Appendix 6.

On-Street Parking Technology Whitepaper

Appendix 6

White Paper: On-Street Parking Technology

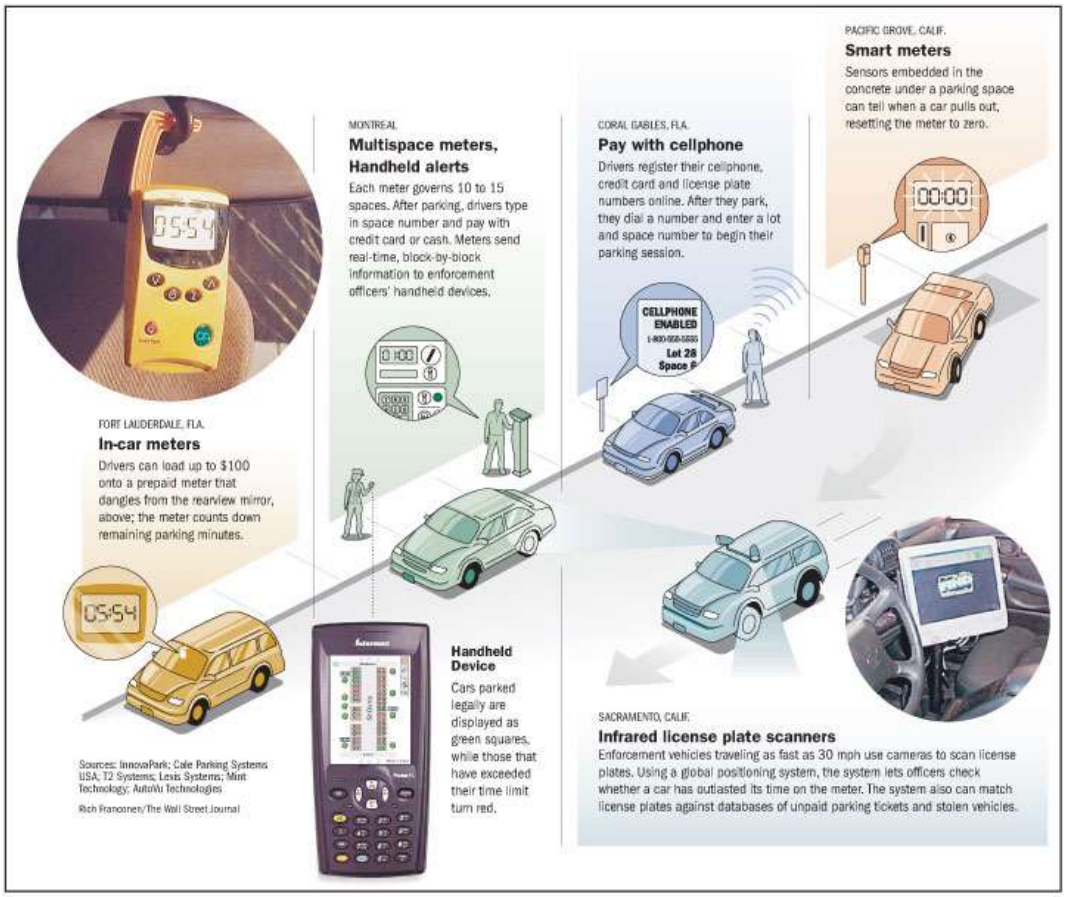
Introduction

This report provides the City of Norman with a summary of current parking meter technology in use today. Our intent in providing this background information is to give you a comprehensive overview of parking meter technology as you prepare for upgrading your on-street meter program. There are many new features and applications that you should be aware of prior to finalizing your equipment RFP.

Over the past decade parking meters have evolved significantly from the traditional coin operated meters to a variety of technologies that include credit card enabled devices, centralized pay stations, and numerous payment methods including pay by cell phone, smart phone applications, in-car meters, etc.

The graphic below, which appeared in the Wall Street Journal, provides a depiction of the type and variety of both revenue control devices and enforcement technology. The following sections describe these technologies, as well as other tools in place today.

Source: Wall Street Journal



On-Street Parking Technology

Operational Methodologies

The following sections provide a summary of current on-street parking revenue control technology devices, including Pay-by-Space Meters, Pay-and-Display Meters, Credit Card Capable Single-Space Meters, and Pay-by-License Plate Meters.

Pay-By-Space

Pay-By-Space is a multi-space meter operational methodology that has grown in popularity over the past decade. The user interface is initially more complicated, but has definite advantages that need to be considered when assessing multi-space meter selection and implementation.

EXAMPLE CITIES THAT USE PAY-BY-SPACE:

- Riverside, CA
- Atlanta, GA
- Raleigh, NC
- Tulsa, OK
- Las Vegas, NV
- Cedar Rapids, IA

This methodology first started in the off-street lots as a replacement option for manual "slot box" systems. These simple "slot box" systems allowed motorists to note the space number where they parked their vehicle, go to the "pay box or honor box", and slip in the proper payment for the amount of time desired into the slot that corresponded to the space number. This allowed the lot to be minimally monitored by the parking operator. Once the electronic version of the honor box was developed (the Pay-By-Space meter) this methodology then migrated to on-street parking where it has grown in popularity.

The basic premise of the Pay-By-Space methodology is that the motorist parks in a space, notes the space number, and proceeds to the closest multi-space meter located near their vehicle. In an on-street application, there are usually one or two machines per block face.

The motorist then operates the multi-space meter as directed by the manufacturer's instructions. Some of the newer meters have instructions right on their digital displays, giving the motorists step-by-step instructions on how to pay for their parking. They may also offer various options at the time of purchase such as the ability to add time or use coupons or special payment cards or codes. The motorist then takes their receipt and continues on to their destination (without having to return to their vehicle to display the receipt).

If all the Pay-By-Space machines are networked, the motorist could actually add more time for their space number at any meter (not just the one on the block face where they parked) as long as they did not exceed the time-limit that applied to their space. The amount of additional time allowed can be assigned on a space-by-space basis as defined in the parking policy rules of the governing agency.

Another important element of a Pay-By-Space system is the need to number each space. Some argue that this requirement defeats the use of multi-space meters to "de-clutter" the streetscape.

In some southern environments with warmer climates space numbering can be accomplished by painting space numbers on the pavement or curbs. However, in northern cities with significant snow accumulation, pole mounted signs are a requirement.

Benefits of Pay-By-Space

1. The motorist does not need to return to their vehicle to display a receipt as proof of payment.
2. Enforcement can utilize handheld devices that allow the enforcement staff to note which spaces are not paid for (or generate a report from each multi-space meter), allowing them to enforce more efficiently than visually inspecting each meter.
3. Used in conjunction with in-street space sensors, occupancy data can be generated for statistical analysis projects for a given area. This data could be useful in determining actual number of vehicles that occupied a given space for a defined amount of time (i.e. a 24-hour period). The data could also aid in determining the amount of revenue collected for the space, and how much potential revenue could have been generated for that particular space, in the specified time period.
4. When the Pay-By-Space system has been networked, payment can be made anywhere within the system. The advantage being, the motorists can make additional time payments at any machine that is operational rather than just the machine near their vehicle.

EXAMPLES OF WELL DONE PAY-BY-SPACE SIGNAGE

The above photo is from Ann Arbor, Michigan e-park program.

The photos above are from the on-street program in Milwaukee, Wisconsin. One positive element of this Pay-By-Space signage is how they incorporated the City's wayfinding signage "downtown district identifiers into the parking space signs.

