Smart Cards and Parking

A Smart Card Alliance Transportation Council White Paper

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About the Smart Card Alliance

The Smart Card Alliance is the leading not-for-profit, multi-industry association of member firms working to accelerate the widespread acceptance of multiple applications for smart card technology. The Alliance membership includes leading companies in banking, financial services, computer, telecommunications, technology, health care, retail and entertainment industries as well as a number of government agencies. Through specific projects such as education programs, market research, advocacy, industry relations and open forums, the Alliance keeps its members connected to industry leaders and innovative thought. The Alliance is the single industry voice for smart cards, leading industry discussion on the impact and value of smart cards in the U.S. and Latin America. For more information, visit http://www.smartcardalliance.org.

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Executive Summary

Over the last decade, advances in technology have fueled major innovations in electronic payment strategies. These strategies are revolutionizing the way payments are made in a variety of environments including retail, banking, and transportation. Transportation in particular has witnessed large-scale investment in the electronic payments infrastructure, with a variety of such programs now reaching the launch stage.

Smart cards are playing an integral role in these new payment strategies. Smart cards provide increased security, enable more distributed processing, and provide a variety of communications options. Smart cards that support contactless communication are becoming more prevalent in mass transit programs and are now rapidly gaining favor with financial payment card issuers and associations. Contact smart cards are seeing continued use in European and Asian financial payment card programs and are also being used for domestic security, on-street parking, and other niche applications.

In the United States mass transit sector, the combination of the fare collection infrastructure life cycle and the introduction of new technologies has resulted in 18 cities awarding over $1 billion in contracts for regional transit payment systems that use contactless smart cards as the primary form of fare payment. A review of the parking market indicates that a similar environment is present, as aging first-generation automated payment systems begin to be replaced. The replacement process may be accelerated as changing credit card regulations, increased security requirements, and new market data on the economic benefits of non-cash payment methods create more compelling requirements for parking facility owners and managers to invest in new payment systems.

Similar changes have occurred in the road tolling industry where operators seeking to eliminate the problems associated with coin processing have moved toward high-speed electronic toll collection using long-range radio frequency (RF)-based transponders. These systems have illustrated consumer acceptance of electronic pre-payment systems and have established new models for customer service and support that have been emulated in other markets. These longer-range RF-based electronic toll collection systems are also being used for some parking applications; however, the Smart Card Alliance believes that the longer range, limited functionality, and lack of security makes the use of this technology inappropriate for many payment applications.

In the parking market, the rationale for electronic payment and the preferred technology vary by operational segment. In the on-street market, the historic prevalence of low-power single-space meters led to the use of contact smart cards as the only form of electronic payment. As cities are increasingly embracing the European model of more powerful multi-space metering systems, opportunities are created for the use of contactless smart cards and online payment processing for credit and debit cards. In the off-street segment, read/write contactless smart card technology represents an attractive alternative to bar code and magnetic stripe-based entry/exit tickets; in addition, the introduction of contactless credit cards by the financial industry provides a powerful tool for credit-card-in/credit-card-out systems.

Smart cards have been used in the parking market for several years, most commonly (as noted above) in on-street parking. These programs met with limited success due to a variety of operational challenges: patron acceptance, distribution, convenience, interoperability of systems, and program support costs. Most city meter card programs depended on disposable smart cards that were sold through selected retail merchants. Parking patrons were forced to seek out these merchants both to acquire the initial card and to replace the card once its value was exhausted. In addition, due to lack of standards, smart cards were not interoperable across systems and metering technologies. The parking card could not be used consistently throughout a region. As a result, patrons did not find that the increased convenience of using a card for parking payment justified the effort of acquiring the card; however, with on-street parking rates on the rise, coins will become a decreasingly viable payment mechanism.

Transit payment programs using contactless smart cards address these issues through the establishment of standards, broad regional collaboration of agencies in adopting a common system, establishment of regional customer service operations, and the use of reloadable cards. As a result, programs like SmarTrip® in Washington, DC, are seeing over half their payment transaction volume moving to the smart card.

Many key benefits are being achieved through the use of smart card technologies including:

- Improved customer service – simplifying product purchases, enhancing customer convenience through new features and offering a reliable and secure technology platform that supports a wide variety of payment and payment-related applications.
- Increased revenues – providing a convenience-driven sales lift, reducing fraud, and decreasing cash handling, resulting in increased motorist compliance, increased use of on-street parking and increased transaction values.
- Increased operational efficiency – offering more operational data, facilitating better planning, improving security, reducing labor and lowering equipment, material and maintenance costs.
- Stronger controls and security – reducing cash payments and cash-handling requirements and providing a payment device with strong security features.
- Expanded marketing opportunities – improving knowledge of customer behavior and enabling partnerships with merchants and other transportation-related organizations.
- Simplified administration of benefits programs – providing a paperless system for distribution and acceptance of parking benefits.
- Improved legal compliance – meeting electronic automation requirements for parking operators.

The transit industry is leading the way in integrating contactless smart card technologies into parking applications. Transit operators worldwide (e.g., Washington, DC, Philadelphia, Atlanta, Hong Kong, Lyon, France) are implementing parking solutions based on contactless smart card technology. The international standard ISO/IEC 14443 is being used by both the transit industry and financial industry for contactless smart cards. Transit agencies are also collaborating at a national level to create technical standards aimed at system interoperability. Multiple national standards are nearing completion in different parts of the world bearing striking similarity to each other in terms of approach and content. Within the United States, the American Public Transit Association has sponsored application-level and inter-system messaging standards allowing systems provided by disparate suppliers to be interoperable, with final standards expected to be published in 2006.

All of this activity paves the way for the parking industry to leverage the broader transportation and payment card industry initiatives and develop solutions for the challenges previously experienced in the use of smart cards. Through industry groups like the Smart Card Alliance Transportation Council, parking facility owners and managers and parking equipment vendors can be exposed to industry developments and establish the relationships needed to benefit from them. By participating in industry initiatives, the parking industry has the opportunity to influence the development of standards and commercial structures aimed at facilitating regional, and ultimately, national transportation payment networks. Without such participation, parking owners and managers face the risk of having such standards imposed on them without their involvement in the development.

The Smart Card Alliance urges parking industry participants to join these transportation industry initiatives and take advantage of the substantial benefits being reaped by counterpart transportation market sectors.

About this White Paper

This white was developed by the Smart Card Alliance Transportation Council to provide the parking industry with an overview of the technology and trends in the smart card marketplace and to provide the transit industry with an overview of the parking industry market and use of smart cards. The white paper is not intended to provide detailed implementation guidance for smart cards programs, but does discuss both the benefits and challenges of implementing smart cards in transportation applications and provides profiles of successful transportation sector smart card implementations. White paper topics include:

- An overview of the trends for electronic payment in transportation markets
- The parking market structure and operations
- Smart card technology use in parking, transit and financial payment applications
- The benefits and challenges of using smart card technology for parking applications
- Profiles of implementations using smart cards for transportation applications

1 Introduction

Since the mid-1990s, momentum has been building throughout the transportation sector for the adoption of more sophisticated ways to automate payment for various forms of travel. The road-tolling industry has achieved nearly universal adoption of radio frequency (RF)-enabled transponders for cashless toll payment. Mass transit operators have been adopting contactless smart cards to replace magnetic fare media. Parking operators have largely used contact smart cards for electronic payment but are beginning to use contactless smart cards to pay for parking functions.

Until 2001, a lack of standards, coupled with a lack of critical mass for any single technology, led to early deployments that consisted of proprietary, single-purpose solutions, with different rates of success. Tolling systems were largely successful, but the transponder technology was ill-suited for transit or for some parking applications. Parking smart card programs were hampered by the challenges imposed by card distribution, customer service operations, and the absence of places to reload the card. Due to long procurement and deployment cycles, only a few North American cities realized appreciable gains in mass transit from the migration to contactless smart card-based ticketing.

Since 2001, however, there have been significant advances in the development of standards, the state of information technology (IT), international transit deployments, and North American transit procurements. In addition, the North American financial payments and mass transit industries have embraced a common electronic standard, creating new opportunities for cross-industry collaboration. Millions of contactless smart cards are now rolling out in major programs in North America and around the world.

In parallel with these developments in the transit and financial sectors, the parking industry is also undergoing a sea change. The first-generation electronic payment infrastructure is nearing the end of its useful life in airports, office buildings, shopping malls, universities, and surface lots. Parking system providers are embracing state-of-the-art information technology to provide more powerful, flexible, and user-friendly payment solutions that improve facility management and revenue control. Municipalities are moving away from conventional coin-operated single-space meters and adopting more sophisticated networked pay stations for managing on-street space.

The parallel developments in the parking, transit and financial payments industries create opportunities for convergence. Such convergence can result in economic benefits for all sectors, in the form of leveraged systems, shared card and distribution costs, and shared support, while creating significantly greater value for patrons.

This white paper is intended to provide the parking industry with an up-to-date overview of technology and trends in the smart card marketplace and to provide the transit industry with an overview of the parking industry market and use of smart cards. The paper describes market developments in the transportation payments industry and discusses the opportunities created in the parking market by advances in payment card technology and ongoing initiatives in related industry sectors.

The white paper explores previous applications of smart card technology to parking and discusses both the challenges faced and the potential solutions provided by recent developments. It also includes basic information on parking operations (Section 3) for those outside the industry who want to understand the potential application and benefits of smart card technology to parking.

2 Market Overview

This section reviews three markets within the transportation industry: mass transit, parking, and road tolling. While this paper focuses on parking, it is important to establish a foundation for understanding the technology trends and the opportunities from which the parking industry can benefit by linking to other systems and collaborating with their sponsors.

2.1 Mass Transit

The U.S. transit industry consists of subway, bus, and commuter rail operations. Nationally, over 9.6 billion trips were taken in 2004, reflecting a growth rate of approximately 2% over 2003.

Automatic fare collection (AFC) grew more prominent during the late 1970s and early 1980s, as transit operators leveraged magnetic ticketing technology to implement stored-value card systems and electronic passes and transfers. By the end of the 1980s, virtually all operators of any significant size had implemented AFC. The field infrastructure typically consisted of electronically controlled validation, processing, and access control devices, such as ticket vending machines, turnstiles, bus fareboxes, and specialized bulk encoding equipment. These devices were networked to a central processing system that monitored the equipment, collected transactions, enabled remote configuration and control, and generated operational reports. The life cycle for this type of infrastructure was estimated to be 15 years.

In keeping with the life-cycle estimates and the maturation of the industry, the second major change began in the mid-1990s, as agencies began to replace their original infrastructure. Advances in IT and contactless smart card technology led virtually all new procurements to require the smart card as the primary fare medium. From 1995 through 2004, over $1 billion in infrastructure contracts were awarded across numerous major cities, including:

- Washington, DC
- Baltimore
- Los Angeles
- San Diego
- Minneapolis
- San Francisco/Oakland
- Seattle
- Boston
- New York
- Atlanta
- Philadelphia

The system in Washington, DC, is now fully operational, while the others are in advanced stages of delivery and scheduled to be fully operational within the next 2 years. The result will be the introduction into these major markets of an estimated 15 million contactless smart cards and over 20,000 payment processing devices.

As part of these initiatives, multiple regional agencies are forging cooperative alliances and establishing regional administrative bodies to manage activities such as card distribution, customer service operations, transaction processing, and IT. By creating regional support structures, operators are generating efficiencies and lowering the costs associated with transaction charges, cash management, and support personnel. Regional support structures are a natural source for similar services for parking facility owners and managers.

2.2 Parking

Public parking constitutes an approximately $17 billion industry composed of systems, equipment, facilities maintenance, and a variety of services, including revenue management. Over $1 billion is spent each year on parking revenue control systems, software, equipment, and related support services.

This market is characterized by three primary segments, defined by different operational practices:

- Entry-/exit-controlled garages and surface lots
- Open surface lots and garages
- On-street parking

Systems and payment practices vary significantly across these segments, and historically each segment has tended to use different solution providers.

In terms of technology and systems, parking revenue automation has developed in parallel with mass transit automation. Currently deployed solutions incorporate the use of a wide range of technologies (e.g., read/write magnetic tickets, bar code tickets, RFID and proximity devices, automatic vehicle identification (AVI) systems, smart cards), currency validation components, and both attended and unattended credit card processing.

One characteristic that distinguishes the parking market from the transit market, however, is the amount of fragmentation in the industry. This fragmentation has led to the presence of significant amounts of aging payment infrastructure, management companies with poorly aggregated data and audit controls, and facilities that are particularly prone to credit card fraud and other forms of loss.

In the on-street market, the industry is looking for the most effective parking solution possible. Many in that market are motivated to introduce changes to their existing infrastructure by a strong desire to enable or increase cashless payments (including credit card) as well as to improve data collection and respond to patron desires to receive receipts. Considering the online communication requirement necessary for credit card transactions and the fact that currently there is no viable single-space solution to enable them, some municipalities are turning to more sophisticated multi-space pay stations incorporated into regional wireless networks. While these features are often achieved with the new pay stations, new challenges arise including costs and enforcement (e.g., for motorcycles and convertibles). Regardless of whether single-space meters or multi-space pay stations are the best for on-street applications, the desire to increase the use of cashless payment and improve data collection in on-street parking equipment are at least two of the factors motivating changes in the parking industry.

When these factors are coupled with the new credit card processing requirements imposed by the card associations (lack of conformance to which creates significant financial risk), the climate created is similar to that of the late-1990s transit industry. A wave of investment in payment technology and infrastructure has already begun and will continue for the next several years. The opportunity currently exists for transit and parking entities to leverage common standards, systems, technology, and support infrastructure to make overall operations more cost-effective and add value for the consumer.

2.3 Road Tolling

Throughout the 1980s, revenue collection on toll roads primarily meant drivers tossing coins into automatic coin machines or using staffed toll booths for payment. During the 1990s, a variety of electronic payment methods were tested, including laser bar-code scanners and long-range RFID transponders that enabled unattended, nonstop cashless payment. The first large-scale system using what today is widely recognized as electronic toll collection (ETC) technology was the North Texas Tollway. Since its commissioning, a variety of toll facilities across the country have implemented such systems.

The Inter-Agency Group (IAG) of New York/New Jersey worked for 4 years to test and finally adopt a common transponder system for all its members. (The IAG includes agencies that extend across several northeastern states and represent the majority of tolls paid in the United States.) Today, millions of vehicles carry E-ZPass transponders and maintain accounts with the IAG clearinghouse. The use of common technology and messaging standards allow the disparate agencies to honor common transponders and reconcile accounts. Automated systems classify vehicles, calculate fees, identify valid transponders, and debit the centralized accounts for E-ZPass users. RFID-based transponder technology is also used in places like Florida, Illinois, California, Oklahoma and Texas. Toll agencies have embraced operating practices that encourage the use of transponder-based technologies through pricing incentives. In some areas, the use of these transponders has been extended to parking facilities such as airports.

