The Contactless Wave: A Case Study in Transit Payments

Nasreen Quibria[1], Sr. Payments Industry Consultant, Federal Reserve Bank of Boston

---

Highlights

- The contactless smart card – a credit card-sized card with an embedded antenna and computer chip (RFID tag) – is beginning to gain traction at public transit agencies.

- Smart cards may offer transit riders and operators some benefits over non-electronic payment methods: increased convenience, security, and flexibility; as well as reduced cash handling, maintenance, and security costs.

- A number of contactless payment systems are emerging in the transit industry. Is there one business model that will be preferred by consumers?

I.   Introduction

On an individual transaction basis, the value of a purchase may be insignificant, but collectively small value payments represent a big market opportunity in the United States (U.S.). Transactions valued at less than $25, also known as micro- or low-value payments, accounted for $1.32 trillion U.S. consumer spending in 2003,[2] and were estimated to be almost $1.7 trillion of personal consumption expenditure in 2005.[3] The potential revenue opportunity from electronifying low-value payments, coupled with the desire of businesses and consumers to improve transaction speed and convenience, is driving the replacement of cash in some venues with electronic payments, particularly the use of contactless cards.

The most common contactless payment form factor is a plastic 'smart' card, although other types include key fob, wristband, watch or mobile phone. Each type is embedded with a short-range radio frequency identification (RFID) chip that can transmit payment information when the cardholder waves it near a secure reader. Referred to as "tap and go" or "wave and pay" transactions, contactless payments are best suited for use at venues such as quick service restaurants (QSRs), parking garages, convenience

---

[1] The views expressed in this paper are those of the author and do not reflect those of the Federal Reserve Bank of Boston or the Federal Reserve System. Nasreen Quibria may be reached at nasreen.quibria@gmail.com.

[2] The average value transaction amount was $3.72. TowerGroup. "Making Sense of Cents: Trends in the Rebirth of Electronic Micropayments." 16 July 2004.

[3] 2006 Visa estimates. Pinkerd, Stacey. Address. 4th Annual Micro and Small Payments Conference. NYC, 28 November 2006.

stores, and movie theaters, where promoting fast and easy transactions is important, and the average purchase is less than $25.

The U.S. retail and public transit micropayments market represents a huge opportunity for converting payments from cash to electronic methods. QSRs represent the biggest portion of the market at $153 billion annually, followed by the vending industry ($14 billion) and movie theaters ($14 billion),[4] with the public transit market close behind at approximately $10 billion.[5]

Despite its smaller revenue base, the mass transit industry in the U.S. and in many other countries is in the vanguard of pioneering contactless payment systems. Given a captive clientele that must use a public transit agency's preferred payment method to utilize its services, the mass transit industry is better positioned than other industries to drive mass adoption of a new payment system. Across the globe, contactless fare collection systems are being implemented to achieve more efficient public transit operations. These systems, if widely accepted, may influence consumer payment use for everyday retail purchases as well.

This *Emerging Payments Industry Briefing* examines new developments in contactless transit fare payment technology, concentrating on how this methodology may be deployed in the United States. A literature review shows that there is no systematic research on the potential costs and benefits of contactless fare media for the U.S. market, particularly when compared to research on other payment methods (such as cash or traditional credit and debit cards). Discussions with several U.S. mass transit agencies suggest that the business decision to implement a smart card system is often based on perceived operational benefits and cost-savings (such as faster throughput and lower equipment maintenance costs), and advantages over other types of cards (such as magnetic stripe or contact-based smart cards), rather than consumer demand.

The paper begins by outlining the mass transit industry's evolution from cash-based to electronic payment systems, followed by a review of the contactless payment business models observed globally. The briefing then explores the economic considerations of introducing contactless ticketing solutions in the U.S. mass transit industry, focusing on the costs and benefits to transit agencies and other commercial stakeholders, as well as the barriers to and potential benefits of adoption by consumers. The final section concludes with current trends and future directions for implementing contactless transit payment solutions in the U.S.

---

[4] Ibid.

[5] *APTA Transit Ridership Report*, Second Quarter 2006 and *APTA Statistics*. 21 December 2006.

June, 2008   2

II.   The Promise of Contactless Payment Technologies

Historically, mass transit agencies have accepted cash (most often coin) or proprietary tokens to pay for public transportation, such as bus or subway systems. Tokens offered a number of advantages over cash as a means of collecting fares. Tokens increased consumer convenience by alleviating the need for consumers to carry exact change, and allowing them to purchase discounted tickets in advance, and reduced employee theft of cash. Historically, tokens helped shape the predominantly closed urban mass transit systems, where only proprietary tokens could be used to pay for local transportation agency services. During the 1970s the prepaid magnetic stripe card began to replace tokens, and by the 1990s some mass transit agencies were beginning to implement more sophisticated *smart* cards.

Smart cards use embedded microchips to electronically store data.[6] This technology enables payments to be tracked, and also monitors the ticket's validity and use. Smart card technology can be *contact-based* or *contactless*.[7] In a *contact-based* scenario, the consumer inserts his card into the contact reader. The chip embedded in the card makes physical contact with the reader, transmitting data from the chip to the reader and writing information back to the chip. In contrast, a *contactless* smart card uses a short-range radio frequency identification chip (RFID) (also known as Near Field Communication (NFC) technology) to transfer data via radio waves when the consumer places the card within 4 inches or 10 centimeters of the reader. No physical contact is required to collect the fare.
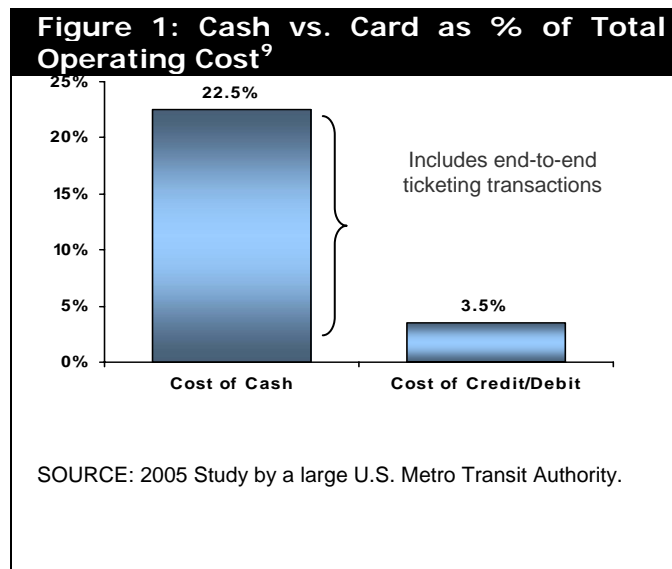
Although the original smart cards were contact-based, today mass transit industry requirements for increased transaction speed, customer convenience, and better managed passenger volume are driving the market towards a predominately contactless medium. In the past decade, since Hong Kong pioneered use of smart cards, more than 100 cities worldwide have introduced them for mass transit fare payments.[8]

---

[6] Smart cards are also referred to as 'chip' cards.

[7] A third type is the combi-card, which combines characteristics of both the contact and contactless cards.

[8] Rueter, Thad. "Closing the Gap: Will Banks and Transit Create a Common Contactless Card?" *Card Technology*. 1 February 2006.

June, 2008

Even though accepting and handling cash payments was recognized as a significant

Figure 1: Cash vs. Card as % of Total Operating Cost[9]

Includes end-to-end ticketing transactions

SOURCE: 2005 Study by a large U.S. Metro Transit Authority.

operating expense, without technology advances to enable implementation of other payment methods, it was not cost-effective for the U.S. mass transit industry to accept alternatives to cash for payment. The overhead processing cost incurred to accept cash is about twice that of debit and credit cards. For one mass transit authority, the cost to run money trains that collect cash and coin, and to pay hundreds of people who manually collect, count, and process the payments, is approximately $2 million per day.[10] Accepting cash slows the transaction process time, and requires a very labor-intensive back-office cash-handling process.[11]

As payment technologies improved, transit operators became more interested in considering alternatives that can reduce the amount of cash received in their fare collection systems. Although accurately quantifying the savings opportunity is difficult given the proprietary nature of certain information, one study conducted in 2005, which examined the costs and benefits of introducing a regional contactless fare card system, showed that moving from cash- to electronic-based collections can result in up to a six-fold reduction in aggregate operating costs (see Figure 1). [12]

Smart cards can be processed more efficiently and potentially reduce complaints and customer service-related costs.[13] Unlike cash, an electronic payment medium that is lost or stolen can be frozen, or "negative listed," to prevent unauthorized use. In the case of Washington, D.C.'s SmarTrip, if a lost or stolen smart card is registered online or at the sales office, it will be replaced at its remaining face value.[14] In contrast, disputed transactions paid by cash are anonymous and more difficult to trace, with a corresponding increase in the cost to investigate and resolve the inquiries. For these reasons, electronic

---

[9] Smart Card Alliance. "Spotlight on Contactless Payment Trends as Smart Card Alliance Annual Conference Opens." 4 October 2006. <http://www.smartcardalliance.org/articles/2006/10/04/spotlight-on-contactless-payment-trends-as-smart-card-alliance-annual-conference-opens>. This study is not necessarily reflective of all U.S. transit authorities.