5. Pay-By-Space systems can offer “pay-by-cell phone” as an option. This option works by the motorist calling a designated phone number, which requires a first time setup. Once the account is activated and tied to a credit card, the motorist pays for their space via their phone.
6. Pay-By-Space systems can also allow motorists the option to “add time” to their current parking space by using a cell phone. This feature is optional, but is seen as a real customer service enhancement. This feature can be set so the motorist cannot park longer than the time limits allow.
7. Pay-By-Space systems have been shown to increase parking revenue up to 40%. This growth in revenue is generated thru more efficient enforcement, freedom of payment (coin, bill, credit card, smart card and cell phone) and a reduction in “borrowed time” from the previous motorist.
8. Pay-By-Space systems provide a less cluttered streetscape while also reducing the amount of infrastructure that needs to be installed. Wireless operations provide standalone systems and remote access to control rates, occupancy and enforcement.
9. Reduces meter maintenance and collections costs. The wireless Pay-By-Space meter can notify you when collections or maintenance are necessary.
10. The Pay-By-Space system software can provide an audit trail both electronically and on paper to prevent theft or fraud in collections.

Disadvantages of Pay-By-Space

1. Motorists forget their space number and have to return to their vehicle to remind themselves of the space number.
2. Motorists enter the wrong space number in the machine and receive a violation. After using the wrong space number, the motorist will return to their vehicle, likely finding that they have received a citation for an expired meter even though they have paid for the parking. The motorist then will have to follow an adjudication process, showing payment to appeal the citation.

3. If the spaces are not properly marked, this can lead to problems with the overall performance of the system. Such problems as those systems in cold weather where the pavement markings or numbered sign posts will be covered by snow and ice. Confusing space signage, as in the photo to the right, would also create significant problems.
4. Regardless of what type of numbering system is used, the numbers are subject to vandalism, wear, abuse, and errors. Any or all of these can negatively affect system performance.
5. In very large cities, numbering systems can get confusing and difficult to manage as well as adding to the maintenance budget.

Pay-And-Display

The Pay-and-Display system has the greatest portion of market share in the US, partly because it was the first model introduced. The motorist parks, then walks to a multi-space meter operating in Pay-and-Display mode. The motorist then pays for the desired duration of parking using coin, cash, credit/debit, or smart card and receives a receipt for payment. The parking patron then returns to their vehicle and displays the receipt on the dashboard or window with the expiration time visible. The displayed receipt proves to the enforcement staff that the space has indeed been paid for through the time printed on the displayed receipt.

EXAMPLE CITIES THAT USE PAY-AND-DISPLAY:

- San Antonio, TX
- Austin, TX
- Denver, CO
- Portland, OR
- Seattle, WA

There are several reasons for the more widespread application of Pay-and-Display systems:

- Pay-and-Display has been in use longer than Pay-By-Space.
- Europe uses Pay-and-Display almost exclusively and only recently have they even considered Pay-By-Space.
- Pay-and-Display is favored for areas that have significant snowfall in the winter. This is because it is more problematic to keep space numbers visible (a requirement for the Pay-By-Space methodology) with snow or ice on the ground. There are also potential problems with snow removal tools accidently causing damage, or vandalism to the numbers used in a Pay-By-Space system.
- Pay-and-Display is a simpler technology to manage as an owner and use as a patron.

Benefits of Pay-and-Display:

1. Pay-and-display is a relatively simple operation, from both the motorist and the maintenance point of view. There are no space numbers to assign to spaces, less street clutter from signage and no maintenance required for space numbers.
2. In this approach, you are buying “time” not a “space”. This can be an advantage because you have what is referred to as “portability of time”. For example, if you paid for 2 hours and came back to your car after 45 minutes, you could drive to another location and park, and the receipt would still be valid for the additional 75 minutes.
3. There is also an argument that because you don’t’ have to designate specific spaces that you can actually increase the number of spaces on a block face. This would depend on a number of factors including available space, number of existing spaces, and typical vehicle space. If you consider that to gain one space you would need to add approximately 20’, there would need to be a lot of space reduction per block face.
4. Eliminates motorist confusion regarding space numbers.
5. All payment forms are available to Pay-and-Display operations, with the exception of Pay- by-Phone. The original transaction could be paid for using Pay-by-Phone systems but an interface with the machine would have to be developed to produce a receipt for display, which could be problematic.
6. Pay-and-Display systems have been shown to increase parking revenue up to 40%. This growth in revenue is generated thru more efficient enforcement and freedom of payment (coin, bill, credit

card, smart card). Additionally, unmarked streets could potentially allow for greater capacity and higher revenue.

7. Pay-and-Display systems provide a less cluttered streetscape while also reducing the amount of infrastructure that needs to be installed. Wireless operations provide standalone systems and remote access to control rates, occupancy and enforcement.
8. Reduces meter maintenance and collections costs. The wireless Pay-and-Display meter can notify you when collections or maintenance is necessary.
9. The Pay-and-Display system software can provide an audit trail both electronically and on paper to prevent theft or fraud in collections.

Disadvantages of Pay-and-Display:

1. Motorists must return to the vehicle to display the printed receipt as proof of payment. This requirement is more problematic in certain environments with extremes in temperature, heat, snow and ice conditions, or extremes in topography.
2. While the use of electronic devices to issue citations is compatible in Pay-and-Display operations, visual inspection of each displayed receipt is required to determine if the vehicle is in violation.
3. Pay-by-Phone is not readily compatible with Pay-and-Display operations as there are no space numbers to associate with the vehicle.
4. With Pay-and-Display the motorist cannot add to the amount of time paid for parking without having to return to their vehicle to purchase additional time, which then has to be displayed in their vehicle.
5. Vehicle sensors and related technologies are problematic in combination with Pay-and-Display meters. Since there are no assigned space numbers (or in some cases even defined spaces) it is difficult to track parking occupancy, duration of stay and other key factors.

Credit Card Capable Single-Space Meters

A viable alternative to multi-space meters that provides many of the primary benefits (at least regarding improved customer payment options, ease of use and back-end software support) is credit card capable single-space meters. Currently, only a few vendors provide the option to retrofit current single-space meter housing with an electronic mechanism that can perform on-line credit card transactions as well as continued acceptance of coin, smart card and cell phone payments. Credit card capable single-space meters need to meet the Payment Card Industry (PCI) security standards. Credit card transactions are encrypted and authorized, and only the last four digits of each credit card number are stored within the meters for security purposes.

EXAMPLE CITIES THAT USE CREDIT CARD CAPABLE SINGLE-SPACE METERS:

- Austin, TX
- Los Angeles, CA
- Washington, DC
- San Francisco, CA
- San Diego, CA

Benefits of Credit Card Capable Single-Space Meters:

1. Because these new meters look like the conventional single-space meters that everyone knows, there is little to no special training needed.
2. Also, because they are so familiar looking, everyone intuitively knows that if you park in a space with a meter, that payment is expected (unlike with a switch to multi-space meters where the meter may be half a block away).
3. From a convenience perspective, the meter is located immediately at the head of each stall with no need to walk to a multi-space meter (and potentially back to the car to display a receipt).
4. The meters provide multiple customer payment options including electronic payment methods (i.e., credit cards, smart cards, etc.).

5. Increased credit card/smart card usage translates to reduced coin collection and handling.
6. Previous installations have demonstrated significant potential to increase the average revenue per meter by allowing for payment by credit card.
7. Improved security due to cashless transactions and reduced need for coin collection, counting and handling.
8. Reuse of existing meter bases and poles for implementation of meters.
9. Meter rates and schedules can be automatically and electronically updated to new meter heads using GIS and RFID technologies.
10. System rate programming and utilization data can be downloaded from a central location.

Disadvantages of Credit Card Capable Single-Space Meters:

1. Higher up-front cost for credit card capable meters than for conventional meters.
2. Credit card companies charge transaction fees ranging from 1-3% for large volumes and 3-6% for smaller merchants with low volumes.
3. Ongoing costs for wireless services and management system access.
4. Credit card number information could potentially be skimmed if physical access is obtained to the credit card reader's circuitry and the reader is tapped.

Pay-by-License Plate

Pay-by-license plate is an operating methodology that has been brought from Europe to the U.S. and Canada. Rather than using space numbers, this operating method requires motorists to pay for parking by entering their license plate number (as well as parking zone, if applicable) into a multi-space meter or cell phone payment system.