While the preference of toll authorities is to convert as many customers as possible to electronic toll collection using RFID-based transponders, a portion of the market continues to pay with cash. Smart cards using contactless technology have emerged as a potential means of electronic payment that may appeal to cash customers. Customers can use the smart card for touch-and-go applications, as shown in Figure 1.

Figure 1. Using a Touch-and-Go Smart Card to Pay Tolls[1]

Contactless smart cards are a less expensive payment device than transponders, costing as little as $1.50 per card (or less for disposable cards), depending on volume. Smart card-based toll payment applications are currently in use in Europe and Asia and have also proved successful in the ORANGES field operational tests in Orlando, FL (for more information on ORANGES, see Section 6.6). Another example is Touch 'n Go, a smart card-based payment system in Malaysia, that has provided the basis for the national electronic toll collection system implemented on many privately operated highways and bridges since 1997. A user simply touches a Touch 'n Go card (a smart card that contains electronic cash) at designated toll booths, busses, or the light rail transit station gates, and the toll or fare is deducted electronically from the card.

Figure 2. Malaysian Touch 'n Go Card[2]

As more transit agencies migrate to smart fare cards, where customers may be registered users as opposed to anonymous, they are increasingly operating in a paradigm similar to toll authorities. The agency/authority has a relationship with the customer and features such as lost card/balance protection and automatic reload (reload of a predefined dollar amount to a card electronic purse or account when a predefined balance threshold is reached) are needed for both. This has led to the transit and tolling transportation market segments having increasingly more in common for customer relations management. The increasing commonality of customer service models is evidenced by traditional toll agency customer service center providers pursuing opportunities within the transit market.

[1] *Source*: http://www.efkon.com
[2] *Source*: http://www.touchngo.com.my/aboutus.htm

3 Parking Market Segments

In the United States, parking is provided by a broad spectrum of public and private entities and, in most cases, fees are collected to pay for this valuable service. The mechanisms for fee collection vary, not only by service provider but also by whether parking is on-street.

3.1 On-Street Parking

On-street parking is primarily the domain of municipal parking programs, although some campus, hospital, transit, and airport parking programs include paid curbside parking. On-street meter programs are typically implemented and managed by municipal parking agencies. The outsourcing of municipal meter operations is a recent development, and companies like Central Parking Corporation, ACS, and Worldwide Parking are selected via competitive procurements to provide these services. The services include meter installation, maintenance, and fee collection.

Because on-street spaces are typically the most convenient, both in terms of accessibility to the motorist and accessibility to nearby places of business, these spaces must be carefully regulated to ensure that they are not monopolized by long-term parkers. On-street spaces must turn over frequently, and frequent turnover is typically encouraged by imposing time limits on their use. However, time limits alone are not adequate. There must also be a mechanism for enforcing these time limits, and the ubiquitous single-space parking meter, first introduced in Oklahoma City in 1935, is a well-established tool for enforcing these regulations. Paid or unpaid status determines whether a parker is in compliance with the time limit.

While the initial intent of using parking meters was regulatory, parking meters generate another obvious benefit—revenue. Municipalities across the country now use parking meters both to control the use of curb space and to generate much-needed revenue.

3.1.1 Single-Space Meters

The total number of on-street parking meter spaces is very roughly estimated to be between 1 million and 5 million metered spaces depending on the industry source. Although no one has recently conducted a comprehensive nationwide tally of the number of on-street parking meters, some data is available through industry resources. In the 2005 edition of the International Parking Institute (IPI) publication *Who's Who in Parking*, 124 municipalities identified indicated that they use single-space meters to regulate curbside parking.[4] Collectively, these 124 municipalities alone account for nearly 399,000 on-street meters, ranging from 175 in Chapel Hill, NC to over 40,000 in Los Angeles and 60,000 in New York City. Single-space manufacturer sources indicate that there are certainly in excess of 1 million single-space metered spaces. Figure 3 shows examples of typical single-space meters.

Figure 3. Single-Space Meter Examples[3]

Today's single-space parking meter does not look significantly different from the meters that were deployed in 1935. However, the materials used to manufacture the meter shell and the timing mechanism have changed considerably. The shells have gone from steel to cast iron or zinc alloy, to improve durability and reduce vandalism. The mechanisms have evolved from springs and gears to electronic components, a development that opened the door for the use of contact smart cards.

[3] *Source*: MacKay Meters

[4] International Parking Institute, *Who's Who in Parking*, 2005 Edition.

Single-space meters are low cost and easy to maintain. They are almost always conveniently located near the user's parked car and they are easy for the parking public to understand and use. Typically, single-space meters accept coins, tokens, and often contact smart cards. A survey for the IPI's 2004 edition of *Benchmarking the Parking Profession* indicates that 12.7% of all parking meters accept smart cards.[5] In addition, 25.7% of the respondents planned to purchase meters that accept smart cards. MacKay Meters, one of three North American manufacturers of single-space meters, estimates that at least 75% of the tenders/bids for single-space meters received during 2004 and 2005 have specified the requirement to accept payment by both coin and a contact smart card, or to accept payment by coin and have the ability to be upgraded to accept payment by a contact smart card at a later date.

Single-space electronic meters are powered by low voltage batteries and are currently incapable of the online communications necessary for remote monitoring and online payment card processing. They also are required to fit into meter housings that have, for the most part, been standardized across the industry. These power and space constraints limit the ability of most such meters to house the RF transceiver required for contactless smart cards. Data is typically collected using handheld data terminals that periodically probe the devices.

3.1.2 Multi-space Meters

While single-space meters have long been a fixture on the parking landscape, new technology is now starting to be deployed in the United States. The operational constraints imposed by single-space meters (described above) have led most of the market outside North America to embrace multi-space meters, which are more sophisticated curbside payment devices. Multi-space meters accept payment for parking at multiple available spaces (either on- or off-street). Multi-space meters support a variety of online functions and a wider array of payment options. Due to their cost, they are typically configured to manage multiple spaces in a single block and provide wireless online communications necessary for real-time credit card processing and remote monitoring. Industry norms are in the range of 8 to 10 on-street spaces per meter. Networked systems also provide value-added features such as paying by cell phone. Figure 4 shows examples of typical multi-space meters.

Figure 4. Multi-Space Meter Examples[6]

When this new approach was first introduced to the U.S. market, municipal parking administrators showed some resistance. Their opposition had less to do with the equipment itself than the anticipated response of their customers to a significant shift in parking culture. Specifically, parking administrators were concerned that motorists accustomed to the one space–one meter standard would pull into a curbside space, not see a meter, and assume the space was unregulated. The fear was that motorists would inadvertently park illegally and receive a parking

[5] International Parking Institute, *Benchmarking the Parking Profession: The Statistical Guide to Parking*, 2004 Edition.

[6] *Sources*: MacKay Meters, Parkeon, Reino, Cubic Parking Systems

citation by not bothering to scan the entire block for a payment device. Eventually, small municipalities such as Aspen, CO, and Fort Lauderdale, FL, deployed multi-space meters, in some cases as one element of streetscape enhancement initiatives. (The multi-space meters were adopted as a means of reducing the visual clutter in gentrified neighborhoods and shopping districts.) The success of these initial deployments has led to increasing industry acceptance. Toronto, Portland, and Seattle combined have 6,000 multi-space meters installed, managing over 44,000 curb side spaces. New York City is now using multi-space meters to regulate and better control commercial vehicle parking in many sectors of the city. During off-peak business hours, passenger vehicles are also allowed to park in the spaces governed by these devices.

Most on-street multi-space meters operate in pay-and-display mode, in which a receipt is printed by a machine that documents the time purchased. This receipt is then placed on the dashboard for visual inspection by enforcement personnel. An alternative to pay-and-display is pay-by-space. In this scenario, spaces are numbered, and the machine logs the time purchased by space number. A printed or electronically retrieved manifest is then used for enforcement. Wireless handheld computers compliment enforcement capabilities, providing access to the paid-space database and facilitating violation issuance.

Multi-space meters are powered by either AC power or larger batteries (often trickle-charged using a solar cell), incorporate the use of wireless communications technology, and facilitate the use of credit and debit cards as well as coins and tokens for payment. Their expanded power capacity makes possible the incorporation of the RF transceivers required by contactless smart card technologies. The machines sit on real-time networks that can communicate alerts and need for collection and/or service, as well as enabling more sophisticated asset management and revenue reporting.

An additional recent development links municipal on-street programs using regional wireless networks. An example of this type of initiative is found in the City of Houston, which is attempting to procure a citywide WiFi network in concert with its movement to upgrade pay-and-display systems.

Multi-space meters are also proving to be a cost-effective alternative for collecting parking fees in off-street surface parking lots. In addition to the obvious benefit of needing fewer devices, there are indirect cost savings. Single-space meters cannot accept credit/debit cards and have limited coin storage capacity, so manual coin collection is required. Both collection and maintenance costs can be reduced if multi-space meter operations are managed effectively.

3.2 Off-street Parking

The parking demands of commuters or motorists who have business that requires more than a 1- to 2-hour visit are served by off-street parking, including surface lots and under- and above-ground parking structures. The location of these facilities is typically dictated by population density. Information compiled by the IPI suggests that there are approximately 40,000 parking garages in the United States.[7] These garages are stand-alone facilities or part of another structure and are operated by a larger group of real estate and facilities owners as well as by municipalities, port districts, stadium authorities, universities, and hospitals.

The number of spaces in the average garage in the primary industry sectors is as follows:[8]

- Airports: 2,875 spaces
- University or college campuses: 1,675
- Private sector: 870
- Public sector: 795
- Medical/hospital facilities: 920

[7] International Parking Institute, http://www.parking.org

[8] National Parking Association, *The U.S. Parking Garages Industry*, 3d Edition, April 2005, p. 38.

Because off-street parking facilities are expensive to construct, there must be a sound value proposition for building them. The value proposition is typically based on the level of demand created by parking generators.[9] The top three generators for the construction of private sector garages are:

- Office (exclusive use): 36%
- Residential (exclusive use): 25%
- Hotel/casino (exclusive use): 11%

The top four generators for the construction of public sector garages are:[10]

- General use: 28%
- Mass event: 19%
- Combination office/general use: 17%
- Office: 15%

Regardless of the business case for construction, once such parking facilities are in operation, management is often outsourced to private parking operators. The recent trend in the industry has been consolidation via mergers and acquisitions, resulting in the creation of three large national companies: Central Parking, Standard Parking, and Ampco Parking Systems. Collectively, these companies operate more than 8,000 facilities, comprising nearly 3 million parking spaces.[11] Combined revenue for the three companies in 2004 was nearly $1.8 billion. There are also approximately 1,000 small, privately held companies that operate regionally or within in a single municipality.

Off-street parking facilities are expensive to construct, but they also generate a significant amount of revenue.[12] In large cities with high population densities and high demand, an individual space can generate $4,000 to $8,000 per year.[13] The median monthly rate for unreserved space in North America is $148.30; the median daily rate for space is $14.04.[14]

The cities with the greatest urban density typically have the highest rates. For example, although Boston and San Francisco are not among the largest U.S. cities, they are among the top five in terms of having the most expensive average monthly rates for unreserved parking space:[15]

- Midtown Manhattan: $492
- Downtown Manhattan: $444
- Boston: $425
- San Francisco: $350
- Philadelphia: $318

The amount of revenue collected by the parking industry is significant.[16] In the U.S., industry receipts for 2005 are estimated to be $17.7 billion, with the forecast in 2008 for $20.86 billion.

Regardless of either the amount of revenue collected at a facility or the entity responsible for collecting it, revenue "shrinkage" due to employee pilferage and customer fraud is an issue. An exact figure for the amount of revenue lost is hard to calculate, but the generally accepted rate within the industry is 5%. However, off-the-record estimates by parking operators and industry consultants suggest that revenue shrinkage could be as high as 15%.

[9] Ibid., p. 39.
[10] Ibid.
[11] Ibid., p. 8.
[12] Ibid.
[13] Ibid., p. 16.
[14] Colliers International, *North America CBD Parking Rate Survey Highlights*, June 2005, p. 1.
[15] Ibid.
[16] National Parking Association, pp. 23-24.

To address this issue, the industry is deploying increasingly sophisticated revenue/access control systems. These systems use a variety of electronic media, and some systems use more than one type of medium. The percentage of systems using each type is as follows:[17]

- Bar code: 20%
- Proximity reader: 28.6%
- Debit system: 10%
- Magnetic stripe: 44.3%
- Automatic vehicle identification technology: 19.7%

The primary objectives of these revenue control systems are (1) to reduce or minimize employee contact with cash, (2) to close loopholes that enable customers to pay less than the required fee or avoid payment altogether, and (3) to improve auditability. A significant additional benefit of such systems is that the data they collect can be used to generate reports on the financial and operational performance of a particular garage or, in some cases, multiple facilities.

Revenue control for collecting off-street parking fees is primarily accomplished using one of two operational models. The first model is used where the length of stay is the basis for pricing. It uses equipment that controls access at both entry and exit points. These systems calculate hourly fees by recording entry and exit times. In the past, systems of this type typically employed a cashier to collect system-calculated fees at the point of exit. However, such systems are now incorporating credit-card-in—credit-card-out capabilities to eliminate cashier involvement and expedite egress. One variation of this type of system incorporates pay-on-foot or central pay stations. Tickets generated at the point of entry are inserted into a pay station located in the garage or at the nearby generator, and cash or credit card payment is made at this point. The ticket is updated to reflect payment and reissued for insertion into the exit lane controller. Central pay stations have been used extensively in Europe and are now gaining popularity in North America. The second operational model utilizes the pay-and-display or pay-by-space metering approach described in Section 3.1.2.

The choice of operational model is largely influenced by lot size and how susceptible the facility is to peak traffic flows. Unstaffed entry–exit systems accelerate payment processing and move people out of a facility quickly, enhancing user convenience.

In both cases, online connectivity is key to the effective processing of credit and debit transactions and to the remote monitoring and reporting functions. Entry–exit systems, in particular, depend on communications. The ability to serve the patron remotely is crucial to preventing a vehicle from being trapped. Systems often incorporate the use of live intercoms to communicate with centralized service personnel. The electronic media used include bar code tickets, magnetic tickets, RFID cards, and credit cards. Encoded tickets carry entry information, enabling local rate table lookup at exit. RFID and credit cards are sometimes processed at entry, updating a back-end database that is then searched at exit to calculate the fee. The use of smart cards can take the place of the encoded ticket.

In order to distribute patron flow and avoid queuing at the exit lane, pay-on-foot stations are often the point at which the rate is calculated and payment accepted. The media issued at entry is coded for exit when payment is accepted, and the exit equipment permits egress upon proper validation. Cashier terminals often compliment pay-on-foot stations to avoid the delays that can result when patrons fail to visit the machine.

