Electronic Payment and Access Systems: Ensuring Interoperability in Vancouver Transportation

Researched and Written by Christopher Gallop,
M.A. Planning (Candidate)

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Acknowledgements

Executive Summary

The purpose of this research project was to explore the possibilities for establishing an integrated electronic payment and access system for transportation and parking services, one that conducts payment and grants access to transportation and parking services over multiple service providers in multiple jurisdictions, through the utilization of contactless cards, proximity chips and mobile devices rather than coins, tokens, paper tickets and paper passes. The research design supports the collection of sufficient background information on electronic payment and access systems for the purposes of establishing key findings and a discussion of the complexities and challenges related to technological and policy development in this area.

In the Vancouver region, Translink has put out a Request for Proposals for a smart card system that would be operable on all transit. In addition, a pay-by-phone parking service, operated by Verrus Mobile Technologies Inc. covers 85% of all meter and surface lot spaces. Electronic tolling that utilizes transponders and automated video recognition is in operation on the Golden Ears Bridge. Zipcar, a carshare company, utilizes contactless smart card technology and a mobile phone application to grant users access to vehicles. Finally, the bikeshare model most likely to be adopted by Vancouver would utilize an electronic key card.

Canadian and American practices are largely similar to Vancouver, although innovative approaches in Utah and New York City leverage the prepaid, debit and credit contactless cards issued by financial institutions by allowing them to be used as a transit smart card, directly at the farebox. In addition, prepaid, debit and credit contactless cards are being deployed in Philadelphia, New York City and Los Angeles taxis, and are being experimented with on tolled roads. In Hong Kong, transit smart cards are used for a wide variety of applications that transcend transit, including retail and parking. In other countries, such as Taiwan and Malaysia, multi-use cards are used that combine transit and credit cards into one. In addition, the installation of proximity chips in mobile devices has given mobile phones the ability to conduct proximity transactions at fareboxes. Finally, in Paris, transit cards can be used to pay for and access the Vélib' bikeshare system, and there are plans to extend the card's use to Autolib', a publicly owned carshare program, when the service is rolled out next year.

For consumers, the contactless interface of transit's payment and access systems and, by proxy, non-transit payment and access systems, is said to improve convenience, provide an ability to use the same card on multiple operators and have

features such as registration/balance protection. For agencies, the interface provides the data capacity and security features to support the ability to capture critical operational data, enhance revenue management activities, create partnerships, facilitate innovative fare options, manage loyalty programs and allow faster boarding time. The weaknesses are generally viewed to be the card fee/deposit, which is higher than traditional media (although the card is reusable), that it is not well-suited for one-time users because of the fee/deposit, and the variety of card interfaces make it difficult to integrate with other regions.

Traditionally, it is necessary to issue transit cards separately from debit cards because transit payment and access systems need to perform at high speeds or face declining customer service. This means that there has traditionally been a niche market for transit cards. However, this traditional distinction is fading as transit payment and access systems, along with large payment companies such as MasterCard and Visa, increasingly adhere to the ISO/IEC 14443 and EMV international standards for contactless cards. This gives payment companies new business opportunities in the transportation industry, and the transportation industry the ability to directly leverage the infrastructure and services of the financial industry.

The main recommendation of this report is that the Vancouver region formally adopt international standards, which are otherwise not compulsory, for payment and access in the region's transportation industry. This way, Vancouver transportation electronic payment and access systems will not only allow for interoperability between service providers, but also interoperability with the services of other regions. Achieving this end may involve some clarification of institutional roles, perhaps via provincial legislation, since it is not clear whether Translink has sufficient neutrality in the matter (i.e. Translink is independently rolling out its own system), whether Metro Vancouver has jurisdiction over a matter that clearly intervenes in regional transportation matters, and whether BIAs and other NGOs have the capacity and authority to consult with service providers in a systematic manner. Upon clarifying institutional leadership in facilitation, the Vancouver region can begin to adopt a common standard, ideally the international standard, for electronic payment and access system in Vancouver regional transportation, and doing so will, over time, lead to a system that is sufficiently integrated so as to allow for interoperability.

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Introduction

Statement of Purpose

The Downtown Vancouver Business Improvement Association is currently interested in acquiring the information necessary to strengthen its position in advocating for a streamlined and integrated electronic payment and access system for parking and transportation services in the Vancouver region. The research design supports gathering and synthesizing information for analysis in order to deliver a report intended to (1) provide the background necessary to develop an understanding of current worldwide practices in transportation electronic payment and access, (2) establish key findings to inform the development of a set of recommendations identifying the opportunities available to further advocate for an integrated electronic payment process for parking and transportation in the Vancouver region and (3) clearly identify complexities and challenges related to technological and policy development in this area.

Problem Statement

Regional governments across North America have established, or have taken the first steps towards establishing what, in this paper, is referred to as *transportation and parking electronic payment and access systems*: a means by which to conduct payment and grant access to transportation and parking services through the utilization of contactless cards, proximity chips and mobile devices rather than coins, tokens, paper tickets and paper passes. These new media can be used as a means by which to pay for any number of parking, tolling, mass transit, bus, ferry, carshare, bikeshare and taxis services. Standard practice is for transportation service providers to adopt these new payment and access systems independently, without a regional vision towards the integration of payment and access procedures (for details, see next 'National and International Practices' section).

A regional payment and access system for transportation and parking services would require the collaboration of numerous service providers in the Vancouver region, including the operators of parking garages, on-street parking, carshare programs like Zipcar, taxis, buses, SeaBus, SkyTrain and a future bikeshare programs. Numerous service providers operate under the umbrella of Translink, including buses, SeaBus and SkyTrain. Other service providers are independent, some of which are privately owned (example: some parking garages and carshare) and others of which are owned by the City of Vancouver (example: on-street parking). With respect to future programs, such as a future bikeshare program, discussion continues over who the owners and operators will be.

A coordinated approach would address issues of interoperability, global acceptance and ease of use. A number of factors threaten to arrest the development of a more integrated payment and access system, including the proliferation of competing network standards, incompatible operating systems/devices, a lack of secure and interoperable standards, market uncertainties and a lack of viable business models that address cooperative interests.

Research Design and Report Outline

This is an exploratory qualitative study on the latest developments of mobile payment and electronic user information systems in the transportation industry and the implications for the Vancouver region. The study employs an inductive approach that does not seek to develop a rigorous framework for experimental control and manipulation of variables. Rather, it seeks to determine what the Vancouver and worldwide practices are and, based on these practices, what the implications are and what recommendations can be made for Downtown Vancouver's diverse set of stakeholders, especially the Downtown Vancouver Business Improvement Association.

The stages of research include (1) essential history and context, (2) case studies, (3) literature review and (4) key informant interviews. These first four stages provide the basis for (5) this final report and analysis.

| Essential History and Context | Case Studies | Literature Review | Key Informant Interviews | Final Report and Analysis |
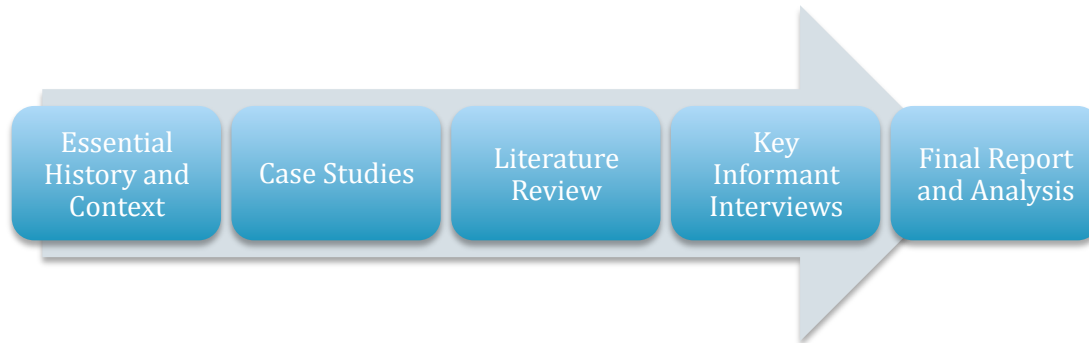
Essential History and Context. This stage involves general web searches for web pages, press releases and newspaper articles that will illuminate the current events in the mobile payment and electronic user information systems in the transportation industry.

