes fuel-dispensing nozzles 12b and 12c. The first communication sent to a vehicle-identification tag reader 46 after an associated fuel-dispensing nozzle 12 is reported to be in a "NOZZLE UP" state is up to about 3 seconds after entering the "NOZZLE UP" state. Each such communication to a vehicle identification tag reader 46 is transmitted within a 10 millisecond time slot and includes: an allocated transmission time slot (e.g., a specific time slot having a duration of 5 milliseconds) to
transmit the results of an attempt to read a vehicle identification tag and an allocated following reception time slot (e.g., a specific time slot having a duration of 10 milliseconds) when service station controller 38 will next communicate with the vehicle identification tag reader.

Upon receipt of the communication from service station controller 38, vehicle identification tag reader 46c enters an energy-saving mode until 10 milliseconds before the allocated 5 millisecond transmission time slot and then activates a respective vehicle identification tag reader 16 in an attempt to read a vehicle identification tag. As there is no vehicle identification tag in proximity of a vehicle identification tag reader antenna 18 of vehicle identification tag reader 46c the attempt fails. During the allocated 5 millisecond transmission time slot, vehicle identification tag reader 46c transmits the result that the attempt to read a vehicle identification tag failed and then reenters an energy-saving mode until the following allocated 10 millisecond reception time slot. Service station controller 38 receives the communication and initiates a command to fuel-dispensing controller 34 to not dispense fuel from fuel dispensing location 24c, thereby preventing the initiation of a process of dispensing of fuel from fuel-dispensing location 24c.

Upon receipt of the communication from service station controller 38, vehicle identification tag reader 46b enters an energy-saving mode until 10 milliseconds before the allocated 5 millisecond transmission time slot and then activates a respective vehicle identification tag reader 16 in an attempt to read a vehicle identification tag. As fuel-dispensing nozzle 12b engages refueling port 26 of vehicle 52 provided with a vehicle identification tag 30, vehicle identification tag reader antenna 18 of vehicle identification tag reader 46b is in read range of vehicle identification tag 30 and the attempt succeeds. During the allocated 5 millisecond transmission time slot, vehicle identification tag reader 46b transmits the identity of the read vehicle identification tag 30 as the result that the attempt to read a vehicle identification tag has succeeded and then reenters an energy-saving mode until the following allocated 10 millisecond reception time slot. Service station controller 38 receives the communication and, based on the applicable rules, optionally communicates an authorization signal including if, under what conditions and how much fuel to dispense to vehicle 52 from fuel dispensing location 24b to fuel
dispensing controller 34 through communication line 44 which forwards the authorization signal to fuel dispensing location 24b through wired communication 36. Upon receipt of the authorization, fuel dispensing location 38b begins dispensing fuel through nozzle 12b.

As noted above, periodically service station controller 38 serially communicates as described above with vehicle identification tag readers 46 associated with a fuel-dispensing nozzle 12 in a "NOZZLE UP" state. During every period where vehicle identification tag reader 46b succeeds in an attempt to read vehicle identification tag 30, and the success is transmitted to service station controller 32, service station controller 32 authorizes continuing the already-initiated process of dispensing of fuel from fuel-dispensing location 24b. If fuel dispensing nozzle 12b is removed from refueling port 26, then a following attempt to read a vehicle identification tag fails. The failure is transmitted to service station controller 38 during an allocated 5 millisecond transmission time slot, which forwards a command to fuel dispensing controller 34 to stop the already-initiated process of dispensing of fuel from fuel-dispensing location 24b.

During the time that a fuel-dispensing nozzle 12 is in a "NOZZLE UP" state the associated vehicle identification tag reader such as 46a is mostly in an energy-saving mode. The respective vehicle identification tag reading transceiver 16 is activated once every second for approximately 10 milliseconds and therefore uses relatively little energy. The respective station communication transceiver 20 is activated to receive communications rarely (10 milliseconds in every 1 second, about 0.17% of the time) and activated to transmit a result of an attempt to read a vehicle identification tag even more rarely (5 milliseconds in every 1 second, about 0.08% of the time) and therefore also uses very little energy.