IPI's *Benchmarking the Parking Profession* indicates that at facilities using some form of revenue collection equipment, 52.8% accept some form of non-cash payment, mostly credit cards.[18] More importantly, 50% of the parking operations that do not non-cash payments have plans to do so within the next 2 years.

[17] International Parking Institute, *Benchmarking the Parking Profession: The Statistical Guide to Parking*, 2004 Edition.
[18] Ibid.

4 Using Smart Card Technology in Transportation

Smart cards are used worldwide for many applications, including transit, financial, telecommunications, healthcare, and secure identification. Defined at the highest level, a smart card is a device that includes an embedded integrated circuit (IC) chip that can be either a microcontroller with internal memory or a memory chip alone. The card connects to a reader with direct physical contact (i.e., a contact smart card) or with a remote contactless electromagnetic interface (i.e., a contactless smart card). Smart cards are available in a variety of form factors, including plastic cards, fobs, SIMs, and USB-based tokens.

This section provides an overview of how contact and contactless smart cards are being used for payment applications in the parking industry and how contactless technology is being used in the tolling, financial, and transit industries. For transportation payment applications, smart cards are most often offered as plastic cards that use a contact interface, a contactless RF interface, or both contact and contactless interfaces (using a dual-interface smart chip). Appendix A includes additional information about contact and contactless smart cards and the different smart card standards that are being used globally.

4.1 Use of Smart Card Technology in Parking

Use of contact smart card technology is well established in the parking market, with vendors providing solutions for all segments: single-space meters, multi-space meters, and off-street parking.

The large parking vendors have installed closed-loop contact smart card solutions in cities around the United States. (Cities with some type of smart card solution are listed in Table 1.) The parking operator issues (and reissues) the smart cards, manages retail outlets (where they exist), manages cardholder queries, reloads the cards (where this is possible), and manages the entire card system.

Many of the cities implementing smart cards are doing so by leveraging their existing meter infrastructure, replacing single-space meters with smart card-enabled single-space meters. Others are upgrading their single-space meters to accept smart cards and adding additional multi-space meters where appropriate. In those cities, the multi-space meters and single-space meters share the same smart card program, and multi-space meters anywhere in the city can be used to load value onto the smart cards.

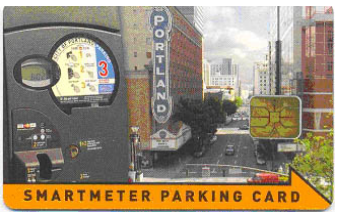
Some of these solutions only work with one parking payment vendor's technology, although there are instances of collaboration between non-competing vendors in some cities. The current implementations are restricted to one type of parking operator (either public or private), with no cross-operator implementations (for example, between public and private operators). Other solutions being implemented allow multiple cities to take part in a single collaborative parking payment system using smart cards. In these systems, a third party manages and operates the smart card payment system on behalf of the participating cities.

Meters accepting smart cards typically also accept coins, and, in the case of multi-space meters, bills and magnetic stripe credit/debit cards. The smart card solutions for on-street parking are have primarily been based on both the ISO/IEC 7816 standard and proprietary smart card technologies, depending on the age of the solution.[19] With the growth in the use of multi-space

[19] There are some exceptions. In 1997, the Hong Kong Transportation Department initially upgraded all of its on-street mechanical coin-operated parking meters with 19,500 battery-powered electronic parking meters that only accepted payment from a disposable contact stored value smart card solely used for parking. Then in 2004, following a number of pilots and trials, the on-street single- and multi-space meter equipment was again upgraded so that it only accepted payment by the City's very popular Octopus card, which is based on technology that is similar to the ISO/IEC 14443 standard.

technology, the door has been opened for the use of ISO/IEC 14443 contactless smart cards as well.

In New York City, the Department of Transportation (DOT) has been using contact smart cards to pay for parking since the summer of 1998. The cards are prepaid and sold as disposable cards. To date, over 1 million cards have been circulated, at a rate of about 25,000 cards per month. The cards are sold by mail order, over the Internet, and through the CityStore, which has two locations in Manhattan.



The City of Portland, Oregon, started a contact smart card program, the SmartMeter Parking Card, for pay-and-display parking meters in 2003. The program uses a closed loop system that employs a proprietary smart card and personal computer software to load value on the card. SmartMeter Parking Cards with pre-loaded value are sold and recharged at retail partnerships in downtown Portland. Card use is popular, with approximately 6,000 cards in circulation and hundreds of cards recharged on a regular basis.[20] In 2004, the City of Portland financed a business case analysis that examined combining existing smart card services with transit, off-street parking, and other city visitor service applications. The regional transit authority, TriMet, and other agencies were involved in the business case. The business case was positive and it recommended a pilot project to verify business case assumptions. Implementation of a pilot project is pending.

In Washington, DC, the Washington Metropolitan Area Transit Authority (WMATA) has implemented a contactless smart card parking solution for subway riders. All of the parking equipment in the Metro parking lots has been upgraded to support payment using the SmartTrip® card, which is used to pay for parking when the motorist exits from the lot. Riders parking in certain WMATA-owned lots can only pay for parking using a SmartTrip card. The cards can be reloaded using the current WMATA reload infrastructure. The system is also designed to allow riders to use the WMATA web site to determine space availability and current monthly rates. (For more information on WMATA's use of smart cards, see Section 6.1.)

Similarly, the Metropolitan Atlanta Rapid Transit Authority and the Port Authority Transit Corporation (a subsidiary of the Delaware River Port Authority operating in Pennsylvania and New Jersey) have contracted for contactless smart card-based payment systems controlling all of their park-and-ride facilities. In both cases, a regional transit smart card is in the implementation stages. The system will allow transit users to pay for parking with the same card they use for bus and rail travel. Transit authorities throughout the world are embracing similar models, thus introducing millions of cards into key metropolitan markets.

The security used in the different smart card solutions is implementation-specific and ranges from the use of passwords to unlock the cards to DES-based cryptography. Most meters that contain security information store it in the memory of the meter, although some contain security access modules (SAMs). The SAM stores cryptographic algorithms and the keys used to encrypt and decrypt messages securely. The smart cards can typically be used only to buy time at the meters, although there are solutions with enough security to allow the cards to be used to purchase items from local merchants.

Historically, the adoption rates for these smart card systems have been low. Many cities record usage rates in single-figure percentages. Low usage rates have been attributed to the lack of an effective card distribution and reload infrastructure, the lack of an effective card marketing plan (for which cities typically lack budget and expertise), and the fact that the cards can only be used to pay for agency-specific parking and, typically, must be purchased from a city-authorized agent. Most implementations have used simple memory cards that cannot be reloaded, forcing the

[20] Program growth has been constrained by the current distribution system that has limited recharging locations. Customer surveys conducted by the City of Portland in 2004 showed an 87% satisfaction rate with the existing card, and 95% of those surveyed indicated they would use the card more frequently if recharging was more convenient and cards could be used to pay for multiple services.

patron to purchase another card when the stored value in the first card has been used up. Some newer systems allow cards to be reloaded at a variety of terminals and over the Internet. Cardholders can also subscribe to auto-load programs, in which a link to a credit or debit card account enables the stored value to be replenished automatically, without forcing the patron to purchase a new card or find a reload location.

If implemented properly, however, a smart card system can allow a city to increase revenues dramatically. The city can increase rates on existing meters without incurring the high initial replacement costs associated with implementing a completely new system.

Table 1 lists some of the cities that have implemented contact smart card-based parking. Note that several universities, which are not listed in the table, have also implemented contact smart card-based parking.

Table 1. Cities with Contact Smart Card-Based Parking

City	State or Country	Single-Space (SS) or Multi-space (MS) Equipment	Number of Cards Issued	Reloadable Cards	Stage of Deployment
Albany	NY	2,000 (SS)	N/A	Yes	Pilot
Arlington	VA	3,200 (SS)	10,000	No	Roll-out
Clemson	SC	N/A	5,000/year	No	Roll-out
Coral Gables	FL	N/A (SS & MS)	N/A	Yes	Roll-out
Denver	CO	N/A	N/A	Yes	Roll-out
Hong Kong	China	14,100 (MS)	N/A	Yes	Roll-out
Miami	FL	8,500 (SS)	15,000	No	Roll-out
Miami Beach	FL	9,500 (SS)	18,000+	No	Pilot
Minneapolis	MN	6,800	N/A	Yes	Roll-out
Naperville	IL	N/A	N/A	Yes	Roll-out
New Haven	CT	500 (SS), 15 (MS)	N/A	Yes	Pilot
New York	NY	64,200 (SS), 1,850 (MS)	1,000,000	No	Roll-out
Orlando	FL	2,200 (SS)	1,500	No	Roll-out
Ottawa	Canada	4,500 (SS)	6,000	Yes	Roll-out
Paris	France	13,000 (MS)	3,000,000+	No	Roll-out
Philadelphia	PA	14,500(SS)	N/A	No	Roll-out
Pittsburgh	PA	N/A	N/A	No	Roll-out
Portland	OR	1,137 (MS)	6,000	Yes	Roll-out
Princeton	NJ	N/A	N/A	Yes	Roll-out
Providence	RI	750 (SS)	500	No	Roll-out
Sacramento	CA	5,000 (SS)	2,500	No	Roll-out
San Diego	CA	2,000	N/A	Yes	Roll-out
San Francisco	CA	26,500 (SS)	N/A	No	Pre-pilot
San Isidro	Argentina	2,000 (SS)	100,000	No	Roll-out
San Jose	CA	200 (SS)	N/A	Yes	Pilot
Santa Cruz	CA	2,100 (SS)	N/A	No	Roll-out
Santa Monica	CA	6,000 (SS)	N/A	N/A	Pre-pilot
Saskatoon	Canada	2,200 (SS)	18,000	No	Roll-out

City	State or Country	Single-Space (SS) or Multi-space (MS) Equipment	Number of Cards Issued	Reloadable Cards	Stage of Deployment
Savannah	GA	N/A (MS)	N/A	No	Roll-out
Seattle	WA	1,600 (MS)	N/A	No	Roll-out
St John	Canada	1,600	7,000	No	Roll-out
Urbana	IL	N/A	N/A	Yes	Roll-out
Victoria	Canada	2,000 (SS)	7,000	No	Roll-out
Washington	DC	15,000 (SS)	500	No	Roll-out
Washington	DC	1,393	N/A	No	Roll-out
West Palm Beach	FL	1,700 (SS)	12,500	No	Rollout

4.2 Contactless Technology Implementations in Other Markets

4.2.1 Contactless Technology Use in Tolling

In general, the contactless electronic payment systems used in tolling do not use smart card technology. Unlike the short-range RF communications used with most contactless smart cards, toll-road contactless payment systems use "long distance" ultra-high-frequency (900+ MHz) transponders. One exception is a hybrid system currently being used extensively in Singapore, where automobile-mounted transponders are used in conjunction with smart cards and the payment card is inserted into a transponder slot to pay for tolls. This type of application has not been deployed in North America.

Three electronic payment systems that are being used on toll roads in the United States are E-ZPass (in the northeastern United States), TollTag™ (in Texas, Oklahoma and Kansas), and FasTrak™ (in California). These systems use ultra high frequencies (902–928 MHz) and have an operational range of anywhere from 3 meters to more than 10 meters. Because the system generally uses a unique ID within the application, the technology is also referred to as RFID technology.

While some transponder devices may be capable of limited channel encryption or device authentication, security is generally an issue, since most of these devices have not been developed for consumer payment applications. In contrast, smart cards typically use encrypted, short-range RF or contact communications.

Toll systems typically use account-based payments. For example, E-ZPass users can make preauthorized account-based payments with predetermined transaction limits. E-ZPass uses an RFID payment device that identifies the consumer to a central system in which the consumer's account and transaction limit information is stored. The consumer funds and replenishes the account using traditional payment methods.

In practice, RFID technology has been used for payments in closed payment applications such as transponder-based toll and garage parking payment. Due to the long read ranges, limited functionality and limited security of the ultra-high-frequency RF technology used by the tolling industry, the Smart Card Alliance believes that this technology is inappropriate for many payment applications. The technology is not used in the payment systems that are used for general retail payment or for transit automatic fare collection systems, both of which are now using contactless smart cards.

4.2.2 Contactless Smart Card Technology Use by the Financial Payments Industry[21]

4.2.2.1 Adoption by Card Associations

American Express® ExpressPay, MasterCard® *PayPass*™, and Visa Contactless have standardized on ISO/IEC 14443 as the contactless payment standard to be used in the United States for financial payments. All three card associations are implementing contactless payment approaches that leverage the existing payment infrastructure.

Vendors are now offering cost-effective contactless cards and point-of-sale (POS) terminals that support the American Express, MasterCard, and Visa payment applications. Contactless terminals can be installed with existing POS systems quickly and easily, either as a retrofit or as an integrated RF and magnetic stripe terminal. ISO/IEC 14443-compliant cards and terminals are available from multiple vendors, providing an issuer with a choice of solutions and a migration path to more powerful devices if required. These interoperable cards and terminals facilitate deployment, decrease costs, and leverage the existing payments infrastructure.

The contactless payment deployments by American Express, MasterCard, and Visa eliminate the need for consumers to swipe their credit or debit cards through a reader. Consumers hold their payment cards near the specially equipped merchant terminal, transmitting payment information wirelessly from the consumer to the merchant. The payment application data is based on the Track 1 and Track 2 information in the magnetic stripe of a traditional credit/debit card with additional security data. The payment transaction is then processed through the existing acceptance network. In order to build on speed and convenience benefits, American Express ExpressPay, MasterCard *PayPass* and Visa Contactless do not require signatures on qualified transactions under $25. These contactless payment solutions have been targeted at traditional cash-only environments where speed is essential, such as quick service restaurants, gas stations, and movie theaters. It eliminates the need for a cardholder to present the card to the merchant, allowing the cardholder to remain in control of the card.

Certain benefits of contactless payment to the consumer are also benefits to the parking industry:

- Faster payment transactions
- Ease and convenience of use
- More cash available in the wallet for essential incidentals
- Option to pay for low-value transactions using a credit card

Benefits to the merchant of contactless payment that are applicable to the parking industry include:

- Faster throughput, speeding consumers through the payment process
- Improved operational efficiency (for example, less cash handling, improved terminal reliability)
- Increased customer satisfaction—more efficient purchases

4.2.2.2 Adoption by Issuers

Several of the major financial payment card issuers are in the process of issuing millions of contactless credit cards over the next few years.