[10] Garback, Gregory. Cash to Electronic Payments Panel. Consumer Behavior and Payment Choice Second Annual Research Conference. Boston, 25–27 July 2006. <http://www.bos.frb.org/economic/eprg/conferences/payments2006/index.htm>.

[11] Smart Card Alliance. "Transit and Contactless Financial Payments: New Opportunities for Collaboration and Convergence." *A Smart Card Alliance Transportation Council White Paper*. October 2006.

[12] Stone, David. "Micropayments/Open Payment Systems and the UTA Pilot." 2006 Smart Card Alliance Annual Conference. San Diego, 3 October 2006.

[13] Korczak, Paul. Personal Interview. December 2006.

[14] To discourage less-than-honest patrons, there is a $5.00 replacement fee for the card itself. Washington Metropolitan Area Transit Authority. *Schedules and Fares*. December 2006. <http://www.wmata.com/riding/smartrip.cfm>.

June, 2008   4

payment methods using smart card technology are more attractive to mass transit agencies and consumers.

III.   Transit Contactless Payment Business Models

In the past decade, several contactless payment business models emerged in global transportation. To better understand the current developments and challenges these new payment systems pose to the transit industry in general, and to the U.S. transit market in particular, this section examines the major contactless business models in operation today.

There are two primary contactless payment systems: *closed-loop* and *open-loop*. The *closed-loop* system uses a stored-value card that is limited to payment of transportation services. As defined for the transit industry, an *open-loop* system uses a payment method that is also accepted by businesses outside the transit agency that issued the card.

Transit systems utilize two types of payment networks. One is a *transit* network, in which the transit operator independently sets up and operates its own payment system. The second is a *card network*, which in the U.S. includes American Express, Discover,[15] MasterCard, and Visa. Figure 2 depicts a contactless payments matrix that maps four business models and examples for the transit sector. Each is based on a combination of *payment system* and *network*: closed-loop card network, closed-loop transit network, open-loop transit network and open-loop card network.

---

[15] Discover plans to launch its contactless technology in early 2008.

June, 2008

Figure 2: Transportation Contactless Payments Matrix

TYPES OF PAYMENT SYSTEMS

	Closed-Loop	Open-Loop
Transit Network	**TRANSIT BRANDED CARD**	
	Boston's CharlieCard	Hong Kong's Octopus Card
Card Network (e.g., American Express, MasterCard, & Visa)	**TOLL BOOTH OPERATORS**	**ALL STAKEHOLDERS** *Transit Operators, Banks, Card Associations, and Technology Vendors*
	E-ZPass, FAST LANE	London's Oyster Card; NYC, Utah, and Utah Pilots

(Row axis label: TYPES OF NETWORKS)

Closed-Loop Card Network

The oldest and simplest contactless payment scheme uses a closed-loop RFID tag or transponder. This model is designed only for payments made at highway tollbooths using a transponder, and requires funding by a prepaid account linked to a debit or credit card. When a consumer's account balance falls below a specified amount, the transportation system automatically charges his debit or credit card and reloads the account.[16] For example, the Massachusetts Turnpike Authority's (MTA) FAST LANE Program accesses and charges all costs associated with the use of the FAST LANE transponder to the credit card or bank account listed on the consumer's application.[17]

The U.S. consumer first encountered contactless transponder payments in the 1990s on highways in the eastern U.S. Well-known programs include the New York and New Jersey E-ZPass and the MTA's FAST LANE. In these programs, as a vehicle passes through the tollbooth, an antenna reads the small electronic tag attached to the car, and the appropriate fee is deducted from the customer's specified account. Because these electronic toll collection systems are designed predominantly for highway use,

---

[16] Some prepaid accounts like E-ZPass can be established with cash, check, credit, or debit card. This model only considers electronic payments that use the card networks. The account is replenished if the prepaid balance falls below a threshold amount, which varies based on the original payment method and the payment type encouraged. For instance, credit card automatic replenishment occurs when the prepaid amount falls below 25 percent of the established replenishment amount or $10, whichever is greater. (With check or cash payments, the prepaid amount required is approximately 50 percent of the replenishment amount.) E-ZPass. *E-ZPass Information*. June 2007.
<http://www.ezpassnj.com/static/downloads/individual_app.pdf>.

June, 2008

they are typically proprietary and not interoperable.[18] They have limited applicability elsewhere because the tag used by a motorist to pay tolls in one state will not work in most other states, except where states have made arrangements to accept each other's tags, as the FAST LANE and E-ZPass programs have done.[19]

Closed-Loop Transit Network

In this scheme, the transit operator uses its own payment network and card to process fare transactions. This model bypasses traditional card association networks. When the consumer taps the card at the reader on the fare box, the fare is automatically deducted from the card balance. Consumers can add value to the contactless transit cards with cash, credit, or debit cards at fare vending machines, subway station ticket windows, point-of-sale terminals at participating grocery, convenience, or check-cashing stores, and, in some instances, on the Internet. Boston's *CharlieCard*, implemented in January 2007, is an example of a closed-loop transit network. Over two million CharlieCards were distributed in the first year, with plans to distribute an additional 1.5 million cards in 2008, and five million cards over the next three years.[20]

Some international closed-loop card networks have been in operation for a few years, and provide better historic insight into the long-term viability of the closed-loop transit model. The most recognized example is Hong Kong's Octopus card, originally launched in September, 1997 to collect fares for the city's mass transit system. Today, the Octopus card is considered one of the most successful electronic cash systems in the world based on its acceptance rate. Estimates are that 95 percent of Hong Kong residents between the ages of 16 and 65 own an Octopus card, largely because of its convenience.[21]

Open-Loop Transit Network

As technology matured, open-loop schemes became available for use in transit systems. One example is the retail e-purse (stored-value card) open-loop model. The e-purse model enables a consumer to use the card for transportation and purchases at participating retail merchants. This scheme can be added to an already-existing electronic network. In 2000, Octopus Cards Limited obtained a "deposit-taking company authorization" from the Hong Kong Monetary Authority to widen the scope of its transactions[22] and transitioned from a closed-loop system to an open-loop system. As the Octopus

---

[17] <http://www.massturnpike.com/travel/fastlane/index.html>.
[18] FAST LANE transponders are accepted for payment for parking fees at limited locations as well.
   <http://www.masspike.com/travel/fastlane/index.html>.
[19] Massachusetts Turnpike Authority. *FAST LANE FAQs*. June 2007.
   <http://www.massturnpike.com/travel/fastlane/fastlanefaq.html#1>.
[20] Business Wire. "G&D Delivers Next Generation CharlieCard to MBTA." 30 January 2008.
[21] Octopus. *Statistics*. October 2007. <http://www.octopuscards.com/corporate/why/statistics/en/index.jsp>.
[22] Ilett, Dan. "Inside China: Oyster and Octopus – A Tale of Two Cities' Contactless Cards." *Silicon.com*. 28 June 2006.
   <http://www.silicon.com/research/specialreports/china/0,3800011742,39159958,00.htm>.

card gained acceptance by consumers, its reach extended to micropayments (under $25). Consumers can now use the Octopus card to make purchases at convenience stores and fast-food restaurants, and pay at on-street parking meters, car parks, service stations, vending machines and many other point-of-sale venues.

As of October 2007, over 14 million Octopus cards were in circulation. To provide some perspective, that figure is more than double Hong Kong's population of 6.98 million people. Octopus cards are popular with both tourists and residents, which may explain why there are more than twice as many Octopus cards in circulation as there are people living in Hong Kong. Over 10 million transactions are processed through the Octopus card daily, totaling $3.7 billion a year. Over 460 merchants and service providers across Hong Kong accept the Octopus card, and new uses are added regularly.[23] For example, in addition to its payment functions, the Octopus card can be used as an access device to enter participating school, residential, and office buildings.

Open-Loop Card Network

The newest transit payment model is the open-loop card network, which enables customers to use an existing bank-issued contactless credit or debit card (such as MasterCard's PayPass) to pay for transportation. As with other contactless payment methods, the consumer waves the card at the reader, whether it is at the fare box gate or at a retail store. The purchase cost is then automatically deducted from the credit or debit card.

One well-known open-loop transit smart card system, modeled on Hong Kong's Octopus card, is the Oyster travel card, issued by Transport for London (TfL) in 2003. Since its inception, more than 10 million Oyster cards have been issued for 38 million trips per week, representing approximately 80% of all underground and bus payments.[24] A key factor in the success of the Oyster card is that it had full backing by all local and regional transport operators. And similar to the Octopus card in Hong Kong, implementation occurred over a fairly small geographic area.

The original transportation Oyster card was a contact smart card but TfL later converted the card to a contactless form. In September 2007 TfL and Barclays Bank launched a trial that paired standard credit card functionality with Oyster prepaid transit functionality on a new Barclay's credit card called OnePulse. This arrangement allows contactless credit card payments to be made using Visa *payWave* for non-transit purchases and Oyster *Pay as you go* for transportation. The card also includes chip and PIN payment functionality, standard for European credit and debit cards.[25] The Oyster and credit or debit account(s) are maintained separately on the card. If a consumer taps the yellow Oyster pad at a subway

---

[23] Octopus. *Statistics*. October 2007. <http://www.octopuscards.com/corporate/why/statistics/en/index.jsp>.
[24] Kline, Ryan. "NFC in London: Will consumers use it?" *RFID News*. 29 February 2008.
[25] The card is loaded with transit agency software to enable payment on Oyster.

station to buy a ticket, money is deducted from the Oyster account. If, instead, the consumer waves the card in front of a reader to pay for coffee and a newspaper in a retail shop, the amount is deducted directly from the customer's credit or debit account.[26] Provided the trial is successful, the strategic alliance between Barclays (which currently has exclusive rights) and TfL will run for three years.[27]

IV. Implementation Challenges for Contactless Payments in the U.S. Mass Transit Industry

The availability of contactless smart card technology for the U.S. mass transit market is in sync with the industry's need to replace its aging infrastructure, as collection systems originally installed in the late 1970s and early 1980s are reaching the end of their useful life.