As a vehicle identification tag reader 46 is primarily in an energy-saving mode whether the associated fuel dispensing nozzle 12 is in a "NOZZLE UP" or a "NOZZLE DOWN" state, and the two most energy-using components (vehicle identification tag reading transceiver 16 and station communication transceiver 20) are only rarely activated, the lifetime of the power storage unit 22 associated with the a vehicle identification tag reader 46 is very long, significantly reducing operating costs of service station 50.
In the embodiment discussed above, communication with a vehicle-identification tag reader 46 associated with a fuel dispensing nozzle 12 in a "NOZZLE DOWN" state is once every 3 seconds. This frequency is considered to provide a reasonable level of service for a person to remove a fuel-dispensing nozzle 12 from a cradle, to place the nozzle in a refueling port of a vehicle, to depress a refueling trigger and to wait for fuel dispensing to commence. In embodiments of the invention, any suitable frequency of communication is used. For example, where a higher level of service is desired or greater throughput is needed, the frequency is increased while where greater energy savings are required, the frequency is decreased. In some embodiments, the frequency is fixed. In some embodiments, the frequency is variable, to allow more energy to be saved at night or when fewer customers are expected, but to increase the level of service during daytime or when higher-throughput is required.

In the embodiment discussed above, communication with a vehicle-identification tag reader 46 associated with a fuel dispensing nozzle 12 in a "NOZZLE UP" state is once every 1 seconds. This is considered a sufficiently high frequency to allow fuel dispensing to be safely stopped without dangerous spilling if a vehicle-identification tag is no longer read, for example if the fuel dispensing nozzle 12 is accidentally removed from a refueling port 12. Generally, any suitable frequency of communication is used so in some embodiments, the frequency is higher or lower. For example, in embodiments, communication with the vehicle identification tag-readers occurs no less frequently than once every 5 seconds, no less frequently than once every 2.5 seconds, no less frequently than once every second and even no loss frequently than once every 0.5 second. In some embodiments, the frequency is a predetermined constant frequency, whereas in some embodiments the frequency is variable, depending on relevant criteria.

In the embodiments discussed above, the duration of transmission and reception time slots allocated by service station controller 38 to the vehicle identification tag readers are exemplary. Generally, the duration of a given time slot is determined by the exact technology used (i.e., radio-frequency technology, data processing technology), the amount of information to be transmitted or received and by the desired level of communication robustness. That said, the duration of the time slots allocated to vehicle identification tag readers associated with a fuel-dispensing
nozzle in a "NOZZLE UP" state is typically not more than about 100 milliseconds, not more than about 50 milliseconds, not more than about 20 milliseconds and even not more than about 10 milliseconds. In some embodiments, the duration of the transmission and reception time slots is predetermined and fixed. In some embodiments, the duration of the transmission and reception time slots is variable and depends on relevant criteria, for example the amount of interference to communications which is influenced by factors such as the number of vehicles in the service station, the size of the vehicles, and whether or not the vehicles are moving.

In the embodiment of the method of the present invention discussed above, the communication with vehicle identification tag-readers 46 includes a command to attempt to read a vehicle identification tag; a command to transmit the results of the attempt to read a vehicle identification tag in an allocated transmission time slot; and an allocated reception time slot when service station controller 38 next communicates with the vehicle identification tag reader.

In some embodiments, a single command initiates an attempt to read a vehicle identification tag and the subsequent transmission of the results of the attempt.

In some embodiments, the communication from the service station controller includes a command to attempt to read a vehicle identification tag while the transmitting of the results by a vehicle identification tag reader is periodic and occurs unrelated to receipt of a command to attempt to read the vehicle identification tag.

In some embodiments, a vehicle identification tag reader periodically attempts to read a vehicle identification tag and the communication from the service station controller includes a command to transmit the results.

The design and manufacture of the components for implementing the teachings of the present invention, including embodiments of a service station controller or embodiments of a vehicle identification tag reader, are preferably done using known methods and materials. A person having ordinary skill in the art is familiar with suitable materials and methods, for example from the fields of computers, integrated circuits, populated circuit boards and radio-frequency communication and may implement the teachings of the present invention upon perusal of the specification and the figures.
It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination or as suitable in any other described embodiment of the invention. Certain features described in the context of various embodiments are not to be considered essential features of those embodiments, unless the embodiment is inoperative without those elements.

Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

Citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present invention.

To the extent that section headings are used, they should not be construed as necessarily limiting.
WHAT IS CLAIMED IS:

1. A method for identifying a vehicle for fuel dispensing authorization, comprising:
   a) providing at least one fuel-dispensing location including a fuel-dispensing nozzle having at least two states: a "NOZZLE-DOWN" state and a "NOZZLE-UP" state;
   b) for at least one said fuel-dispensing location, associating a vehicle identification tag reader therewith; and
   c) when said fuel-dispensing nozzle is in said "NOZZLE UP" state, periodically communicating with said vehicle identification tag reader, wherein said communication includes:
      i. a command for said vehicle identification tag reader to attempt to read a vehicle identification tag and/or
      ii. a command for said vehicle identification tag reader to transmit results of an attempt by said vehicle identification tag reader to read a vehicle identification tag and/or
      iii. a reception time slot in which said vehicle-identification tag-reader is to expect further communication.

2. The method of claim 1, further comprising: upon receipt of a said transmission from said vehicle identification tag reader associated with said fuel-dispensing location that an attempt to read a vehicle identification tag has succeeded, authorizing the dispensing of fuel from said fuel-dispensing location.

3. The method of any of claims 1 to 2, further comprising upon receipt of a said transmission from said vehicle identification tag-reader associated with said fuel-dispensing location that an attempt to read a vehicle identification tag has failed, initiating a command to prevent the dispensing of fuel from said fuel-dispensing location.
4. The method of any of claims 1 to 3, further comprising, in response to a said command to attempt to read a vehicle identification tag:

said vehicle identification tag reader attempting to read a vehicle identification tag; and

said vehicle identification tag reader transmitting the results of said attempt to read a vehicle identification tag.

5. The method of claim 4, wherein said transmitting of the results by said vehicle identification tag reader is periodic and occurs unrelated to receipt of a said command to attempt to read said vehicle identification tag.

6. The method of claim 4, wherein said transmitting of the results by said vehicle identification tag reader is in response to a said command to transmit results of an attempt to read a vehicle identification tag.

7. The method of any of claims 1 to 6, further comprising:

said vehicle identification tag reader periodically attempting to read a vehicle identification tag; and

in response to a said command to transmit results of an attempt to read a vehicle identification tag, transmitting results of said periodic attempt to read a vehicle identification tag.

8. The method of any of claims 1 to 7, wherein said at least one fuel-dispensing location is at least two fuel-dispensing locations, and a different vehicle identification tag reader is associated with each fuel-dispensing location of said at least two fuel-dispensing locations.

9. The method of any of claims 1-8, wherein said communication with a said vehicle identification tag reader includes allocation of a transmission time slot in which said communicated-with vehicle identification tag is to transmit said results of an attempt to read a vehicle identification tag.
10. The method of any of claims 1 to 9, wherein a vehicle identification tag reader antenna through which a vehicle identification tag reader reads a vehicle identification tag is mounted on said fuel-dispensing nozzle of said fuel-dispensing location with which said vehicle identification tag reader is associated.

11. The method of any of claims 1 to 10, wherein said vehicle identification tag reader is configured to read an active vehicle identification tag.

12. The method of any of claims 1 to 11, wherein said vehicle identification tag reader is configured to read a passive vehicle identification tag.

13. The method of claim 12, wherein said vehicle identification tag reader is configured to transmit power to a said passive vehicle identification tag so that said passive vehicle identification tag receives and uses said power to affect said transmission from said vehicle identification tag reader.

14. The method of any of claims 1 to 13, wherein said vehicle identification tag reader is provided with a tag reader station communication transceiver configured for receiving said communication and for transmitting a response to said communication.