- Chase Bank U.S.A. announced a broad roll out of “blink” MasterCard and Visa credit cards with contactless payment technology in May 2005. Chase is the nation’s largest Visa and MasterCard issuer by card volume, with over 90 million credit cards in

[21] Up-to-date information on status of the contactless payments programs being launched by the financial industry in the U.S. can be found at http://www.smartcardalliance.org/alliance_activities/contactless_pmts_resources.cfm.

circulation. Chase is now issuing cards to consumers, with over 4 million cards delivered to cardholders in Atlanta[22], Denver and throughout the Northeast.[23,24] Chase is also working with over 400 merchants in each of its initial markets to ensure the broadest possible acceptance.[25]

- American Express began issuing new Blue cards with ExpressPay contactless payment technology in June in all 50 states. American Express is the largest issuer by charge volume and maintains the largest active smart card payment program in the United States, the American Express Blue Card.
- In August, Keybank announced that it will offer its customers debit cards incorporating MasterCard *PayPass* contactless technology.[26] Key began replacing its debit cards with *PayPass*-enabled debit cards beginning September 1, and all new Key customers will receive a *PayPass*-enabled debit card when they open a checking account.
- Also in August, Meijer Stores announced plans to offer a *PayPass*-enabled Meijer Platinum MasterCard card, issued by GE Consumer Finance. Meijer Stores will also accept MasterCard *PayPass* as a contactless payment option at all of its locations.[27]
- Citibank announced in August that they will launch a contactless debit product using MasterCard *PayPass* technology that customers can use to make small purchases. Citibank estimates that they will issue 2.5 million contactless key fobs in the United States.[28]
- In September, HSBC Bank, the U.S. banking unit of one of the world's largest financial services companies, announced it has begun issuing new debit cards that feature MasterCard *PayPass* contactless payment technology to its new and existing customers. The bank expects to issue about 1 million cards through the end of 2005.[29]

4.2.2.3 Adoption by Processors and Merchants

Processors and merchants are now working to enable the payment infrastructure required to accept contactless payments. Payment processors like First Data, National Processing Company (NPC), Paymentech, and Vital have initiated programs to process contactless payments. They are sponsoring pilot projects with their merchants and implementing support for the new data elements required by MasterCard and Visa for contactless payment.

Both national and regional retailers have recognized that contactless payments are quick and convenient, and are integrating contactless readers into their existing payment infrastructure. Retailers who have announced contactless payment initiatives include drug stores (CVS/pharmacy®, Walgreens, and Duane Reade), movie theaters (Regal Entertainment Group, United Artists Theatres, and Edwards Theatres), convenience stores/gas stations (7-Eleven, Sheetz, Meijer Stores, and Wawa), fast food restaurants (McDonald's®, Arby's®, KFC, Cold Stone Creamery®, and Carl's Jr.®), and other speed-driven merchants (e.g., canteen vending machines in select markets). Acquirers and independent sales organizations are also starting to promote the solution to smaller merchants.

[22] "Chase's 'Blink' Card Gets A Long Look In Atlanta," CTWeekly, June 14, 2005
[23] "Time-Strapped New York Tri-State Residents 'blink' Their Way to Faster Purchases," Chase press release, October 27, 2005
[24] "Chase Launches Credit Cards with 'blink' in Philadephia Tri-State Area," Chase press release, October 27, 2005
[25] "Chase Bank to bring 'contactless' credit cards to Colorado," The Denver Post, June 8, 2005
[26] "Keybank First Bank In Nation To Issue MasterCard *PayPass* Debit Cards," MasterCard press release, August 4, 2005
[27] "Meijer Stores and GE Consumer Finance Introduce MasterCard *PayPass* as Newest, Most Convenient Payment Option," press release, August 15, 2005
[28] "Citibank Taps Debit PayPass for Contactless Payment," CTWeekly, Sept. 1, 2005
[29] "HSBC Gives U.S. Customers a Simpler Way to Pay," MasterCard press release, Sept. 14, 2005

Contactless payment shows great promise as the fastest technology shift that the payments industry has experienced in the United States. In this environment—issuers with solid field trial experience and the business clout and marketing power to make the roll-outs a success; retailers whose markets can reach millions of consumers; consumers who are seeing real benefits from the technology—contactless payment is expected to be used by millions of U.S. consumers to pay for increasing numbers of day-to-day transactions.

Significant for the parking industry, the ISO/IEC 14443 standard being used by the financial payments industry is the same standard being used by the mass transit industry for contactless smart card-based fare media. As a result, two separate applications are pushing compatible infrastructure into merchant locations, train stations, bus routes, parking lots, and most importantly, the hands of consumers. Accordingly, much discussion is taking place between financial card issuers and transit agencies about areas in which collaboration and mutual economic benefit are possible.

4.2.3 Contactless Smart Card Technology Use by the Transit Industry

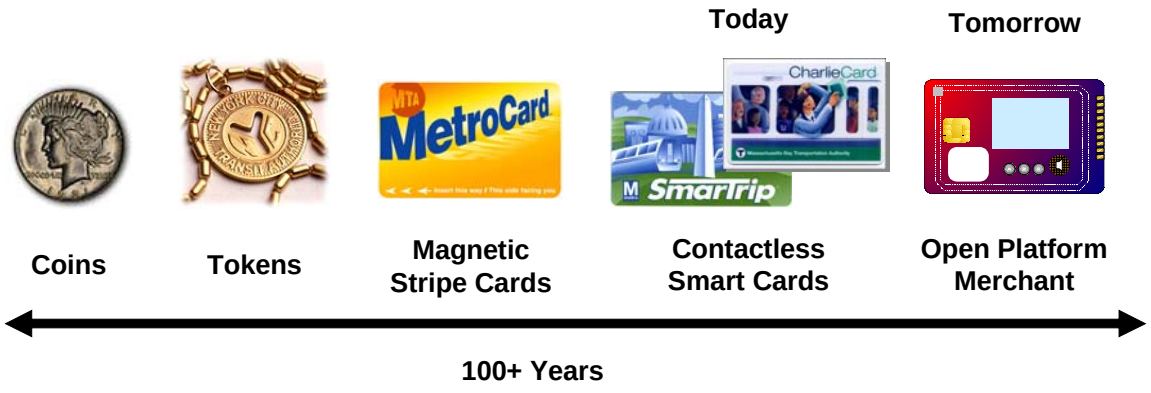
Like the parking industry, the transit industry is currently integrating smart card technology into its fare collection equipment. Several major transit authorities have fully embraced the new technology and promote the use of smart cards over the use of magnetic stripe cards, tokens, or cash to pay for fares. Transit implementations of smart card technology are carefully planned efforts that include pilots, phased roll-outs and customer education programs. Some authorities are forcing their customers into this new technology, while others are offering unique benefits to customers who use smart cards. The Atlanta transit authority (MARTA) and the Los Angeles transit authority (LACMTA) have decided to implement smart card-only systems using a combination of permanent and limited-use smart cards with the latter targeted at occasional riders.

4.2.3.1 Current Status

The majority of public transit operators have already migrated from cash payment systems through token systems to magnetic stripe card systems (Figure 5), and today many of them are switching to smart card-based systems. Contracts totaling over $740 million are underway across 17 major metropolitan areas in North America to deploy fully integrated contactless smart card-based transit fare systems. These systems are in various stages of delivery and are all expected to be operational within 24 months.

Although some transit authorities (i.e., TransLink® in the San Francisco Bay Area or SmartLink in New Jersey) have introduced dual-interface smart cards, contactless smart cards are the choice of the majority of the large transit authorities.

Figure 5. The Evolution of Fare Collection



4.2.3.2 Advantages of Contactless Systems

For the transit industry, the key to attracting and maintaining customers is customer satisfaction, and shifting to the use of contactless smart cards enhances customer service. However, installing a contactless payment system benefits transit authorities as well as customers.

Customers of a contactless system benefit from a faster, easier, and more convenient transit process, including decreased transaction and boarding times. In addition, in a smart card supported system, the customer benefits from increased functionality and card interoperability.

Many of the benefits that accrue to the customer are also benefits to the authority. The operational efficiency of a contactless system allows for improved passenger flow, reduced fare evasion rates, decreased maintenance and consumables expense, increased electronic payments (i.e., fewer cash fares), and new transit/merchant business opportunities. These benefits, along with lower perceived customer costs (e.g., less frequent dips into the pocket book), increase an authority's revenue sources and provide a modern fare collection system that can be leveraged in the marketplace.

4.2.3.3 Examples of Use

There are obvious opportunities for the parking industry to use the smart card technology implemented by the public transit industry across the country. The parking industry can also benefit from the lessons learned by the public transit Industry.

4.2.3.3.1 CHICAGO TRANSIT AUTHORITY

The Chicago Transit Authority (CTA) started a smart card pilot project in 2000 with 3,500 cards. In November 2002, CTA launched the Chicago Card, which was joined in January 2004 by the Chicago Card Plus. Cubic's Gocard® is being used for both types of cards. Today, 80,000 Chicago Card and 100,000 Chicago Card Plus cards are in circulation. Figure 6 summarizes the key differences between the two cards.

Figure 6. Key Differences between the Chicago Card and the Chicago Card Plus

Key Differences		
Adding value	Only cash at vending machines	Only credit cards or transit benefit dollars at www.chicago-card.com
Checking value	Check at vending machines	Check online or by calling CTA customer service
Fare types	One choice: pay-per-use	Two choices: pay-per-use or 30-day pass
Registration	Optional	Required, including email address

Recognizing the benefits of achieving high smart card market penetration, the CTA continues its effort to offer more convenience and flexibility to Chicago Card and Chicago Card Plus holders. In 2005, the CTA started a pilot program that allows Chicago Card and Chicago Card Plus customers to board busses more quickly than other passengers or use dedicated turnstiles at eight busy subway stations. To provide a majority of riders with access to smart card technology, CTA, which has primarily relied on mailing cards to customers, is now looking into the installation

of Chicago Card retail sales terminals throughout its service area. The CTA is also working on a pay-per-space parking program.

4.2.3.3.2 WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

WMATA was the first transit authority to push aggressively for the use of smart cards in its systems. WMATA has been using the SmarTrip card (based on the Cubic Gocard) for Metrorail and parking since May 1999. The Metrobus system became fully SmarTrip capable in August 2004, and a series of contracts are in place between the system provider and multiple independent transit agencies throughout the State of Maryland, the District of Columbia, and Northern Virginia to expand SmarTrip acceptance throughout the region. In all, 17 agencies will accept SmarTrip, with over 8,000 processing devices deployed.

The SmarTrip card is available as a stored value card (up to $300) for full-fare and reduced-fare customers. A SmartBenefit service allows the cards to be loaded with transit benefits.

In June 2004, SmarTrip became the only form of payment accepted at Metro-operated parking lots. To handle card availability and distribution, WMATA placed card dispensers in each of its rail stations with parking facilities. This mandatory use of the card at parking facilities resulted in a surge in the quantity of cards sold. During the last year, WMATA sold over 700,000 SmarTrip cards, of which 80% were sold from the card dispensers.

In 2005, WMATA and Citibank teamed up to offer the Citi® Platinum Select® SmarTrip MasterCard, a combination Metro SmarTrip card and Citibank credit card. As an added benefit to the SmarTrip program, customers receive 5% back as a statement credit for 6 months (up to $300) when they use the card to pay for Metrorail and Metrobus fares or Metro-operated parking.

The WMATA smart card distribution network includes retail stores and mail-order options. At WMATA parking locations, the organization relies on vending machines that sell cards with value to patrons requiring the mandatory card to park. The addition of these vending machines has sharply increased the penetration rate of the cards.

4.2.3.3.3 U.S. TRANSIT SMART CARD IMPLEMENTATIONS

Table 2 summarizes the status of smart card implementations by U.S. transit authorities.

Table 2. Examples of Smart Card Use by Transit Programs in the U.S.

Location/Lead Agency (Program Name)	Type of Program	Integrator/ Vendor	Status
Atlanta/MARTA (http://www.itsmarta.com)	Inter-modal smart card fare collection system	Cubic	System commission is scheduled for 2006.
Boston/MBTA (http://www.mbta.com)	AFC option	Scheidt & Bachmann	Equipment installation 2005–2006. Smart card issuance started in Spring 2005 to reduced-fare patrons, with system-wide issuance projected for 2006-2007. Pilot program to be started in Fall 2005.
Chicago/CTA (Chicago Card and Chicago Card Plus) (http://www.chicago-card.com)	Fully inter-modal and inter-agency smart card fare collection system	Cubic	Recent CTA/Cubic contract to provide 300,000 smart cards over the next 2 years. As of April 2005, 115,000 cards were currently in use. Central computing system upgrade contract also awarded.

Location/Lead Agency (Program Name)	Type of Program	Integrator/ Vendor	Status
Houston/METRO	AFC upgrade	ACS/Ascom	Contract awarded 2005.
Las Vegas/Monorail (http://www.lvmonorail.com)	New fare system (new service)	ERG	Transit service opened in July 2004.
Los Angeles/LACMTA (UFS) (http://www.mta.net)	Regional farecard	Cubic	Contract awarded; rollout planned in 2005-2006. Contract has also been awarded for a central computer system that is designed for multi-operator regional ticketing systems and that will integrate all bus and station equipment to a central source for revenue and data management.
Maryland Transit Administration (MTA) (http://www.mtamaryland.com)	Statewide smart ticketing with all subway, light rail and commuter rail systems using the same smart card, plus linking the state's commuters to the regional bus and commuter rail system that feeds into Washington, DC	Cubic/GFI	Equipment is scheduled for installation in stages between the third and fourth quarters of 2005. More than 3,000 smart card-enabled readers/writers will be installed on busses throughout Washington, DC, Maryland and parts of Virginia.
Miami-Ft. Lauderdale-Palm Beach/MDTA/SFRTA (UAFC) (http://www.sfrta.fl.gov)	Regional farecard	TBD	RFP expected for release in Fall 2005.
Minneapolis-St. Paul/Metro Transit (http://www.metrocouncil.org/directions/transit/smartcards.htm)	Regional ticketing system for light rail and bus rapid transit	Cubic	In revenue service. Pilot testing to start September 2005, with rollout planned by end of 2005.
Newark/PANYNJ & NJT (SmartLink)	AFC option	Ascom/ASK	Pilot implemented in 2001.
Orlando/Lynx (ORANGES) (http://www.centstobits.com)	Multi-modal integration	TTI/Ascom/ Efkon	Pilot completed.
Port Authority Trans Hudson (PATH) (http://www.panynj.gov/path/)	Cubic "open system" smart card technology that will be integrated with New York City Transit's (NYCT) MetroCard system	Cubic	Contract awarded in June, 2003.
Philadelphia/PATCO (http://www.drpa.org/patco)	Multi-modal contactless smart card-based AFC system that will link rail and parking services	Cubic	Contract awarded in March 2005. Delivery of new system is scheduled for end of 2006.
San Diego/MTDB (http://www.sdcommute.com)	Regional integrated smart card-based AFC system for the county's busses, trolleys, Coaster Commuter Rail, and future expansion of light rail system	Cubic	Contract awarded; rollout underway with regional completion planned for 2007.

