A New System of Mobile Payments for Gated Garage Parking

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9/17/2020, Version 3.0

Summary

This paper presents a number of disruptive new technologies developed by TWS to facilitate mobile payments for parking in gated garages. Such garages abound in the Central Business Districts (CBDs) of cities, airports and other facilities. **Collectively, gated garages fetch approximately 20-times the revenue of on-street (municipal) parking [1].** In total, the National Parking Association estimates the US parking industry to be an $18 B business [2]. **Addressing gated garages should therefore be an important objective of any wireless parking payment system**.

Today, pay-by-cell is rare for gated garages. Our suite of payment methods, encompass both gated garages and municipal parking [3]. They represent a **universal parking payment system,** which users are likely to prefer over disparate payment methods. Single payment method is the reason behind the success of payment services such as PayPal.

For garage owners, our TWS system offers many benefits, such as: loyalty programs, employee fraud reduction and a smartphone based broadcast channel for communicating garage information to prospective customers. This can be a significant competitive tool. Examples of broadcast information are occupancy status, special promotions and other real time messages. We also address **manually operated (e.g. valet parked) gated garages**.

For end users, our methods provide user experiences unmatched by any existing system. If the user loses his ticket, we provide a facile way for determining his actually consumed session time requiring the physical ticket. We achieve all this by **exploiting the latest wireless technologies** while minimizing the number of required user actions. We also minimize disruption to existing garage infrastructure by offering methods that blend optimally with the garage's existing IT system (avoiding rip and replace) but still improving user experience.

The benefits of our TWS system are delivered by the following, patented ***technical innovations***.

1. Automatically determine garage/gate ID using a low power (self powered) Bluetooth Low Energy (BLE) broadcast device mounted at the gate or smartphone GPS position location.
2. Determine the ID of the issued paper ticket by an innovative, smartphone app that is easier for the user than NFC sensing or optical ticket scanning.
3. Secure, pay-by-cell, direct (to garage employee) payment method for use in manually operated garages, such as valet parked garages.

1.0 Background: characteristics of existing parking systems

In the last 5 years, a number of companies have started offering cellphone based payment systems for on-street parking (commonly referred to as “pay-by-cell”). Of these, Parkmobile appears to have the highest market penetration in the USA. However, pay-by-cell for parking in gated garages is rare, although some trials and demonstrations have been reported.

The technical feasibility of authenticating a vehicle to a gated garage with RFID is well known. In the early days of using RFID for highway toll collection, the RFID tag was trialed for a number of non-highway toll payment applications, including garage parking [4]. However, none of these became mainstream services. RFID authentication appears to be unpopular for garage parking payment for at least two reasons – (i) some garages consider the installation of RFID infrastructure to be too disruptive and (ii) there is a strong preference to base the payment method on the present capabilities of smartphones, most of which do not support RFID with no known plans to do so in the future.

Trials have been reported using smartphone based QR scanning [5] or performing an NFC transaction at the gate using the user’s smartphone. However, this still requires the user to wind down his window and present an object (the phone) to a scanning device, which is no less onerous than swiping a credit card or other ID card at the gate -- a method that is currently in widespread use; optically scanning a ticket and uploading it to a server is also more burdensome than our TWS methods described below.

In many gated garages where paper tickets are used (airports overwhelmingly use this method today), the user experience is more onerous than even an ID card swipe at the gate. This is causing some airports to migrate to ID cards[1] as an improvement over present practice. Our TWS methods, adapted to garage infrastructure using ID cards, improve the user experience beyond present ID card methods.

In paper ticket based systems, the user is issued a barcoded paper ticket, which he has to save and, on his return, present at a payment kiosk inside the airport. Sometimes, there is a queue at the kiosk. Several payment options (credit card, cash, etc.) are typically available at the kiosk. Upon a successful payment transaction, the system notes the ID of the paper ticket and allow the user to exit within a fixed time period when the user presents the same ticket to a ticket reader at an exit gate. If the ticket is lost, a large fee is usually levied as it is impossible to determine the session period except by trusting the user’s word. ***Our patented TWS methods allow the session period to be***

[1] This term is used here in a general sense and includes any physical token that reliably authenticates the user, including bank issued cards.

determined by authenticating the user without the presence of the physical ticket. This may allow garage owners to reduce the fine, perhaps eliminate it altogether.

2.0 Our TWS system

To blend in maximally with the existing garage infrastructure, TWS offers different methods for garages using ID tokens and paper tickets. The two systems are described in Sections 2.1 and 2.2 below. Also described in Section 2.3 is a system for secure pay-by-cell in manually operated gated garages, including those using valet parking.

The method *actually* used for a particular garage can be customized to the preferences of the garage owners. The methods described in this paper should be seen as *examples* of what can be done with smartphone apps and modern wireless technologies, rather than as a catalog of rigid product offerings.

2.1 TWS system for garages using ID tokens (cards)

ID tokens are physical objects, such as credit cards or special ID cards (such as long term parking passes) carried by the user. Such tokens can be used to both authenticate the user and to establish the times of entry and exit. The card is read (magnetically, or wirelessly by NFC) at the entrance and exit gates. If a credit card is used, a payment transaction may also be performed at the time of exit.

Our TWS system performs a wireless equivalent of the above transaction, which requires the user to perform **only three interactions** with his smartphone at the entrance and exit gates, without having to roll down his window. The process is described below.

Signing up to TWS service: Before service commencement, a business arrangement is set up between TWS and the garage, whereby TWS agrees to provide payment services similar to credit card companies or payment service companies like PayPal. Once this trust relationship is in place, a successfully authenticated request from the TWS Parking Application Server to the Garage Server to open a specific entrance gate will be honored by the Garage Server. The user signs up for TWS parking payment services by accessing the TWS website and providing usual mobile payment credentials, including credit card or bank account details.[2]