Two of the contactless smart card models discussed earlier have emerged as front-runners: the closed-loop (transit network) proprietary system and the open-loop (card network) system. Both models pose potential ramifications for industry governance, business policy and possibly public policy related to consumer usage, within the U.S.

The U.S. mass transit market, which is geographically large and relatively fragmented, faces some unique challenges as it considers how to expand the implementation of contactless smart card technologies. In 1999, Washington, D.C., was the first American city to deploy a system-wide contactless smart card for mass transit. Chicago and San Francisco followed suit in 2002. Although Boston's "T," which opened in September 1897, was the first U.S. subway system, it was not until December, 2006 that the Massachusetts Bay Transit Authority (MBTA) offered a contactless stored-value card to the public.[28] In general, the U.S. lags behind many other countries in implementing electronic payment methods for the mass transit market, and is only in the initial stages of this transition.

One reason for the slow adoption of contactless smart cards in the U.S. mass transit market is because the stakeholders (transit agencies, municipalities, card issuers, and technology vendors) have not been able to agree on a standardized interoperable platform. In addition, the high cost of investment capital, as well as the incongruent positioning among stakeholders, has created significant obstacles. As a result, s*tandardization* and *cost* are the main challenges that the U.S. mass transit industry needs to address in the development and deployment of a common contactless payment solution.

---

[26] Barclays. "Barclaycard and TranSys Sign Agreement to Put Oyster on Credit Cards." 13 December 2006.
<http://www.newsroom.barclays.co.uk/Content/Detail.asp?ReleaseID=892&NewsAreaID=2>.

[27] According to Tfl and Barclays, the trial was completed successfully in May, 2008.

[28] The MBTA introduced reusable and rechargeable fare media, the CharlieCard and the CharlieTicket. The CharlieCard is a plastic stored-value card, which has online account management and reload features. The CharlieTicket is a paper stored-value card, for

June, 2008

Standardization Issues

Standards are vital to the success of contactless ticketing applications for mass transit systems and to encourage broad consumer acceptance across transportation systems. Standards set communication requirements and protocols between the card and reader, and provide a degree of interoperability to support multiple applications, including transit, banking, retail, security, and building access. Standards also enable operators to buy products from competitive vendors that will work at multiple venues. The established technical standard for the U.S. is ISO/IEC 14443.

A major challenge preventing widespread implementation of contactless ticketing in the U.S. is how to coordinate the efforts of transit authorities, municipalities, financial institutions, and technology suppliers to develop interoperable systems. Establishing transit fare pricing and policies can be complex and may require specialized fare collection engines. For example, some U.S. transit agencies price trips according to the distance traveled, while others price per use. Various stakeholders across the U.S. have competing interests and may exert opposing political and financial pressures. Thus, successful standards will require agreements about what platforms to use, and how to reconcile different budgeting, cost allocation, and profit-sharing approaches – factors that, until they are resolved, can hinder all interested parties from successfully moving forward.
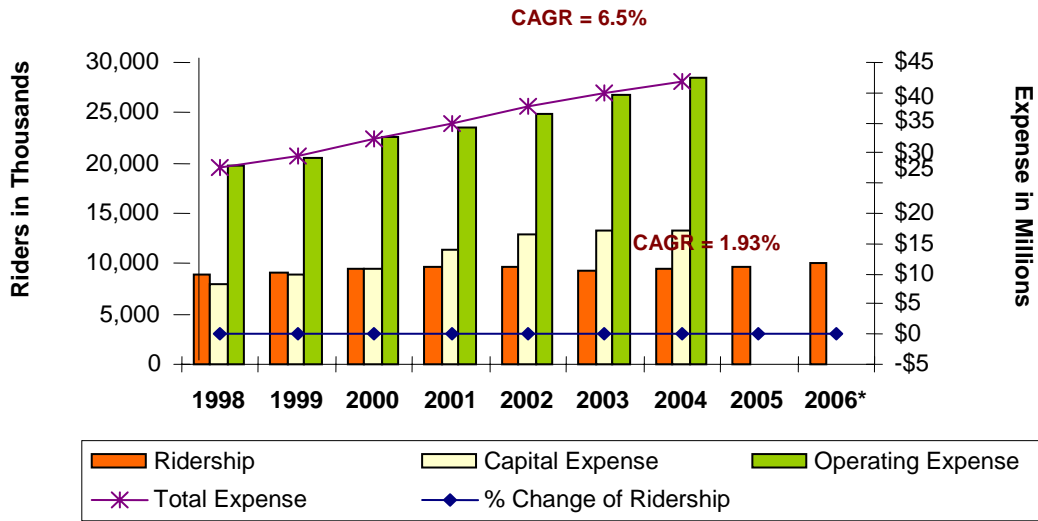
Cost Considerations for the U.S. Mass Transit Industry

The goals of mass transit operators vary widely depending on their particular operating environments, financial conditions, and client base. Regardless of individual circumstances, the primary objectives for all transit agencies are to minimize capital expenditures and reduce operating costs. Over the last nine years, the U.S. mass transit ridership has remained relatively flat with a compound annual growth rate (CAGR) of 1.93 percent (see Figure 3). Yet during that same period,[29] operating expenses and capital expenditures grew much more rapidly, with a combined CAGR of approximately 6.5 percent.

---

which riders must pay standard fare plus a surcharge for the ticket. Massachusetts Bay Transportation Authority. *Fares and Passes*. June 2007. <http://www.mbta.com/fares_and_passes/charlie/>.

[29] Note that data is not available after 2004.

Figure 3: U.S. Transit Metrics

CAGR = 6.5%

CAGR = 1.93%

Legend: Ridership | Capital Expense | Operating Expense | Total Expense | % Change of Ridership

(Left axis: Riders in Thousands — 0 to 30,000; Right axis: Expense in Millions — -$5 to $45; X-axis years: 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006*)

*Projected based on six-month ridership.   SOURCE: Author's calculations based on *APTA Transit Ridership Report*.

Operating costs can significantly undercut profits**.** The largest mass transit operator in the U.S. is New York City's Metropolitan Transportation Authority (MTA), which provides almost 50 percent of all daily mass transit trips in the U.S. Each year the MTA spends approximately $60 million on revenue support, maintenance, and other fare collection costs, to generate gross revenues of about $2 billion.[30] The need to improve their financial condition prompted the New York City MTA to look at ways to leverage the payments industry infrastructure.

Tight budgetary environments and intense competition from other modes of transportation are prompting public transit authorities across the U.S. to find ways to reduce expense and increase revenue by improving customer travel experiences. Contactless payment technologies offer a way to achieve both goals, but beyond the standardization issues discussed above, cost is still a major consideration in the decision to utilize this new payment technology. The challenge with implementing contactless technology is determining how to balance the long-term benefits and cost savings with managing the considerable near-term increase in capital investment and expenditures.

Implementation costs, which include purchasing and installing new equipment, integrating the old and new systems and equipment, and production and distribution of new payment media, are high. However, the cost to maintain and replace old and technically obsolete equipment is increasing. This

---

[30] Smart Card Alliance. "Spotlight on Contactless Payment Trends as Smart Card Alliance Annual Conference Opens."
4 October 2006. <http://www.smartcardalliance.org/articles/2006/10/04/spotlight-on-contactless-payment-trends-as smart-card-alliance-annual-conference-opens>.

increase is prompting more mass transit operators to seriously explore contactless alternatives. For example, the MBTA's fare collection equipment was over 25 years old prior to its upgrade in 2006 to contactless ticketing technology.[31]

Costs Related to a Closed-Loop Proprietary System

In a closed-loop environment, there are two types of costs to consider: (1) purchase and production costs; and (2) card life cycle management costs. The unit cost of a contactless card is a key factor for public transportation. Although low-cost RFID tags enable volume production and economies of scale, both of which are realized with more applications and higher production rates, a smart card payment solution may not provide a positive investment return in the short-term.

Approximately 50% of the cost of a contactless card is derived from the memory chip and antenna built into the RFID tag (see Figure 4 for breakdown of manufacturing costs).[32] A full-featured contactless smart card costs between 90 cents and $1.00 to produce, which is 25 times more expensive than a magnetic stripe card that costs four cents on average.[33] As a result, the cost to issue a contactless smart card for a single trip or a daily pass purchased by occasional riders may not be cost-justified. For monthly riders the picture is more positive if mass transit agencies consider the "effective cost" of the smart card medium in addition to the actual cost, based on how long the cards are retained by consumers. For example, if a monthly rider keeps a smart card for one year, the effective monthly cost to the transit agency is reduced to 8.3 cents ($1.00/12). Clearly, if it is held longer, the cost declines further.