Location/Lead Agency (Program Name)	Type of Program	Integrator/ Vendor	Status
San Francisco/MTC (TransLink) (http://www.translink.org)	Regional multi-modal integrated smart card-based AFC system that will extend to over 25 operators	ERG	Pilot completed in mid-2002; full rollout planned for 2006. Includes the operation of a centralized clearinghouse.
Seattle-Puget Sound/KC Metro (http://www.transit.metrokc.gov/prog/smartcard/smartcard.html)	Regional multi-modal integrated smart card-based AFC system that will extend to 6 operators	ERG	Contract awarded; rollout planned in 2005 with full operations in 2006. Includes the operation of a centralized clearinghouse
Ventura County (http://www.goventura.org/home/index.asp?page=92)	Regional dual-interface farecard	ERG	Implemented in 2002 on 100 buses.
Washington-Maryland-Virginia/WMATA (SmarTrip) (http://www.wmata.com/riding/smartrip.cfm)	Regional multi-modal integrated AFC system that will extend to over 15 operators.	Cubic/GFI/ ERG	Over 1,200,000 cards in use on MetroRail, in Metro-operated parking lots, and on Metro buses; contract awarded for rest of region; multi-application pilots in process. Includes the operation of a centralized clearinghouse.

4.2.3.4 Universal Transit Farecard Standards

One key to the success of smart cards in the transit industry is the industry's migration toward universal standards, both using the international ISO/IEC 14443 standard for the card to reader interface and defining new application-level and inter-system messaging standards.

4.2.3.4.1 STANDARDIZATION IN THE UNITED STATES

In 2003, the American Public Transportation Association created a task force to establish standards and guidelines for transit fare cards and payment systems. The mission of the APTA Universal Transit Farecard Standards (UTFS) Task Force is to develop a series of documents that will provide the industry guidance necessary to accomplish the following:

- Create an open architecture payment environment
- Integrate currently independent payment systems

Dozens of companies, including systems integrators, consultants, transit agencies, technology firms, payment processors, and service providers, have collaborated under the UTFS Financial Management committee to develop five work packages aimed at achieving these goals. The first step has been to establish the minimum standards necessary to allow individual agencies to procure systems independently and still achieve interoperability between cards and readers across systems. In later stages, agencies will be able to procure equipment items within systems from multiple suppliers and achieve a similar level of interoperability. The four work packages are identified as WP1, WP3, WP4, and WP4-Plus.

WP1 is the standard that describes the card data format. The format is defined to contain the data elements and organization necessary to support common transit fare policy and to process fares as quickly as possible. Armed with this standard, terminal manufacturers will be able to procure readers and develop software that can interrogate and update any smart card that complies with the standard. As of August 2005, a first draft is substantially complete and undergoing work group review.

WP3 is informative only and describes the security requirements and recommended guidelines for an electronic fare payment system using smart cards. As of August 2005, a draft has been completed.

WP4 is the standard for messages exchanged between the terminal, the agency's central computer, and the clearinghouse. By properly reading and updating the smart card, processing the transaction at the terminal, and formatting the transaction record according to the standard in WP4, a supplier can ensure interoperability across cards and systems. This work package is currently under development.

WP4-Plus (an extension of WP4) is the standard for messages exchanged between a vendor subsystem and the agency's central computer. Work will start on this standard once WP4 is completed.

4.2.3.4.2 SIGNIFICANCE OF STANDARDIZATION TO PARKING

The significance of the UTFS to the parking community could be profound. Once the UTFS is finalized, it is anticipated that most new domestic transit fare payment systems procured will require compliance with these standards. Several recently procured systems that have already gone to contract are tracking the standard's development so closely that they will likely be compliant at or soon after delivery. The WP1 data organization was derived considering other pending applications (including parking) that may also reside on transit cards. Such considerations include support for multiple electronic purses on cards and provisions for discrete Section 132 benefits programs. Many of the suppliers to the parking industry (e.g., Cubic Parking Systems, Scheidt & Bachmann, Thales, ACS) were participants in the development of the standard and are expected to deliver compliant solutions.

Accordingly, the UTFS serves as a natural launch point for the development of a national smart card standard for the parking industry. The parking industry could leverage its development and move toward an interoperable smart card-based payment solution.

4.2.3.4.3 INTERNATIONAL STANDARDIZATION EFFORT

A series of national and international interoperability standards are also being developed for transit/transportation smart cards outside of the United States. These include:

- VDV in Germany
- ATIP in Australia
- ITSO in the United Kingdom
- IOPTA in the European Union

In Europe, several previously disparate standards, such as ITSO, VDV, and Calypso (France), are being harmonized under IOPTA. This move to standardization is also reflected by national smart card programs currently in the design stages in countries such as the Netherlands, Denmark, and Germany.

The basic principles and approach being followed in these standardization initiatives are quite similar to those of UTFS. In fact, UTFS task force leadership has met with many international leadership teams to discuss and understand approaches being taken worldwide. This international communication and the participation of international firms in UTFS committees have driven elements of commonality across the standardization initiatives. Differences will exist in data structures and approaches to security but common basic principles will provide a road map for some level of convergence and perhaps, more importantly, the ability for varying standards to be supported on the same smart card. As such, an application file written to co-reside on a UTFS-complaint smart card has the potential to also co-reside on a card using a foreign standard. In a similar fashion, a card carrying a properly-defined parking application file could also carry a transit application file.

The significance of these standards is that the opportunity exists for the parking industry to build upon the public transit initiatives and establish application standards that can be sufficiently generic such that collaboration on smart card programs can be achieved. Through collaboration, parking operators can achieve savings in card acquisition, distribution, processing, and customer support operations through leveraged infrastructure and services. Parking systems suppliers working on an international basis will also have the opportunity to generate scale economies by using consistent technology, thus resulting in lower equipment costs for their customers.

5 Benefits of Smart Card Technology for Parking Applications

The parking industry generates over $17 billion per year in revenues.[30] A significant portion of the fees paid for parking is collected as cash. However, according to the American Bankers Association (ABA) 2003/2004 *Study of Consumer Payment Preferences*, increasing numbers of consumers are using electronic forms of payment. In 2003, for the first time, electronic payments in the United States surpassed payments made by cash or check. Cash and checks now account for only 47% of in-store purchases, as compared to 57% in 1999 and 51% in 2001. Since consumer use of credit cards has remained relatively constant, at around 21% of purchases during this period, the decline in cash and check transactions may be attributed to increased debit card transactions. According to the ABA, "Consumers will continue to look for — and migrate toward — new payment methods that satisfy their payment needs."[31]

Both traditional credit/debit cards and smart cards are well suited for all-day and long-term parking payments. However, smart card technology is the clear leader for on-street and short-term electronic parking payments. By implementing smart card technologies, parking operators can take advantage of the increasing consumer preference for electronic payments and achieve significant benefits:

- Better customer service
- Increased revenues
- Increased operational efficiency
- Stronger internal controls and security
- Expanded strategic marketing opportunities
- Simplified tax benefits administration
- Compliance with laws/statutes

This section describes each of these benefits in more detail.

5.1 Better Customer Service

Smart card technology allows customers to use one card both for parking and for other payments, such as transit, tolls, or small purchases. While customers appreciate the convenience of being able to use a single card for a variety of uses, parking operators can also spread the cost of operating the smart card system over a larger number of transactions and share the costs with other application providers.

For example, schemes such as the Hong Kong Octopus card and Washington SmarTrip card (see Sections 6.4 and 6.1, respectively) allow customers to use one payment card to pay for parking at multiple sites over a large geographic area. In the United States, two pilots currently being conducted by Parcxmart promote the use of smart cards for a variety of payments. Currently in New Haven, 19 merchant locations and 9 parking garages and lots accept cards for purchases and parking. Just over 500 parking meters will be installed in downtown New Haven by the end of September 2005 that accept the cards for payment. In San Jose, customers will be able to use cards to pay for on-street parking by the end of 2005. The cards are currently being used in the Japantown neighborhood, with terminals in six stores and restaurants. A total of 200 parking meters will be equipped to accept cards by the end of September.

[30] Marketdata Enterprises Inc., *The U.S. Automobile Parking Garages Industry*, April 1, 2005, available at http://www.marketresearch.com/product/display.asp?productid=1098121&xs=r

[31] American Bankers Association, *Consumers Now Favor Credit and Debit over Cash and Checks as Payment for In-Store Purchases*, press release, Dec. 16, 2003, available at http://www.aba.com/Press+Room/121503ABADOVESTUDY.htm

Smart cards, due to their strong security features, do not necessarily require the same level of user verification (i.e., a signature) as credit cards. This advantage can result in reduced transaction times, lowering customer wait times.

Smart card applications can protect users if their cards are lost or stolen. For example, a smart card can be disabled by the terminal at first use after the card is reported lost or stolen. This capability allows parking operators to ensure that customers suffer no financial loss while minimizing the cost of providing such service.

Customers using contactless smart cards never need to let the card leave their hands. Presenting the smart card to the reader enables the terminal to scan the card for user data and encode relevant data into the chip for future use. If the card is a contactless payment card, the terminal processes the transaction without the danger that the card may be captured and not returned due to equipment malfunction. This capability can be particularly beneficial at gated parking locations, such as airports.

For parking applications that calculate fees according to length of stay, entry data can be encoded into the card's chip memory and then accessed for rate table lookup. This capability eliminates the need to issue magnetic or barcode tickets, increasing customer satisfaction. Stored value or contactless credit card systems allow customers to avoid even visiting a pay-on-foot machine; the exit terminal calculates the fee and debits the transaction from the card in less than 1 second.

Smart cards allow parking operators to charge motorists only for the amount of parking time actually used. Motorists find this to be a much fairer system and the parking operator benefits by achieving a higher turnover at each parking space, since these types of systems reduce the ability for motorists to "feed the meter." For example, in Saskatoon, Saskatchewan, Canada, motorists use a smart card to purchase the maximum time allowed at a particular meter. When they return, they reinsert the card, which is then credited for any unused time, and the meter is set back to zero.

Another customer service example is the University of Wisconsin Flex Parking Program, which has implemented personal parking meters that hang on a car's rear-view mirror and work in conjunction with prepaid smart cards. The personal parking meter tracks the time and subtracts the required amount directly from the smart card. Unlike traditional parking permits, personal parking meters can pay for only the precise amount of parking time used. The meters also allow faculty the option of parking in staff and public spaces. The personal parking meters therefore allow users to park in more locations than the traditional permit, and offer the flexibility of infrequent parking for those users who opt to use alternative modes of transportation.

Smart cards make it easy for motorists to maintain value on their cards, thus encouraging use of parking services that accept smart card-enabled payments. For example, SmarTrip and Octopus cards that allow payment for parking can automatically be topped-up when the amount in the card falls below a predefined level. Smart cards can also be recharged manually at kiosks, retail locations, and gas stations, using traditional payment methods like cash and credit/debit cards.

5.2 Increased Revenues

Smart cards increase motorists' willingness to pay at the meter. In most cases, motorists have only one choice for payment which, for a single-space meter, is generally coins. If motorists do not have the correct coins, they are more likely to simply risk a ticket. Studies have shown that offering flexibility in payment options can increase motorist compliance by as much as 20%, thereby increasing revenues for the parking operator.

Another source of increased revenue is increased rates for on-street parking. Local governments have been reluctant to raise rates to market levels, fearing that motorists would resent not only the higher rates but also the need to carry more coins. However, the City of San Francisco recently approved significant on-street parking rate increases (from $2 to $3 per hour in the city center). These increases were approved because the city is implementing a MacKay Meters

smart card payment system for parking meters, thus offering motorists an alternative method of payment.

Since smart cards can eliminate the need for coins, consumers are also likely to increase their use of on-street parking, rather than searching for off-street parking in less convenient areas. Businesses located in city centers often claim that they have a disadvantage when competing against businesses located in suburban areas, where parking is free. While there is no direct evidence to suggest that card payment options for on-street parking provide downtown businesses with any competitive advantage over suburban shopping locations, the City of Portland has found that more people choose on-street locations when they can pay by card. In addition, it appears that in Portland the average card transaction is approximately $2, while the average coin transaction is approximately $0.70. The implication is that people park for longer periods and shop for longer periods when they use cards to purchase parking.

Smart card-based electronic purses may also provide parking operators with a benefit by allowing them to accrue interest on funds that the customer has prepaid. The more cash there is in the bank (as opposed to the machine), the more interest the operator earns on the money. In addition, transaction amounts tend to be higher when customers pay with credit, debit, or stored value card payments as opposed to cash.

5.3 Increased Operational Efficiency

Using smart cards can increase the efficiency of parking operations in several areas: security; labor requirements, and equipment.

Smart card systems incorporate advanced security features that reduce the risks associated with not having every transaction authenticated by a back-end management system. Parking operators need not incur the cost of installing and maintaining a full-time communication link for each parking device.

Electronic parking payments also provide economies of scale that are not available for labor-intensive processes like servicing coin-operated parking meters. The incremental cost for each additional smart card transaction declines sharply, in comparison to the transaction costs incurred using coin-operated parking meters. In addition, reduced transaction times mean that fewer staff (or gates) are required at off-street parking facilities. If the smart card used for parking is also used for other applications, parking operators can spread the cost of operating the smart card system over a larger number of transactions and share the costs with other application providers.

Other benefits can be realized in lower equipment and material costs. Cash-handling systems are complicated electromechanical assemblies that suffer from extensive wear and tear and intermittent failure. They are expensive to design, build, and maintain. Using smart cards can decrease failure potential and repair costs and also decrease the cost of consumables, such as the ticket stock associated with entry/exit systems.

However, parking operators must take into consideration that as long as cash continues to be accepted for payment, the unit cost of handling cash will increase as the percentage of total revenues collected from cards increases.

5.4 Stronger Internal Controls and Security

Cash-heavy businesses in general are vulnerable to errors made while handling cash. By reducing cash-handling requirements, smart card parking meters strengthen internal controls, reducing opportunities for inaccuracies.

Smart card technology incorporates stronger security features than any token or payment card technology. Applications can leverage the many security features supported by smart cards to ensure the integrity, confidentiality, and privacy of stored or transmitted information and to counter potential security threats. Smart card systems are much harder to compromise than magnetic stripe systems, decreasing the losses experienced by parking operators due to fraud.

This is one reason that credit card issuers in Europe and elsewhere are now issuing smart card-based credit cards.

Smart cards also have extensive built-in tamper resistance. A variety of hardware and software capabilities can detect and react to tampering attempts immediately. The ability to support authenticated and authorized information access combined with strong data security make smart chip-based devices excellent guardians of personal information and individual privacy. Consequently, implementing a smart card system allows parking operators to assure motorists that effective security measures are used to protect their personal information.