Case Studies. This stage involved a survey of programs and infrastructure in other cities, the picking of representative cases and a detailed look at the representative cases. This stage involved web searches that yielded news articles, press releases and the informational web pages of the websites of the relevant transportation agencies. As discussed in the next section, electronic payment and access systems are being used to varying extents in all parts of the world, so it can be an overwhelming task to create a complete inventory. The approach to selecting case studies was to focus on the Vancouver, Canadian and American practices, thus highlighting the immediate context within which Vancouver sits, and then to supplement the discussion with unique cases from outside of North America for the purposes of inspiring Vancouver's approach towards constructing its own unique and integrated transportation payment and access system. The North American practices are already practiced widely outside of North America. Thus, the international cases presented in the next 'National and International Practices' section are only those international practices that vary in some way from the base Vancouver and/or North American cases.

Literature Review. In this stage, a search for scholarly articles pertinent to mobile payment and user information systems is conducted. Whereas the purpose of the 'Essential History and Context' section is to determine what the relevant current events are, the purpose of the 'Literature Review' is to construct an abstracted conceptual understanding of the mobile payment and electronic user information systems in the transportation industry, as well as to provide an account of other similar studies that have been conducted in the past.

Key Informant Interviews. Whereas the first two stages involve a survey of public and academic information, this stage involves nuancing the Vancouver institutional context through one-on-one key informant interviews. Participants are members of the Downtown Vancouver Business Improvement Association's Access and Mobility Committee, on which sit several pertinent representatives of stakeholder groups, as well as independent experts.

Interviews are semi-structured, meaning that they are flexible, allowing new questions to be brought up during the interview as a result of what the participant's particular expertise is, and what he or she says during the interview. While not formalized with a limited set of questions, specific topics have been thought about in advance. In particular, the participants are asked about each of mobile payment and user information technologies - what the advantages and disadvantages are from his or her organization's point of view, what he or she sees as the barriers to the technologies' proliferation, and what the organization's prerequisites to the technology's adoption are.

Final Report and Analysis. The final stage involves compiling all of the research in a final report for the Downtown Vancouver Business Improvement Association that comments on the implications for and makes recommendations to the Vancouver region's various stakeholders. This report draws together best practices, industry trends and the Vancouver context to make recommendations that will not only assist in developing policy around the adoption of mobile payment and user information technologies in the Vancouver transportation industry, but also identify

opportunities for and barriers to institutional cooperation on the matter. The report also identifies areas where further study is required.

What follows in the next two sections are the projects findings, organized under the descriptive titles of 'National and International Practices' and 'Conceptual and General Items'. Following these two sections is an 'Analysis' section that has been used to synthesize the findings. Finally, a 'Recommendations' section is targeted at institutions in the Vancouver region.

National and International Practices

The purpose of this section is to provide an overview of worldwide practices in transportation payment and access systems in order to place Vancouver within broader national and international contexts. As discussed in the introduction, the approach to composing this section was to focus on the Vancouver, Canadian and American practices, thus highlighting the immediate context within which Vancouver sits, and then to supplement the discussion with unique cases from outside of North America for the purposes of inspiring Vancouver's approach towards constructing its own unique and integrated transportation payment and access system.

The Vancouver Context

Innovations in Vancouver's payment and access technologies span transit, parking and carshare. I have also included bikeshare, even though it has not been deployed in Vancouver because serious consideration is being given to bring it to the Vancouver region in the future.

Transit: The Translink Smart Card

Translink is presently committed to implementing a smart card-based payment and access system for SkyTrain, SeaBus, buses and West Coast Express. Three consortia (Thales/Octopus International Projects, Serco/Parkeon, Cubic/IBM) that supply smart card electronic fare payment systems to other cities have qualified to submit proposals to supply a smart card and faregate system for Translink. A contract, that will include operations and maintenance of the system for 10 years, could be awarded later this year, with work beginning in 2011 and operations beginning in 2013.

Funding for the smart card electronic fare payment system, first announced in April 2009, comes from the Government of Canada, British Columbia and Translink. The Province is investing up to $40 million and the Government of Canada has agreed in

principal to commit up to $30 million to a maximum of one-third of eligible costs in this project. Translink will fund the balance of the project, with the total project budget being $171 million.

The fare payment system will utilize a card, about the size of a credit card, that will be available at all transit stations and replace current forms of tickets and passes on Translink's system. Smart card holders will be able to "load" their cards with money in person, via phone or on the Internet, and then use it on all forms of Translink-operated transit in Metro Vancouver by "tagging on / tagging off" at electronic readers as they board and exit transit vehicles. In addition, Bob Paddon, Vice-President, Corporate & Public Affairs for Translink, pointed out in an interview that the system might eventually allow Visa and MasterCard proximity chips to be scanned at the gate as well.

Translink expects it's electronic fare payment system to have the following benefits:

- Provide a more seamless travel experience for passengers accessing Translink's transit network
- Produce data that can provide Translink with greatly more accurate and detailed information about the ridership behavior of transit customers
- Allow for new fare options and a greater variety of price incentives to reward customer loyalty and attract new people to transit
- Address problems associated with fare evasion and help Translink capture additional revenues that are being lost

Parking: The Verrus Pay-By-Phone Service

In Vancouver, a pay-by-phone parking service is operated by Verrus Mobile Technologies Inc. As of 2007, the service covered 500 lots and 8,300 on-street meters in the Vancouver area. According to Verrus, this represents over 85% of all meter and surface lot spaces, the largest North American deployment of pay-by-phone parking services. In 2001, Imperial Parking was the first parking operator to adopt the Verrus pay by phone parking service, which it operates under its "Impark Wireless" brand. Since then, Advanced Parking, Metro Parking, Diamond Parking

and Easy Park formed partnerships with Verrus. The City of Vancouver and its neighboring cities of White Rock and Richmond have also incorporated the service into their on-street parking spaces.

To use the service, motorists call or send a text message to the Verrus system, enter the location number of the meter or parking lot, and then enter the total time they would like to park for. First-time users of the system can create their accounts online using a credit card and license plate. Not only does the service eliminate the need for coins, cash or pay stubs, but the service also provides automatic text reminders and the ability to remotely extend your time from any phone. Mel McKinney, General Manager for Easy Park, says that, at present, pay-by-phone represents a relatively small proportion of the company's overall revenue at about $410,000 of about $28million. Unlike Translink's payment and access system, the Verrus system was adopted at no upfront cost to EasyPark. Instead, Verrus extracts a small fee for its services each time it is used by a customer. There have been some issues with the lack of detail on account statements that Easy Park gets from Verrus (i.e. the company operates parking garages at a number of locations and the statements were not location-specific) but the systems is, otherwise, functionally working well.

Figure 1: A meter in Vancouver that enables pay-by-phone

Tolling: The Golden Ears Bridge

The new Golden Ears Bridge, which opened in 2009, uses an electronic tolling system to recover construction costs, the first time tolls have been used in the Lower Mainland since the 1960s. Drivers have the option of opening a tolling account that includes a transponder that is mounted on the vehicle's windshield. It will detect usage of the bridge, allowing toll charges to be automatically billed to the driver's account. Vehicles without an electronic tolling device will have their license plates identified through an automated video recognition system, and will be billed accordingly. Drivers will also have the option to pay for their trip in advance by establishing a temporary account with a credit card.

Carshare: The Zipcar Access Card

U.S.-based Zipcar initially invested about $2 million to launch the car-share service in Vancouver with a fleet of 100 new vehicles spread throughout the city. The commercial venture competes with the non-profit Co-operative Auto Network, which has operated in Vancouver since its creation in 1997. The Co-operative Auto Network has more than 3,000 members who can choose from about 160 vehicles throughout the Lower Mainland. Car sharing allows members to reserve a car for personal use and to pay by the hour. Zipcar members pay a one-time application fee ($25) and an annual membership fee ($55) to join. It costs from $8.30 to $14.75 an hour to use a vehicle, which includes insurance, gas, designated parking, maintenance, and up to 150 km of driving in a 24-hour period. The Cooperative Auto Network uses a different rate structure than Zipcar, charging a $500 membership fee, which is refundable, and a $2-an-hour vehicle usage charge, plus driving charges of 18 cents to 38 cents per kilometer. These services differ from traditional car rental services in fee structure, as they are meant to provide incentives for short-term use within a city, and features cars placed at convenient on and off-street locations.