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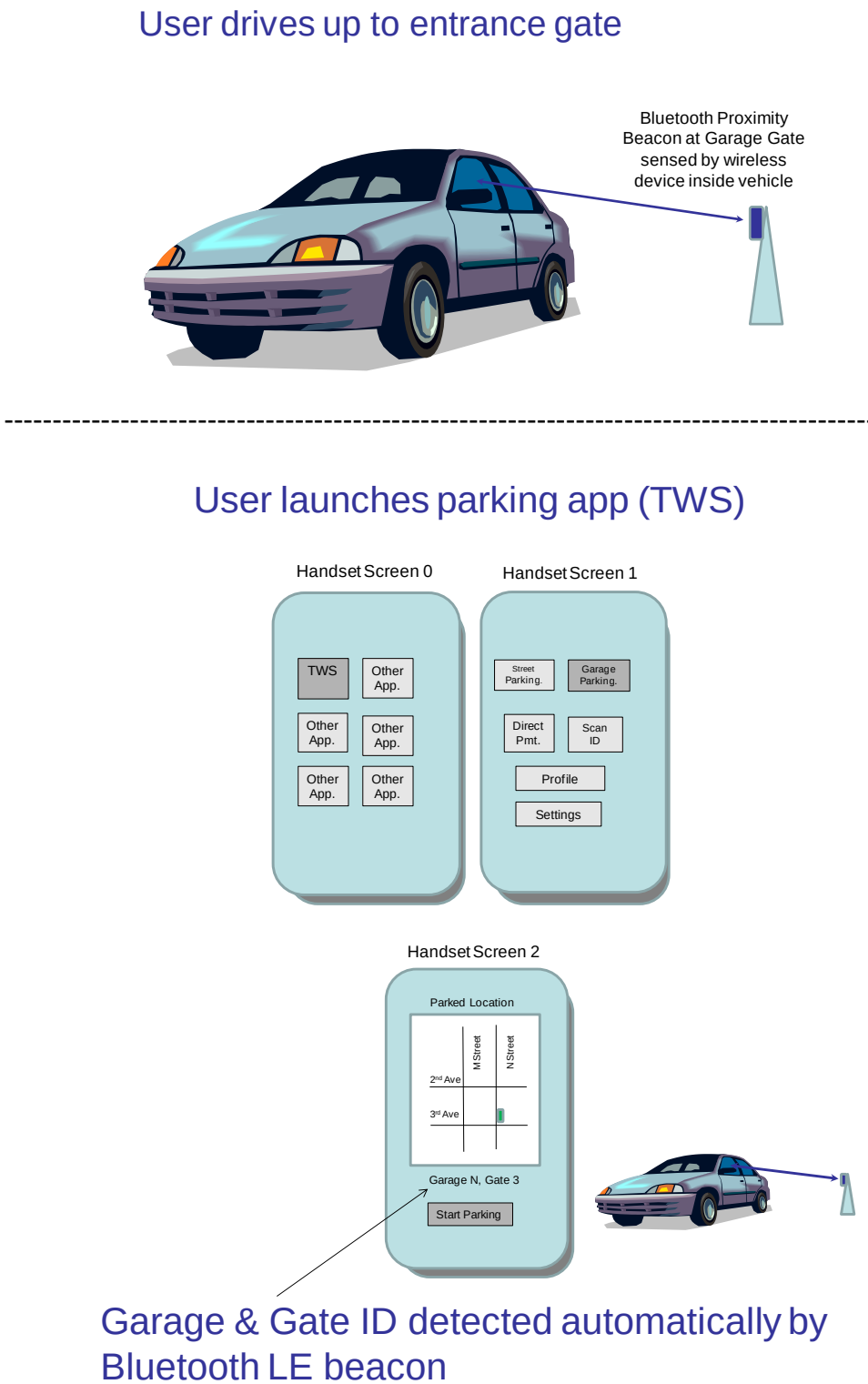
[2] Although the present description assumes the presence of a payment service provider, like Parkmobile or PayPal, the payment system could be a ‘closed entity’ that is owned and operated wholly by the garage owner, such as an a airport or hospital. The TWS methods are equally applicable to both situations.

Entrance Transactions: A cellular data link connects the smartphone to the TWS Parking Application Server, which is connected via the internet to the Garage Server controlling the gate. The user approaches a garage gate and performs 3 interactions with the TWS app on his smartphone to open the gate, as illustrated in Figure 1. Only 1 interaction involves an over-the-air transaction – hence the latency of the process is very small, leading to an extremely facile user experience.

A key requirement in any garage parking payment system is identifying the garage and gate (if the garage has multiple gates). One of the ways this can be performed in our TWS system is by mounting a Bluetooth Low Energy (BLE) module near the gates. The module periodically announces the garage/gate ID, which is read by the user's smartphone. For a typical announcement frequency of 1/s, the module can last more than a year. Hence, the module can be self-powered. It has very low cost (less than $5 - 10) and, therefore, may be considered disposable. Other methods of establishing the garage/gate ID using the phone's GPS function are also available options but not described here.

Figure 1 Start Parking sequence in Gated Garage using ID Tokens



- Smartphone sends Garage/Gate ID to Parking Application Server with request to open gate
- Parking Application Server sends request to Garage Server to open gate
- Following authentications, Garage Serve opens gate and advises Parking Application Server that gate has been opened

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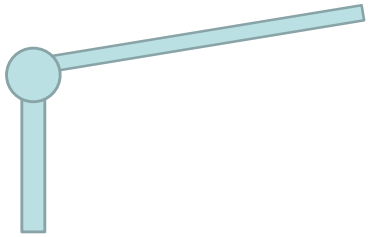
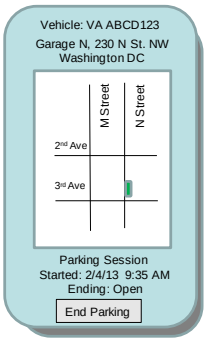


Gate is opened

Handset Screen 3

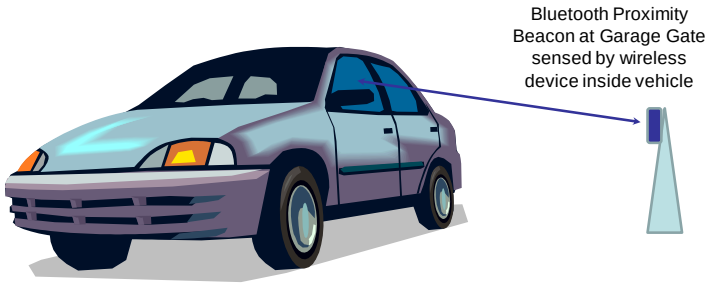


Active-Session screen returned to user

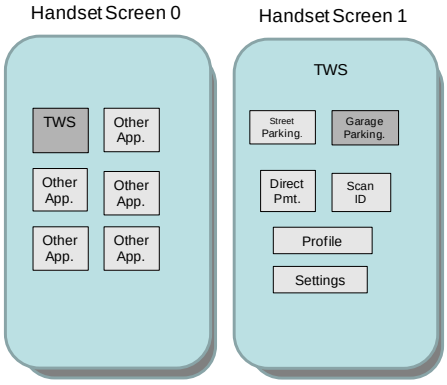
Exit Transactions: The exit process is very similar to entrance, requiring 3 interactions between the user and the smartphone, as illustrated in Figure 2.

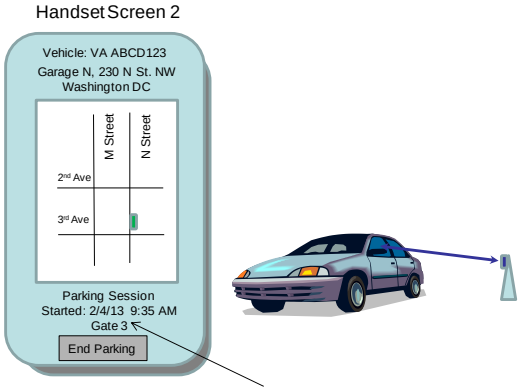
Figure 2 End Parking sequence in Gated Garage using ID Tokens

User drives up to exit gate



User launches parking app (TWS)





Gate ID detected automatically by Bluetooth LE beacon

- Smartphone sends Gate ID to Parking Application Server with request to open gate
- Parking Application Server sends request to Garage Server to open gate
- Following authentications, Garage Serve opens gate and advises Parking Application Server that gate has been opened

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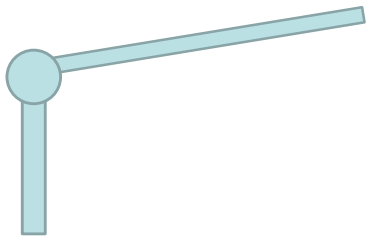
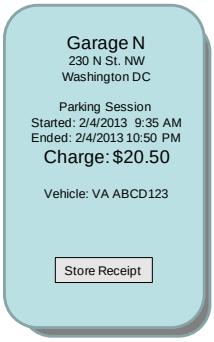


Gate is opened

Handset Screen 3



Final Session screen returned to user

The parking session is identified by a session ID, which is linked to the smartphone and serves as a proxy for the user/vehicle ID. When the user leaves the garage, another gate-opening request for a specific exit gate is sent from the TWS Parking Application Server to the Garage Server, referencing the same session ID. As above, after successful authentication of the request, the Garage Server opens the requested gate. Subsequently, the Garage Server invoices TWS for the fee associated with the particular parking session. The TWS Parking Application Server can validate this invoice as it has an independent record of the entrance/exit times corresponding to the particular session.