Figure 4: Breakdown of Contactless Card Production Cost

SOURCE: Author's calculations

---
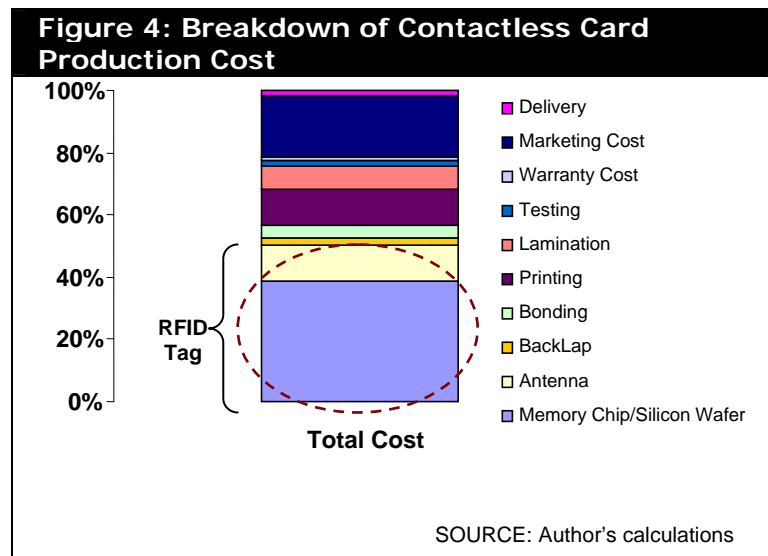
[31] Massachusetts Bay Transportation Authority. *Capital Investment Program*. June 2007.
<http://www.mbta.com/about_the_mbta/financials/?id=1052>.

[32] Bonneau, Walt Jr. "New Work Proposal Limited Use Contactless Card Standardization." *Three Point Consulting Inc.* 6 December 2002. <http://www.incits.org/tc_home/b105htm/b105Doc2003/N03-108.PDF>.

[33] In considering the cost of smart cards, it should be noted the cost of contactless cards can vary widely depending on the capabilities of the cards. Similarly, the range in cost of magnetic stripe cards differs substantially based on additional features. Korczak, Paul. Personal Interview. December 2006.

June, 2008   12

The ability to accommodate the one-time or occasional rider cost-effectively remains a problem in a system based on a high-cost payment medium. To retain a lower-cost non-cash fare option, several U.S. mass transit agencies currently support two types of payment options, the traditional magnetic stripe tickets and the newer contactless smart cards. This straddling strategy is, in part, an effort to address the cost issues mentioned earlier, while taking advantage of the newer technology. Nevertheless, support and maintenance of dual technologies remain costly.

The components of card lifecycle management (distribution, marketing, risk management, and customer service), make management of the contactless payment process very expensive.[34] Combined with the unit cost of a smart card, a contactless solution may not be a viable option in a closed platform environment, unless the card can be used for additional applications beyond mass transit.

A significant obstacle to implementing a proprietary card is *limited consumer demand*, particularly until contactless payments technology gains wider acceptance. Transit operators seeking to differentiate and expand their products and services beyond mass transit may face large barriers. On the demand side, as illustrated by several European experiences where a closed contactless scheme was implemented, cardholders found the payment medium inconvenient to reload and abandoned it for an open contactless debit card.[35] On the supply side, as the TfL experienced, attempts to negotiate with retailers to add payment functions to the Oyster transit card were a challenge. Retail merchants are reluctant to pay card transaction fees – similar to interchange fees charged by financial institutions – to a transit authority. As a result, the open-loop system seems more promising than a closed-loop system.

Costs and Risks Associated with Open-Loop System

An open-loop contactless model eliminates the need for the transit operator to own and manage the entire card lifecycle. Production and distribution tasks can be outsourced to financial institutions and technology vendors. Off-loading payment tasks permit transportation authorities to focus on their core competency, to run more efficient mass transit systems.

While open-loop systems offer clear benefits, Mercator Advisory Group, a payments research and consulting firm, suggests that when deciding whether to choose a closed- or open-loop contactless system, the transit operator should compare the speed and cost of the transaction.[36] In closed-loop proprietary systems, payments are prepaid and do not require external payment authorization. In contrast, paying with a credit or debit card in an open-loop network requires online, real-time interaction with a financial institution to authorize payment and perform fraud checks and other edits. These steps

---

[34] Korczak, Paul. "The Merchant Perspective." *2007 EPRG Contactless Forum.* Boston, 21 May 2007.

[35] Rueter, Thad. "Closing the Gap: Will Banks and Transit Create a Common Contactless Card?" *Card Technology*. 1 February 2006.

[36] Friedman, Michael. "A True Test for Contactless Payments: The Market for Open-Network Transit Solutions." *Mercator Advisory Group*. November 2006.

June, 2008

could reduce transaction throughput in a situation where every second counts, and possibly offset some of the efficiencies gained from using the open-loop contactless payment method. Hopefully, this issue is more than outweighed by the overall benefits of a more efficient and multi-purpose electronic payment system that can be used for mass transit and other venues.

To accept credit and debit card payments, mass transit authorities must pay interchange fees to the issuing banks. The fees are usually based on a percentage of the transaction value plus a flat rate per transaction. Since 75 percent of the MTA's transactions are less than $6.00, the fees can significantly impact profit margins. Aggregation, or bundling of payments into fewer larger transactions for processing, can reduce interchange fees. Both the NYC MTA and the Utah Transit Authority (UTA) are testing aggregation to address potential throughput issues and reduce fees.

Finally, accepting credit and debit cards can expose the mass transit authority to payment risks such as fraud and data breach, and require some investment in risk mitigation resources. Also, when mass transit authorities accept card payments, they are considered card merchants, and must comply with the Payment Card Industry (PCI) Data Security Standards – risk mitigation policies developed by the card associations to protect personal and financial consumer information. This process may be time-consuming and costly to implement, but carries penalties for non-compliance.

Whether the system is open or closed, lack of a good security program may lead to social costs, and result in monetary losses from fare evasion. In locations where add-value vending machines are unattended, the equipment may be prone to vandalism, or more serious criminal activity, such as fraud. In Boston, the combination of technology (i.e., computerized CharlieCard kiosks and the footage from closed-circuit cameras) and investigators are helping credit card companies identify perpetrators of credit card fraud.[37] In Singapore, there are severe penalties for destruction or damage to property. Therefore, an effective security program might include clearly defined rules and penalties, and vigilance in order to deter bad behavior and ensure continued consumer use of contactless cards for transit payments.

Open-Loop Contactless Pilots in the U.S.

Several U.S. trials of open-loop contactless systems are currently in progress. These cooperative arrangements include pilot programs in Utah, New York City, and Ohio. The Utah Transit Authority (UTA) program accepts bank-issued or open contactless cards on 41 ski buses in Salt Lake City, replacing the existing season passes and employee IDs. It is the first program in the U.S. to accept all branded contactless cards (i.e. American Express, Discover**,** MasterCard, and Visa), and the first open

---

[37] Wallace, Christina. "CharlieCard Fighting Crime." *Metro*. 1 March 2007.

June, 2008   14

contactless program on buses. The trial was completed officially in April of 2007.[38] Another program is planned to run during the 2007–2008 ski season.

The New York City MTA implemented a similar initiative. This pilot program with Citibank and MasterCard PayPass began on July 5, 2006, and included 79 turnstiles in 30 stations across four New York City boroughs. The MTA is testing different payment options and various forms of payment media. Its "pre-pay" service, requiring advance registration, allows the rider to fund a transit account using a Citibank credit or debit account. The transit account is automatically replenished when the balance falls below a set amount. The "pay-as-you-go" alternative does not require registration and allows a participant to tap his contactless Citibank credit card, debit card, or key fob at the reader on the turnstile to pay for a ride. Several months into the trial the MTA added NFC-enabled mobile phones as an alternative payment form factor. The MTA has observed positive results in terms of "good customer acceptance," zero chargebacks, and no fraud or customer phone calls transferred to the MTA.[39]

Due to the positive response, the MTA extended the trial to December 31, 2007, and plans to expand it later in 2008 to include buses in a strategic alliance with New Jersey mass transit authorities. In the meantime, a new pilot between the New York Port Authority and the New Jersey Transit was announced and is scheduled to begin in early 2009. This eight-month pilot, compatible with the MTA's trial on the subway system, will use contactless readers that connect commuter trains in New Jersey and Manhattan with buses running on two routes between New York and New Jersey. This test will be key in determining if customers can use contactless media seamlessly and conveniently to pay fares on all of the region's transit systems, including NYC's subways and buses. Considering the size of the NY/NJ mass transit network, this will be an important trial.[40]

In January 2007, the Ohio Turnpike demonstrated the viability of contactless payments for toll roads by outfitting select exit lanes and service plazas with self-service toll payment machines. The trial expected to deliver positive results with an average transaction time of about five seconds for a proximity card, compared to 8-10 seconds for magnetic stripe card transactions.[41] The 90-day trial accepted the MasterCard PayPass brand, and was the first Turnpike Authority in the U.S. to accept contactless payment cards on a highway .[42]

As demonstrated by the success of these trial programs, the open-loop scheme, which utilizes card association networks, banks, and technology vendors in its infrastructure, may be a good value

---

[38] Williams, Andy. "NYC and Utah Pioneer Use of Bank-Issued Contactless Cards for Transit Fare Collection." *SecureIDNews*. 12 September 2007. <http://www.secureidnews.com/library/2007/09/12/nyc-and-utah-pioneer-use-of-bankissued-contactless-cards-for-transit-fare-collection/>.