EXAMPLE CITIES THAT USE PAY-BY-LICENSE PLATE:

- Washington, DC (Pilot Study)
- Pittsburgh, PA (Recently Implemented)
- Eugene, OR (Limited Implementation)
- Whistler, British Columbia, Canada
- Calgary, Alberta, Canada
- Missoula, MT (Off-Street)

While this works well in Europe, this methodology has been slower to take hold in the U.S., due to U.S. license plate numbers. Europe uses a standard license plate with straight-line numbers assigned by country. Europe does not allow vanity plates or special characters. In the U.S. the numbering systems varies by state with special plates, vanity plates, special characters and other items that complicate the entering of the "number." The success of the system will be contingent upon motorists remembering their own specific license numbers, and the ability of the system to accept specialized information.

Below are the fundamental steps in the pay-by-license plate/zone process:

1. **Vehicle parks in a zoned area**
   - Each metered space is located within a zone, with signage indicating zone numbering
   - Motorist uses multi-space meter or Pay-by-Phone option for payment
   - Motorist enters zone and license plate information
   - Motorist pays applicable parking rate
2. **License plate and payment information stored in a real-time database**
   - License Plate Recognition (LPR) equipped vehicle patrols zones
   - LPR Patrol takes digitized picture of parked vehicle's license plate
3. **License Plate Recognition Patrol Communicates with system database**
   - Database informs LPR Patrol of vehicle's payment status
   - If expired, a violation with photo, is processed and mailed to the vehicle owner
   - LPR Patrol continues route enforcement

Calgary is a great example of a successful implementation of this operating method in North America. In Calgary, the pay-by-license plate process utilizes both multi-space meters and pay-by-cell phone technology. For parking enforcement, the system incorporates a mobile License Plate Recognition (LPR) system. The LPR system allows the City to gather parking utilization data by date, time and zone. This data allows the City to better analyze parking usage, needs and enforcement patterns. Additionally, the City is able to effectively adjust parking rates to encourage short-term on-street parking while encouraging long-term parkers to utilize less expensive off-street parking facilities.

Benefits of Pay-by-License Plate:

1. Pay-by-License Plate cleans up streetscape by eliminating traditional per space meters.
2. Pay-by-License Plate eliminates the need for numbering spaces
3. Pay-by-License Plate provides the flexibility of taking your time with you to another parking space, similar to that of Pay-and-Display.
4. Reduces human error in enforcement and allows enforcement officers to patrol larger areas in less time.
5. Applicable with Pay-by-Phone integration for additional time and warnings for time expiration.
6. Versatility in payment options and locations. Pay-by-License Plate allows the motorist to pay at any location.

Disadvantages of Pay-by-License Plate:

1. Most motorists don't have their license plate memorized.
2. Requires additional License Plate Recognition equipment and software to be installed in order to assist enforcement.
3. License Plate Recognition does have a margin of error in when reading license plates.
4. Public perception of the license plate recording as a violation of privacy.
5. In cold climates with snow and ice buildup on and around the license plate can render the License Plate Recognition almost useless.

Additional Payment Technologies

The following sections provide a summary of additional payment technologies that can be used as either an add-on, or in some cases, a standalone payment method. These technologies include Pay-by-Cell Phone, Smart Cards, In-Car Metering, and one of the newest payment methodologies, Smart Phone Applications.

Pay-by-Cell Phone

The Pay-by-Cell Phone system is just as it sounds – once the motorist has parked their vehicle, they then call a phone number, send a text, or use a smartphone application to begin the transaction. Once the transaction is initiated, the customer will enter the space number they're parked in and then complete the transaction. There is an initial, one-time set-up where the credit card number is matched with a phone number and a license plate of the vehicle(s) on the account. After the initial setup, the system then uses caller ID to match the user with the account or another type of account ID.

EXAMPLE CITIES THAT USE PAY-BY-CELL PHONE:

- San Francisco, CA
- Washington, DC
- Albuquerque, NM
- Denver, CO
- Long Beach, CA

Pay-by-Cell Phone has been in use for a few years, however, the latest utilization numbers indicate that only 3% of those parking in a location that supports this technology use it on a regular basis. However, many parking professionals see this as the parking technology with the great potential going forward.

The big advantage of this type of system is the ability to "add" time remotely from your cell phone, especially in commuter lots. If the motorist, who planned to stay half an hour, decides to extend their trip for additional shopping or dining, they can call the number provided and "add" time to their parking to avoid a violation. Once the customer has paid for the maximum time allowed (per posted time limits) adding more time is not allowed.

Benefits of Pay-by-Cell Phone:

1. Eliminates the need to carry cash or coins when parking on-street
2. Warning text messages notify the motorist that their meter time is close to expiring and allows them to extend time remotely from anywhere, including a local restaurant or store.
3. Eliminates the need to stop at a meter to pay - simply identify your parking space number, dial the appropriate enforcement number and proceed to your destination at the same time.
4. Receipts can be viewed and printed online from your established Pay-by-Cell Phone account.
5. Handheld devices notify enforcement officers exactly where and when a time will expire and allows them to proactively move in that direction.

Disadvantages of Pay-by-Cell Phone:

1. Not everyone has a cell phone.
2. Requires each space to be numbered and if not properly marked this can lead to problems with the overall performance of the system. Such problems as those systems in cold weather where the pavement markings or numbered sign posts will be covered by snow and ice. Confusing space signage would also create significant problems.
3. Each motorist is required to set up an account with a credit card number linked to that account.
4. Some external companies that operate the payment processing can charge fees per transaction or apply a monthly user fee.

Smart Cards

Smart cards provide a mechanism to pay for parking (and potentially other services) with a single card. Merchants sell the smart card, and load/reload value on the cards with cash or credit/debit, similar to how a gift card works at retail stores. The Smart Card is then inserted into the parking meter and the cost of parking is deducted from the Smart Card.

EXAMPLE CITIES THAT USE SMART CARDS:

- Denver, CO
- Charleston, SC
- Boston, MA
- Des Moines, IA
- Philadelphia, PA

Benefits of Smart Cards:

1. They are very convenient for users - no need to carry coins or tokens. Some cards even utilize contactless communications.
2. Improved security due to cashless transactions and reduced need for coin collection, counting and handling.
3. Reduced vandalism because parking revenues are stored electronically instead of in coin format.
4. They can be used with other systems or as a new “stand alone” system.
5. The parking system receives payment “up front”.
6. Motorists receive receipt whenever parking time is purchased.
7. Unique card numbers provide for additional features such as disallowing extra payments with the same card past the legal parking time limit, and refunding unused time back to a card.
8. Cards can be used to promote an image or brand.
9. Merchants participate in value chain “economics”.
10. Pricing flexibility on rate increases.

Disadvantages of Smart Cards:

1. Value is stored in the card, and if the card is lost or stolen, the value is lost.
2. Customers must purchase cards in advance.
3. Limited locations where value can be added (if user cannot add time via cell phone or online).
4. Smart card programs are generally not economically viable unless widely utilized by a large portion of the target market.
5. There is a high implementation and operation cost for the smart card system.
6. Interoperability with other agencies' smart card systems can be challenging.
7. Smart card programming can be hacked to obtain unlimited free parking on the card.

In-Car Metering

The in-car meter allows the parking operator to sell a small metering device, which remains in the car, to a motorist. The motorist pre-pays for parking by adding time to this device, usually by taking it into a location that will "add time" to the system. In another version of in-car meters, time is added to the meter via cell phone.

When the motorist parks, the motorist activates the in-car meter device, which usually has a digital readout indicating that the motorist has "paid" for the parking they're using.

EXAMPLE CITIES THAT USE IN-CAR METERING:

- Fort Lauderdale, FL
- Arlington, VA
- Miami, FL

These devices have not caught on in large numbers throughout the U.S., but still remain a good alternative for those parking systems with a large regular or repeating customer base that would benefit from this type of device.