2.2 TWS system for garages using paper tickets

While the method described in Section 2.1 above could be used for *any* gated garage, the method described below comprises a better (less disruptive) fit if paper tickets are currently in use and the owner is not interested in replacing it, at least in the short term. Figures 3 – 6 illustrate the method with the aid of example handset screens and transaction diagrams.

Exactly as in legacy systems, the user enters the gated garage and takes a paper ticket, which causes the gate to open. The only exception (relative to legacy practice) is that he must launch the Garage Parking app before he enters the garage. This is a simple step of selecting/touching an icon on his handset.

The TWS method is based on estimating the approximate time of ticket issuance, and linking the ticket ID and the phone ID on the basis of this estimated time. Two methods are available for establishing this time:

(i) Based on user cooperation: The user selects <Enter> on his smartphone, as shown in Figure 3, just before he presses the button on the entrance gate which causes the ticket to be issued;

(ii) Transparent to user (requiring no user action): The user's smartphone estimates the approximate ticket issuance time based on the time when the smartphone was closest to a BLE transmitter mounted on or near the ticket dispenser at the entrance gate. This BLE transmitter may also be used for communicating the garage/gate ID to the smartphone, as for ID token based systems described in Section 2.1. However, there may be certain advantages to separating the functions and placing a second BLE module at the entrance gate, closer to the street, for announcing garage/gate IDs.

For (i), the time when the user selected <Enter> is noted and remembered by the smartphone.

For (ii), there is absolutely no change required to the user's behavior while entering the garage except for launching the app at *sometime* before he approaches the entrance gate (closer in time is better). He does this by selecting <TWS> and <Garage Parking> in the smartphone screens shown in Figure 3. The smartphone remembers when BLE coverage started, ended and reached its peak value. From the above observations, the handset forms an intelligent estimate of the approximate time when the ticket was issued. The estimate only needs to be sufficiently accurate so as to distinguish the ticket issued to a particular user from the ones issued to the next or previous user.

As soon as the estimation of ticket issuance time, based on method (i) or (ii) above, is complete, the smartphone sends a message to the Parking Application Server containing the estimated time[3] and the garage and gate IDs. Both IDs are sensed by the smartphone by means of a BLE beacon as described above. The garage ID tells the Parking Application Server which Garage Server to address with the payment transaction.

The estimated ticket issuance time and gate ID are forwarded by the Parking Application Server to the Garage Server in a message that is identified by a message ID, which is a proxy for the smartphone. The Garage Server compares the estimated ticket issuance time with a list of actual ticket issuance times, known to it via independent means, such as the direct control link to the gate (identified in the message from the Parking Application server). The best match is determined and the message ID (i.e. smartphone ID) is now linked to a particular ticket ID in the Garage Server's database. Furthermore, the server marks this ticket as "authorized to exit".

The Garage Server sends a confirmation message back to the Parking Application Server that the user's credentials have been accepted, which means that he will be allowed to exit when he presents his ticket to the ticket reader at any exit gate. The Parking Application Server forwards the confirmation message to the phone, where it is displayed as "Accepted", as shown in Figure 3, Handset Screen 3. This is the user's assurance that the payment transaction has gone through correctly.

At some time, long after the above linking of phone and ticket IDs has been completed by the Garage Server, the user returns to his vehicle. The cautious user may want to check the Active Session Screen (Figure 5, Handset Screen 2) before he proceeds to an exit gate. The Active Session Screen is displayed whenever the user launches the Garage Parking app and the session is active. He confirms that the payment

[3] This time is the time-of-day as per the smartphone's own clock. As this clock is synchronized to the cellular network operator's clock, which is tied to GPS time, it is expected to be approximately in sync with the Garage Server's clock as long the latter has a relatively accurate clock (accurate to at least 1 s). This time synchronization does not impose a major cost burden on the infrastructure.

transaction was accepted by the Garage Server. These steps are optional – the user may also exit with no handset steps at all by simply entering his ticket into a ticket reader, as in legacy practice.

The ticket is immediately recognized by the Garage Server as authorized to exit and the gate is opened. The latency of the above process is indistinguishable from a legacy gate opening. An invoice containing the parking session time and charge, for the parking session linked to the message ID, are sent by the Garage Server to the Parking Application Server. The latter identifies the smartphone from the message ID and sends a receipt to the phone, as shown in Figure 5, Handset Screen 3.

More technical details are provided in the transaction diagram in Figure 6.

Exiting when ticket is lost

In present garages using paper tickets, if a user loses his ticket, he has to pass through a manually controlled gate where he has to pay a maximum charge which is set at a penalizing level while covering the garage owner for likely actual charges. In some garages, the user can call a remote, human operator who will collect a credit card payment and open the exit gate. This is onerous for both the garage and the user.

In our TWS system, as the user can identify himself by his handset to the Parking Application Server, his ticket can also be identified in the Garage Server's database. He can therefore be charged the actual amount corresponding to his session. The lost ticket exit method involves a slightly longer, machine transaction delay at the exit gate than if the user had the ticket but it is clearly a much better outcome for both the user and the garage when the ticket is absent.

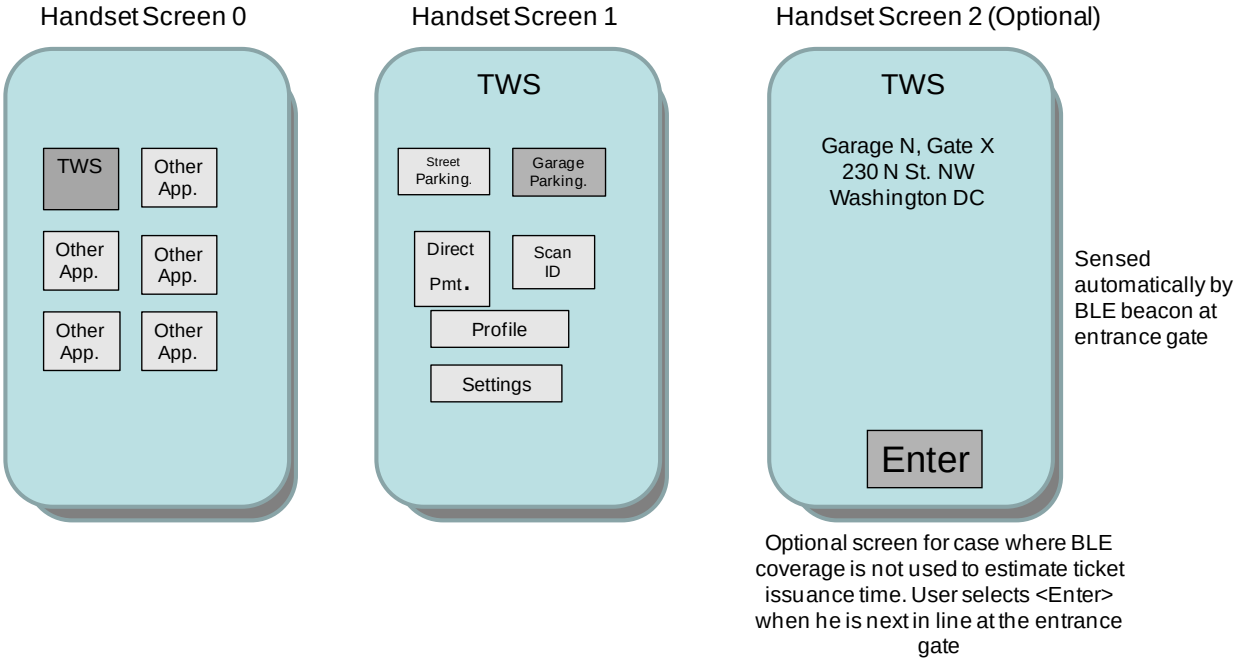
The method is illustrated by the handset screens of Figure 7 and the transaction diagram of Figure 8. The steps are described below.