[39] Korczak, Paul and Steve Frazzini. "The Merchant Perspective." *2007 EPRG Contactless Forum.* Boston, 21 May 2007.

[40] *"More Contactless Testing for Transit in NY/NJ."* www.paymentsnews.com. 22 February 2008.

[41] TOLLROADSnews. "Ohio Turnpike Has Toll Payment Machines Taking Proximity Cards." 21 December 2006.

[42] Business Wire. "MasterCard Trials PayPass on Ohio Turnpike." *ePaynews.com*. 4 January 2007. <http://www.epaynews.com/index.cgi?survey=&keywords=contactless&optional=&subject=&location=&ref=keyword&f=view&id=116781655815913457233&block=>.

proposition for the U.S. mass transit market. Collaborative ventures between transportation agencies and other stakeholders can create economies of scale, avoid duplication, and develop a common standard with the associated network externality. Specifically, financial institutions, which own most card and check-based payment systems, can offer their expertise in payments that transit operators may lack. Mass transit operators, in turn, can combine their skills in monitoring and driving consumer payment behavior with the experience and scope of financial institutions to develop a mutually beneficial and complementary relationship.

V.   Barriers to Consumer Adoption of Contactless Payments

Even after the costs, technology standards and compatibility issues surrounding contactless payments are resolved, real success will only be achieved with widespread consumer adoption. Unless there is a clear added value to gain by switching to this payment method, consumers will not change their payment behavior.

Consumer Inertia

Consumers face an array of conflicting payment choices in all venues. Public transportation passengers may be reluctant to adopt a new payment type when current payment options are perceived as equally effective, although adoption appears to vary by mode of transportation. On the Washington, D.C., Metrobus, which accepts cash, tokens, and the *SmarTrip* contactless smart card, market penetration for the card is only 22 percent.[43]

While contactless cards are advertised as user-friendly, consumer inertia, or habit, may impede acceptance and use. Generally, consumers do not adapt quickly to change. Commuters are accustomed to routine, from the look of the station when they enter a fare gate to the loading and use of their cards.[44] Adapting to a new process, even a simple one such as using a new payment type, can confuse riders averse to change and prompt complaints and resistance that might slow down the transition.

To minimize consumer concerns, many U.S. mass transit operators, including leaders like WMATA, have been implementing the new technology in phases, in combination with uniform public education. The Metrorail in Washington, D.C., accepts magnetic cards and the SmarTrip at the fare gate. In contrast to the Metrobus, the Metrorail has a higher penetration rate for the SmarTrip. During the week, SmarTrip has a 65 percent market penetration rate overall on the Metrorail, yet it is much higher at certain stations at specific times. For example, on some express Metrorail routes more than 90 percent

---

[43] Garback, Gregory. Personal Interview. May 2007.

[44] Garback, Gregory. Cash to Electronic Payments Panel. Consumer Behavior and Payment Choice Second Annual Research Conference. Boston, 25–27 July 2006.

June, 2008

of the passengers use SmarTrip.[45] The numbers suggest that extrinsic motivations such as faster transactions and rewards may influence some consumer payment behavior and shift demand to newer payment methods.

Security Concerns

Another potential inhibitor to the growth of contactless payments is consumer concern with security. A number of industry surveys suggest that consumers perceive a significant risk of data interception between the card and the reader. In its *2008 Contactless Strategy Forecast*, Javelin Strategy & Research reported that sixty-five percent of the respondents who said they were unwilling to adopt a contactless payment method indicated that their dominant reason was that they did not consider it "a safe form of payment."[46] Consumers must be assured that the value on their cards cannot be stolen, and that the information on their cards is captured accurately by the card reader.

Privacy

Privacy protection is also a sensitive issue, since commuters might be averse to organizations tracking their behavior. In addition to maximizing the versatility of smart card applications, mass transit agencies must clearly communicate how they collect, use, and handle personal information. Sophisticated smart card technology can partition transit and payment functions on chips, with firewalls protecting the separate applications.[47] One approach, taken by South Korean card issuers, is to embed a contactless chip for transit payments, and a magnetic stripe for retail payments on the card.[48]

Switching Costs and the Unbanked/Underbanked Populations

According to available data on family incomes of public transportation passengers, over 80 percent of commuters are in the low- or middle-income population.[49] Use of a proprietary smart card requires an initial deposit, which might discourage lower-income consumers from migrating to contactless technology. (For instance, in Washington, D.C., a $5.00 initial investment is needed.)

Beyond switching costs, the unbanked and underbanked populations – those without any, or with very limited, relationships to financial institutions – present a concern for transit authorities. The open contactless cards may be unaffordable by segments of the lower-income population that transit agencies (more specifically subway and bus) traditionally serve. Furthermore, contactless credit cards, despite the low-dollar spending limits, could lead to accidental overdraft. A separate prepaid card option that does

---

[45] Data collected up to November 2006. Garback, Gregory. Personal Interview. December 2006.
[46] Javelin Strategy & Research. *Contactless Strategy & Forecast*. April 2008.
[47] Rueter, Thad. "Closing the Gap: Will Banks and Transit Create a Common Contactless Card?" *Card Technology*. 1 February 2006.
[48] Schuman, Evan. "How Safe Are the New Contactless Payment Systems?" *CIO Insight*. 20 June 2005.

not allow overdrafts may be a better solution, and one that would further help consumers, such as parents, better control their children's expenditures.

VI. Consumer and Transit Operator Benefits

To move into the mainstream, contactless payments should demonstrate advantages over the existing fare media: cash, token, paper ticket, and magnetic cards. Contactless smart ticketing applications must offer operators sufficient benefits to encourage merchant deployment, while providing consumers compelling reasons to adopt a new payment method.

One approach to comparing fare media is presented in Figure 5,[50] which summarizes criteria used to evaluate different transit payment options. The qualitative measures are based on payment option characteristics and their impacts on the transit authority, the consumer, or both parties.

Figure 5: Fare Media Evaluation						
Rating Key: 3 = High, 2 = Medium, 1 = Low Positive Impact	Relative Impact of Payment Options					
				Magnetic Stripe Card	Smart Cards	
			Paper Ticket		Contact Card	Contactless Card
Evaluation Criteria	Cash	Token				
Consumer — Convenience (ease of use)	1	2	2	2	2	3
Flexibility and Cost Savings	1	1	2	3	3	3
Security (personal risk and information)	1	1	1	2	3	3
Both — Speed (on throughput, time saved)	1	2	1	2	2	3
Positive Externalities	1	2	1	2	3	3
Transit Authority — Operations Impact (lower operating costs)	1	2	1	2	2	3
Reliability of Technology	1	2	2	2	3	3
Cost of Equipment[51]	3	2	3	1	1	1
Cost of Purchase or Production of Media	3	3	3	3	1	1
Fraud Risk Reduction (resistance to counterfeiting)	2	1	1	2	3	3
Customer Relationship Management	1	1	1	1	3	3
Accountability (impact on revenue control)	1	2	2	3	3	3
Total Score	17	21	20	25	29	32

SOURCE: *TCRP Report 10: Fare Policies, Structures, and Technologies*, author's analysis

---

[49] APTA. *Annual Family Income of Passengers by Population Group*. 12 December 2006.
<http://www.apta.com/research/stats/ridership/income.cfm>.

[50] The table is derived from fare media evaluation originally developed by the Transit Cooperative Research Program (TCRP) in its research for the Federal Transit Administration. Each payment option was rated on a scale of 1 to 3 with 1 lowest and 3 highest positive impact. The matrix uses an unweighted rating scheme (i.e., all ratings are weighted equally). Thus, slight changes to any of the elements can potentially alter the overall ranking. TCRP Report 10. *Fare Policies, Structures, and Technologies, National Research Council*. 1996. <http://www.trb.org/news/blurb_detail.asp?id=2606>.

[51] The costs of procuring, installing, and maintaining equipment are high for both magnetic and smart cards (contact and contactless). Since costs are high, they have a 'low positive impact' rating.

June, 2008

In evaluating these ratings, electronic payment options (i.e., magnetic stripe cards and both types of smart cards) offer improvements over traditional options, specifically in the areas of security, flexibility, operations impact, and accountability. Contactless cards rank highest (32 points) in relative impact of payment options, as explained below.

Convenience

With regard to convenience, all prepaid options (i.e., non-cash) are relatively convenient to the rider. Convenience depends on ease of use of the payment option (need to purchase less often) and collection (i.e., whether the physical payment medium has to be deposited, inserted, and removed).

Contactless cards offer high utility for mass transit cardholders because they are easy to use. Unlike cash, where consumers must make repeat purchases and carry change, the contactless card allows consumers to purchase tickets or "top up" from one transit operator and travel seamlessly between regions and different modes of transportation (e.g., bus, subway, and train) on participating mass transit systems. The ability to use one card on multiple transportation modes saves the customer time by reducing the need to research travel information and purchase individual tickets. The smart card also takes the guesswork out of paying for fares. Unlike magnetic stripe cards, smart card technology can perform complicated transactions: charging for each leg of travel accurately or capping the maximum fee charged on any one day. Combined with their automated reload and recharge capabilities (via Internet, telephone, and credit card link), smart cards increase customer convenience and thus encourage ridership.