Upon completing an online application, customers of ZipCar are sent a contactless smart card by mail. Upon receiving the card, users can reserve cars online by location, type of car and time slot. A car that has been booked by a customer can be

unlocked by tapping the contactless smart card to the car's windshield. Alternately, a new iPhone application allows ZipCar members to find, book and unlock the doors to vehicles. The application acts as a virtual key fob that sends a signal to the ZipCar system, then to the car for unlocking. In both cases, payment is made using a credit card, so the contactless smart card and iPhone application are solely used for access purposes.
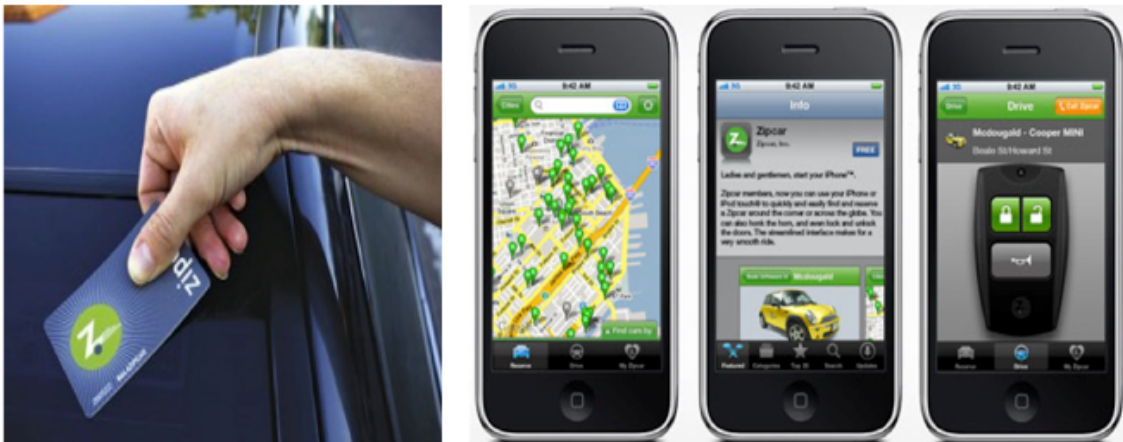
Figure 2: (left) smart card swiped at windshield to gain access to reserved car and (right) mobile application allows user to reserve car online and unlock reserved car

Bikeshare: The BIXI Access Card

While not yet built, public bike sharing has been identified by the City of Vancouver as a 'high priority' project for the near future, with the most feasible platform being the BIXI system used in Montreal (City of Vancouver, 2009). For users subscribed to a yearly or monthly BIXI service plan in Montreal, a small card is sent by mail that can be used to unlock a bike. When finished, the bicycle is returned to any BIXI bike station in the city. One-time users can pay with a credit card at the automated pay station that will then print an access number for 24-hour day pass users. Paddon suggested that Translink is the likely operator of future Vancouver bikeshare because municipalities want it to be a regional program. He agrees that it ought to share an electronic purse with the payment and access system being planned for other Translink services.

Figure 3: BIXI keycard allows rider to access a bike

Canadian Practices

Transit Smart Cards

Several transit payment and access systems are in development in Canada. The cities listed below have already rolled-out or are planning to rollout transit electronic payment and access systems.

Regional Programs

- Ontario PRESTO
- Quebec OPUS

Municipal Programs

- Calgary (in development)
- Edmonton ETS BLUE (piloting)
- Kingston MY CARD
- Regina (in development)
- Saskatoon GO-PASS
- St. John's M-CARD

Typically, coins continue to be accepted at fare boxes, but the use of paper money and paper tickets are discontinued. Instead, tickets and monthly passes are loaded onto a reusable smart card at the time of purchase. As will be the case in Vancouver, holders will generally be able to put money on their cards in person, via phone or on

the Internet, and then use it on all forms of transit by scanning their card at electronic readers as they board and exit transit vehicles.

Canada's two largest systems are worth special mention as they bring together multiple transit authorities. The Quebec OPUS system was the first in Canada and covers the Montréal and Québec City region, including Longueuil and Laval (this is most of the public transit systems in Quebec). The Ontario PRESTO system began its rollout almost two years after the OPUS system, and is still in the rollout phase. Plans call for PRESTO to finish being rolled out across the Toronto, Hamilton and Ottawa region by the end of 2011. The OPUS system brings together sixteen transit authorities and PRESTO brings together eleven.

OPUS	PRESTO
Agence métropolitaine de transport	*Ontario Ministry of Transportation*
Société de transport de Montréal	*GO Transit*
Société de transport de Laval	*Oakville Transit*
Réseau de transport de Longueuil	*Burlington Transit*
Réseau de transport de la Capitale	*Brampton Transit*
CIT Sorel-Varennes	*Mississauga Transit*
CIT Laurentides	*Hamilton Street Railway*
CIT Chambly-Richelieu-Carignan	*York Region Transit*
CIT Le Richelain	*Durham Region Transit*
CIT Roussillon	*OC Transport*
Ville de Sainte-Julie	*Toronto Transit Commission*
CIT La Presqu'Île	
CIT Vallée-Richelieu	
CRT Lanaudière	
CIT Sud Ouest	
CIT Haut-Saint-Laurent	

It is standard practice in the development of electronic payment and access systems that the transportation industry engage in a collaborative process involving a multitude of stakeholders, often across multiple jurisdictions that have historically utilized separate ticketing systems, payment procedures and passes. The first widely used electronic payment system was developed in Hong Kong (discussion forthcoming) and required the coming-together of five major transportation operators. Similarly, Toronto's regional electronic payment system required coordination amongst ten agencies, including involvement from the provincial Ministry of Transportation. Other regions in Quebec, Washington state and elsewhere in North America and worldwide have engaged in a similar collaborative processes in the development of their transit electronic payment and access system.

Figure 4: (left) Quebec Opus card and reader, (right) Ontario Presto card and reader

American Practices

Transit

Transit payment and access systems in the United States are largely similar in nature to those in Canada, with a few differences and innovative exceptions. Examples of American transit payment and access systems:

State-Wide

- Maryland CHARM CARD
- Utah (open payment system)

Municipal/Regional

- Atlanta BREEZE
- Boston CHARLIE CARD
- Chicago CARD
- Houston Q CARD
- Los Angeles TAP
- Miami EASY CARD
- Minneapolis – Saint Paul GO-TO
- New York/New Jersey SMART LINK and open payment pilot
- Philadelphia/New Jersey FREEDOM
- San Francisco Bay Area CLIPPER
- San Diego COMPASS
- Seattle ORCA
- Spokane GO
- Ventura GO VENTURA
- Washington D.C. SMAR-TRIP

As is the case with Canadian systems, most American systems will eventually be discontinuing paper tickets and passes by loading them onto a reusable smart card that can be reloaded in person at stations, via phone and Internet. In one case, Washington D.C., the SMAR-TRIP card was made the exclusive form of payment for all park 'n ride lots owned by the transit agency, although complaints eventually led to the acceptance of credit cards too. Besides park 'n rides in Washington D.C., however, there has been little experimentation with how payment and access systems can be extended beyond transit.

However, innovative approaches to access and payment systems that differ from those in Canada and most other regions of the United States are being experimented with in Utah State and New York City. Transit agencies there accept contactless prepaid, debit and credit cards issued by financial institutions at the farebox, meaning that these third-party cards are functionally both payment and access passes. In addition to accepting the cards of financial institutions, other cards such as company and school-sponsored annual passes can be used in Utah. It is these

third-party cards, rather than agency-issued transit cards, that are tapped to gain access to a bus or transit fare-zone. In addition, Visa recently released an application for the iPhone that allows transit riders in New York to tap their NFC-enabled[1] phone, rather than their Visa card, at the farebox. It is expected that the new approach will save transit agencies money that is now used to issue fare media (i.e. the contactless smart cards) and manage the fare payment and collection system.