Cash left in parking meters between collection cycles can be an enticing opportunity for vandals and thieves. Smart card-enabled parking meters reduce the amount of cash present in meters, thus reducing the potential and incentive for vandalism. However, it should be noted that without adequate security and controls, the reduction in physical vandalism can be offset by an increased potential for other types of fraudulent activities, such as the use of counterfeit cards, issues with reconciliation of tendered revenues with the cash receipts from the sale of cards, and theft of cards.

5.5 Expanded Strategic Marketing Opportunities

Smart cards can capture critical operational data. Captured operational data can then be analyzed to enable strategic marketing schemes such as increased price points, loyalty reward programs, payroll deductions, corporate billing, customer relationship management, and usage forecasting applications. The promise of mining such data has long been discussed; however, the majority of smart card programs have yet to reach sufficient maturity and the necessary standards have been lacking for this promise to be fulfilled. That said, a new era in the market place is coming where payment card issuers and transit collectives are embracing common technology, while interoperability standards are nearing completion. In addition, large-scale infrastructure deployments are being completed with major card roll-outs approaching. The new systems are offering a variety of “opt-in” web-based facilities that will create the mechanisms for commercial agreements surrounding shared data and applications. Discussions are taking place between transit agencies, financial institutions, online ticketing firms, parking operators, and venue managers, just to name a few.

For those municipalities deploying multi-space on-street metering programs, smart cards make a significant new revenue opportunity available. The municipality can offer load services using the meter infrastructure. For example, transit agencies are constantly looking for ways to provide convenient reload capability for bus riders. Current strategies include placing specially equipped terminals in selected retail locations. By providing a contactless transceiver on a parking meter, the meter could accept currency and credit and debit cards in payment and facilitate the sale of stored value or pass products on behalf of the transit agency. By doing so, a municipality may be eligible for the commission typically paid to a retail merchant. As smart card programs increasingly support multiple applications, the opportunity to use the meters to sell a diverse range of digital products is possible.

Smart cards allow parking lot vendors to offer consumer loyalty benefits and subsidized parking programs in partnership with local merchants. In addition, discounts can be offered to selected consumer classes like students, senior citizens, or clergy. Zoning and preferential parking rates can be offered to residents.

In places like Hong Kong and Korea, co-branded cards are being issued, smart objects (e.g., watches) are being sold and non-transit applications are being supported on cards issued primarily for transit payment. Examples include retail payment, recreational facilities access, parking payment, and security access control. The forecasted promise appears to be arriving.

5.6 Simplified Tax Benefits Administration

In 2005, employers can provide employees with a tax-free or pre-tax transit benefit of up to $105 per month and a parking benefit of up to $200 per month. A smart card payment system can

reduce or eliminate the need for employers to purchase and distribute paper transit/parking benefit checks to employees. In addition, a parking operator can easily accept and process smart card transactions. The paperless smart card-enabled payment system allows employers to simply update a cardholder database and perform an electronic funds transfer. The system can then electronically distribute the benefit to the smart card at the next point of use (train station, bus, or parking lot).

Similarly, employers can provide their employees with prepaid smart cards to use for local business travel. Both employees and employers can then receive a single monthly statement for all parking payments, eliminating the need to store or acquire individual receipts. This valuable service may encourage motorists to use the operator's facilities over others.

5.7 Compliance with Laws/Statutes

Many municipalities collect taxes on the parking revenues generated by private operators. But the cash-only systems common in private lots do not generate an effective audit trail, putting the operator at risk of being accused of tax evasion. To deal with this problem, in July 2001, the City and County of San Francisco implemented the Parking Revenue Control Ordinance. This ordinance has levied new, electronic automation requirements for parking operations on parking owners and operators in San Francisco. The ordinance requires parking operators to provide a receipt for parking, signage with contact information (in the event of problems), and assistance with mediating disputes. State-of-the-art revenue control parking equipment ensures that reporting is accurate and correct rates are charged. By implementing a smart card system, a parking operator can eliminate the need to purchase and maintain parking machines, using only a handheld computer to collect parking fees from motorists securely.

5.8 Challenges

While there are benefits to using smart cards, there are also challenges and obstacles. One of the biggest challenges is that smart card systems are not viable unless a significant portion of the target market has and uses smart cards. This creates a chicken-or-egg dilemma. Motorists are not likely to carry smart cards if the cards do not provide sufficient value. Merchants, including parking operators, do not wish to invest in a smart card system unless large numbers of people can use it.

While there is no easy solution to this problem, experience with established projects clearly demonstrates that one of the key factors to success is a good card distribution network. The more places a motorist can obtain and load (reload) a smart card, the better the chance that the motorist will get the card.

Similarly, many parking authorities that have attempted to launch smart cards have struggled with the costs of acquiring cards and establishing effective distribution and customer support operations. With a small card base and low transaction volumes, these costs can simply render smart card programs uneconomic.

While this is a dilemma, it represents a business challenge, not a technical one. The challenge can therefore be addressed by implementing an effective marketing strategy, building alliances, and planning operations carefully.

The magnitude of transit operations in major metropolitan areas is driving solutions to operational challenges. Transit agencies sharing geographies and connected services are establishing jointly leveraged regional service operations. Regional agreements have been executed by 17 agencies in the Washington/Baltimore corridor and 27 agencies in the San Francisco Bay Area, with similar structures forming in San Diego, Los Angeles, New York/New Jersey and other major metropolitan areas. Under these agreements, agencies are awarding collective customer service contracts where a single contractor or consortium of service providers takes responsibility for all aspects of card program operations and support. Under such regimes, millions of cards will enter key geographic markets and business support capabilities will be established that will facilitate the inclusion of new program participants such as municipal parking authorities and private

parking management companies. These operating regimes are either operational (Washington DC), in the start-up phase (San Francisco) or in the procurement stage (Los Angeles). As many as 10 such regimes are expected to be in full operation within the next 18 to 36 months.

Another challenge to success is interoperability. While there are standards for communicating between a smart card and a reader, they are not comprehensive enough to ensure interoperability between different manufacturers. As a result, each smart card parking application is in essence a custom installation, driving up the cost to the parking operator. To ensure interoperability, the parking industry must develop a smart card data architecture and processing standards like the standards being developed by the public transit industry.

One of the strengths of smart cards is their ability to process complex data encryption schemes. However, cryptography schemes, such as public key infrastructure, require a significant effort to plan and develop, resulting in system complexity and additional cost.

One final challenge is that smart card systems are expensive to implement and operate. The cost of the cards can vary greatly, depending on what features are integrated into them (i.e., contact chip, contactless chip, dual-interface chip). However, these costs will decrease as more organizations begin to deploy smart cards. The U.S. Government's plan to purchase millions of cards over the next few years for Federal ID badges should also help drive down costs.

One of the ways parking smart card programs can reduce operating costs is to take advantage of recent trends toward technology and standards that are common to those being promulgated by the transit and financial communities. This will open greater opportunities for sharing application space on smart cards issued by others, thus increasing the potential for greater use of the card for payments, and by extension reducing unit transaction costs.

However, while transit and parking seem to overlap in their customer base and thus would appear to be good candidates for multi-use smart cards, any such initiatives must take into account that the parking market and the transit market significantly differ in their operating environments.

Transit agencies generally apply consistent technology across the different modes of transportation (i.e., bus, subway, commuter rail) and operate in a relatively stable business environment. However, many parking operators deliver services under management contracts that are often of limited duration and change hands frequently. Many parking operators manage parking contracts by providing the equipment (capital funding) and systems and structuring the return accordingly. As a result, one parking service provider may have dozens of facilities in one city, each with systems of varying age, different origins and different technologies. This type of a fragmented business environment requires a very high return on investment that may be difficult to achieve with smart card technologies.

These differences in business environments had resulted in two markets with little incentive to share standards, invest in interoperable payment methods, or set up a payment service link to a shared back office.

This situation has begun to change. The advent of increased Federal subsidies for transit and parking benefits programs has heightened the need for the two business groups to find a common payment mechanism for transit riders who park their cars and take public transportation. Various payment schemes are being considered that enable parking and transit partners to charge less for parking when someone parks and rides. Smart card technology and some clever programming have enabled this application, as illustrated by the system in Washington, DC.

Notwithstanding these initiatives, any expansion of collaborative efforts between the parking and transit markets will need to address the volatile business environment under which many parking management companies operate. This will require the joint efforts of parking and transit industry leaders to convince stakeholders, such as owners of large parking installations, that smart card-based payment systems are good for them and their customers.

6 Implementations Using Smart Cards in Transportation

This section describes selected implementations using smart cards for transportation fee collection. Only systems that are in operation and beyond the pilot or other test stages are included. Implementation profiles include:

- WMATA SmarTrip, Washington, DC
- PATCO contactless smart card system, Philadelphia, PA
- Metropolitan Atlanta Rapid Transit Authority (MARTA), contactless smart card system, Atlanta, GA
- Octopus card, Hong Kong
- Park-and-ride smart card implementations in Lyon, Rennes and Toulouse, France
- ORANGES smart card pilot, Florida
- EasyPark parking application, Israel

6.1 Transit and Parking Applications in Washington, DC

The major public transit operator in the Washington, DC, marketplace is the Washington Metropolitan Area Transit Authority (WMATA), which is an interstate compact agency. WMATA operates the local subway system (Metrorail, with 86 stations, 106 miles) and a regional bus system (Metrobus, with 1,450 buses) with ridership of approximately 1.3 million trips per day. WMATA is also the largest parking operator in the region, with 55,280 parking spaces at 35 subway stations, including both surface lots and parking garages. Throughout most of WMATA's operating history, parking operations have been handled through third parties. WMATA has been using SmarTrip for the subway and for parking since May 1999.

The subway and bus contactless smart card fare collection systems are tightly controlled and provide both revenue and a wealth of information about passengers. In contrast, the WMATA parking facilities were viewed as losing large amounts annually; cash was the primary way customers paid for parking. As a result, in early 2004 the WMATA Board of Directors decided to take over the parking operation and institute cashless parking at all WMATA lots, effective June 27, 2004. This gave WMATA staff about 120 days to replace the parking lot attendants and the existing payment infrastructure.

6.1.1 SmarTrip Dispenser Introduced

To handle the problem of card availability and distribution, WMATA contracted with Lexis Systems (now Cubic Parking Systems, a new business unit for Cubic Transportation Systems) to purchase 55 card dispensers to be placed in each Metrorail station that had parking facilities. Several stations with large parking facilities received multiple devices to assure sufficient sales capacity. The dispensers are equipped with bill validators and accept $1, $5, $10, and $20 bills. They do not escrow bills, give change, or issue receipts. The devices accept Visa, MasterCard, Discover, and American Express credit cards with zip code verification. They also accept debit cards and require authentication with the cardholder's personal identification number (PIN).

Figure 7. Smart Card Dispensers

Patrons who park in a WMATA lot are required to use a SmarTrip card to exit the parking facility. Fees are collected until midnight or until the facility closes. The card is preloaded with $5 of value and sold for $10 in Metrorail stations with parking lots. Cards can also be purchased from three dispensers at the Metrorail sales office at the Metro Center station.

6.1.2 No-Cash Policy

The Metrobus system became fully SmarTrip capable in August 2004. By June 2004, WMATA had issued in excess of 500,000 smart cards. Card issuance was handled primarily by three transit store sites, the Internet, tables in stations, and a bank lockbox.

The card base increased by 700,000 to 1.2 million during the last year. Cards sold using the card dispensers accounted for 80% of the increased sales; store sales dropped to 15% of total sales. Station dispensers sold as many cards in a single year as were sold in the previous 5 years.

6.1.3 Reserved Parking

The WMATA parking contractor was also operating a monthly reserved parking program for about 5,000 daily users. Each reserved parking patron received a mirror hanger and a monthly payment sticker to display when the patron parked at an assigned reserve space at the designated facility. Patrons paid $90 per month and exited without additional payment. This approach represented potentially missed revenue.

Under the new system, customers pay a monthly premium of $45 for reserved parking but must also pay a daily fee when they exit the lot. The reserved parking patron is guaranteed a spot until 10 AM, at which time any unused reserved spaces are opened to the general public. Parking is free on weekends and Federal holidays.

To accommodate the contractor's reserved parking program, WMATA used their existing web site to host patron enrollment and support internal lot administration. Between the 10th and 15th of the month, a reserve parking permit subscriber's credit card is charged and a sticker is mailed out for the hang tag. There are approximately 5,000 such subscribers, representing about 10% of the spaces available. Approximately 500 people pay by check. WMATA is considering discontinuing check acceptance.

Figure 8 illustrates how the reserve permit system works.

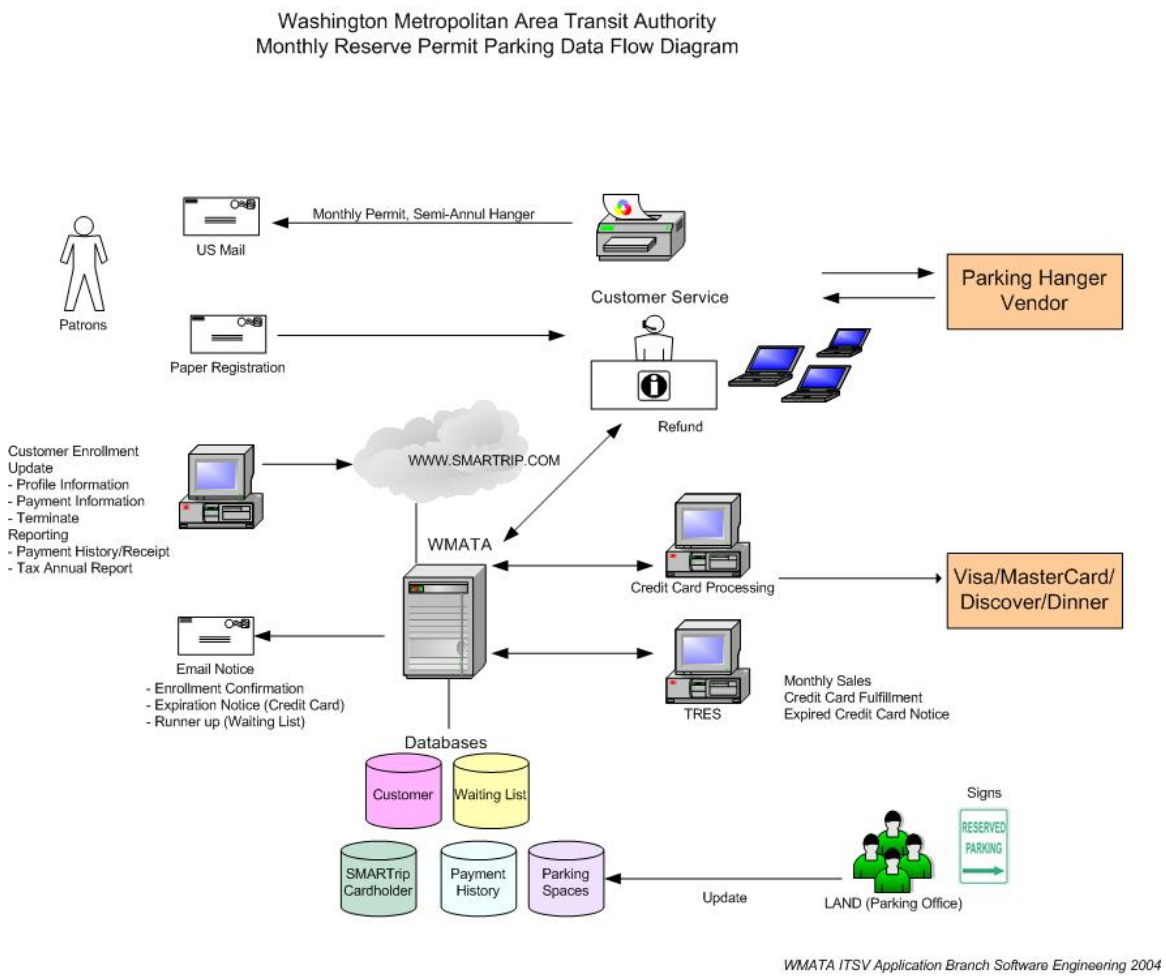


Figure 8. WMATA Reserve Permit Data Flow

6.1.4 One-Time Visitors

While many lots are at or near capacity daily (90% system wide), spaces remain available. Utilization rates remain fairly consistent through the year, with tourists filling in for local residents who are on vacation. About 50% of the current patrons who buy a SmarTrip card through the dispenser use it only once. Many presumably find the park-and-ride fee of $10 reasonable for the Washington, DC, area.