- The session initiation occurs as per normal operating procedures described above for the TWS method for paper tickets.
- As per normal operating procedures, the following have been already been completed by the time the user decides to exit:
    - A parking session has been started
    - In the Garage Server, the Handset ID (represented by a session ID issued by the Parking Application Server) has already been linked to a specific Ticket ID, based on the time of ticket issuance at the entrance gate.
    - The Garage Server has marked the ticket as "Authorized to Exit" in its database

- It is assumed that, sometime before the user actually appears before the exit gate, he discovers that he has lost his ticket
- He launches the TWS app by selecting <TWS>, <Garage Parking> and <Lost Tkt>, as shown in Figure 7.
- He then drives up to an exit gate and selects <Exit>, as shown in Handset Screen 3.
- The above causes a message, Lost_Ticket_Open_Gate (Garage ID, Gate ID), to be sent from the Handset to the TWS Parking Application Server (referred to as TWS server hereafter). The Garage and Gate IDs have already been sensed by the Handset, thanks to a BLE module near the exit gate. This is shown in Handset Screen 3.
- The TWS Server authenticates/recognizes the Handset and looks up the Session ID for this Handset. It sends a message to the Garage Server, requesting it to open the indicated gate and identifying the Session ID. The message format is: Lost_Ticket_Open_Gate (Session ID, Gate ID)
- The Garage Server authenticates/recognizes the trusted TWS Server and opens the requested gate.
- The Garage Server then builds an invoice for the particular Session ID[4] and sends it back to the TWS server. The message format is: Invoice (Session ID, Charge, Session Details)
- The TWS Server builds a receipt and forwards it to the Handset. This receipt is FYI relative to the user – it has no effect on gate opening. By this time, the user may have left the garage, as shown in the Transaction Diagram of Figure 8.

[4] Recall that the time of entry for the particular Session ID is known to the Garage Server