Benefits of In-Car Metering:

1. In-car meters can be programmed for multiple parking zones, with different rates for each zone.
2. They can be used with other systems or as a new "stand alone" system.
3. Controlled parking areas can be increased by adding in-car meters only in fringe areas with minimal capital investment.
4. They are very convenient for users - no need to carry coins or tokens, or to interface with parking revenue control equipment.
5. The system is fair - charging only for the actual time parked.
6. The parking system receives payment "up front".

Example instructions for motorists (*taken from City of Fort Lauderdale, FL website*):

The SmartPark device uses a SmartCard that's loaded with a prepaid amount of parking hours. The SmartCard is inserted into the SmartPark, which is then placed inside the vehicle and displays the parking zone selected. The SmartPark unit is a one-time $55 (plus sales tax) purchase and customers must purchase the SmartCard for a one-time fee of $10. Customers can preload the SmartCard in increments of $25, $50, $75, $100, $150, $200, and $250.

7. Motorists receive receipt whenever parking time is purchased.

Disadvantages of In-Car Metering:

1. If value is stored in the device and the device is lost or stolen, the value is lost.
2. Customers must purchase meters and time in advance.
3. Limited locations where value can be added (if user cannot add time via cell phone or online).
4. Motorists may forget to turn meter on, resulting in a parking violation.
5. Motorists may forget to turn meter off, resulting in wasted parking time.
6. Meter batteries have to be replaced.

Smart Phone Applications

Similar to the pay-by-cell phone methodology described previously, the motorist is able to pay for their parking transaction using a Smart Phone application. This technology is relatively new, and is currently in limited markets. The motorist must download the application to their Smart Phone. The application could either be free or cost a nominal purchase fee (usually less than $5).

Most applications require the motorist to register online, or through their phone, prior to the first usage. The motorist will have to store a credit card on file, just like the pay-by-cell phone system. After initial registration, the motorist locates a parking meter, opens the application, and then pays for their transaction.

Some of the newer applications not only allow you to pay for parking, they also help you locate available parking. One of the early methods of this premise relied solely on its network of application users. If you were a user of this (titled OpenSpot and developed by Google), you would use your application not only to find parking, but also to notify other application users of available parking. The methodology included opening the application and indicating that you had left a spot, which notified other users of the space, and gave you "Karma Points" which indicated your level of parking generosity. While a primitive method (albeit, with a tech savvy approach) for locating parking spaces, it symbolizes that the parking public is looking for easier methods to find open spaces and reduce cruising.

Newer and more advanced applications that use either parking operator back end data or in-street sensors are able to actually provide real-time occupancy information and location of available spaces. These applications are relatively new and are being marketed as a solution for cruising and delay related to hunting for that last on-street space. These applications also let you pay for parking, and just like the

pay-by-cell phone method, will provide you notifications when you are about to exceed your time and allow you to add time up to the regulated limit.

Benefits of Smart Phone Applications:

1. Provides real time information related to parking occupancy
2. Can provide turn-by-turn directions to available parking
3. Eliminates the need to carry cash or coins when parking on-street
4. Warning text messages notify the motorist that their meter time is close to expiring and allows them to extend time remotely from anywhere, including a local restaurant or retail store.
5. Eliminates the need to stop at a meter to pay - simply use your application and proceed to your destination at the same time.
6. Receipts can be viewed and printed online from your established application account.
7. Handheld devices notify enforcement officers exactly where and when a time will expire and allows them to proactively move in that direction.

Disadvantages of Smart Phone Applications:

1. Not everyone has a Smart Phone.
2. If the wireless network is not operating, the application is not functional.
3. Requires user to download application to their Smart Phone, which could have a cost.
4. Requires each space to be numbered and if not properly marked this can lead to problems with the overall performance of the system. Such problems as those systems in cold weather where the pavement markings or numbered sign posts will be covered by snow and ice. Confusing space signage, as in the photo on the following page, would also create significant problems.
5. Each motorist is required to set up an account with a credit card number linked to that account.
6. Some external companies that operate the payment processing can charge fees per transaction or apply a monthly user fee.

Specific Meter Benefits

The following subsections provide a brief overview of several potential smart meter benefits, and provide a generic scoring to define how well each of the previously described meter technologies provide these benefits.

Flexible Payment Methods Benefit Rankings

Digital Coin Meters	(
Pay-by-Space	!
Pay-and-Display	!
Credit Card Capable Meter	!
Pay-by-License Plate	!
Pay-by-Cell Phone	<
Smart Cards	<
In-Car Metering	<
Smart Phone Applications	<

Flexible Methods of Payment

One of the primary reasons for upgrading your on-street revenue control equipment is to provide your customers with more payment options. Up until the past decade, most on-street revenue control equipment has been limited to coins, with the addition of pre-paid cards or cash keys in some instances. The newest technology allows for much more flexible payment options, including credit cards, bills, coins, smart cards, and pre-paid metering devices.

!	Maximum Benefits
<	Marginal Benefits
(	Limited Benefits

- **Credit/Debit Cards** – the use of credit/debit cards is available in all of the devices that are being evaluated for this study. Both the multi-space meter and the single-space credit enabled meter use the credit/debit card as their primary payment device. All of the other add-on payment options (pay-by-cell, smart cards, in-car metering, and smart phone applications) use credit card payment to either pre-pay the transaction or pay for the transaction virtually through a pre-stored credit card.

- **Coins** – All of the on-street metering options allow for payment via coin. In some situations, cities have chosen not to allow coin payment to force motorists to pay via credit card, but this application is extremely limited, given the fact that some members of the population either prefer not to use or don't have credit/debit cards. The add-on features typically do not allow coin payment, although technically a person-to-person transaction for loading a smart card or in-car meter could be paid via coins.

- **Cash** – the use of paper money in the newer on-street revenue control equipment is fairly limited. Some meter types allow for it, but the cost of maintaining and monitoring that system is fairly high, for several reasons. First, the storage space for bills in most of these machines is small, so a heavier occurrence of bill usage would mean more collections. Second, a large occurrence of paper money stored in the machine adds the incentive for vandalism. Third, and most importantly, the use of bills creates an increased maintenance situation as the fibers from the bill tend to accumulate in the reader over time, causing jamming and malfunctioning problems. In locations with high rainfall, humidity, or snow accumulation, the moisture can also create issues with the bill acceptor and cause further jams.

- **Alternative Payment Methods** – the alternative methods described in the initial research document, including pay-by-cell phone, smart cards, in-car metering, and smart phone applications, are all compatible with the newer on-street revenue collection equipment, including both the multi-space meter and the single-space credit enabled meter.

Cleaner Streetscape

The notion of a cleaner streetscape is typically attributed to the multi-space meter devices, because they are the most likely to remove the visual and physical clutter associated with individual parking meters affixed at each parking space along a block. The notion of cleaner streetscape is an urban design initiative, with the additional street space gained from removing meter poles rededicated to pedestrian use, restaurant and retail activity, and enhanced streetscape.

Cleaner Streetscape Benefit Rankings

Digital Coin Meters	(
Pay-by-Space	<
Pay-and-Display	!
Credit Card Capable Meter	(
Pay-by-License Plate	!
Pay-by-Cell Phone	(
Smart Cards	(
In-Car Metering	(
Smart Phone Applications	(

!	Maximum Benefits
<	Marginal Benefits
(	Limited Benefits

The meter technology that best fits this notion is pay-and-display, which only requires the multi-space parking meter to regulate parking on the block. Under the pay-and-display system, you can even remove pavement space markings for your meters. The only installation needed in these systems is the meter itself and the appropriate signage indicating where to pay for parking.

Pay-by-license plate is similar to pay-and-display in its ability to remove clutter. Assuming that the appropriate signage is minimal, the pay-by-license plate system can be limited to the meter and signs. The pay-by-license plate system will need signage that indicates instructions for how to enter your license plate number, what particular zone you are in, and how to pay. All of this signage can be located at or on the machine, reducing much of the clutter. In regards to zone numbers, these especially need to be advertised well in conjunction with a pay-by-cell system to allow for adding time from any location in the community.