Experimenting in these regions comes following the release of MasterCard PayPass and Visa PayWave, contactless payment platforms that allow customers tap their card, phone, FOB or other payment device on a contactless-enabled terminal or reader at checkout. Customers do not have to swipe or hand their card to a cashier, and there's no signature required for purchases under $50. These companies are experimenting with other transportation payment solutions in the United States. For example, MasterCard is working to bring PayPass terminals into New York City taxis, as well as taxis in Philadelphia and Las Vegas. Taxis in Philadelphia began accepting contactless prepaid, debit and credit cards in November 2006 and New York City taxis began accepting them in 2007. In 2006, MasterCard worked with the Ohio Turnpike Commission to bring a consumer trial of PayPass payments in selected exit lanes and service plazas on the Ohio Turnpike. The Ohio Turnpike is the first toll road in the U.S. to accept payment cards for self-service toll transactions and the first to test general-purpose contactless payment cards in a highway environment. Finally, Affiliated Computer Services has been working with MasterCard to bring PayPass to its parking applications at major airports throughout North America.

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[1] NFC refers to 'near field communication', typically enabled using a computer chip that can be read when it is held near (usually within 10 cm) of a reader

Figure 5: (left and middle) MasterCard PayPass tapped near contactless reader directly at transit farebox in New York City and (right) card is tapped near contactless reader at farebox on a public bus in Utah

Tolls

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 United States have implemented such systems. The Inter-Agency Group (IAG)[2] of New York/New Jersey worked for 4 years to test and finally adopt a common transponder system for all its members (Smart Card Alliance, 2006).

Today, millions of vehicles carry E-Z Pass 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-Z Pass users. RFID-based transponder technology is also used in Florida, Illinois, California, Oklahoma and

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[2] IAG includes agencies that extend across several northeastern states and represent the majority of tolls paid in the United States

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 (Smart Card Alliance, 2006).

Figure 6: E-Z Pass transponder installed near the rearview mirror

International Practices

Hong Kong Octopus System

The Octopus payment and access system was originally introduced for fare payment on the MTR, the rapid transit railway, but, in 1994, Hong Kong's five major public transport operators – the MTR, KCRC, KMB, Citybus and the Hong Kong and Yaumatei Ferry – established a joint venture known as Creative Star Limited (renamed Octopus Cards Limited in 2002) to oversee the development and implementation of contactless smart card technology. As with Canadian and American systems, the Octopus utilizes a rechargeable contactless stored value smart card to transfer electronic payments. Customers "load" money onto their cards and then "tag on / tag off" at electronic readers. According to Octopus Cards Limited, 95% of people in Hong Kong aged 16 to 65 use Octopus (Octopus, "Corporate Profile: Services in Hong Kong").

In 2000, Octopus obtained deposit-taking company authorization from the Hong Kong Monetary Authority, which allowed the company's expansion into a wider range of different applications, especially in the retail sector. Over 3,000 service providers throughout the territory now support the card (Octopus, "Corporate Profile: Services in Hong Kong"). The card can also be used in soft drink vending machines, pay phones and photo booths. In addition, the card doubles as an access control card for numerous buildings and for school administrative functions. At certain office buildings, residential buildings, and schools, usage of an Octopus card is required for entry. In 2006, the first trial of taxis equipped with Octopus card readers was launched but many drivers dropped out of the program because they had to return to the office every day for accounting. Therefore, Octopus is working on upgrading the system to allow automatic account updating from taxis in the future.

Today, the card is not only used for purchasing consumer products and the vast majority of public transit but also for most on and off-street parking. As of 2006, close to 200 parking garages accepted Octopus cards for payment of parking fees. The parking garage system works as follows: on entry, the customer obtains a ticket and a barrier rises automatically. The ticket is a magnetic ticket retained by the customer. On exit, the customer drives to the exit gate, inserts the magnetic ticket in the gate, and pays by presenting the Octopus card. To obtain a receipt, the customer presses a button at the exit gate. 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. In addition, all on-street metered parking spaces in Hong Kong (over 17,700 in 18 districts) are equipped with Octopus parking meters as of November 21, 2004. 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 (Smart Card Alliance, 2006).

Since its inception, the technology has since been exported to the Netherlands and Dubai. Octopus Cards Limited is also one of ten companies that responded to Translink's 'Request for Qualifications' last year to supply and operate a transit payment and access system for the Lower Mainland, and is now one of three companies selected by Translink to submit formal proposals.

Figure 7: Parking meter in Hong Kong accepts Octopus

Malaysia: Touch 'n Go

In Malaysia, a smart-card based payment and access system called Touch 'n Go provides the basis for a national electronic toll collection system implemented on many highways and bridges since 1997, but is also used at many locations throughout the country for transit, parking and theme park charges. As with other smart cards, the user simply touches a Touch and Go card at designated readers and the toll or fare is deducted electronically from the card.

In addition, a NFC-enabled phone is being piloted on the network that lets customers use a Nokia NFC-enabled phone to not only make Touch 'n Go contactless transactions, but also Visa PayWave transactions. In this case, the cell phone has an embedded RFID chip that allows the proximity transaction to take place. Several stakeholders teamed up in order to launch this product, including Maxis, the largest wireless carrier in Malaysia, Nokia, Maybank, a leading Malaysian financial institution, transport payment card issuer Touch 'n Go and Visa. Customers who

sign up for the new Maxis FastTap service are able to use their Nokia 6212 Classic phones to purchase goods and services at more than 1,800 Visa PayWave merchant locations as well as pay for toll, transit, parking and theme park charges at over 3,000 Touch 'n Go points nationwide. Customers simply wave their NFC-enabled Nokia 6212 Classic handset in front of a contactless reader to complete their transactions (Clark, 2009). Similar NFC mobile payment technology is in use in Japan.

Figure 8: Maxis FastTap enabled Nokia mobile phone and reader

Taiwan Money Card

The TaiwanMoney Card, used for payment in the city of Kaohsiung and its vicinity, is an all-in-one payment card that combines credit, debit, stored value features and provides access to ATMs. Although the card utilizes MasterCard PayPass contactless technology, this card differs from program in New York and Utah in the credit and debit functions of the card are not used to payment at the farebox to gain access to transit. Rather, the Taiwan money card is three cards combined into one, including a transit card that still must be loaded. It is similar, in concept, to the Nokia NFC-enabled phone in Malaysia as it too combines credit and transport-payment services, but does not allow VISA PayWave itself to be used directly at the reader (MULTOS, 2006).

Figure 9: TaiwanMoney Card is both a transit card and a credit card

Paris: Navigo, Vélib' and Autolib'

A payment and access system similar to elsewhere is used in Paris, but is worth special mention here because the system includes the Vélib' bikeshare program. Use of the transit card with bikeshare differs from other cities such as Montreal and London where it is necessary to obtain a separate access key. Similar in concept to Vélib', a program called Autolib' is under development with deployment expected in 2011. Autolib' is a program which allows casual car users to pick up a publicly owned battery-powered car in one part of the city and drop it off in another. Users will either pay an annual subscription, or pay at pick-up points on the spur of the moment by using their public transport pass. An increasing number of neighboring cities have also joined in developing and funding the Autolib' program.

Figure 10: (left) bikeshare in Paris is payable using Navigo transit card and (right) an artistic rendering of a future carshare program that would accept Navigo transit card

Conceptual and General Items

The purpose of this section is to convey findings that are broader than those of the previous section. This section includes generalized findings that not only arise out of the literature, but also general web searches for relevant news articles and other websites such as those of transit agencies. In addition, the nine interviews that were conducted are discussed in this section, usually at the end of each subsection. Thus, a secondary purpose of this section is to show how the general findings apply to the particular context of Vancouver. A synthesis of these findings is not provided here, but rather in the next section, 'Analysis'.

The section begins with a discussion specific to contactless smart cards *in transit* because they are the best documented electronic payment systems in the transportation industry, and because, as further discussed in the 'Analysis' section, the discussion is largely generalizable to other forms of electronic payment. The second part of this section discusses mobile payments in transportation more generally, including a classification of mobile payments according to attribute. The general discussion of mobile payments is included for the purposes of framing mobile payment in transportation within the broader mobile payments discussion (for example, retail payments made by mobile devices).