Figure 3 Entrance Smartphone Screens for Gated Garage using Paper Tickets



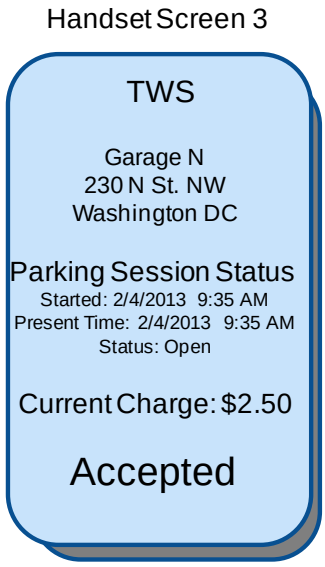


Figure 4 Entrance transactions for Gated Garage using Paper Tickets

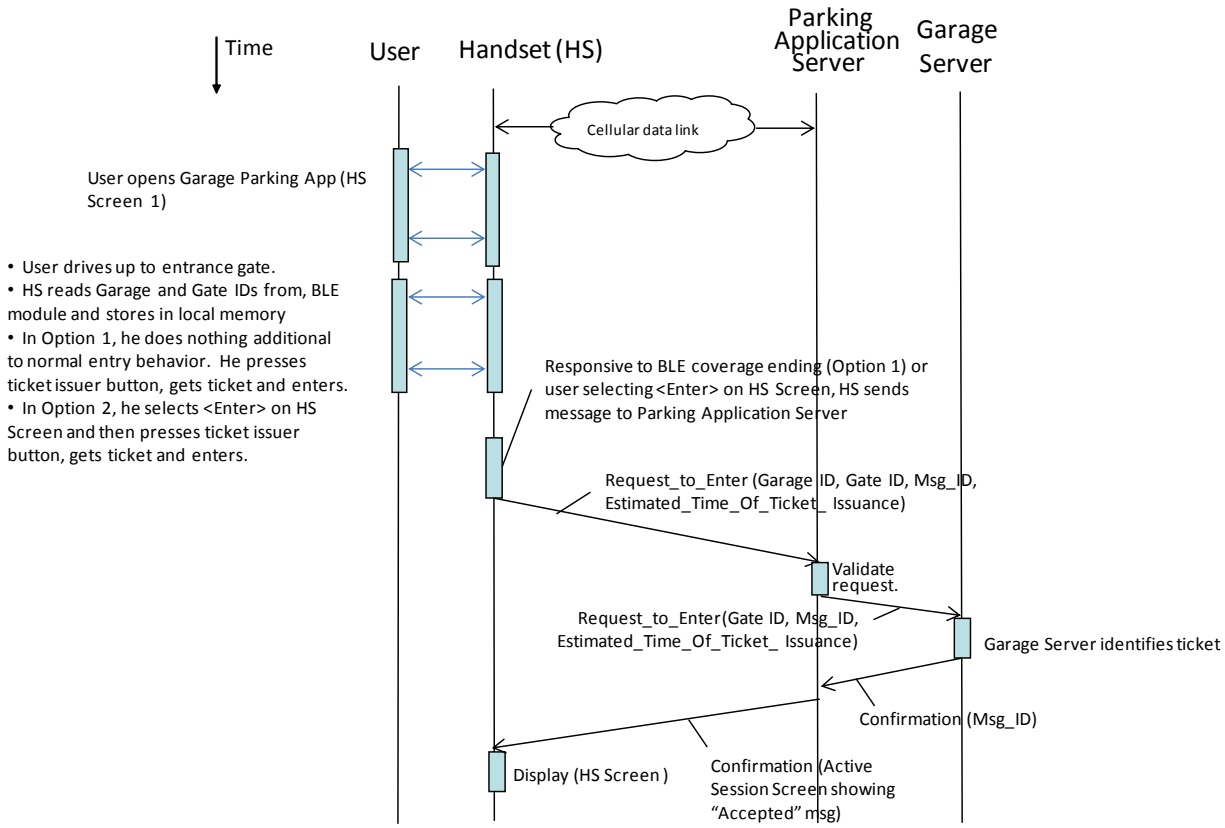


Figure 5 Exit Smartphone Screens for Gated Garage using Paper Tickets

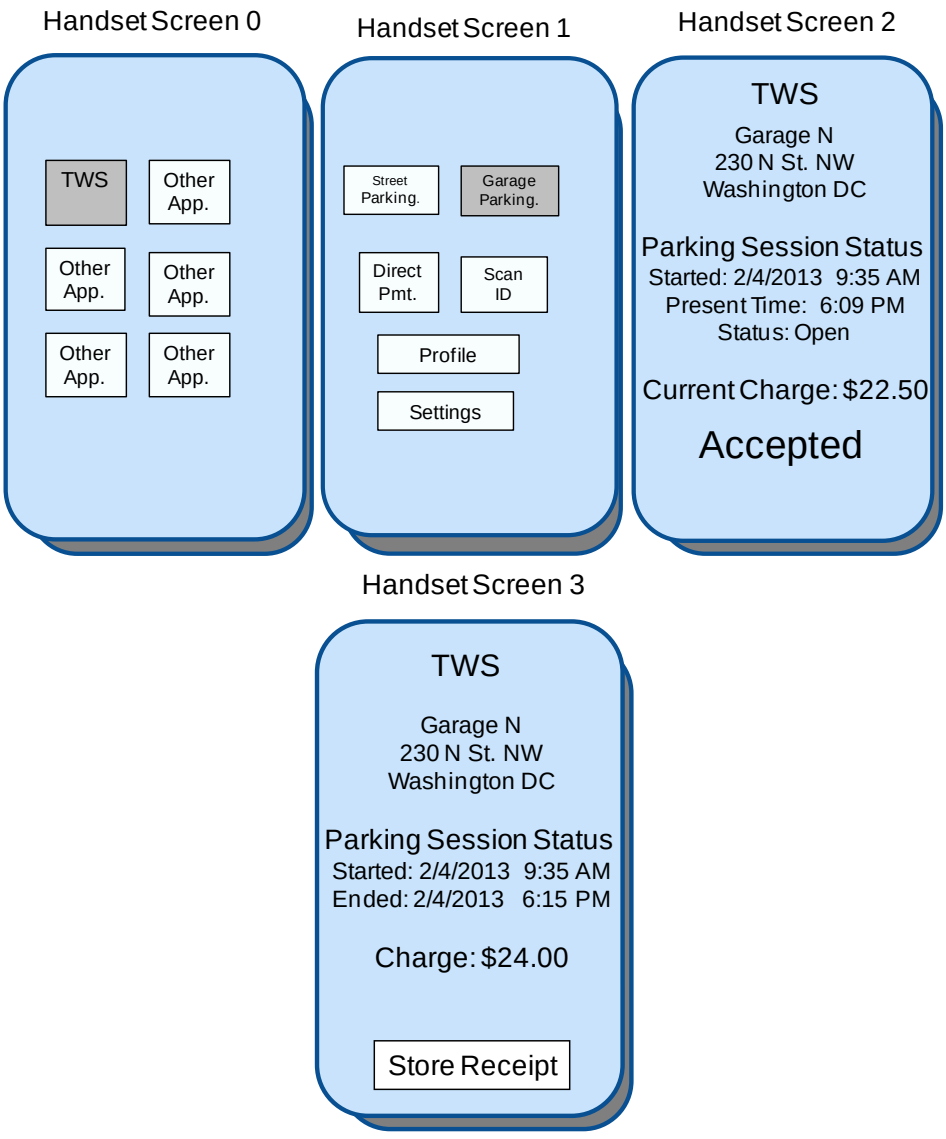


Figure 6 Exit transactions for Gated Garage using Paper Tickets

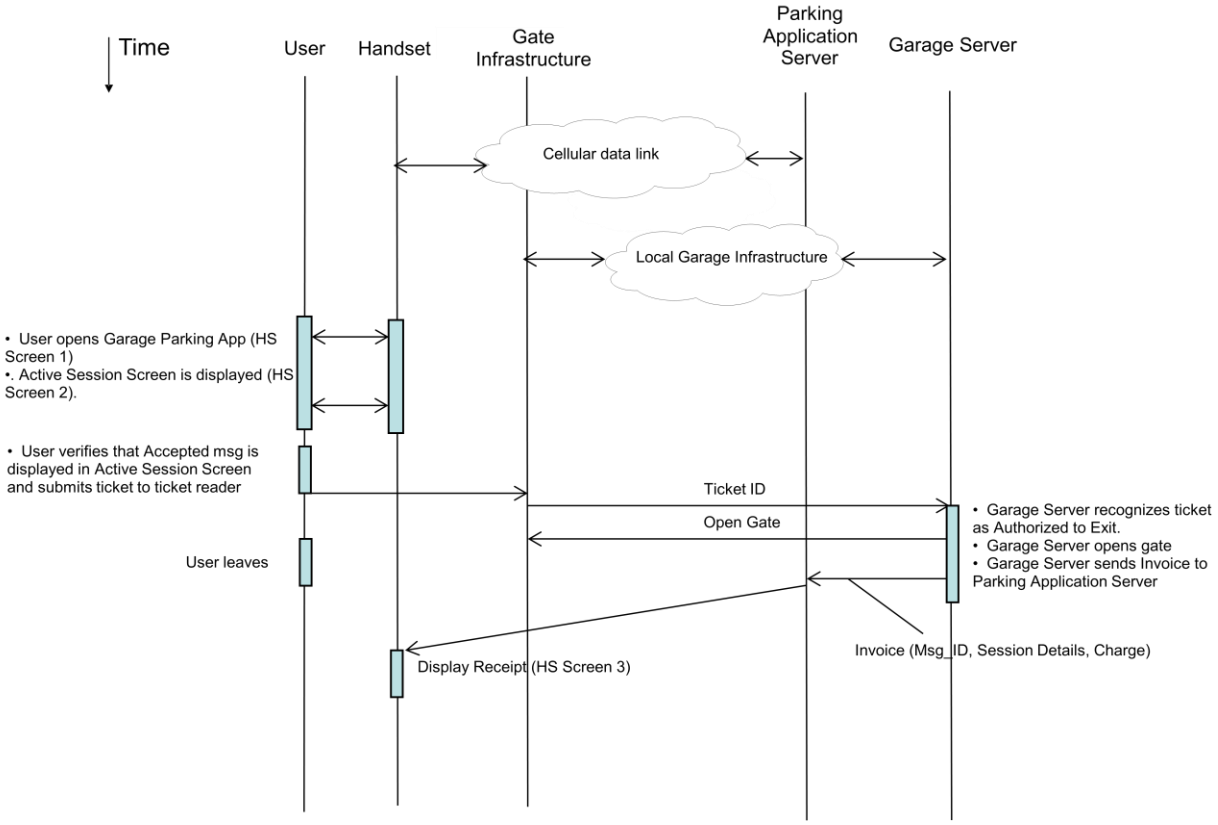


Figure 7 Lost Ticket Exit Smartphone Screens for Gated Garage using Paper Tickets