Since WMATA continues to pay over $3 per card for card stock and the card must be handled prior to sale, WMATA is anticipating the introduction of limited-use paper-based contactless cards. One-time visitors often react very negatively to paying $5 just to obtain a zero value card, although this reluctance can often be overcome when the visitor receives an explanation of how to use the card. WMATA is in the process of evaluating limited use (previously called disposable) smart cards to reduce the cost for one-time visitors.

The system experiences 400–500 non-payer transactions per day (1%), where the patron does not have a card when arriving at the exit gate. Each non-payer receives a form and payment can be made to a bank lockbox.

6.1.5 Conclusions

WMATA was in a unique position to move to cashless parking as a result of its substantial investment in contactless smart card technology. Nevertheless, adoption of cashless parking

constituted a significant risk to the SmarTrip card program. WMATA's move to cashless parking has been a success: shrinkage in cash collections is no longer a factor. SmarTrip card distribution through dispensers has resulted in dramatic growth in card ownership and use. Web site applications allow staff and users to manage parking program spaces more efficiently.

Table 3 summarizes the situation before and after WMATA implemented this system.

Table 3. Comparison of Parking Payment Before and After Smart Card Implementation.

Early 2004 System (Cash and Smart Cards)	Late 2004 System (Smart Cards Only)
• Fees collected in cash on exit by the contractor at parking kiosks • Kiosks open weekdays from 2–10 PM • Reserved parking spaces paid monthly in advance; $90 for a hang tag and monthly sticker; space reserved until 10 AM weekdays • No exit fee collected from reserved parkers • More than 95% of all patrons registered their cards to insure replacement if lost or stolen	• SmarTrip required for payment at all Metro parking facilities • Parking fees collected from 9 AM to closing each business day • Card dispensing machines in all stations with parking and at Metro Center station • Contract employees assist customers and monitor transaction process at SmarTrip readers (but do not handle cash) • Reserved parking fee reduced to $45/month, but now exit fee must be paid (daily $3.50 to $4.00 fee upon exit) • Registration dropped to 55% of card base
Cashier Lane  Express SmarTrip Lane	 Contract employees assist customers and monitor transaction process. 

6.2 Port Authority Transit Corporation (PATCO)

The Port Authority Transit Corporation (PATCO), operating in Pennsylvania and New Jersey, is in the process of implementing a contactless payment system for both their transit and parking operations. The parking operations will use Cubic's X3SC smart card entry terminal in conjunction with standard vehicle loop detectors and gate controllers. Implementation is scheduled for completion in mid-2006, and will see 31 X3SC units deployed over six station lots. The resulting parking operations will be cashless and fully integrated as a sub-system of the overall transit infrastructure.

PATCO has chosen to implement a flat fee, pay-on-entry format where the patron presents their card to the entry controller, which deducts the fee, and opens the gate to allow access to the parking facility. Egress from the lot is controlled by an automated exit gate system.

By using contactless smart card technology, transaction times, and ultimately queues are reduced to a minimum. The contactless smart card transaction is significantly faster than a cash or credit card payment at a terminal. The typical transaction time for cash/credit payment is approximately 10-15 seconds, and may be up to a 30 seconds for credit verification on some systems. In the contactless smart card scenario, the customer's card is acknowledged, payment is deducted, the event is written back to the card for future tracking purposes, and finally the gate is activated, all in less than 1 second.

The system operates in a real-time environment, transmitting sales and other data to the back office system as it is generated. A database, common to PATCO's transit operations, ensures seamless smart card account maintenance, data analysis, and reporting.

6.3 Metropolitan Atlanta Rapid Transit Authority (MARTA)

Similar to the PATCO system, MARTA has elected to introduce Cubic entry/exit parking technology into its 10 park and ride facilities. The primary difference between the PATCO solution and the one that will be installed for MARTA is the introduction of a limited use contactless smart card that will be issued to patrons not already possessing a permanent card. Patrons who have a permanent "Breeze" card need only present the card to the reader. The card is then encoded with entry data for use upon exit. At exit, the entry data is read, the fee calculated, and the amount debited from the stored value. If the patron has insufficient stored value, the card value can be replenished in the station at the ticket vending machine which takes on the dual role of pay-on-foot functionality. For those patrons not possessing a "Breeze" card, a button is pushed and the entry terminal issues and encodes a limited use smart card. The limited use smart card is the thickness of a typical magnetic stripe ticket but contains a thin 256-byte chip and internal antenna. Once issued, the patron may take the card to the ticket vending machine and add value to the card. The card may then be used for rail, bus, and parking applications until the stored value is exhausted.

A parking application server provides all lot management functionality and an integrated cashier's station doubles as a smart card customer service terminal and central cashier's station with smart card load functionality. The parking application server interfaces with the Cubic Nextfare regional processing system and provides full integration of the parking smart card sub-system with the overall regional network.

6.4 Parking and Transit Applications in Hong Kong

The phenomenal success of Hong Kong's Octopus program is well documented. Approximately 6.9 million citizens reside on the island, and they collectively have about 12 million Octopus contactless smart cards. The Octopus card can be used for transit, at photo booths, on all regional transit systems (with different agencies/owners), and at 7-Eleven stores.

Now parking has been added. Close to 200 car parks (parking lots) accept Octopus cards for payment of parking fees. The legacy magnetic-ticket-based system is retained, and the smart card system is applied as an electronic purse (e-purse) application. The following example describes the operation of Octopark in Wilson Parking.

1. On entry, the customer obtains a ticket and a barrier rises automatically. The ticket is a magnetic ticket retained by the customer.
2. On exit, the customer drives to the exit gate, inserts the magnetic ticket in the gate, and pays by presenting the Octopus card. There is no need to go to the cashier's office to get a ticket validated for exit.
3. To obtain a receipt, the customer presses a button at the exit gate.

Plans call for expansion of this approach to other car parks in the Hong Kong region.

6.4.1 Implementation

More than 180 car parks accept the Octopus card for park-and-ride, including about 800 parking spaces at Mass Transit Railway (MTR) sites. The parking fees and any discounts are determined by the car park operators. A total of 700 park-and-ride users enjoy the "park and greet" and "park and fly" MTR Airport Express Line daily. Customers without the Octopus card are charged higher fees for parking (about HK$20 per hour). Fees are discounted at two sites, the MTR Airport Express and KCR West Rail.

MTR has integrated Octopus with MTR Property, Wilson Parking, Adams Parking, Kwik, Edward Keller, Urban Parking, Amano, and ACSL. Suppliers generally include Skidata, Edward Keller, MTR Property, and Amano, usually with a mix of hardware and software from overseas and local suppliers.

Transaction records are sent from the car parks to Octopus daily. The Octopus back-end system processes the transactions, generates reports, and sends out the reports the next day. The car park operators reconcile these reports with their own records and can request an investigation if there are discrepancies. The car park operators receive their parking revenue before 4 PM the same day.[32]

6.4.2 On-Street Parking[33]

As of November 21, 2004, all metered parking spaces in Hong Kong (over 17,700 in 18 districts) are equipped with Octopus parking meters.

Octopus parking meters use touch-screen technology to permit customers to select a parking space and an amount of time. The customer then presents the Octopus card to the card reader to pay for parking.

The current system is being managed by Hong Kong Parking, under contract. Single-space parking meters that accept the Octopus card are supplied by Focus International of Melbourne, Australia. A total of 9 million e-park contact-type cards had been used in the system from 1998-2004 that preceded the current Octopus system.

6.2 Parking and Transit Operations in France

Ascom has implemented a park-and-ride system in Lyon (France), with Rennes and Toulouse also planning to install the same system (commissioning in 2006 and 2007, respectively). In each of these 3 systems, parking is free provided that the smart card holder uses some form of public transit. As a result, parking is only used by public transit riders. When entering the parking lot, patrons do not have to validate their smart card; however, they do validate the card on exit. If

[32] Additional information is available at http://www.mtr.com.hk/eng/train/parkandride.htm
[33] *Source*: Hong Kong Transport Department web site, http://www.td.gov.hk/

patrons did not use public transit, they must pay a fine. The parking lots belong to the transport network and are not equipped with a parking fare payment system.

The Calypso technology is used on all of these transport networks, with Ascom developing and selling terminals that can process Calypso smart cards. All new systems installed in France must be compatible with the Calypso technology since it guarantees compatibility between the transport operators and the national railways (SNCF).

Lyon's park-and-ride system includes 11 parking lots (with 9 new lots planned) and is used by 2,450 patrons per day. The Rennes implementation will include a contactless smart card ticketing system for buses and integration with the existing metro system. The Toulouse implementation will include a ticketing system for the metro, railway and bus lines and parking lots, with 1.4 million smart cards and tickets expected to be issued.

All new medium- to large-size projects (cities above 300,000 inhabitants, such as Lille and Marseilles) are planning to include park-and-ride schemes.

6.6 Parking, Transit, and Toll Operations in Orlando, FL

The City of Orlando Parking Bureau, the Orlando Orange County Expressway Authority (OOCEA), and the Central Florida Regional Transportation Authority (LYNX) conducted a field operational test (FOT) of a regional electronic payment system from July 2003 to August 2004. The Orlando Regional Alliance for Next Generation Electronic Payment System (ORANGES) FOT consisted of a single regional clearinghouse that processed smart card and smart card transponder-based transactions. A touch-and-go smart card application was implemented at three parking garages in downtown Orlando, at the busiest toll plaza (the Holland East toll plaza) at the Orlando-Orange County Expressway Authority, and on two LYNX bus routes. Approximately 1,200 ORANGES smart cards were distributed to FOT participants.

The ORANGES card was a GemCombi MPCos Pro contact and contactless card. A shared electronic purse (e-purse) application on the card was used to deduct payment for touch-and-go parking, tolls, and single transit fares. The parking application was used to pay only for hours-based transactions, not weekly or monthly applications. The card also supported payment of transit fares using weekly and monthly transit passes and account-based electronic toll collection express payments via a smart card transponder. All transactions for parking, transit, and toll payments were contactless. The contact interface was used to add value to the e-purse at a point-of-sale (POS) terminal.

To park, an ORANGES customer entering a garage touched the card to a McGann reader at the gated entry lane (which also accepted proximity cards for monthly parkers), which then recorded the time of entry. To exit, the driver would touch the card to the reader at the gated exit lane, which recorded the elapsed time from entry to exit. The elapsed time was multiplied by the parking rate and the corresponding dollar amount was deducted from the e-purse. (Business rules were put in place to account for minimum and maximum parking charges.) The garage reader displayed e-purse balances to ORANGES customers upon entry and exit. The gate would not lift if there was insufficient balance on the smart card upon entry or exit. ORANGES customers could add value to their smart card upon entry or exit from the garage in the entry or exit lanes, or at point-of-sale locations provided by any of the three agencies.

Parking garage attendants used a VeriFone 3350 POS terminal to add value to ORANGES customers' smart cards in the garage lane. Cash payment was accepted in the lane (at parking

garages and toll lanes) and credit card payment was accepted at customer service locations to add value to ORANGES smart cards.

A parking garage customer who used the toll road (State Route 408, East-West Expressway in the FOT) to get into Orlando could add value in the lane at the toll plaza and then use the e-purse balance to pay for parking transactions at any of the three downtown Orlando parking garages or on a LYNX bus. The clearinghouse reconciled and settled funds between agencies to ensure appropriate payment for services rendered by each agency.

All ORANGES customers were registered customers. This registration provided balance protection for customers and enabled customer feedback with respect to the FOT. A dedicated customer service desk with one phone number for all ORANGES customers was used. Inquiries were assigned a tracking number, and then passed to the specific agency (parking, tolls, or transit) for resolution. The customer was then contacted with a resolution to the inquiry through the ORANGES customer service desk.

Most customers who engaged in multi-modal payment used their smart card for payment of parking and tolls. Cardholder focus groups conducted before and after the test by an evaluation consultant also revealed the following:

- The comfort level experienced by cardholders using smart card technology rose from 7.6 to 9.4 (on a 10-point scale) during the FOT.
- There was universal agreement among cardholders that the card improved the transportation experience.
- Cardholders indicated that they would use agency services more than before if the program were expanded.
- Cardholders wanted to see smart card applications for travel available nationwide.

The participating agencies agreed in advance of the FOT to limit field operations to a 12-month period and then engage in an evaluation of the results. A change in executive-level management at two of the three agencies toward the end of the FOT undoubtedly has added a new dimension to the post-FOT evaluation and deliberation process.