The topics in this section include:

- Differences Between Transit and Debit Cards
- Functions and Features of the Contactless Transit Card
- Business Issues
- Card *Issuing* Versus Card *Accepting*
- International Standards
- Payment Classification and Other Technologies

Difference Between Transit and Debit Cards

Transit agencies typically invest in their own smart card payment and access system and issue cards that must be "loaded" with passes and/or credit. In contrast, ordinary retail outlets seldom *issue* their own cards. Rather, they typically *accept* third-party debit and credit cards. Transit agencies often accept third-party debit and credit cards as well, but these cards are usually only used to load credit onto a transit card, meaning that the customer is always carrying at least two cards.

There is good reason debit and credit cards have not traditionally doubled as a transit access card at the farebox. Specifically, debit and credit cards are generally too slow for farebox payment. Transit operators need to assure that any payment device performs at speeds ranging from 70 to 300 milliseconds for the entire customer interface (i.e., using the fare medium at a gate, performing the transaction, and opening the gate) because transaction speeds have a significant impact on transit customer service (i.e. reducing the length of queues and speeding passengers through the system) (Smart Card Alliance, 2003). This speed is significantly faster than a typical debit/credit transaction at the point-of-sale in a retail setting. Other differences/limitations exist, and are explored under the next subheading.

Functions and Features of the Contactless Transit Card

Listed here are the espoused functions, benefits and weaknesses of transit contactless smart card systems. I say 'espoused' because at least some of the benefits/weaknesses are *potential* benefits since there have not yet been any objective studies to confirm them. The functions, benefits and weaknesses discussed here are a summary of what the literature and transit agencies conceive of as the benefits and weaknesses.

To begin, transit smart cards have at least two basic functions:

- Payment
- Access

In many cases terminals read the amount of money on a card and then deduct the transit fare (this is the *payment* function). Following payment, the user is permitted *access*. In other cases, a weekly or monthly pass may have been loaded onto the smart card. In the case of passes, payment is not made at the farebox. Rather the pass, which has been loaded onto the card, is merely confirmed by the reader, and the user is granted access. Debit/credit cards are not typically viewed as access cards, although I will discuss in the Analysis section how this is not necessarily a limitation on the use of debit/credit cards in transit payment.

Differing perspectives mean that the card may perform additional basic functions. For example, transit agencies frequently cite the card's ability to capture critical operational data to improve service planning as a rationale for spending large amounts of public funds the cards and their infrastructure. Below is a list of frequently espoused benefits and weaknesses. Data collection and discount programs are elaborated on following this list.

A. Customer Benefits

• Improved convenience of the contactless interface (i.e. the card does not have to be removed from a wallet or purse to scan)

• Ability to use the same card on multiple operators and for nontransit purposes (e.g., parking or retail payments, university or employer ID/access, and other functions)

• Features such as registration/balance protection, employer autoload, and negative balance

B. Agency Benefits

• Data capacity and security features needed to support partnerships that can help spread system costs

• Faster boarding or throughput than other fare media could ultimately translate into service reliability improvements

- Higher data capacity and processing capabilities facilitate innovative fare options, and the management of loyalty and other discount programs

- Ability to capture critical operational data to improve service planning

- Nontransit applications (e.g. retail payments, university or employer ID/access, and other functions)

- More efficient revenue management activities. Depending on how the transit operator processes currency, reconciling reports from electronic transactions can be more efficient (thus reducing operation costs), reduce inaccuracies and provide an audit trail, which can lead to a strengthening of internal controls.

C. General Weaknesses

- A card fee/deposit may be needed which has raised equity objections from low-income riders

- Not well- suited for one-time users (e.g., visitors) because of card fee/deposit

- Variety of card interfaces in market place complicate potential to integrate with other regions or other applications

Here, I will make special mention of two features raised by interviewees: discount programs and data collection. Finally, I end this section with a discussion on the criticisms made by interviewees.

Both McKinney and Paddon raised the topic of managing discount and loyalty programs. McKinney suggests that, for parking, an electronic payment system could help to manage sustainability programs such as discounted parking rates for those who carpool. Similarly, Paddon points out that an integrated payment system could help identify commuters who use transit avidly during the week so that they can be given a discount on parking on the weekend (see 'Analysis' section for more on this). Others made such comments as well. Although I did not identify an existing program of this nature, I did find that loyalty programs are an important feature of transit smart cards where they are used in retail. In Hong Kong, for example, loyalty programs are one of three 'business applications' of the Octopus card, the other two

functions being 'payment' and 'access'. In the Hong Kong case, a user earns cash value every time a purchase is made that can be used at numerous partners, a list which includes international companies such as McDonald's.

Also worth rising, Paddon points out that electronic payment systems play the dual function of collecting data about their users. Users 'tap-in' when they get on the train and 'tap-out' when they get off the train. Translink can analyze such travel data for the purposes of improving service along crowded corridors. Collecting the data from electronic readers would be a significant improvement over current data collection techniques. With such a system, data from the readers can potentially be viewed according to smaller temporal units such as a particular time of a particular day.

Finally, although the use of smart cards in transportation were widely viewed by interviewees as both enhancing customer convenience and bringing benefits to agencies that use them, Richard Drdul, community transportation planner, suggested that the customer and business benefits are not clear. He makes the point, which has been confirmed through this report's research, that objective studies testing these benefits have not been conducted. While many suggest, for example, that the increased convenience will lead to an increase in the number of customers, in turn increasing revenue, there is no objective evidence to suggest this is the case. Others, such as Dave Lewin agree, predicting that an adoption of such technology will not increase the number of customers. One study out of the United States has examined how transportation agencies evaluate smart card systems and found that analyses across agencies are neither consistent with one another nor definitive to provide any systematic evaluation of costs and benefits of smart card deployment. These shortcomings are mainly due to: (1) difficulty of estimating many of the qualitative benefits, such as convenience for transfers and comprehensive regional travel data, (2) a significant variation in quantitative cost estimates among the analyses for unclear reasons, and (3) difficulty in generalizing costs and benefits among cases with the unique organizational structures and particular political issues in different regions (Iseki, 2008).

While it is true that adequate evaluation are not generally conducted, customer satisfaction studies have been conducted. Users of smart cards have expressed generally high levels of satisfaction with the cards and programs. For instance, in Chicago, 93% of survey respondents were satisfied or very satisfied with the cards, and 86% expressed willingness to continue using the card after the conclusion of the pilot period and to recommend the card to others. In the San Francisco program, both survey respondents and focus group participants expressed a high level of satisfaction with the program. Moreover, two-thirds of non- card users surveyed said that they are "very likely" to try the card. Finally, sales of the SmarTrip card in Washington have grown steadily since its introduction, despite the fact that WMATA has done very little marketing of the program (Coverage, 2009).

Business Issues

In the case where regional transit authorities and service providers issue their own card, issues such as fraud exposure and liability need to be considered. When a card is accepted outside a particular transportation network, say public transit, the card issuer is exposed to additional losses associated with fraud. These are expenses to the card operator. Partners in a payment scheme must consider and define the liability for payment fraud. This is in addition to how funds are moved, customers are served and how information is shared (or not shared). Numerous articles have been written that address the business case and issues in collaborative governance of regional automated payment systems. A good example of a 'how-to' establish and operate a regional transportation payment system and clearinghouse can be found at:

http://www.aptastandards.com/LinkClick.aspx?fileticket=V1JSPsB9CPI%3d&tabid=168&mid=703&language=en-US. This document covers key terms, functions of a regional payment system, funding and governance structure.

A critique of the business case for regional payment systems will be covered in the 'Analysis' section in more detail. A discussion of the Vancouver interviews will be covered in the remainder of this section.

Paddon and others from Translink say that adding applications to their smart card will be simple, thus making it possible for parking operators and other businesses to utilize the card. However, allowing independent service providers to use the card would have to make business sense. In other words, allowing others to utilize the card would have to add value to the card. At present, Translink is focused on getting the card established. Initially, the card will not share an electronic purse like Hong Kong's Octopus card because Translink will not be operating a central clearinghouse. In addition, there are no current plans to extend the usage of the card. Having said this, Paddon did say that extending the card's usage could potentially create revenue opportunities for Translink as well as enhance Translink's business image.