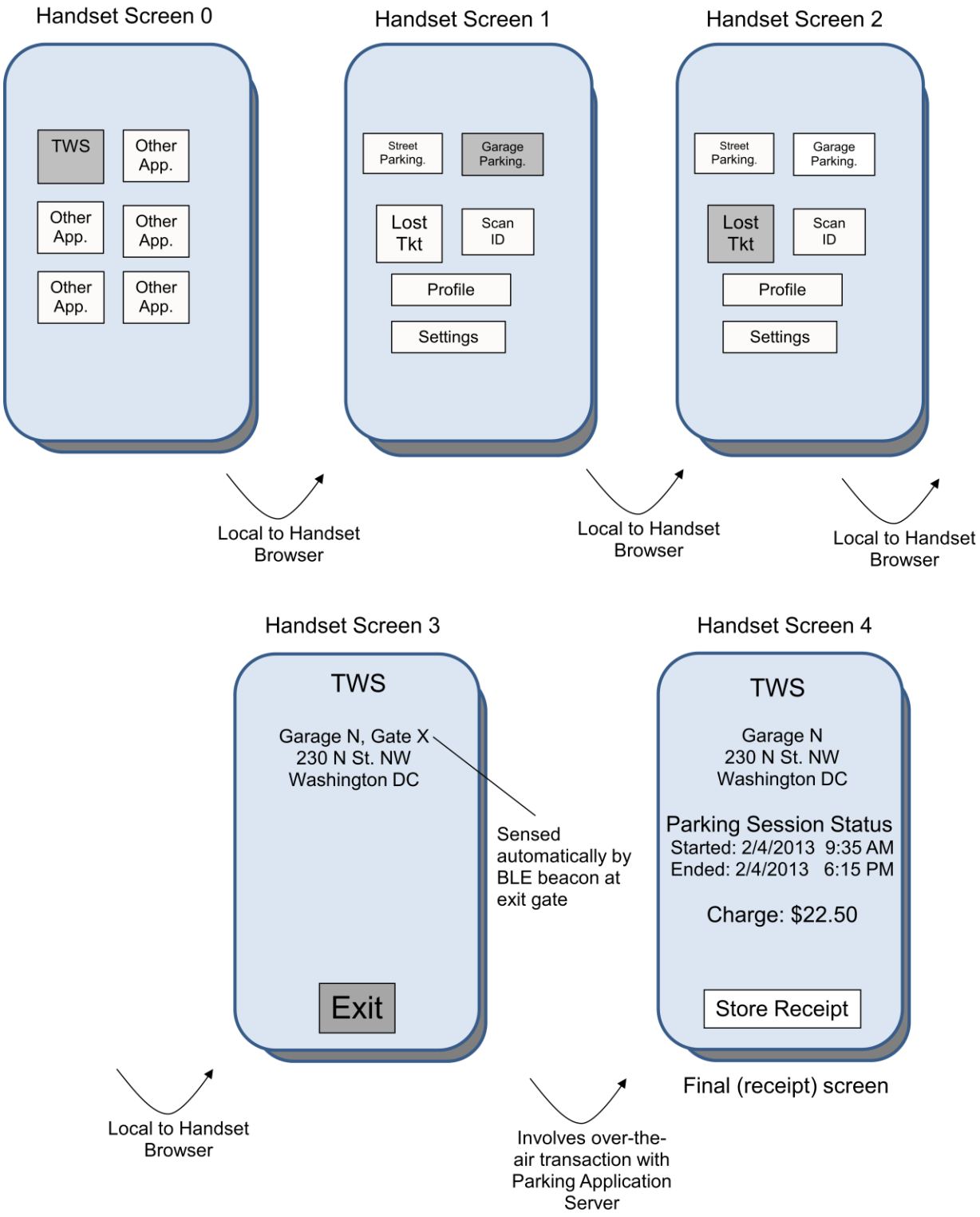
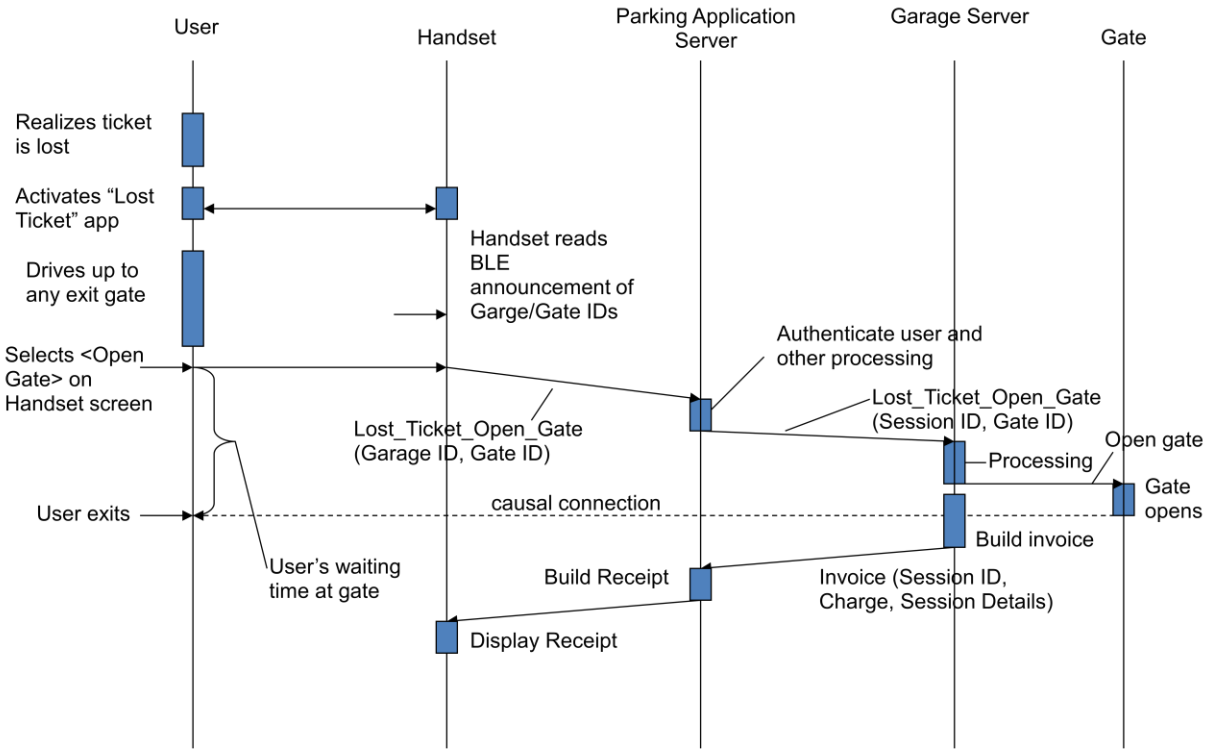


Figure 8 Lost Ticket Exit transactions for Gated Garage using Paper Tickets

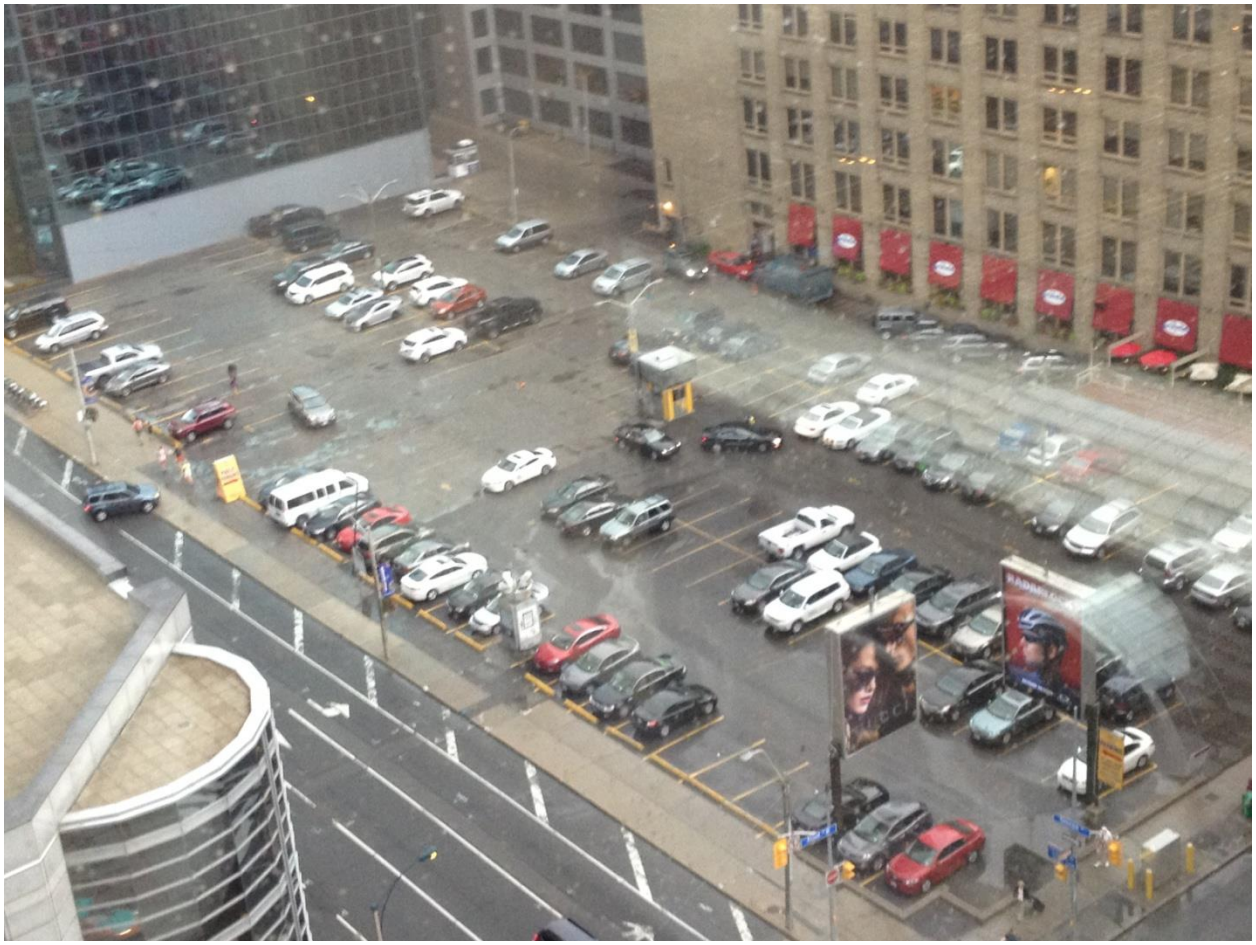


2.3 Payment at manually operated gated garage (valet parking)

Many gated garages are manually controlled. This means that human operators, not computers, control the gates and/or collect payment through manually swiped credit cards. This is often the case with small garages in dense urban areas where small lots have been turned into paid garages. Manual operation is also the practice in valet parked garages, which are common in very densely populated cities like NYC.