Figure 9. A City of Orlando Parking Garage (left) and ORANGES Smart Card Reader

6.7 Parking Operations in Israel

Israel has implemented a nationwide parking application called EasyPark that uses one card to pay for parking anywhere in the country. Previously, on-street parking in Israel was paid for using a municipal punch card that was available for purchase in local kiosks. EasyPark was an ideal solution for this environment. Drivers simply activate a contactless in-vehicle parking device (card) when they park and display it in the card window (see Figure 10). When they return to the

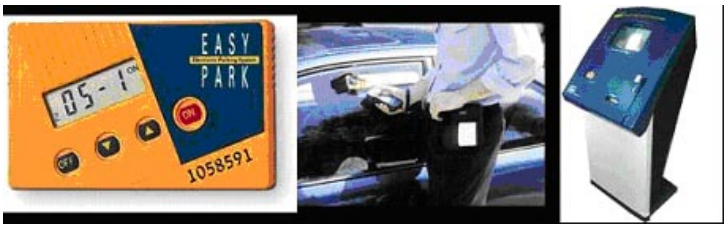
car, they turn off the device. Drivers are no longer required to obtain individual parking punch cards for every city, and they pay only for the exact amount of time parked, whether it is an hour or only 10 minutes. The card includes a built-in screen that displays payments and remaining balances.

The EasyPark card is sold in post offices; value reload stations are available in post offices and gas stations. The system is currently fully operational, with 250,000 subscribers using it in 30 different parking zones across the county. (Parking zones can be different areas of a city in which it costs different amounts to park, or time periods, which can be classified as subzones, or even entire cities.) The EasyPark application can manage up to 60,000 parking zones. A total of 30 zones have been assigned to date.

In addition, residents use a residential parking permit to park in their neighborhoods. This permit is renewed annually and is automatically updated once the annual fee is received by the parking authority participating in each city/zone.

Municipal and private parking lots can participate if they choose. EasyPark's parent company, OTI, compensates the 30 parking authorities according to usage. OTI EasyPark manages the system for the parking authorities for a negotiated transaction fee. OTI implemented a business model of generating revenues from product sales as well as transaction fees and customer support. This business model shares the risk and success of the project between municipal parking authorities and vendors, reducing the risk for both entities.

Figure 10. Easy Park System Components



EasyPark card (left), a hand-held terminal (center), and a loading station.

6.7.1 System Characteristics

The EasyPark card and the residential parking permit use ISO/IEC 14443-compliant smart card chips. The parking authority needs to acquire only the enforcement reader/printer and loading stations; no other on-street devices are required.

The value loading stations are kiosks or POS-type devices deployed in retail locations, gas stations, or postal facilities. They are clearly identified as loading stations and placed strategically throughout each zone. Each parking authority decides on the number and location of the stations. Reloading is accomplished using credit/debit cards. The stations can be outfitted with bill acceptors at the discretion of the parking authority.

Over-the-counter attended POS devices could also be used as loading stations. In Israel, however, a totally unattended, cashless system is being used, further reducing cost to the parking authorities.

6.7.2 Customer Benefits

EasyPark provides customers with the following benefits:

- The customer pays only for exact time used.
- The device is simple to operate.
- There is no need to leave the vehicle to pay for parking or search for coins for a meter.
- The system provides a receipt and proof of payment/parking.

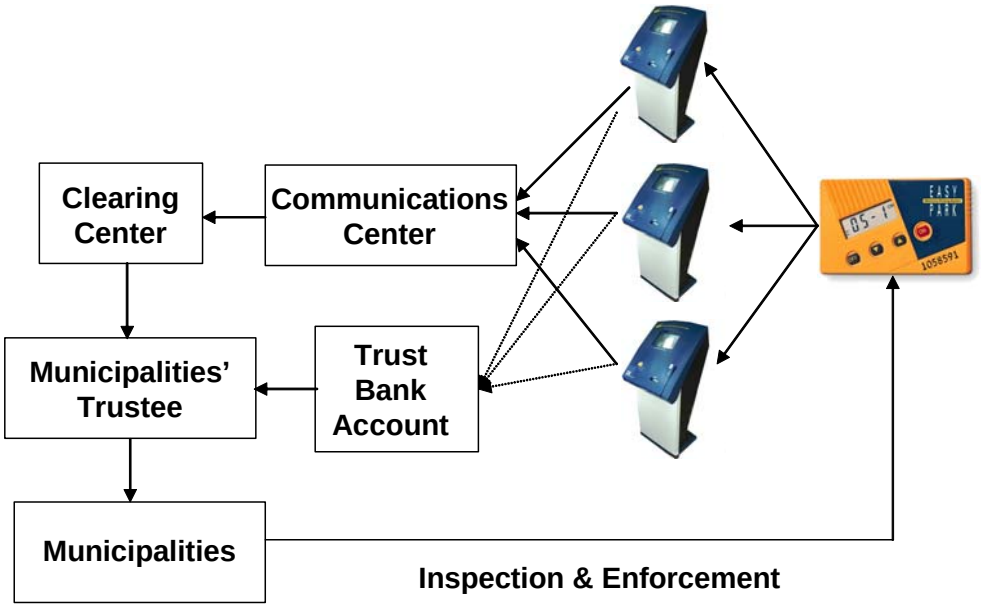
- The system can be reloaded in convenient retail locations and gas stations using cash or credit or debit cards.

6.7.3 Municipality Benefits

EasyPark provides the municipality with the following benefits:

- The system provides higher income, which is distributed proportionally among parking authorities for actual usage in each city/zone.
- Minimal initial investment is required.
- EasyPark operates in parallel with other systems.
- The prepayment principle provides float.
- The system is tamper-proof, reducing losses from meter break-ins.
- The system is eco-friendly—there are no pay-and-display tickets or unsightly meters.
- Using EasyPark creates a positive, progressive image for the municipality.
- A parking monitor can check a larger number of vehicles per shift.

Figure 11. Easy Park System Diagram



7 Conclusions

A variety of forces is leading to the increased use of innovative electronic payment strategies in the transportation sector. Smart card technology provides a wide range of operational and customer benefits for transportation payment applications. Business services and system solutions can now address the challenges previously faced by parking professionals attempting to use smart card technology.

The parking industry, like mass transit several years ago, is entering a new phase in the payments infrastructure life cycle and is in the position to benefit both from what transit has accomplished in electronic payments and from other developments in the financial payment card industry. However, to ensure that the specific needs of the parking industry are incorporated into the design of smart card payment systems, parking customers, operators and suppliers must become actively involved in the development of standards and commercial structures aimed at facilitating regional, and ultimately, national transportation payment networks. Without such participation, parking owners and managers face the risk of having such standards imposed on them without their involvement in the development.

The goal of this paper has been to provide the parking industry with an overview of the technology and trends in the smart card marketplace and to provide the transit industry with an overview of the parking industry market and use of smart cards. The white paper was not developed to provide detailed implementation guidance for parking smart cards programs. However, by participating in industry groups like the Smart Card Alliance Transportation Council, parking facility owners and managers can be exposed to industry developments and establish the relationships needed to benefit from them. These will form the critical knowledge foundation required for the successful design, implementation and operation of parking smart card programs.

The Smart Card Alliance urges parking industry participants to join the transportation industry electronic payment collaboration and standardization initiatives and take advantage of the substantial benefits being reaped by counterpart transportation market sectors.

For more information about smart cards and the role that they play in payment and other applications, please visit the Smart Card Alliance web site at *http://www.smartcardalliance.org* or contact the Smart Card Alliance directly at 1-800-556-6828.

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About the Smart Card Alliance Transportation Council

The Transportation Council is one of several Smart Card Alliance Technology and Industry Councils, a new type of focused group within the overall structure of the Alliance. These councils have been created to foster increased industry collaboration within a specified industry or market segment and produce tangible results, speeding smart card adoption and industry growth.

The Transportation Council is focused on promoting the adoption of interoperable contactless smart card payment systems for transit and other transportation services. Formed in association with the American Public Transportation Association (APTA), the Council is engaged in projects that support applications of smart card use. The overall goal of the Transportation Council is to help accelerate the deployment of standards-based smart card payment programs within the transportation industry.

The Transportation Council includes participants from across the smart card and transportation industry and is managed by a steering committee that includes a broad spectrum of industry leaders. Current Steering Committee members include: APTA, the Bay Area Rapid Transit District (BART), Booz Allen Hamilton, Cubic, ERG Group, IBM, Infineon Technologies, MasterCard International, Northrop Grumman Corporation, the Port Authority of New York and New Jersey (PANYNJ), TriMet, U.S. Department of Transportation/Volpe Center, and WMATA.

Transportation Council participation is open to any Smart Card Alliance member who wishes to contribute to the Council projects. Additional information about the Transportation Council can be found at http://www.smartcardalliance.org/about_alliance/councils_tc.cfm.

Trademark Notice

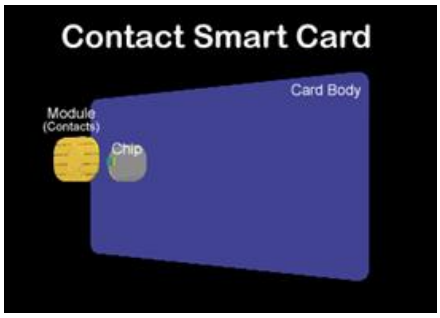
10 Appendix: Smart Card Technology and Standards

A smart card is a device that includes an embedded integrated circuit chip (ICC). The chip can be either a microcontroller with internal memory or a memory-only chip. The card communicates with a reader, either through a physical connection (a contact smart card) or a remote contactless interface (a contactless smart card). Contactless payment implementations in North America are based on use of RF technology. The ICC transmits stored data when the card is exposed to radio waves transmitted at the correct frequency.

Smart cards are available in a variety of form factors, including plastic cards, fobs, subscriber identification modules (SIMs), and USB-based tokens.

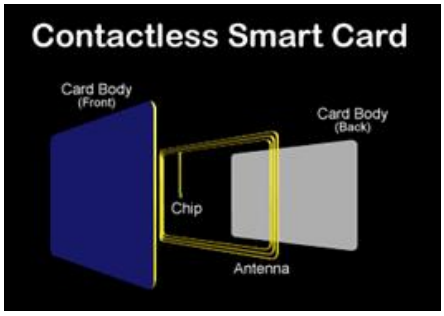
10.1 Smart Card Technology[34]

There are two general categories of smart cards: contact and contactless.



A contact smart card must be inserted into a smart card reader with a direct connection to a conductive micromodule on the surface of the card (typically gold plated). Transmission of commands, data, and card status takes place over these physical contact points.

A contactless card requires only close proximity to a reader. Both the reader and the card have antennae, and the two communicate over this contactless link. Most contactless cards also derive power for the internal chip from this electromagnetic signal. The range is typically two–three inches for non-battery-powered cards, ideal for applications such as mass transit that require a very fast card interface.



Two additional categories of cards are dual-interface cards and hybrid cards. A hybrid card has two chips, each with a contact or contactless interface. The two chips are not connected. The dual-interface card has a single chip with both contact and contactless interfaces. With dual-interface cards, it is possible to access the same chip using either a contact or contactless interface with a very high level of security. The mass transportation and financial industries are expected to be the first to take advantage of this technology.

The chips used in all of these cards fall into two categories as well: microcontroller chips and memory chips. A memory chip is like a small floppy disk with optional security. Memory chips are less expensive than microcontrollers but with a corresponding decrease in data management security. Cards that use memory chips depend on the security of the card reader for processing and are ideal for situations that require low or medium security.

A microcontroller chip can add, delete, and otherwise manipulate information in its memory. A microcontroller is like a miniature computer, with an input/output port, operating system, and hard disk. Smart cards with an embedded microcontroller have the unique ability to store large amounts of data, carry out their own on-card functions (e.g., encryption and digital signatures) and interact intelligently with a smart card reader.

The selection of a particular card technology is driven by a variety of issues, including:

- Application dynamics
- Prevailing market infrastructure

[34] Images provided courtesy of Gemplus.

- Economics of the business model
- Strategy for shared application cards

For example, the financial market in the United Kingdom has adopted a contact smart card and personal identification number (PIN) for all credit cards. This implementation is based on the EMV standard and has caused a large contact POS infrastructure deployment within the country. A dual-interface card would likely be necessary to bridge retail and transportation applications. In the United States, on the other hand, very little contact infrastructure has been deployed. As a result, it appears that the prevailing standards are moving toward the use of contactless technology both for financial and transportation applications. It is important to note, however, that single-space meters do not maintain sufficient power to support contactless transceivers. Therefore, contact cards have typically been used for this application.

10.2 Smart Card Standards

Smart cards have been implemented around the globe in a number of diverse industry segments, to satisfy a number of business needs. As these markets have matured, of necessity both low level and application level smart card standards have been developed. These standards are typically written and supported by either international organizations (such as ISO/IEC and CEN) or business organizations (such as EMVCO and APTA).

10.2.1 Low Level Standards

Two low level standards have been widely adopted, one for contact smart cards and one for contactless smart cards.

The basic contact smart card standard is the ISO/IEC 7816 series, part 1-10. ISO/IEC 7816 is a multi-part international standard that defines many aspects of a contact smart card and its interfaces, including the card's physical dimensions, the electrical interface, the communications protocols, the card file structure, and the application programming interface. The most commonly used parts are 1 through 6. These standards are derived from the financial card standards.

The primary contactless smart card standard being used for transit and financial applications is ISO/IEC 14443. ISO/IEC 14443 is an international standard that defines the interfaces to a contactless smart card, including the RF interface, the electrical interface, and the communications and anti-collision protocols. There are two parts to the standard, A and B, which describe two basic modes of operation for an ISO/IEC 14443-compliant card.

10.2.2 Application Level Standards

Many application level standards have been designed by industry groups and are used in various parts of the world. This section describes some of the more widely used standards.

10.2.2.1 Credit and Debit Card Payments—EMV 2000

The EMV specification provides a standard for credit and debit smart card applications and was developed by Visa and MasterCard. It is the standard for contact smart card payments. It is currently deployed in much of the world but is not used in the United States. The standard is managed by EMVCO.

10.2.2.2 Transit—UTFS

The UTFS specifications are currently under development. The goal is to develop a series of documents that provide industry guidance for achieving the following:

- Creation of an open architecture payment environment
- Integration of independent payment systems

These standards are managed by the American Public Transportation Association (APTA).

10.2.2.3 Government Identity Cards

As a result of Homeland Security Presidential Directive 12 (HSPD-12), issued by President George W. Bush on August 27, 2004, NIST published Federal Information Processing Standard Publication 201 (FIPS 201), *Personal Identity Verification (PIV) of Federal Employees and Contractors*, on February 25, 2005. FIPS 201 provides the specifications for a standard Federal smart ID card, called the PIV card, that must be used for both physical and logical access and can be used for other applications as determined by individual agencies. The PIV card is a smart card with both contact and contactless interfaces. Government agencies are currently moving to implement FIPS 201-compliant systems.

10.2.2.4 Mobile Telephony – GSM SIM

The mobile phone industry has several telecommunication standards, but the predominant one globally is GSM. The GSM standard uses smart cards called Subscriber Identification Modules (SIMs) that are configured with information essential to authenticating a GSM-compliant mobile phone, thus allowing a phone to receive service whenever the phone is within coverage of a suitable network. This standard is managed by the GSM Association.