Pay-by-Space can be just as effective at de-cluttering street space through the removal of individual parking meters, assuming that climate and local conditions do not require the installation of pole mounted space numbering systems. If the space markings are able to be painted on the asphalt, curb, or both locations, you essentially remove the vertical clutter, which frees up the curb space for additional pedestrian and business use. Similar to pay-and-display (in climates with no snow accumulation) can be limited to the installation of the meter and the appropriate signage.

The single-space credit enabled meter does not reduce the visual and physical clutter, because like the current digital meter technology, the meters are placed at each parking space.

Additional add-on features don't provide much impact in the way of de-cluttering streetscape, because most are tied in with an actual metering system. Pay-by-cell phone and in-car metering have replaced actual meters in other countries, but for applications within the United States, it is still necessary to provide a physical parking meter for motorists who either don't have a cell phone, or access to an in-car metering device.

Ability to Add Time from Anywhere

One of the features of the newer revenue collection equipment is the ability to add time from anywhere in the system. For example, if a motorist parks and then visits several destinations throughout the downtown and then realizes that they are four blocks away and about to run out of time, they can go to the nearest pay station and add more time. This system only works with a pay-by-space, pay-by-license plate, or pay-by-cell phone system (including smart phone applications).

Ability to Add Time Remotely Benefit Rankings

Digital Coin Meters	(
Pay-by-Space	!
Pay-and-Display	(
Credit Card Capable Meter	(
Pay-by-License Plate	!
Pay-by-Cell Phone	!
Smart Cards	(
In-Car Metering	<
Smart Phone Applications	!

!	Maximum Benefits
<	Marginal Benefits
(	Limited Benefits

This feature is an added benefit for consumers and allows your downtown parking system to be more user-friendly and dynamic. For this system to be truly effective, you will need to market this feature and have appropriate signage on parking meters notifying customers. Many communities have this feature, but because it is not properly communicated, the benefit is lost on the unknowing consumer.

From a pay-by-cell phone component, this feature is typically communicated by the pay-by-cell vendor, either through online user registration or notification text messages. The ability to provide these notification texts is quickly growing as one of the primary features that downtown parkers respond to and appreciate. While this might lower the number of overtime citations written in the downtown, the positive reinforcement from downtown parkers through increased time and money spent in the downtown will offset this lost revenue.

Portability

Portability of Time Benefit Rankings

Digital Coin Meters	(
Pay-by-Space	(
Pay-and-Display	!
Credit Card Capable Meter	(
Pay-by-License Plate	<
Pay-by-Cell Phone	<
Smart Cards	(
In-Car Metering	!
Smart Phone Applications	(

!	Maximum Benefits
<	Marginal Benefits
(	Limited Benefits

The concept of portability of time refers to the ability of a motorist to take their remaining paid time with them when they leave the parking space. The only meter system that truly provides portability of time is the pay-and-display meter. Because the motorist is paying for a period of time, rather than a specific space, the time is transferable within the parking area (specific zones or areas may be defined). The pay-by-license plate system can also set up to be transferable, depending on the size and location of parking zones.

This feature is another added benefit for consumers, especially those who move around the downtown area frequently, such as shoppers who move from retail area to retail area, or delivery drivers. Much like the previous benefit, for the portability of time to truly be an effective benefit, there needs to be good marketing and communication of the feature so that motorists understand that they can take their time with them.

Eliminates "Borrowed Time" Transfer

One of the biggest drawbacks of the traditional single-space meter (from an operations and revenue collection point of view) is the lost revenue from "Borrowed Time". Borrowed time (or found time in the eyes of the consumer) is the remaining time on a meter, from the previous parking space inhabitant, that is utilized by a new motorist. Because of this found time, the motorist does not need to pay for a full duration of stay, because the previous motorist left them their overage.

Elimination of Borrowed Time Benefit Rankings

Digital Coin Meters	(
Pay-by-Space	!
Pay-and-Display	!
Credit Card Capable Meter	<
Pay-by-License Plate	!
Pay-by-Cell Phone	!
Smart Cards	!
In-Car Metering	!
Smart Phone Applications	!

!	Maximum Benefits
<	Marginal Benefits
(	Limited Benefits

All of the researched meter technologies have the ability to eliminate this borrowed time, although some need additional features to realize the full elimination of borrowed time. All of the multi-space meters eliminate borrowed time, basically by requiring the motorist to start a new transaction on that space. For example, in a pay-by-space system, the previous motorist might have left 15 minutes on their space, but the new motorist will have not been aware of this borrowed time once they start their new transaction.

In a pay-and-display system, because the previous motorist was paying for a block of time, once they leave, the next motorist has to pay for their own block of time. Pay-by-cell, pay-by-license plate, and smart phone applications are all similar in that they require the next user to begin a new transaction, essentially voiding, or zeroing out remaining time. However, the voided time is still paid for by the previous user, so there is an opportunity for the City to collect additional revenue for the overlapping time.

The only system that does not expressly eliminate borrowed time is the single-space credit capable meter. To truly zero out time or eliminate borrowed time, the single-space meter needs a vehicle sensor to notify the meter that the previous vehicle has left, which zero's out the remaining time.

Reduces Maintenance and Collection Costs

Reduced Maintenance and Collections Benefit Rankings

Digital Coin Meters	(
Pay-by-Space	!
Pay-and-Display	!
Credit Card Capable Meter	<
Pay-by-License Plate	!
Pay-by-Cell Phone	!
Smart Cards	!
In-Car Metering	<
Smart Phone Applications	!

!	Maximum Benefits
<	Marginal Benefits
(	Limited Benefits

All of the new technologies reduce maintenance and collections costs in some form or fashion, typically through better responsiveness to each element. Maintenance and collections are two of the highest and most frequent administrative costs associated with on-street parking management. Maintenance of the traditional on-street parking meter system usually requires either constant meter observations (including frequently checking each meter on a route) or responding to complaints and notices from motorists or enforcement officers. Collections for traditional on-street meters usually requires a collection employee following a route or a beat, collecting certain meters on certain days, whether the meter has five cents or five hundred dollars in it.

The new technologies all provide some level of improvement over these methods. For the meter technologies, each of the technology types provides better real time information to help determine when and where to deploy maintenance and collections employees. For

example, both multi-space and credit card enabled single-space meter systems provide notifications when they reach a certain threshold of currency, to allow for proper collection timing. In addition, they can provide the same data about battery levels, paper availability, paper jams, and mechanical issues. This allows parking management to deploy employees in reaction to problems, rather than along maintenance or collections routes.

Additionally, the use of credit cards as a form of payment reduces the physical currency that has to be collected from meters. For example if a meter that used to hold two hundred dollars in quarters (800 coins) now has fifty percent credit card usage, the meter can go twice as long without needing to be collected. Along these same lines, pay-by-cell phone, smart cards, in-car metering, and smart phone applications all provide lower collections cost, through increased credit card usage. Additionally, these applications don't add to the wear and tear of the meters themselves, which helps reduce maintenance needs.

For the benefits ranking system noted in the table on the previous page, the single-space credit enabled meter receives a lower ranking, only because the use of this technology requires a larger number of meters, which will naturally require more maintenance for the volume of meters. However, these meters have the same capability of the multi-space meters to provide real-time input related to maintenance needs and collection times.

Eliminates "Visual Inspection" Enforcement

Under traditional on-street meter systems, enforcement officers must visually inspect or observe each parking meter to determine whether there are violations, including staying over time limits, not paying, or illegally parking. With each of the new meter technologies, there is an enhanced approach to enforcement that helps improve efficiency, and in some cases, react to violations rather than searching for them.