Flexibility and Consumer Cost Savings

Labor patterns continue to change as fewer people work between nine and five, or even at the same geographic locations. The contactless card further supports flexible fare arrangements for riders by providing automatic discounts and multiple fare options. More sophisticated ticketing can provide trend information showing cost differences based on factors such as peak times, distance, or discount programs. The business rules feature, which defines policies on ticket information, including monthly passes and distance-based guidelines, ensures that a contactless card, when used regularly, will be just as cost-effective for the passenger as an all-day pass.

Security

Contactless smart cards offer greater security for the consumer. Compared with other payment options, they provide more storage as well as secure reading and writing of data. With contactless debit or credit cards, additional security is provided through a series of encryption algorithms and electronic

keys.[52] One of these security measures is the 128-bit triple DES encryption that generates a unique digital watermark for every transaction (a dynamic CVC/CVV).[53] Even if the CVC/CVV code is skimmed, it changes for each transaction. This security concept is similar to one-time password-issuing devices, where the identification code changes every few seconds, making a stolen code virtually ineffective. Since most contactless payments are limited to purchases below $25.00, the financial loss to the consumer would be small, and the customer would most likely be reimbursed by the financial institution if information about the transaction were stolen.

The consumer also has greater control over payments with a contactless smart card. Active participation of the cardholder is required to perform a transaction. The payment device never leaves the consumer's hand; and the distance factor of four inches between the reader and the RFID chip to communicate makes unauthorized scanning for customer data more difficult.

Speed and Operational Efficiency

A considerable benefit of the contactless smart card is quicker transaction time through the transit turnstile. The average speed requirement is less than 300 milliseconds.[54] Commuters no longer need to fumble for their tickets or tokens at the turnstiles, feed payments into machines, retrieve tickets, walk through turnstiles, and put tickets back into their wallets. In Japan, the railway operators claim that their contactless system can admit 60 passengers per minute through each ticket barrier.[55] More people moving quickly through the turnstiles translates to higher passenger throughput and increased operational efficiency for the mass transit operator.

Lower Operating Costs

Contactless smart cards offer other advantages for mass transit authorities. With nearly 33 million trips made daily on public transportation in the U.S.,[56] accepting contactless card payments can result in more efficient equipment operation and lower maintenance costs. In its findings to the MTA, the Permanent Citizens Advisory Committee (PCAC) noted that, while the deployment of a contactless card-based system is capital intensive, lower fare card equipment and turnstile maintenance costs make these

---

[52] The dynamic CVC or CVV (card verification code or card verification value) is a unique code assigned to every transaction based on data about that card and that particular purchase. Once the card is authenticated and the transaction processed, existing fraud detection tools are applied as they currently are for magnetic stripe transactions.

[53] Visa. *Visa Contactless*. December 2006. <http://usa.visa.com/personal/cards/contactless/faq.html>.

[54] Smart Card Alliance. "Transit and Contactless Financial Payments: New Opportunities for Collaboration and Convergence." *A Smart Card Alliance Transportation Council White Paper*. October 2006.

[55] "The Future of Money: A Cash Call." *The Economist*. 15 February 2007.

[56] American Public Transportation Authority. *Average Weekday Unlinked Passenger Trips*. 12 December 2006. <http://www.apta.com/research/stats/ridership/wkdytrip.cfm>.

June, 2008   20

payment types more attractive.[57] Contactless card systems eliminate mechanical parts in ticket validating machines that cause lead deposits to build up, and minimize the high costs associated with malfunction, misuse, and maintenance.

Contactless payments can also improve cash flow. For example, Boston's MBTA offers a corporate program for companies to distribute passes to their employees. Prior to the implementation of contactless smart cards, the MBTA sent new passes each month to the 2,000 companies enrolled in the program. Today, one card can be programmed, potentially saving companies $20,000 per month on packaging and shipping.[58]

Although it is less expensive to produce other fare media vs. contactless cards, contactless payments are less costly overall because of the lower investment in contactless equipment. Furthermore, the maintenance savings from eliminating magnetic stripe tickets can more than offset the incremental cost of using contactless smart cards.[59]

An ancillary benefit of contactless cards is the ability to reduce staff. Transit card vending machines and rechargeable contactless smart cards require less single-ticket sales support. In Washington, D.C., the migration to electronic payments reduced staff by approximately 15 percent over a five-year period.[60] However, mass transit authorities should make sure that staff cuts do not affect patronage, which is why most public mass transport systems still maintain some staff presence to deter riders from trying to avoid paying fares, to assist riders with the new technology, and to ensure passenger safety.

Reliability of Technology

In connection with lower maintenance costs, the absence of moving parts and direct contact between card and reader make contactless equipment more reliable. Another advantage is derived from the physical smart card. Unlike paper tickets that deteriorate quickly, or the wear-and-tear inherent with traditional magnetic stripe cards, the more durable waterproof contactless cards have a longer lifecycle, and therefore require fewer replacements.

---

[57] Brower, Katherine. "In Your Pocket: Using Smart Cards for Seamless Travel." *The Permanent Citizens Advisory Committee (PCAC) to the MTA*. October 2004.

[58] Williams, Andy. "Boston's New Contactless CharlieCard Makes Commuting Easier for a Million Daily Riders." *CR80News*. 19 April 2007.

[59] Moreau, Bruno. "The Case for Contactless Smart Cards is Overwhelming – Fare Collection." *International Railway Journal*. January 2003.

[60] Garback, Gregory. Cash to Electronic Payments Panel. Consumer Behavior and Payment Choice Second Annual Research Conference. Boston, 25–27 July 2006.

June, 2008   21

Fraud Risk Reduction

One transit authority estimated revenue loss due to fraud and fare evasion to be $2 million per year, or five percent of its annual fare revenue. Some losses are reported to be as high as 10 and 15 percent of annual revenue.[61] While figures on employee card skimming or theft from cash handling are not available, the risks have been big enough to induce some agencies to implement electronic fare collection systems.

Smart cards create a more secure fare collection process. The established technology standard includes a number of components designed to manage risk and mitigate card skimming. In contrast, duplicating a paper magnetic stripe card or a token is relatively simple and inexpensive. Smart cards with built-in microprocessors are inherently more difficult (and more costly) to counterfeit.

The systematic validation on entrance also improves the read rate and minimizes "free ridership," or fare evasion. In aboveground transit systems such as Boston's MBTA, monthly transit passes are flashed at the drivers. During peak hours when there is insufficient time to check passes, contactless cards provide faster rate of entry and decrease opportunities for fraud by dishonest commuters.

Improved Customer Relationship Management

Another advantage for mass transit authorities is the valuable information that smart card ticketing systems can generate. The miniature computer chips embedded in smart cards can be programmed not only to store cash value, but also to collect data that can help transit operators better understand consumer behavior and service customers more effectively.

It is generally difficult to collect information about transit customers, as data is often collected manually by counting passengers at the ticket booth. Manual counting has limitations because it can identify the number of riders, but not the origins and destinations. Additional rider profiles might be gathered from observations or assumptions generated from interviews with travelers.

Smart cards are uniquely designed to collect data because the data can be electronically captured and analyzed quickly and efficiently. The information can then be used for traffic management and logistics, leading to better allocation of resources, efficient timetables, reduced delays, and improved social safety (e.g., increased staff and/or surveillance at locations with a higher incidence of crime). Smart card technology enables transit agencies to better control, monitor, and influence ridership patterns through measures such as congestion pricing techniques.

Contactless technology can also drive loyalty by enhancing the overall *stickiness* of a card program. The cards may contribute to revenue growth by extending an operator's product ranges and expanding into new areas, such as retail, through joint ventures with businesses located near transit

---

[61] Iseki, Hiroyuki. "Survey on Status of Knowledge and Interest of Smartcard Fare Collection Systems Among US Transit Agencies." *California PATH Research Report*. June 2006.

June, 2008   22

stations. For example, in Hong Kong consumers can use the Octopus smart card to pay for clothing or drinks in addition to riding the subway. In 2005, shops in Hong Kong began offering loyalty points to customers who carried Octopus cards; and in less than one year more than 800,000 people, or almost 12 percent of the population, had signed up.[62]

Accountability

Depending on how the transit authority processes currency, electronic payment options can offer better accountability and a higher degree of accuracy than other options, particularly cash and tokens, in terms of revenue control.

The improved data collection and monitoring capabilities offered by streamlining agency system operations and financial accounting also make it much more difficult for employees to skim fare receipts.

Positive Externalities

Beyond the more direct consumer benefits, contactless payments can generate ridership growth. For example, less travel time for riders can also mean less wait time for other passengers and more satisfied customers overall.

Contactless cards can also benefit the environment. Governments in cities such as Mexico City want to encourage more use of public transportation to decrease street congestion, and reduce local air pollution and carbon-dioxide emissions. Fewer paper tickets sold each day also reduce paper usage and further support the environment.