Figure 9 shows an example of such a garage in the city of Toronto, Canada.

Figure 9 Manually controlled gated garage in downtown Toronto



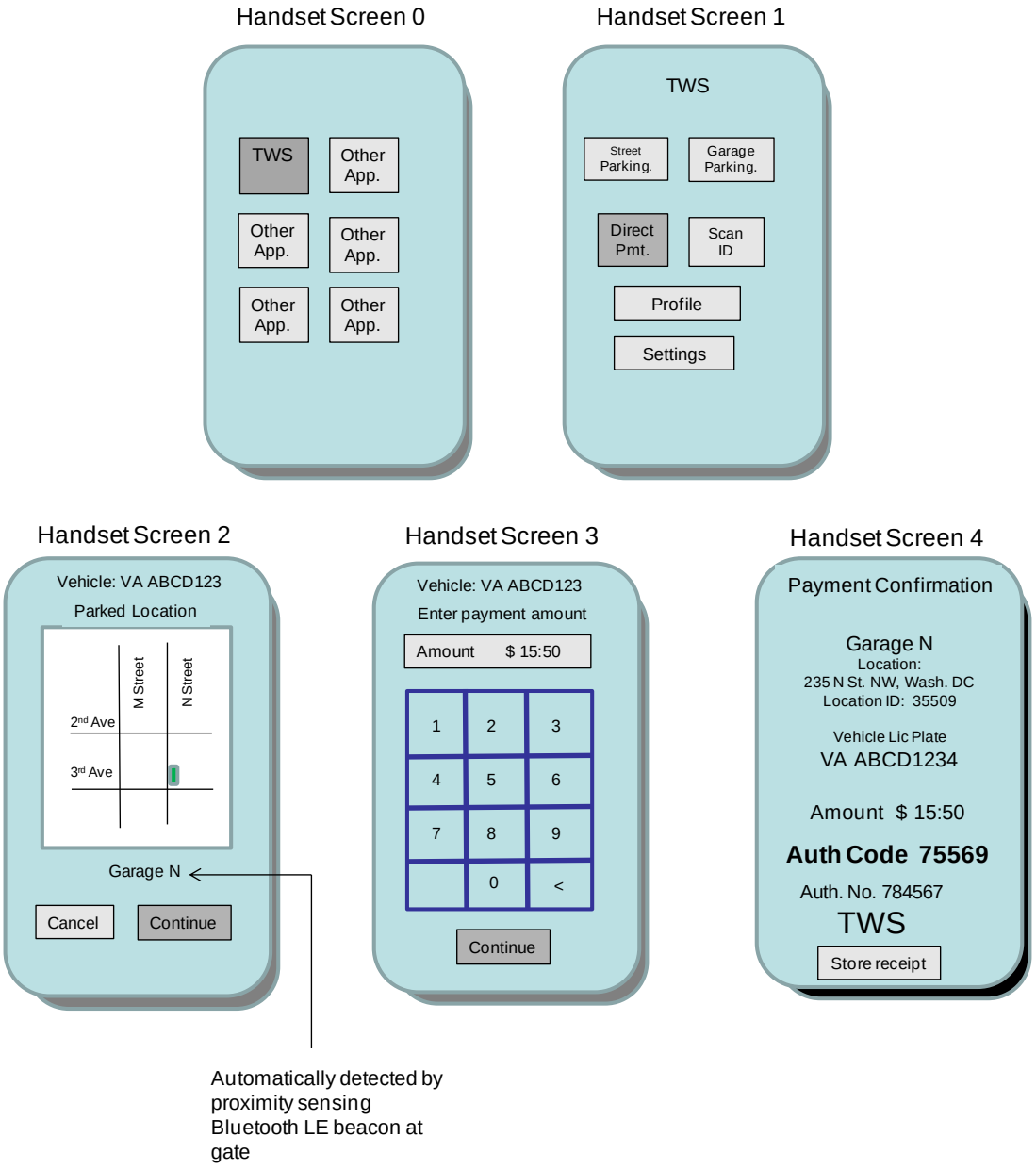
Our TWS system supports a cellular-data payment method for such scenarios, similar to mobile person-to-person payment. In this document, this payment method is referred to as “direct payment” as shorthand for *direct payment by the user to the garage* (the payment amount is *user-entered* as opposed to being *server-determined*).

Figure 10 shows smartphone screens in the Direct Payment method in our TWS system. The first step is common with that used for automatically controlled gated garages.

- The user launches the Direct Payment app on his smartphone (via Screens 0 and 1) when he approaches the gate at which payment is required (payment gate). This could be either an entrance or exit gate, depending on the garage. A BLE beacon module, announcing the Garage ID, is located at a suitable point near the payment gate. The beacon is sensed by the smartphone, as shown in Screen 2.
- The user enters the payment amount on his smartphone (Screen 3) and sends a payment request message to the Parking Application Server by selecting <Continue>. The message contains the Garage ID sensed above.
- Upon successful user authentication, the Parking Application Server returns to the user a page, such as Screen 4, containing, beside other information, an ***authentication code***.[5] An authorization number is also sent for tracing the transaction in the case of disputes.
- A page is also sent to a handheld terminal or computer, used by the garage staff, containing the same authentication code and authorization number.
- The user shows a garage staff the authentication code received, or some other ID known to the Parking Application Server, on his smartphone.
- If the authentication code on the user's phone matches the one received by the garage staff, he regards that as proof of payment. It is treated in the same way as the trusted "payment authorization" message from a credit card company.
- The vehicle ID (license plate number), which is easily checked by a garage staff, may also be used an independent proof of payment or in lieu of an authentication code. Figure 10, Handset Screen 4 shows both Authentication Code and License Plate Number as parts of the common message sent to both the user and the terminal used by the garage staff.

[5] The authentication code could also be a pattern or image, e.g. car picture and its license plate number.

Figure 10 Examples of smartphone screens for Direct Payment in manually operated gated garages



The benefits of this method over legacy payment methods are the following:

For the end user

- Quicker and more convenient than credit cards (for both the user and the garage staff).

- More secure than credit cards (which may be subject to ID theft if not associated with a PIN and the card is handed over to strangers).
- One payment system with consistent user experience for all parking.