For the pay-by-space system, the locating of parking violations is as easy as the enforcement officer going to the pay station, printing a report that details payment by space, and then moving to spaces in violation. This report can also be pushed to handheld devices that the officers utilize, which will improve efficiency even further, allowing officers to check compliance as the enter an area or start down a block.

Eliminates "Visual Inspection" Enforcement Benefit Rankings

Digital Coin Meters	(
Pay-by-Space	!
Pay-and-Display	<
Credit Card Capable Meter	<
Pay-by-License Plate	<
Pay-by-Cell Phone	(
Smart Cards	(
In-Car Metering	(
Smart Phone Applications	(

!	Maximum Benefits
<	Marginal Benefits
(	Limited Benefits

The new single-space credit capable meters provide a more enhanced version of the current enforcement method – the flashing red light. In traditional on-street meter technology, when a meter is not paid, the screen flashes red, indicating either a violation or an unpaid meter. The new version of this technology uses LED lighting to indicate the violation. The concept is basically the same, but the newer version is easier to distinguish for enforcement officers, from further distances.

Pay-and-display and pay-by-license plate can both provide more advanced data related to number of paid parkers, but enforcement still requires some level of visual inspection. For pay-and-display, the enforcement officer must visually inspect each vehicle to ensure that the receipt indicates payment. With the pay-by-license plate system, the officer must visually inspect license plates, either manually, with a handheld device, or with a mobile license plate recognition system.

The add-on payment options don't provide any measurable benefits related to enforcement, because the primary source of enforcement information will still come from the parking meters.

Improved Maintenance (Pavement Markings or Signage)

Depending upon the meter technology selected, there might be additional maintenance needs or reductions, based on the level of pavement or curb markings and signage. For example, pay-by-space technologies will require space numbering painted on the curb or a sign, which will require additional maintenance to ensure that numbers are visible and legible. Additionally, all multi-space meter equipment will require signage directing motorists to the pay station for parking. This signage usually requires posted signs at each end of the block directing motorists to the centrally located pay station, as well as a sign at the pay station identifying that as the payment location.

Improved Signage and Pavement Marking Maintenance Benefit Rankings

Digital Coin Meters	!
Pay-by-Space	<
Pay-and-Display	<
Credit Card Capable Meter	!
Pay-by-License Plate	<
Pay-by-Cell Phone	(
Smart Cards	(
In-Car Metering	(
Smart Phone Applications	(

!	Maximum Benefits
<	Marginal Benefits
(	Limited Benefits

Single-space credit enabled meters don't require any additional signage over the current levels provided, and can actually reduce needed directions and/or signage that is posted directly on the traditional meter (i.e. time limit and regulatory stickers) by posting that information on the digital interface. The single-space meters also don't require space numbering on the pavement, even in a numbered system. The numbered system would be required due to the use of pay-by-cell phone, which would be connected to specific space numbering. With the single-space system, the space numbering can be included on the meter, or even in the digital interface.

The add-on payment options don't provide any measurable benefits related to reduced maintenance, because the primary maintenance requirements will still come from the parking meters.

Ease of Use

Ease of use measures the complexity of each technology, in terms of user interface and operations. All of the new technologies are rated fairly high in this category, because they have been designed to provide easy operations and use. The only two technologies that score marginal are pay-by-space and pay-by-license plate, because they require the user to input either a space number or license plate number, which increases the difficulty of the transaction.

Ease of Use Benefit Rankings

Digital Coin Meters	!
Pay-by-Space	<
Pay-and-Display	!
Credit Card Capable Meter	!
Pay-by-License Plate	<
Pay-by-Cell Phone	!
Smart Cards	!
In-Car Metering	!
Smart Phone Applications	!

!	Maximum Benefits
<	Marginal Benefits
(	Limited Benefits

Pay-and-display is widely considered the easiest multi-space meter technology, requiring the user to pay and then return the valid receipt to their vehicle. Single-space credit enabled meters are also considered to be easy to understand and operate, primarily because they are so similar to the existing technologies. Pay-by-cell phone has an initial setup that requires a little more effort on the part of the consumer, but after this setup the use and operation is as easy as a phone call or text message to initiate service. Similarly, smart phone applications simply require the push of a

button to initiate parking transactions, as well as find available parking, and information about rates and restrictions.

User Walking Distance

The comparison of walking distances is based on how far each motorist must go to complete a transaction and move towards their destination. All of the technologies score fairly high in this regard, because walking is confined to the distance from the car to the meter and then from the meter to the destination.

Pay-and-display technology requires the most walking distance, requiring the user to walk to the pay station and then back to their vehicle before they can move on to their destination. Pay-by-space and pay-by-license plate requires less walking distance, but still requires the user to walk from their vehicle to a pay station and then to their destination, which may be prohibitive if the pay station and the destination are in opposing directions. The single-space credit enabled meter does not increase the existing walking distance because it is configured exactly like the traditional meter.

Walking Distance Benefit Rankings

Digital Coin Meters	!
Pay-by-Space	<
Pay-and-Display	(
Credit Card Capable Meter	!
Pay-by-License Plate	<
Pay-by-Cell Phone	!
Smart Cards	(
In-Car Metering	!
Smart Phone Applications	!

!	Maximum Benefits
<	Marginal Benefits
(	Limited Benefits

Pay-by-cell phone and smart card applications actually reduce walking distances, because the user can complete the transaction as they walk to their destination. In-car metering also does not require additional walking distances, because the parking transaction is initiated in the vehicle. Smart cards don't really have any impact on walking distance, because the user must still travel to the meter to initiate payment.

Collections and Maintenance – General Benefits

Collections and maintenance benefits are not vendor specific, but rather should be improved with the implementation of new parking machinery. Several of our previous clients have indicated to us that increased credit card usage and larger coin cashboxes have reduced the number of times the change in a meter needs to be collected. In addition, the meter technology informs parking management of which meters are approaching capacity and need to be collected, instead of making collection rounds regardless of the amount of money in the meter. As a result, collection costs have decreased since employees only have to collect money when necessary. One of the cities mentioned that their single-space meters are collected based on the fullness of the cashbox. As a result, some meters are collected weekly while others are collected monthly.

Similarly, peer cities have also indicated that maintaining the meters has become more efficient with the new parking meter technology. Maintenance personnel no longer have to learn about a meter failure from a citizen or from a parking officer. The meters send a text or email to parking management and maintenance staff when the meters have an issue, allowing maintenance personnel to track and solve maintenance issues quicker and more efficiently. However, the cities indicated that even though maintenance issues could be identified easier, this did not necessarily translate into reduced maintenance costs. Instead, the costs have been shifted to retrain staff and technicians on how to appropriately work on the new parking meters and its features. Additionally, maintenance funds also need to be set aside to pay for parts once the warranty expires. Administration costs also have been shifted with implementation of the new technology. The new technology provides data and reports that

are useful to parking personnel for a number of reasons. However, personnel have to be trained on the new software associated with the data, and new field devices have to be acquired to record and access the data. Although collection and maintenance benefits are inherent with the implementation of new technology, there will be offsetting demands from staff training and operations that will lessen the implied impacts of the installation.

Secondary Features

The following section provides an initial look at some key secondary features that support the previously described technologies. The review of secondary features includes information provided by parking meter vendors as well as industry research conducted by Kimley-Horn.

Solar Power Backup

Most new parking meter technologies take advantage of solar power to enhance battery life and promote sustainable energy use within the parking system. Many communities are implementing solar powered machines as a function of reduced cost. With the addition of a self-sustaining power source, meters no longer need underground power mains, which have the potential to lower implementation costs significantly.

In the southwestern part of the country, the use of completely solar meters is more likely sustainable than in the northwest where rain and overcast skies can drain a system. However, the parking meters don't necessarily need direct sunlight to operate. Many meters are designed to operate with ambient light sources only recharging internal sealed lead acid batteries, which are capable of completely powering the machines. In the event that the panels fail and the battery voltage drops too low, the meters typically have a backup power source that they can automatically roll over to.