VII.   The Road Ahead

So, what lies ahead for implementing contactless payment technologies in the U.S.? International developments in transit industry payments illustrate the potential market efficiencies and cost savings to be gained from contactless technology. Business analysis further demonstrates the promising return on investment of contactless smart cards in the long term. The main advantages of a contactless payment mass transit system are lower maintenance costs, speed and flexibility provided by the smart card application, better security over payments for mass transit operators, merchants and consumers, and implementation of an electronic information system that can gather usage statistics. These advantages should motivate the U.S. mass transit industry to implement smart card electronic payment options. However, mass transit operators and other participating retail merchants will need to invest in smart card

---

[62] Ilett, Dan. "Inside China: Oyster and Octopus – A Tale of Two Cities' Contactless Cards." *Silicon.com*. 28 June 2006.
  <http://www.silicon.com/research/specialreports/china/0,3800011742,39159958,00.htm>.

June, 2008

programs that provide benefits beyond expected cost savings. The challenge is to select the type of contactless fare medium that will also gain critical mass acceptance by consumers.

Because of this challenge and the financial investment, to date contactless payment options have been limited in the U.S. Changing an established transaction processing infrastructure is costly, and the returns may not materialize immediately. However, one potential impetus for growth may be the natural replacement cycle of the aging ticketing equipment.

Looking ahead towards desired long-term outcomes, the closed-loop proprietary business model does not appear to represent an optimal strategy for U.S. mass transit operators to pursue. This model can be more complex, more time-consuming, and more costly, requiring transit systems to build and own the payments infrastructure, develop and refine credit management skills, and foster consumer trust when dealing with payments. Yet in the short-to-medium run, closed-loop systems may ease the transition to an open-loop model as shown in the Hong Kong and London examples. However, the major drawback to a closed-loop model is that it still requires mass transit users to carry another payment card, which goes against a consumer's desire for convenience and consolidation of payment methods. Consumers already feel they carry too many cards: credit cards, debit cards, retail loyalty cards – all competing for a "share of wallet."

A more sustainable payment method – and the one that is more likely to succeed in the long run – is a vehicle that provides consumers with payment choices and availability at multiple venues. An associated rewards program might further build consumer acceptance. Such a model may be the open contactless solution that we are seeing today in some trial programs or something yet to be developed, such as an open, hybrid payment method that combines multiple capabilities in a variety of forms, and also addresses the needs of the largely unbanked and underbanked populations that transit authorities serve.

Technological advances alone will not ensure the long-term success of contactless smart cards. Prospective participants will need to overcome real and perceived industry and consumer barriers. Therefore, interested U.S. stakeholders should position themselves appropriately in the value chain. Transit operators should partner with local government agencies, financial institutions and technology suppliers to offer an integrated standard that provides value-added benefits for all concerned by collaborating on new policies, new processes, and required investments at every stage of the supply chain.

At the end of the day, the U.S. mass transit industry faces a tough question: Should it develop its own electronic card payment system; wait for multifunctional contactless cards and other form factors that will be accepted across many industries to provide the functionality required in the market; or simply do nothing?

June, 2008   24

Whatever the industry's short-term decisions and actions, the outlook for contactless payments looks promising. Increased economic activity in the U.S. continues to generate consumer demand for electronic payment transactions. Whether mass transit applications drive the contactless card market, or a broader national infrastructure is developed to accept contactless payment options, the momentum for contactless smart cards is growing.

Appendix A – Glossary

ACRONYM	NAME	DEFINITION
3DESE	**128-Bit Triple DES Encryption**	A security solution that is based on cryptography using a triple-data-encryption algorithm to process electronic transaction information.
AVMs or **FVMs**	**Add-Value Machines** or **Fare Value Machines**	Self-service vending machines that allow passengers to purchase tickets or add value and travel passes to cards, or stored-value tickets.
	Aggregation	An offline payment solution that groups small payments together and presents them as one transaction to the merchant acquiring system to lower transaction costs.
AFC	**Automatic Fare Collection**	A system that automates the ticket accounting and selling processes, provides detailed data on system usage, and reduces ticketless travel.
	Business Rules	Business rules are policies that transit authorities define in order to conduct their operations. These include the types of tickets, monthly passes, mandated discounts and bonuses, concession tickets, and distance-based information.
	Card (Association) Network	Transactions that use the American Express, Discover, MasterCard, or Visa network.
CAGR	**Compound Annual Growth Rate**	The growth rate over a specified period of time.
	Closed-Loop (Proprietary)	A single-purpose or private label stored-value card restricted to the payment of transportation services.
	Contact (Smart) Card	A smart card that connects to the reading device via physical contact between the smart card chip and the smart card reader. Contact cards typically require the user to insert the card into a slot or reader.
	Contactless (Smart) Card	A smart card with an embedded chip that communicates with the reader using radio frequency (RF) and does not require physical contact with the reader. Also referred to as "chip cards."(See *PICC*.)
	Dual Smart Card or **Combi-Card**	A smart card with one chip that is able to communicate in contact or contactless environments. Combi-cards can use either two separate e-purses for the interface or a single purse capable of being accessed in either manner.

June, 2008

| ACRONYM	NAME	DEFINITION
e-commerce	**Electronic Commerce**	A term used to describe retail transactions that take place online where the buyer and seller are remote from each other.
e-money	**Electronic Money**	Value that is stored for dollar transactions.
e-purse	**Electronic Purse** or **Digital Purse**	A form of monetary value, which is stored on an electronic device and paid in advance. It is sometimes called the "electronic wallet," or the "stored-value card (SVC)." (See *stored-value card*.)
	Fare Gate or **Ticket Validator**	The fare gate forms a barrier between the "unpaid" area of the station and the "paid" area where passengers must possess a valid ticket. The fare gate will read and release the gate when a valid ticket is presented.
FI	**Financial Institution**	Any institution that provides financial services, including banks, card associations, and similar businesses.
	Hybrid Smart Card	A smart card that combines the characteristics of both contact and contactless cards, or a combi-card with separate memory and processing for the contact and contactless interfaces. (See c*ombi-card*.)
IR	**Infrared**	Infrared refers to energy in the region of the electromagnetic radiation spectrum at wavelengths longer than those of visible light, but shorter than those of radio waves. Infrared is used in a variety of wireless applications, such as proximity transactions.
IC	**Integrated Circuit** or **Chip**	An electronic component that performs logic, processing, and memory functions: also called a *chip*.
	Interchange Fee	The fee charged to the merchant acquirer and paid to the card issuer.
ISO/IEC 14443	**International Standards Organization**	ISO/IEC 14443 sets communication standards and protocols between the card and reader to create interoperability for contactless smart card products. This standard is the most widely used contactless standard in the world. The standard is divided into two types, A and B. Types A and B differ on the choice of the modulation depth (100% and 10%, respectively).
	Magnetic Strip(e) Card or **Magstripe Card**	Type of card with a magnetic strip(e) in the back, which stores data.

ACRONYM	NAME	DEFINITION
	Micropayments or **Low-value payments**	Transactions valued at $5.00 or less, and may be as defined as high as $25.00.
	Multimodal	Integration of multiple transit service providers.
NFC	**Near Field Communication**	NFC is a standards-based, short-range wireless connectivity technology that enables convenient short-range communication between electronic devices.
	Online Payment Solution	Real-time authorization of a transaction.
	Payment Method or **Payment Type**	Form of payment used in a transaction like cash, a check, a credit card, a debit card, or a stored-value card.
PCI DSS	**Payment Card Industry Data Security Standards**	A common set of technical and business requirements developed by the major credit card companies to help ensure the safe handling of sensitive customer information by merchants.
PCD	**Proximity Coupling Device**	Contactless device reader. (See *reader*.)
PICC	**Proximity Integrated Circuit Card**	PICCs are intended to operate within 4 inches, or 10 cm of the reader antenna at a frequency of 13.56 MHz. (See *contactless cards.)*
QSR	**Quick Service Restaurant**	Also known as fast food restaurants, in this casual dining experience food and services are quick.
RFID	**Radio Frequency Identification Device**	RFID is a technology (alternative to bar coding) with a built-in microprocessor chip that transmits signals by radio frequency to an RFID receiver/reader to uniquely identify an object, animal, or person. In a contactless or a proximity payment, it comprises an embedded microchip that stores all of the customer's credit/debit information, and a radio frequency antenna to transfer that information to a reader. Advantages of RFID include data capacity, read/write capability, and no-line-of-sight requirements.
	(Terminal) Reader	A point-of-sale device that communicates with cards to process payment transactions.
	Skim	Electronic data stolen from a credit card's magnetic strip(e) and put on a counterfeit card used to make fraudulent purchases.

June, 2008

ACRONYM	NAME	DEFINITION
	Smart Card or **Chip Card** or **IC Card**	A tamper-resistant plastic card with an embedded microprocessor and memory chip that can store data, including electronic cash payments, and that has read/write capabilities.
	Smart (Card) Ticketing	Smart card fare payment with electronically encoded data content indicating the validity and/or use of the ticket. (See *Smart Card*.)
	Stored-Value Card or **Prepaid Card**	A pre-authorized payment product. The payments are deducted from the card as the customer makes transactions. (See *e-purse*.)
	Ticketing or **Fare**	Evidence that the holder has paid admission or is entitled to some service, right, or the like.

June, 2008

Appendix B

Worldwide Smart Card Deployment in Public Transportation[63]

Figure 6 depicts the worldwide adoption of contactless payments in the transit market, as evaluated on the Rogers Model for the Adoption and Diffusion of Technology.[64] The adoption curve shows the phases of development and key countries in each phase.