15. A service station controller, comprising:

   a) a service station controller processor configured to be functionally associated with a transceiver for wirelessly receiving communication from and transmitting communications to at least one vehicle identification tag reader, each said vehicle identification tag reader associated with a different fuel-dispensing location; and

   b) an input channel configured to provide said service station controller processor with a "NOZZLE UP / NOZZLE DOWN" status of said fuel-dispensing locations;

wherein said service station controller processor is configured to use said transceiver to periodically sequentially communicate with every said at least one vehicle
identification tag-reader associated with a fuel-dispensing location which is in a "NOZZLE UP" status;

wherein said communication includes:

i. a command for said vehicle identification tag reader to attempt to read a vehicle identification tag; and/or

ii. a command for said vehicle identification tag reader to transmit results of an attempt by said vehicle identification tag reader to read a vehicle identification tag and/or

iii. a reception time slot in which said vehicle-identification tag-reader is to expect further communication from the service station controller.

16. The service station controller of claim 15, further configured to authorize dispensing fuel from a said fuel-dispensing location upon receipt of communication from a said vehicle identification tag reader associated with said fuel-dispensing location that an attempt to read a vehicle identification tag has succeeded.

17. The service station controller of any of claims 15 and 16, further configured to initiate a command to prevent dispensing fuel from a said fuel-dispensing location upon receipt of communication from a said vehicle identification tag reader associated with said fuel-dispensing location that an attempt to read a vehicle identification tag has failed.

18. The service station controller of any of claim 15 to 17, further configured to sequentially communicate with said vehicle identification tag-readers which are in a "NOZZLE-UP" status.

19. The service station controller of any of claims 15 to 18, wherein said communication includes allocation of a transmission time slot for each communicated-with vehicle identification tag reader during which said communicated-with vehicle identification tag reader is to transmit said results of a said attempt to read a vehicle identification tag.
20. A vehicle identification tag reader, comprising:
   a) a tag-reader controller;
   b) functionally associated with said tag-reader controller, a vehicle
      identification tag-reading receiver configured to, upon activation by said tag-
      reader controller, attempt to read a vehicle identification tag; and
   c) a tag-reader station communication transceiver configured to:
      i) receive communications from a service station controller; and
      ii) transmit communications to a service station controller

wherein said tag-reader controller is configured to:
   activate said vehicle identification tag-reading receiver to attempt said reading
   of a vehicle identification tag upon receipt of a communication including a
   command for such from a service station controller; and/or
   activate said tag-reader station communication transceiver to transmit results
   of an attempt of said vehicle identification tag-reading receiver to read a
   vehicle identification tag upon receipt of a communication including a
   command for such from a service station controller and/or
   remove said tag-reader station communication transceiver from a reduced
   energy-usage state to receive communication from a service station controller
   during a reception time slot, said reception time slot allocated by a service
   station controller and subsequently place the tag-reader station communication
   transceiver back in the reduced energy-usage state.

21. The vehicle identification tag reader of claim 20, wherein said vehicle
    identification tag-reading receiver is a vehicle identification tag-reading transceiver.

22. The vehicle identification tag reader of claim 20 or claim 21, wherein
    said vehicle identification tag-reading receiver is configured to read an active vehicle
    identification tag.

23. The vehicle identification tag reader of claim 20 or claim 21, wherein
    said vehicle identification tag-reading receiver is configured to read a passive vehicle
    identification tag.
24. The vehicle identification tag reader of claim 23, wherein said configuration of said vehicle identification tag-reading receiver to read a passive vehicle identification tag includes configuration to:
   i) wirelessly transmit energy to provide power to a passive vehicle identification tag upon said activation by said tag-reader controller; and
   ii) receive a signal transmitted by a said passive vehicle identification tag.

25. The vehicle identification tag reader of claim 23, wherein said configuration of said vehicle identification tag-reading receiver to read a vehicle identification tag includes configuration to read an RFID vehicle identification tag.

26. The vehicle identification tag reader of any of claims 20 to 25, wherein said tag-reader controller is further configured to implement a said command to activate said vehicle identification tag-reading receiver, wherein said command includes a delay time.

27. The vehicle identification tag reader of any of claims 20 to 26, wherein said tag-reader controller is configured to implement a said command to activate said tag-reader station communication transceiver to transmit said results, wherein said command includes a transmission time slot during which said results are to be transmitted.
Fig. 1a (Prior Art)