Many of the systems have battery lives of five to seven years, which is a stark improvement over the traditional coin meters with 9 volt alkaline batteries that expire annually. The battery type varies by vendor, but these were identified as common types by vendors: Ni-MH rechargeable battery pack, 12V DC 27 AH batteries, and 12V/54Ah battery. Because the batteries are sealed lead acid batteries, they can be recycled once the life of the battery has expired.

Real-Time Maintenance Status Capability

Many new parking meter technologies provide the ability to provide real-time maintenance status updates, either at the meter or in the parking management center. This provides a more functional maintenance program, as parking operators can react to problems as they occur, rather than when a patron discovers the problem and phones it in. There are several forms that the vendor can provide this information to the operator or client, including:

- Text and email to operators
- Management system reports
- Alarms sent to cell phone accounts, emails, or via a web portal
- A query of individual meters to determine maintenance, collections, and operation needs

- Most of this information can be accessed via the back-office software management provided by the vendor

Parking Space Detection (Sensors) and Monitoring

The use of parking space detection devices is a rather new technology that provides enhanced management and operations capabilities. These devices allow the parking operator, through wireless communications, to know when a vehicle is parked in an on-street space. This allows for better understanding and maintenance of occupancy data, more efficient enforcement, and better management of the entire system.

There are generally three types of vehicle detection devices. The first is an "above pavement" sensor that resembles a retro reflective pavement marking. This sensor is essentially glued to the pavement. The second type is "in pavement", and is often referred to as a puck because of its resemblance to a hockey puck. These devices are placed into the pavement, via a cored out section of asphalt, and when inserted, are flush with the pavement. The third type is a device that can be mounted securely to the meter pole.

All three devices provide real-time information back to the parking management center, including whether a space is occupied and whether or not the motorist has paid for their parking space. The enforcement benefits are numerous, as the officers no longer have to "chalk" tires and can actually be deployed to violations based on data provided from the devices. The devices can also be used to reset or "zero out" meters that are vacant, removing the "found time" occurrence where a motorist drives up to a paid meter.

One of the more recent uses of these devices has been patron wayfinding to on-street spaces, through the use of Smart Phone applications. The sensors can identify when a spot is empty, update an online inventory, and then push the information out through the application. This provides for less time circling for parking, as motorists can actually make an open space their end trip destination. Once at the space, the motorist then has the ability to pay for the space through the smart phone application.

Additional networking hardware is not necessary for any of these devices. Inside the sensors are electronics powered by an internal battery that can detect a vehicle parked in a space. All three devices can be integrated with other parking equipment (digital parking meters, mobile handheld devices, and ticket and payment technology) to monitor near real-time occupancy status, equipment status, violation status, and collection status. The sensors communicate to a central server over a wireless short-range radio network and cell phone-based internet connection.

<u>Benefits of Parking Space Detection</u>

1. The sensors can be integrated with other parking technologies (single-space and multi-space parking meters, handheld enforcement devices, central information servers).

2. Parking managers have the option to adjust parking rates based on demand. Where parking demand is higher and/or at higher demand times, the parking rates can be increased. Conversely, where parking demand is less, the rates can be lowered.
3. The sensors can enforce the parking meter time limit, which improves efficiency in enforcement by providing violation data to handheld devices used by enforcement officers.
4. Since the devices collect real-time occupancy status, that information can be relayed from the server to wayfinding signs or smart phone applications (discussed in greater detail in the next section) to provide motorists with the location of available parking spaces, number of available spaces, rates, and time limits. This reduces the time it takes motorists to find parking and relieves aggravation associated with finding an open parking space.
5. The devices can reset or "zero out" meters that are vacant, removing the "found time" occurrence where a motorist drives up to a paid meter.
6. Occupancy data can be generated for statistical analysis projects for a given area. This data could be useful in determining actual number of vehicles that occupied a given space for a determined amount of time (i.e. a 24-hour period). The data could also aid in determining the amount of revenue collected for the space, and how much potential revenue could have been generated for that particular space, in the determined amount of time.
7. Systems typically offer "pay-by-cell phone" as a payment option.
8. For a parking manager, these devices provide additional data that helps to understand the actual use of their parking system. This data can be used to inform policy decisions like parking rates and time restrictions. It can also be used to inform infrastructure decisions, as higher occupancy areas can be identified for additional parking capacity.

Disadvantages of Parking Space Detection

1. One of the values of the sensors, for the parking managers and motorists, is the reliability of the real-time occupancy status. The system is technologically advanced and communicates with other parking devices; therefore it must be monitored frequently to identify any glitches or failings in the relaying of information. False information can result in missing a vehicle that is illegally parking or a wrongful citation of a vehicle that is legally parked. Both of which are costly for the city.
2. The sensors have to be configured to block out "interferences" such as other cell phone traffic, underground cables, and overhead wires. This can be achieved with noise cancelling filters.

Real-time Parking Management Applications

The next generation of parking management is in the form of applications that can be accessed through the internet, smart phones, and navigation systems. Parking applications communicate with parking management servers, and link parking managers and the public to the data collected by the parking meters (multi-space and single-space meters).

The data is collected from partners at parking lots and garages, and distributed in the application. The technology is starting to offer this same service for on-street parking spaces. However, this data is reliant on cities installing vehicle detection sensors that relay near real-time parking occupancy for each space to a centralized server. The application can access the data on the server and make it available on the web, smart phones, and navigation systems. The application uses a Google maps interface to display the parking information.

Benefits of Real-time Parking Management

1. Users can view percentage of occupancy, view rates, identify parking restrictions, locate entrances to the garages or lots, make payments to the meter by cell phone, and to reserve a parking spot by paying in advance at participating garages all before they get in their vehicle. One application, soon to be rolled out in San Francisco, has the ability to warn drivers not to use the application when it is being used while driving faster than 10 miles per hour. This is to remind drivers that it is unsafe to use a cell phone while driving.
2. Allows parking managers to identify and track areas with higher parking demands and can then make improvements to the parking system based on that information.
3. Provides users with flexible payment options, such as pay-by-cell phone, and the ability to reserve parking spaces in advance, at participating locations.
4. The applications are typically free and require no software or network installations.

Disadvantages

1. The applications are reliant on available parking data collection technologies and therefore only provide information for parking lots and garages for the time being. As cities install new parking technologies that have the ability to monitor and track on-street parking occupancy in near real-time, the application will be expanded to include on-street parking occupancy as well.
2. As with other applications (i.e. traffic applications) the parking application is near real-time, meaning that parking rates and occupancies may change before they can be updated in the system. This can frustrate some drivers and give those drivers the perception that the application is unreliable.

Electric Vehicle Charging Stations

In recent years, the United States has seen an increase in the number of electric cars. In fact, President Obama announced in January 2011 a challenge to place one million electronic vehicles on the road by 2015. As the market of electronic vehicles grows, parking facilities must grow along with it to accommodate such vehicles. A number of cities across the U.S. have implemented electronic vehicle charging stations in garages, residential areas, and metered on-street parking spaces. Charging stations are similar in appearance to pay stations, except they have a cord that attaches to an electric vehicle. The stations accept credit cards and can charge two vehicles at once typically at 240V/30A (3-4 hours to fully charge a car). The cost to charge ranges depending on the city, vehicle type, length of charge, and price of electricity. Some stations are solar powered or they can draw electricity from the pay station or meter. Appropriate signage, similar to that on a pay station, should be present on a charging station to indicate payment and charging instructions, time limits, and rates. Similar to pay stations, charging stations are capable of communicating maintenance and other critical information.

Wayfinding Technology

Wayfinding technology for parking is used to direct drivers to available parking areas. The purpose of using wayfinding is to reduce vehicle miles traveled and congestion by limiting the amount of time it takes for drivers to find available parking. Wayfinding can be static or dynamic. Static wayfinding signs are positioned to direct drivers to parking areas, but do not provide further information, such as availability. Dynamic wayfinding signage uses electric messages to provide real-time parking availability as well as the location of parking. In areas with special events, the dynamic wayfinding signs are flexible and can accommodate changes in parking rates and times on those event days.