Others commented on the business logic of collaborating to release a joint mobile payment system. The joint payment system discussed in the interviews did not necessarily take the form of a smart card. McKinney suggested that the selling points to Easy Park are more efficient accounting, more convenience for customers, enhanced brand and the possibility of generating new business. As with Translink, brand recognition was stressed. McKinney points out that 25% of people recognize the EasyPark brand while 90% recognize the Impark brand. However, McKinney suggests all these benefits are limited because, in parking, customers ultimately choose parking based on proximity to their final destination. Finally, McKinney also suggests that a pre-requisite to adopting an electronic payment system is that it must communicate with enforcement. In other words, enforcement officers must know who has paid for parking and who has not, which would require a means by which to download information electronically to a portable device. Another pre-requisite is that the system be provided at little or no upfront cost. Unlike Translink's future smart card and faregate system, EasyPark's current mobile payment scheme, operated through Verrus, did not cost anything to establish.

Dave Harkness, Director, Parking & Ground Transportation for the Vancouver Airport Authority, points out that there is a different culture at EasyPark because of the company's relationship with the city. Dave Harkness' opinion is that any integrated system that involves parking would be best started with EasyPark in a manner that leaves it open to others joining later. Harkness also echoes McKinney's (and others) sentiments that brand is of central importance, even though parking is ultimately driven by location. An example of this is how the Verrus system had to be rebranded Impark Wireless when it provides services to Impark customers. Harkness suggests that the Verrus/Impark system functionally works great, but that the public needs to be educated so that they think it is convenient too.

Dave Lewin of ZipCar points out that their electronic access system is operated through Boston, so changes made in Vancouver have to be made elsewhere, although this would not be the case with the Car Co-op. Levin's pre-requisite is transparency and accountability. A drawback that Lewin sees for an integrated system is that competitors would be put on a list alongside ZipCar, showing customers that they have another option that they didn't know they had before. Lewin also points out that he has been approached before for an intertwined card and discusses how it would have hurt Zipcar's brand. With respect to Brand, Lewin also points out the importance of having an independent card with the company's logo. Every time a customer takes out the card, he or she sees the company's logo. An integrated card would not leave the same brand impression on the customer. In addition, the card has other functions including contact numbers for ZipCar, the customers ID number and instructions for accessing the company's cars.

Card *Issuing* Versus Card *Accepting*

As mentioned in the previous 'National and International Practices' section, several agencies are transitioning to an 'open source' payment system, meaning that agencies' payment systems are built to accept cards from third parties. Third-party cards can be accepted both in place of and in conjunction with an agency's self-

issued cards. Two North American examples stand out. As discussed earlier, New York City's three transit agencies are together piloting readers at the faregate that allow customers to use third-party contactless prepaid, debit and credit cards, along with other devices such as NFC-enabled cell phones and key chains, issued by financial institutions to be scanned directly at the faregate for both payment and access to transit. Utah is already using a similar system that not only accepts debit and credit cards, but other cards such as ski passes that have been built to conform to the system's standards. Paddon points out that Translink's system may also allow Visa and MasterCard's proximity chips to be scanned directly at the gate, giving customers payment options that go beyond the Translink smart card. Paddon points out that third parties such as Visa and MasterCard are not quite ready to deploy their cards to the mass transit market (but does expect they will step in at some point) so transit agencies are stepping in with their own card in the meantime.

It is apparent from their websites that such as Visa and MasterCard no longer wish to be viewed solely as credit card companies. While it is true that such companies began as credit card companies, they have grown into much more generic "payment product and solution companies". MasterCard maintains a webpage summarizing the company's milestones in introducing cashless payments into the transit environment: http://www.mastercard.com/us/company/en/whatwedo/paypass_in_action.html. The products they offer go beyond credit cards to include debit, prepaid, commercial, chip and contactless cards. In addition, they offer payment mediums besides cards. For example, in May 2007, MasterCard launched a watch equipped with PayPass technology. Another example is the previously mentioned Nokia phone equipped with Visa PayWave technology in Malaysia, which cannot be used at the transit farebox, and the application that allows the iPhone to be waved at any contactless reader, including fareboxes in New York City. Traditional credit card companies, now more generic "payment product and solution" companies are well positioned in terms of technology and customer account management to offer products and solutions that address the distinct needs of the transportation industry. Transit agencies in other places, such as Chicago and Vancouver, are

building new systems with the expectation that, one day, they will not have to issue their own cards because third-parties will not only step in with their own cards, but with other NFC-enabled devices.

International Standards

An important standard to pay attention to when planning for a new electronic payment system is the ISO/IEC 14443 standard for contactless integrated circuit cards. It is a non-binding standard that comes out of a joint technical committee of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), both of which are made up of national committees that include governmental agencies, professional societies, trade associations and standards developers from national standards bodies. Cards that meet the ISO/IEC 14443 standard are of two types: Type A and Type B, each of which has particular specifications for physical characteristics, power and interface, initialization and anti-collision and transmission protocols. The standard is not only relevant to transit smart cards, but also to contactless debit and credit cards.

For example, Cubic, a company leading in automated fare collection systems for public transport in North America, developed a contactless card prior to the 2001 ratification of the ISO/IEC 14443 standard. This technology was used as the basis for the initial transit smart card deployments in Washington D.C. (SmarTrip) and Chicago (ChicagoCard). Upon ratification of ISO/IEC 14443, Cubic developed a contactless card processor (the Tri-Reader) that supports both the ISO/IEC 14443 protocols (Type A and Type B) and which has been the basis for all subsequent Cubic transit cards, including London's Oyster Card. As of 2004, the ISO/IEC 14443 standard for contactless cards is the standard that most, although not all, transit agencies include in their fare collection system designs (APTA, 2004).

Given the potential overlapping configurations of transit cards and the prepaid, debit and credit cards of financial institutions, it is also worth mentioning the EMV standard for interoperability. The EMV acronym comes from the initial letters of the

three companies that created it: Europay, MasterCard and Visa, although the company's four current members, each with an equal ¼ of the voting share, are JCB International, American Express, MasterCard and Visa. Together, they define the interaction at the physical, electrical, data and application levels between integrated circuit cards and the card processing devices for financial transactions. As is increasingly the case with transit cards, the EMV standard is based on the ISO/IEC 14443 standard for contactless cards (and the ISO/IEC 7816 for contact cards).

An organization to pay attention to regarding standards for transit cards is the American Public Transportation Association (APTA) Standards Development Program, a non-profit international association of more than 1,500 public and private member organizations that claims to represent over ninety percent of persons using public transportation in the United States and Canada. Under the auspices of the APTA, the Universal Transit Fare System (UTFS) Task Force was established with the mission of creating an open architecture payment environment and to integrate independent payment systems. A payment and access system based on the ISO/IEC 14443 standard, the EMV standard, with consideration of the APTA Standards Development Program would ensure the widest possible card interoperability as well as the potential to leverage the infrastructure and services already established by the financial industry.

Payment Classification and Other Technologies

Mobile payment systems and approaches are driven by a variety of concepts and technologies. In this section I speak more broadly about mobile payment systems (i.e. the discussion covers retail payment as well) but follow it with a discussion of transportation payment technologies in transit, parking, tolls, carshare and bikeshare. This section draws on Stamatis Karnouskos and Fraunhofer Fokus' *Mobile Payment: a Journey Through Existing Procedures and Standardization Initiatives* to summarize some of the essential concepts and technologies in mobile

payment. Grouping the technologies according to attribute does this. Specifically, the technologies are grouped according to location, value and charging method.

A. Payments Grouped Based On Location

- *Remote Transactions*: Transactions are conducted independent of the user's location. Examples include prepaid top-up services, delivery of digital services, m-tickets, digital cash, peer-to-peer payments, etc.

- *Proximity/Local Transactions*: Transactions occur where the mobile device locally communicates (e.g., via Bluetooth, IrDA, RFID, Near Field Communication) with a POS/ATM, e.g. payments at unattended machines, mParking, payments at traditional POS, or money withdrawals from a bank's ATM.

B. Payments Grouped Based On Value

- *Micro-Payments*: These are the lowest values, typically under $2. Micro-payments are expected to boost mobile commerce as well as pay-per-view/click charging schemas.

- *Mini-Payments*: These are payments between $2 and $20, targeting commonly purchased small items.

- *Macro-Payments*: These payments are typically more than $20.

C. Payments Grouped Based On Charging Method

- *Pay-now*: In this method the user pays in real-time or close to real-time (based on technical limits), with the funds immediately available to the merchant (same as cash).