For the garage owner

- Addresses a large segment of gated garage parking, especially valet parking
- Minimizes fraudulent use of the facility
- Possibility of user profiling
- Communication of bulletin board messages to potential users

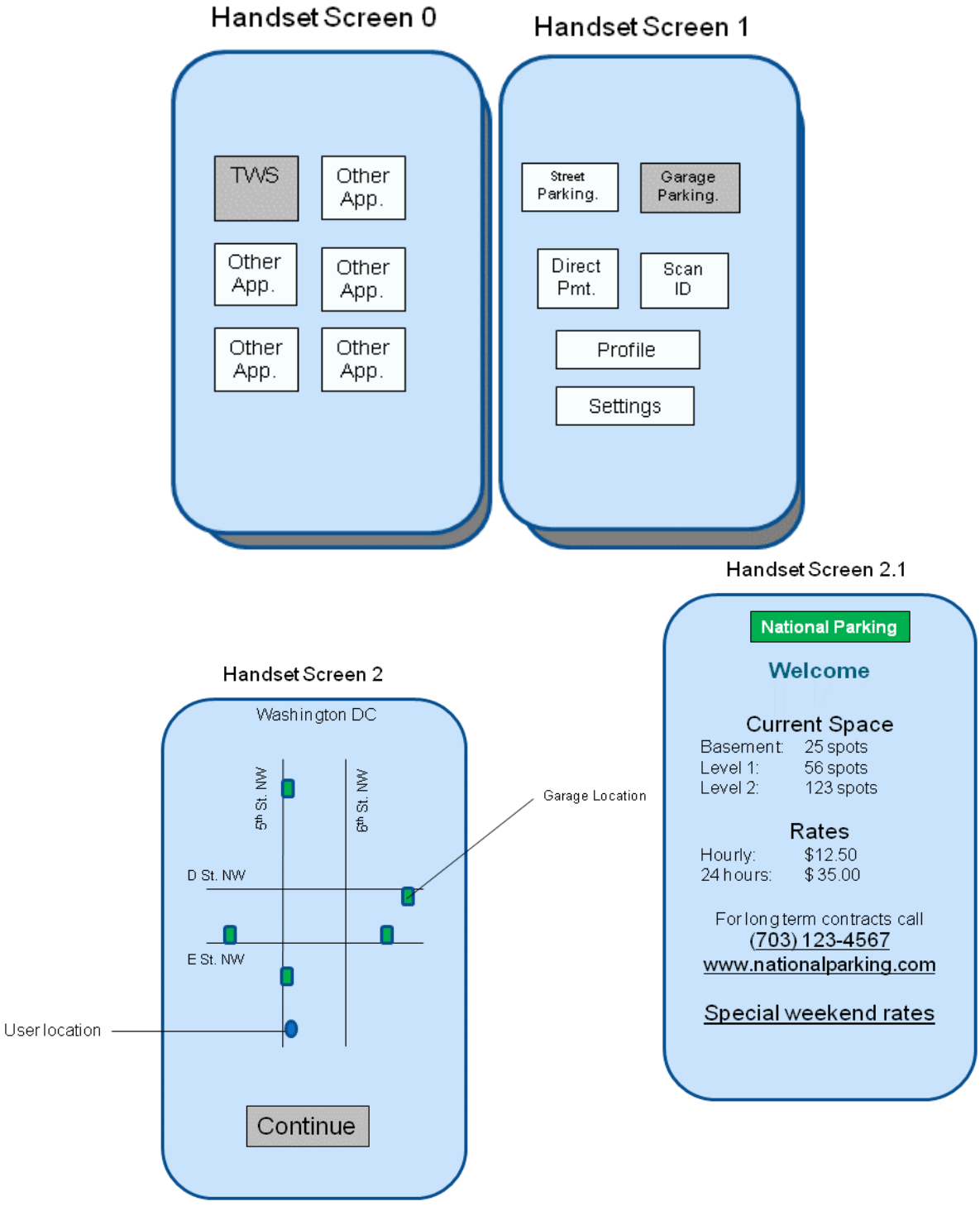
2.4 Broadcasting Bulletin Boards to Prospective Customers

Bundled with TWS's payment system is the ability to broadcast bulletin board information to proximate users. This is enabled by the following aspects of the TWS system: (i) the Garage Server is connected (e.g. via the Internet) to TWS's Parking Application Server, (ii) the Parking Application Server becomes aware of the locations of the smartphones when they initiate a parking transaction (indicating a desire to park at a gated garage). The bulletin board information may be updated as frequently as desired by the garage.

The bulletin board of a garage can be pushed out to a user *before* he enters the garage, as soon as he selects <Garage Parking>, as shown in Figure 11, Handset Screen 1. When the user selects <Garage Parking>, a message is sent to the Parking Application Server indicating the user's present location. In response, the Parking Application Server sends the smartphone the locations of proximate garages with which TWS has business relations. The locations are displayed on a geographic map, as shown by an example in Figure 11, Handset Screen 2. The user's own location and those of proximate garages are indicated by blue and green dots, respectively. The user can view the bulletin board of each garage by selecting the corresponding green dot on the smartphone screen. An example bulletin board is shown on Figure 11, Handset Screen 2.1

The bulletin board may show the current parking rate, occupancy levels, future promotions and any other information the garage owner may wish to advertise. The information may persuade the user to pick one garage over another.

Figure 11 Examples of smartphone screens for broadcasting bulletin board information from garages



2.5 Benefits of TWS System for Garage Owners

Our TWS system offers the following benefits for garage owners. Some of them can also (potentially) be offered by other payment systems but no existing system is known to provide them today.

Support for loyalty programs

The TWS system has knowledge of the parking profiles of its users. This can be used to build custom fees for different user classes, thereby supporting both loyalty programs and corporate/fleet parking programs.

Real time, smartphone app based broadcast channel to prospective customers

Bundled with our parking payment system is a means for garage owners to push real time, bulletin-type board information to prospective customers. Examples of such information are garage occupancy status, dynamic rates based on occupancy levels, and special promotions such as reduced rates during off-peak hours.

Dynamic rates are being considered/implemented by city authorities for on-street parking as way to assure a minimum level of space availability in high demand areas such as urban cores; such policies also help to increase revenues over preset fixed rates. A broadcast channel comprises a significant competitive advantage for a garage.

Employee fraud reduction

It is known that employees can deprive owners of revenue by offering lower than official rates to users willing to forego receipts. This is easier where the barriers are manually operated. Even when the barriers are automatically operated, they may allow employees to override the automatic control. Our TWS system maintains parking records that cannot be manipulated by the employees; moreover, the payment records go directly to the Garage Server, bypassing the employee.[6]

Better handling of cases of lost tickets

Our TWS system can identify the user to the Garage Server even when the user has lost his ticket. This means that the user does not have to go through a manual gate, which causes delays and holds up traffic. As the actual session time can be

[6] This fraud prevention measure is only available if the user chooses to use the TWS payment method or is the only payment method accepted (if the method gains widespread acceptance in the future).

determined, the charge does not have to be set to an artificially a high value. A small penalty can be levied by the garage to discourage users from discarding their tickets.

3.0 Core Innovations and associated Value Propositions

Innovation relative to present systems	Benefit	Beneficiary	Comments
Substitute ID Tokens with TWS smartphone app	Extremely facile for user (minimal user steps)	User	Better than cards, NFC/Optical scanning with phone
Substitute paper tickets with TWS smartphone app	Extremely facile for user (minimal user steps)	User and garage owner	Much less onerous than any present system.
Facile handling of lost paper tickets	User's session can be identified without the ticket	User and garage owner	User pays much less than maximum lost-ticket amount, payment remains app based. Avoiding manual gate/payment is better for both the user and garage.
Automatic sensing of Garage/Gate ID by RF beacon .	No user interaction required	User	Reduces several user steps relative to legacy credit card or ID pass payment systems
	No garage rewiring	Garage owner	Significant cost savings relative to use of RFID
Auditable trail of garage usage	Helps avoid employee fraud.	Garage owner	Potentially significant cost savings
Real time communication of bulletin board information to potential users	Implement dynamic rates. Communicate occupancy status & promotional offers to prospective customers.	User and garage owner	Not supported by existing systems
Support custom rates for different user classes	Enables loyalty and corporate/fleet parking programs	Users and Garage Owners	Feasible with other systems but not known to be supported today

References

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