Off-street parking can utilize both static and dynamic wayfinding systems. Theses signage systems prove beneficial to off-street parking locations, because they are confined to single locations with large capacities of parking that are ideal for directing large amounts of traffic to. Additionally, it is easier to use parking space detection sensors in off-street garages and lots to monitor availability in real-time. These sensors can relay the availability information to the dynamic wayfinding system to show real-time availability for that garage or lot.

Using wayfinding technology for on-street parking is more challenging. On-street parking spaces are spread out, making it difficult to direct drivers to specific locations. The signage required to direct motorists to available parking would number in the hundreds or thousands and would create an especially clustered look in the downtown area. At this point, there are no known communities that have used dynamic wayfinding signage to provide navigation to on-street parking. The closest possible alternative is the use of GPS or smart phone applications to direct drivers on an individual basis. However, the use of on-street parking space detection sensors has yet to be thoroughly tested and proven to be effective and cost efficient.

PCI Compliance & Certification

A critical consideration in implementing multi-space meters or credit card capable single-space meters, is the need to provide data security related to credit card data. The purpose of this section of the report is to provide an overview of the Payment Card Industry (PCI) standard for ensuring credit card security. This is not an exhaustive treatise on PCI and all of the ramifications of PCI certification. However, it is important to note that under no circumstances should you, the parking system or your contracted private parking management firm, allow the operation of equipment under your control that is not PCI certified. It should also be noted that PCI certification requires verification; that is, if a vendor shows you a certificate of PCI certification you need to obtain independent verification that the certificate is valid.

PCI certification is ever evolving and will change each year – it should be noted that all vendors who are currently certified PCI compliant will have to renew their certificates. It should be a requirement that these updates be part of your standard operating procedures to minimize your liability.

PCI compliance is a complex subject affecting millions of businesses – including banks, Independent Sales Organizations (ISOs), processors, hosts, e-commerce and retail merchants and other merchant services providers.

PCI compliance is critical in terms of protecting consumers from identity theft. The Identity Theft Resource Center, a non-profit organization located in San Diego, is committed to helping victims of identity theft and to protect others from the crime. According to two studies done in July 2003 (Gartner Research and Harris Interactive), approximately 7 million people became victims of identity theft in the prior 12 months. That equals 19,178 per day or 799 per hour or 13.3 per minute. Today, the number of identity theft victims is much larger - it has increased to more than 10 million people per year. What is even more shocking is that, in 2005, at least 152 data disclosure incidents were disclosed, potentially affecting more than 57.7 million individuals.

Getting Ready for EMV

The purpose of this section is to provide an overview of the EMV1 specifications and processes. The document is intended to describe the "what" and the "why" of EMV within the context of the wider payments industry. The EMV Integrated Circuit Card Specifications for Payment Systems are global payment industry specifications that describe the requirements for interoperability between chip-based consumer payment applications and acceptance terminals to enable payment. The specifications are managed by the organization EMVCo and are expected to be rolled out in the US sometime around October of 2015. This information is being provided here because any agency looking to upgrade their technology that will utilize credit card payments, should be planning to incorporate these new payment card specifications and processing into their new system requirements.

Named after the original organization's that created the specification, Europay, MasterCard and Visa, the EMV specifications were first published in 1996. Fourteen years later, there are now one billion active EMV chip cards used for credit and debit payment, at 15.4 million EMV acceptance terminals deployed around the world.

The distinguishing feature of EMV is that the consumer payment application is resident in a secure chip that is embedded in a plastic payment card, often referred to as a chip card or smart card, or in a personal device such as a mobile phone. The chip provides three key elements - it can store information; it can perform processing; and because it is a secure element, it is able to store secret information securely, and perform cryptographic processing. These capabilities provide the means for secure consumer payments.

In order to execute a payment, the chip must connect to a chip reader in an acceptance terminal. There are two possible means by which this physical connection may be made which are often referred to as contact or contactless. With contact, the chip must come into physical contact with the chip reader for the payment transaction to occur. With contactless, the chip must come within sufficient proximity of the reader, (a maximum of 4cm), for information to flow between the chip and the acceptance terminal. In both scenarios, the acceptance terminal provides power to the chip to enable the chip to process.

Chips that are embedded in form factors such as plastic payment cards may support only a contact interface, only a contactless interface, or both contact and contactless. Chip cards that support both contact and contactless interfaces are referred to as dual interface. When the chip is installed inside a non-card form factor, such as a mobile phone, contactless is typically the only option for connection to the acceptance terminal.

<u>Why EMV</u>

EMV is designed to significantly improve the security for consumer card payments by providing enabling features for reducing fraudulent payment that results from counterfeit and lost and stolen cards.

The features that are defined by EMV are as follows:

1. Authentication of the chip card to verify that the card is genuine so as to protect against counterfeit fraud for both online authorized transactions and offline transactions.

2. Risk management parameters to define the conditions under which the issuer will permit the chip card to be used and force transactions online for authorization under certain conditions such as offline limits being exceeded.

3. Digitally signing payment data for transaction integrity.

4. More robust cardholder verification to protect against lost and stolen card fraud for EMV transactions.

Counterfeit and lost and stolen card fraud represents significant cost to all participants in the payment process, including retailers, acquiring banks, card issuers and cardholders. Costs are realized through the processing of cardholder disputes, research into suspect transactions, replacement of cards that have been counterfeited or reported as lost and stolen, and eventual liability for the fraudulent payment itself. By reducing counterfeit and lost and stolen card fraud, EMV offers real benefits to retailers, acquirers, card issuers and cardholders.

For more information, the following references are provided:

1. The EMVCo web site www.emvco.com
2. EMV Integrated Circuit Card Specifications for Payment Systems, version 4.2, June 2008 (EMVCo LLC)
3. EMV Contactless Payment Specification For Payment Systems, version 2.1, September 2010 (EMVCo LLC)
4. Type Approval Process Documentation for terminals and cards available from EMVCo LLC.

EMV Security Guidelines, version 4.0, December 2010 (EMVCo LLC)

Wireless Communications

Practically all new parking meters use wireless communications to transmit data between the parking meters and the parking management center. Wireless parking meters offer many advantages over hard-wired meters, such as lower installation costs and more flexibility in the placement of the meters. Wireless communications also allow for remote monitoring of the parking meters and for real-time encrypted credit card transactions that meet PCI security standards – functionalities not possible in stand-alone parking meters. There are two primary wireless communications technology options for parking meters: cell phone technology and Wi-Fi broadband technology.

In parking meters using cell phone technology for wireless communications, the source modem inside the parking meter transmits data to a nearby cell phone tower, which then relays that data to a destination modem at the parking management center via other cell phone towers. Data can be transmitted through buildings and trees over relatively long distances between the modems and towers. Existing third-party cell phone carrier networks and towers need to be in place in order for communication to be possible between the parking meter and the parking management center. These third-party cell phone carriers (e.g., Verizon and AT&T Wireless) assess monthly fees of $3-$20/month/meter for the “airtime” used by the parking meter wireless communications. Most existing parking meters utilize cell phone technology for wireless communications because of the low initial cost and the ease of installation and maintenance of the communications network.

In parking meters using Wi-Fi broadband technology for wireless communications, the source modem inside the parking meter transmits data to a nearby router, which then relays that data to a destination modem at the parking management center via other routers and gateways. Gateways are the transition point where wireless communications are converted to wire communications (e.g., a fiber optic cable). Data can be transmitted through buildings and trees over relatively short distances between the modems and routers. Routers need a clear line of sight to be able to transmit long distances.

While both methods of communications are technically feasible, the city should be careful when making a selection to choose one alternative over the other. By utilizing the city’s Wi-Fi network, a city may be placing unnecessary risk on its system by assuming PCI compliance responsibility.