- *Post-paid*: This is the most common method used in electronic/mobile commerce transactions today. Mobile network operators use the phone-bill based charging method and the account-based method is by banks and credit card companies.

- Pre-paid: This is a common charging method for mobile network operators as well as third-party service providers in order to be able to evaluate only that the user is capable of paying. A transit card onto which money must be loaded is an example.

- Near "real-time": This method includes solutions that charge the user of the service in a reasonable amount of time. A typical example of this category is the debit card, as well as systems that do real-time fund reservation, but the clearing and fund transfer happens later and typically at the end of the day. The timeframe between the reservation and the clearing can be handled by the bank according to its risk management policy.

Canada is ahead of other countries like the United States in introducing general forms of mobile payment technologies. Canada's three largest wireless carriers, Bell Canada, Rogers Communications Inc., and TELUS Corporation formed a joint venture in 2005 called EnStream which, as stated on its website, is "working to become a driving force at the heart of mobile commerce". In 2009, EnStream launched a mobile payment service that allows mobile phone users with a plan with Bell, Solo, PC Mobile, Rogers, Fido or Telus to send, request and receive money via their mobile phones using an account the user sets up or from their credit card.

The company has also announced that it is testing a tag that, when attached to the back of your phone, can allow you to pay for goods with a quick tap at locations with PayPass sensors. The technology does not hinge on handset manufacturer making elaborate upgrades, or vendors to adopt niche hardware, since PayPass terminals are already being adopted by merchants who take debit and credit cards. There is no indication that EnStream itself is piloting transportation-specific applications, but with its links to MasterCard's PayPass platform, it is a mobile payments company worth paying attention to, or even partnering with.

Mobile devices are increasingly able to process both proximity/local transactions as well as its remote transactions, meaning that, in the future, users may use a phone where once a separate card was required. It is also increasingly the case that traditional debit and credit cards are able to process the micro and mini payments as conveniently as transit cards have been able to. For example, Hong Kong's Octopus card is not only used for transit's micro and mini payments, but also for micro and mini payments at convenience stores, snack shops and other retailers. Debit and credit cards have traditionally been cumbersome for such small

purchases. However, it is increasingly the case that debit and credit cards do not require signatures or pin codes for smaller purchases, meaning that the payment procedures of contactless prepaid, debit and credit cards are increasingly functionally equivalent to transit cards such as the Octopus.

Analysis: Collaboration Over Standards is Most Practical

Vancouver is a unique case because; as is only the case in select other cities like Chicago, most regional transportation projects are managed by a single agency – Translink. In Vancouver, an automated fare collection system is being developed that will be owned by Translink to serve users of Translink services exclusively. Although Translink has said it is open to allowing other entities to join the payment network they are creating, no official initiating steps have been taken, making the Vancouver region an exception when it comes to what is generally a multi-stakeholder approach to a unified payment and access system. In many ways, however, such steps are unnecessary because Translink already brings together the region's major transportation operators. Once fully rolled-out, the Translink smart card will be usable for payment with SkyTrain, SeaBus, buses and other operators that fall under the Translink umbrella. The extent of this payment system's coverage will be equivalent to other similar regional payment and access systems in North America.

The Vancouver region should strive to achieve interoperability beyond the Translink system for several reasons.

1. Carrying numerous payment cards, pay stubs and tickets is cumbersome and the technology exists to improve upon the current system. From a customer-centric point of view, an integrated payment system for transportation makes sense because it is only necessary to obtain a single card, thus making traveling more convenient for both residents and visitors to the city.

2. Electronic payment systems in other cities, especially Asia and Europe, but also in North America, are more competitive because they span a greater array of services, making access and mobility convenient relative to Vancouver.

3. Vancouver's population is technically sophisticated, with a high usage rate of debit cards, credit cards and mobile phones. Therefore, we can expect that

new technologies, where they increase convenience, would likely be utilized in this region.

4. New modes of transportation such as bike share and car share are challenging the traditional dichotomy of transit users versus drivers, thus we can expect Vancouverites to increasingly envision themselves utilizing multiple modes of transportation, rather than being exclusively a driver or transit rider.

5. Many of Vancouver's operators are already moving to electronic payment systems anyway, but lack coordination, meaning that there could be challenges for future interoperability and global acceptance in Vancouver. Coordinating the purchases of expensive infrastructure would not only increase convenience and regional competitiveness, but, potentially, would be in the interests of the businesses who are already purchasing these technologies anyway.

The lack of consistent and systematic evaluation of costs and benefits of integrated electronic payment and access systems, however, suggests that decisions over whether or not to adopt a regional electronic payment and access system should be left to individual service providers. As discussed, there exists difficulty in generalizing the costs and benefits among cases with unique organizational structures and issues. This makes coordination among service providers in a large region such as Vancouver complicated, even unlikely. The second reason is that a high degree of coordination would be necessary and expensive new bureaucratic structures would have to be constructed. For example, service providers would need to collaborate on funding, timelines and the creation of a clearinghouse. Provisions would need to be made for how funds are moved, customers are served and information is shared (or not shared) in addition to how individual service provider that request systematic changes or to opt out of the system are dealt with.

In addition to these complicated logistical issues, Paddon, McKinney, Lewin and Harkness all caution that the success of an integrated regional payment system is dependent on complimentary business interests. In particular, their respective

businesses are only interested in adopting a common payment and access system if it is expected to lead to an increase in revenue, enhancement of brand or a cost savings. As already pointed out, the benefits of an integrated payment system are not proven, meaning that there will be a large degree of uncertainty for individual service providers that are asked to join. In addition, partners in a payment scheme must consider and define the liability for payment fraud and other contingencies. Therefore, even if business issues align at present, they will be subject to change and the opting-out of individual service providers, thus rendering a payment and access system unstable and creating uncertainty for the consumer.

Having said this, an integrated electronic payment and access system can be achieved without collaboration over funding, timelines, clearinghouse, provisions for funds movement and the sharing of information. Rather, stakeholders can come together and collaborate over a broad set of standards that define the parameters that must be operated within to ensure interoperability.   In this case, other considerations are left to individual service providers. Collaboration over standards is not only a much simpler process, but small and large service providers alike retain the freedom to purchase the payment and access system that works best for their respective priorities, while sub-groups of service providers are also still free to collaborate should their interests happen to align and/or if they can benefit by economies of scale.

The trend is to move away from closed systems to those that accept third-party cards, especially those issued by financial institutions.   Robust international standards based on the ISO/IEC 14443 and EMV standard simplify the process of selecting a regional standard on which to base an electronic payment and access system. Individual institutions, such as Translink, are more likely in the past to select a payment and access system that conforms to these standards, but this is not guaranteed since international standards are not compulsory and not all technology is built to this standard. In addition, while evidence to suggest that transit payment and access systems are more likely than in the past to adopt the standard, there is

no evidence to suggest that parking, carshare, bikeshare and tolling schemes have progressed in the same manner as transit schemes.

Any industry that adopts the ISO/IEC 14443 standard, whether it is transportation or otherwise, creates an opportunity to leverage the existing infrastructure and services of the financial industry. Contactless prepaid, debit and credit cards are increasingly adapted to serve as payment and access cards for the transportation industry. As previously discussed, there has traditionally been a need for the transportation industry to manufacture and deploy its own card system because, for example, response time for a magnetic-strip contact debit or credit card swiped at a reader is traditionally too slow. Contactless cards are much faster and investment is being made by innovative transit agencies and major payment companies such as MasterCard and Visa to further adapt these cards and readers to better serve the transportation industry. Examples include trials on New York and Utah transit; New York, Philadelphia and Los Angeles taxis; the combined PayPass/Transit TaiwanMoney Card; and Malaysia's combined PayWave/Touch 'n Go NFC-enabled phone. Experimentation with these kinds of products continues.

Other payment and access media exist as well. For example, the transponder, used for paying tolls. While there is precedent for the use of smart cards to pay for tolls (ex: Malaysia), transponders are more commonly used in North America. Transponders utilize NFC technology, just as smart cards, but at a much wider proximity. It is not practical to request that other payment and access technologies, such as transponders, be replaced with a smart card for the sake of an integrated system because transponders have certain advantages over smart cards. For example, the transponder is mounted onto the vehicle, meaning that drivers do not have to slow down to tap a card to a reader. The issue of integration for transponders is not so much a hardware issue, as the transponder has certain advantages over a smart card, but rather an issue of how multiple accounts are managed. One could speculate that, one day, payment companies such as MasterCard and Visa will expand their business into transponders as they are attempting to do with the transit cards. As it stands, however, certain hardware, for

practical reasons, should not be forced to physically integrate with a regional payment and access system (although, they can still be coordinated virtually through linking accounts).