Figure 6: The Adoption Curve – Diffusion of Innovation
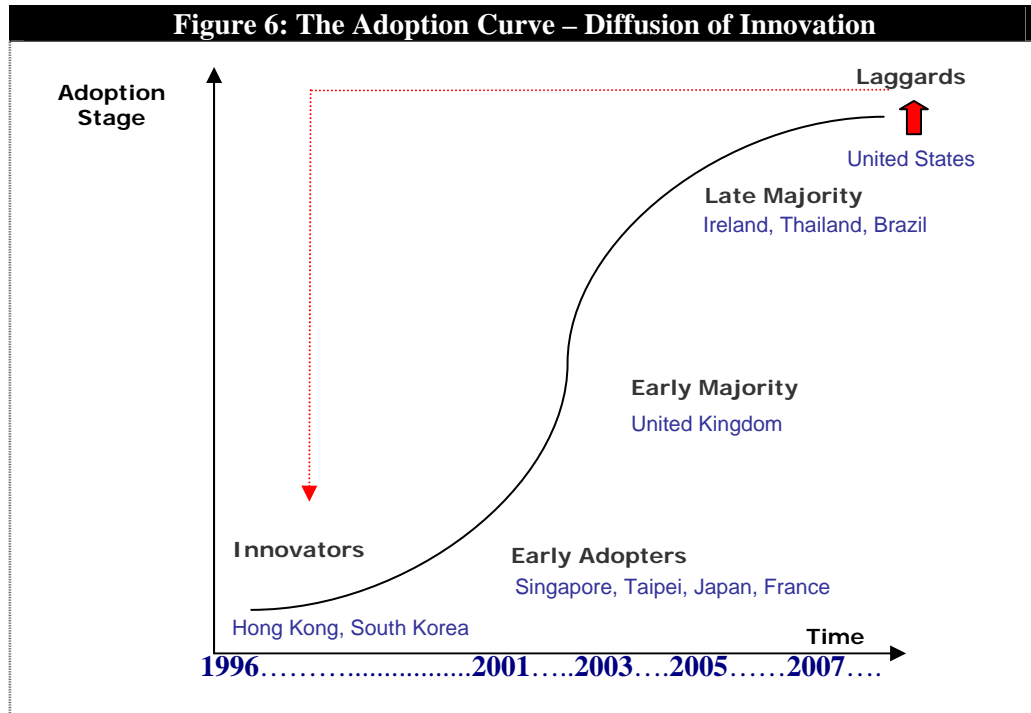
Innovators – the International Experience

South Korea was one of the first countries to trial contactless ticketing in 1996. However, Hong Kong is considered the pioneer in smart card adoption. Its Octopus card was the world's first major public transport ticketing system to use the NFC technology in 1997. Octopus Cards Limited, the operator of the Octopus system, is a joint venture between all of the Hong Kong transportation agencies.[65] This business model worked in Hong Kong for several reasons. First, as a monopoly,

---

[63] As of June 2007, information gathered from company websites and press releases.

[64] The *theory of the innovation adoption curve* was formalized by Everett Rogers in his 1962 book, *Diffusion of Innovations,* which classifies adopters of innovation into various categories.

[65] The Octopus Cards Limited is composed of the major operators: the Mass Transit Railway (MTR) Corporation, the Kowloon Canton Railway Corporation (KCRC); the Kowloon Motor Bus (KMB) Company; Citybus, Hong Kong; and Yaumati Ferry. Tradelink Electronic Commerce Limited. "Our Winning Card." *Tradlink-eBiz*. 8 February 2007. <http://www.tradelink-ebiz.com/english/331n08or3m9a51l/newscast/ss_0412a.html>.

June, 2008   30

Octopus Cards Limited dominates the transportation market, and is in a position to impose a new system. Moreover, with vehicle ownership in Hong Kong at a very low 20 percent,[66] the majority of trips made on public transportation provided an enormous client base for conversion. Second, after 1997, Hong Kong experienced a coin shortage when consumers began stockpiling old coins believing that they would appreciate in value following the accession to China. Third, customers became accustomed to using their transit payment cards as a lifestyle product to make everyday retail purchases.

The Octopus card can be used beyond public transportation services at apparel stores, bakeries, car parks, cinemas, convenience stores, fast-food chains, household stores, leisure facilities, personal-care stores, photo-finishing stores, photocopiers, supermarkets, and vending machines.

Early Adopters

Another early mover in contactless transit cards is France, one of the nations considered to be the inventor of the smart card in the early 1970s. Paris's transit body, the Régie Autonome des Transports Parisiens (RATP), is the third-largest transport network in the world, trailing Tokyo and New York City. With approximately 11 million inhabitants (about 20 percent of the population of France), Île-de-France, the Paris metropolitan area, is the nation's most highly populated area, and attracts approximately 60 million tourists each year.[67]

According to a 1999 study by the RATP, and the region's railway network, the Société Nationale des Chemins de fer Français (SNCF), revenue losses due to fraud and counterfeit totaled more than 110 million euros a year. The risk-related costs combined with the aging ticketing terminals of legacy systems prompted the agencies to examine alternative fare collection schemes during their natural replacement cycle.

In response, in 2001, the public-transit operators in Paris introduced the first phase of the NAVIGO pass, the capital's card-based contactless fare-payment system. In May of 2006, public-transit operators in Paris expanded the NAVIGO card to replace the paper-based transit ticket that allowed unlimited weekly and monthly travel passes.

Early Majority

The United Kingdom engaged in a fast follower strategy, learning from the technology integration of Hong Kong's transit system. In May of 2003, Transport for London (TfL) in the United Kingdom introduced London's Oyster card. The "Oyster" educated the population about a convenient

---

[66] Online Consumer Survey of ACNielsen, which polled over 14,100 Internet users in 28 countries across Asia Pacific, Europe, and the United States in October 2004. ACNielsen. "Asians in the Driving Seat for Future Car Ownership." 16 March 2005. <http://asiapacific.acnielsen.com/news/20050316.shtml>.

[67] EUROSMART. "Open Smart Card Infrastructure for Europe," *eEurope Smart Cards Common Specifications*, Vol. 6, 24 February 2004. <http://www.eurosmart.com/Update/Download/February04/SINCE_survey.pdf>.

and safe way to pay, and is now used in over 3.9 million journeys every weekday to pay on London's subway system, "the Tube," and for bus fares.[68]

Late Majority

Currently at the forefront of the RFID market, Asia – with some of the largest and fastest-growing economies – has implemented many of the early contactless ticketing transportation schemes.

Thailand was one of the late majority countries to employ contactless solutions in Asia. Much like most cities around the world, Bangkok ran on a system of diesel-powered buses for public transportation, increasing its pollution levels. As the population grew, so did the traffic – considered to be one of the worst in the world. To address these issues and encourage use of the more efficient underground subway and its elevated system, the Skytrain, Thailand's two main transit operators modernized their transportation platform, which included implementation of contactless solutions in 2005.

Laggards?

As suggested earlier, the U.S. transit market has been an early entrant as well as a laggard in the contactless ticketing space. Although the U.S. has had limited experience, the transit authorities are now exploring some innovative contactless solutions with a number of pilot launches. A more comprehensive list of smart cards (contact and contactless) used in the U.S. transit market – including underground subway, bus, and railway services – is depicted in the following table.[69] The launch dates include introductory pilots or trials, of which the rollouts may have been conducted in phases.

---

[68] Transport for London. "Best Value Performance Summary." *Summary 2006*. 29 March 2006.
  <http://www.tfl.gov.uk/tfl/pdfdocs/BVPerformancePlan29Mar2006.pdf>.
[69] Information collected from press releases, company websites, as of July 2007.

United States Transit Market			
Location	**Card**	**Transportation Agency (Provider)**	**Launch**
Atlanta	Breeze Card	Metropolitan Atlanta Rapid Transit Authority (MARTA)	2005
Boston	CharlieCard	Massachusetts Bay Transportation Authority (MBTA)	2006
Chicago	Chicago Card	Chicago Transit Authority	2002
Houston	Q Card	Metropolitan Transit Authority of Harris County, Texas	Currently testing
Las Vegas		Las Vegas Monorail	Currently testing
Los Angeles	TAP Card	Los Angeles County Metropolitan Transit Authority	Currently testing, rollout expected in early 2008
Maryland	Maryland Transit Pass	Maryland Department of Transportation	Currently testing
Minneapolis/St. Paul	Go-To Card	Metro Transit	2006
New York City	*Citi Card or Citibank Debit Card*	Pilot by NYC Transit, Citibank, and MasterCard	2006–2007 (Trial)
Philadelphia	FREEDOM	Port Authority Transportation Corporation (PATCO)	2006 (Pilot), Full rollout in mid-2007
San Francisco Bay Area	TransLink Card	Metropolitan Transportation Commission	2002 (Trial) 2010 (Complete Bay Area expansion)
Seattle Region	ORCA Card	Seven area transit agencies led by King County Department of Transportation	2006 (Trial)
Utah	*Any Card*	Pilot by UTA, Visa, MasterCard, and American Express	2006–2007 (Trial)
Ventura County	Go Ventura	Ventura County Transportation Commission (VCTC)	2002
Washington, D.C.	SmarTrip	Washington Metropolitan Area Transit Authority (WMATA)	1999

*Open-loop (credit and debit) cards.