Another example is pay-by-phone. Pay-by-phone is distinct from both transponders and smart cards because it is a remote rather than proximity/local transaction. It too offers advantages over the smart card, including warnings via text message that the meter is expiring. It also offers the advantage of extending time over the phone or via text message. As is the case with a transponder, there may be no argument for integrating hardware by adopting the smart card platform instead. However, as with the transponder, it would be made more user-friendly if accounts were linked virtually. It may not be as far-fetched as the case of transponders to speculate that MasterCard or Visa might, one day, step in to offer their own pay-by-phone solution because, as previously discussed, the mobile devices are increasingly functioning in both the remote and proximity transaction environments with the advent of NFC-enabled phones. Software applications could conceivably link the remote and proximity transaction functions, and they could conceivably be developed by any third-party card issuer, thus enabling one to access parking directly via a prepaid, debit or credit card account.

Finally, should the transportation industry choose to pursue a standard that is in common with the international contactless standards and leverage the infrastructure and services used by financial institutions, the industry will need to place itself within a much broader mobile payment context. As pointed out, mobile payment systems and approaches are driven by a variety of concepts and technologies. International standards focus on the interface between proximity cards and reader and, by proxy, other proximity hardware such as proximity chips in mobile phones. Formalizing pertinent international standards in Vancouver would not only ensure interoperability among third-party cards and card readers, but a large degree of interoperability between readers other proximity-chip enabled devices such as mobile phones. Where international standards are less clear about what the parameters are for particular types of hardware, experimentation and

collaboration should be allowed to continue. The Vancouver region could benefit, however, by ensuring it adheres to the most up-to-date standards. At present, this means understanding how the ISO/IEC 14443 and EMV standard can be applied to transportation services in Vancouver.

Recommendations

This section begins with substantive recommendations, based on the findings and analysis of this paper, for the Vancouver region. Afterwards, recommendations are given on how to proceed given the Vancouver institutional context.

Substantive Recommendations

The general recommendations are as follows:

1. Formally adopt the ISO/IEC 14443 and the EMV contactless standards as minimum standards for all transportation and parking electronic payment and access systems in the Vancouver region. This could take the form of a new bylaw or, alternatively, the writing and signing of a binding agreement amongst service providers. Doing so will ensure a seamless transition between various modes of transportation, over time as new payment and access systems are rolled-out. It will also ensure interoperability between Vancouver and other regions built on the standard.

2. Ensure changes to international standards are tracked over time, and incorporated into the relevant bylaws and/or agreements. Changes to the ISO/IEC 14443 and EMV standard are likely only to be periodic since the former requires collaboration amongst hundreds of stakeholders – governmental agencies, national standards bodies, professional societies and trade associations under the auspices of international organizations – and the latter requires collaboration amongst four competing payment companies that have made significant investments in technologies in order to meet the standard, and led the majority of other financial institutions around the world to do so as well. Even so, the possibility remains that norms and conventions will change over time.

3. Compose a minimum set of third party payment media that all service providers must accept. Ensuring a common standard merely ensures the *possibility* that interoperability will exist. Individual service providers may still choose to issue their own media to the exclusion of others, so it is

necessary to ensure a minimum set of cards so that the possibility of interoperability is made reality.

4. Commit to a review of how the transportation industry can leverage the infrastructure and services of the financial industry to reduce operational costs. There is opportunity to save on operational costs not only through using media issued by financial institutions, but also through utilizing potential financial reports and auditing trails. Information sessions can be provided to service providers who wish to increase operation efficiency.

5. Develop partnerships with innovative payment companies in the financial industry. The transportation industry presents a large opportunity for payment companies such as MasterCard and Visa to expand their businesses. A coordinated regional approach to payment and access systems in the Vancouver region could yield problems to which payment companies will be eager to pilot solutions. Pilot projects could be mutually beneficial for both payment companies and the Vancouver region.

Institutional Recommendations

The recommendations, should they be accepted as objectives, will require an effective planning process if they are to be achieved. The purpose of this section is to assess the institutional context and provide recommendations for how to proceed.

The stakeholder groups include:

- Service Providers (not including Translink)
- Translink
- Regional Business Improvement Associations (BIAs)
- Other Nongovernmental Organizations (NGOs)
- Municipal Governments in the Vancouver Region
- Greater Vancouver Regional District (Metro Vancouver)
- British Columbia Provincial Government

Service Providers: It is possible for service providers to self-organize and engage in a planning process that results in a common standard that can be proposed as a bylaw or adopted as a binding memorandum of understanding. However, the social and other regional benefits of an integrated system may be largely external to the businesses of individual service providers. For this reason, it would not be prudent to expect service providers to self-organize.

Translink: Is not unlike other service providers in that it has a limited interest in providing regional social benefits that largely external to its business. Translink's core business is to plan, finance and manage regional transit, roads, bridges and cycling specifically. It is not clear if or to what extent Translink would be interested in spearheading an effort that goes beyond its own internal system. However, a point could also be made that Translink differs from other service providers in that it also has a public mandate. Even so, if Translink were to lead service providers in a planning process, it would have to think outside of its own business interests.

BIAs and Other NGOs: Can self-organize, raise awareness and facilitate discussion among service providers. However, BIAs and NGOs often have particular interests in contained geographical areas. A convening of service providers on the magnitude of the whole region, in addition to facilitating the negotiation of a binding contract or bylaw among as many service providers, may be beyond the capacity of these institutions.

Municipal Governments: Have a public mandate, but interests are local rather than regional. It is unlikely that a particular municipal government would take the lead in organizing transportation service providers operating beyond their jurisdictional boundaries. In addition, municipal governments have a stake in parking, particularly on-street parking, so are themselves partially service providers. Municipal governments would have to partner with other municipal governments in the region. It would not be prudent to expect municipal governments to self-organize, especially since a regional institution, Metro Vancouver, already exists to address regional needs.

<u>Metro Vancouver:</u> Is responsible for regional policies including regional growth and "acts as a facilitator, convener, partner and advocate and significant conduit for information and education in the community". Metro Vancouver could conceivably raise awareness and would be a more neutral facilitator than Translink (since Translink is in the midst of planning its own system). However, it is not clear whether Metro Vancouver has the mandate necessary to address this issue, especially given that a regional transportation authority, Translink, exists.

<u>Provincial Government</u>: Because ambiguity exists in who is responsible for addressing such matters, it may be necessary for the provincial government to clarify institutional responsibilities through legislation. The provincial government would ideally give Metro Vancouver authority to create bylaws regarding payment and access systems that apply to Translink as well as other service providers.

NGOs and BIAs can play a role in raising awareness and facilitating discussion among service providers, but it is ultimately the regional government, Metro Vancouver, that has the necessary institutional capacity, neutrality and representativeness to serve as a legitimate authority and facilitator. Because ambiguity may exist in how powers are delegated with respect to regional standards regarding payment and access systems, it may be necessary for the provincial government to clarify roles with new legislation. Thus, my recommendation would be to check with Metro Vancouver to see if they have the interest/capacity to facilitate a process that would end with a binding agreement among service providers. Translink would have to agree to relegate its role to that of a service provider (although it could still maintain a leadership role among service providers). If the process does not obtain sufficient participation or requires stronger legal enforcement, BIAs and other NGOs should lobby the provincial government to clarify roles through legislation, particularly with respect to the authority to create bylaws on the matter. Once an adequate authority is found, a strategic planning process should be undertaken that involves consultation with various service providers. Adherence to the standard should be binding, with a

mechanism to allow for an evolution (or dissolution) in the standards, but in consultation with a third-party that represents the interests of the residents and businesses that are ultimately affected by the adopted standards.

Conclusion

Vancouver's practices are not dissimilar to other regions of the world. Service providers are independently establishing payment and access systems, with the risk that operating systems/devices will not be interoperable between service providers. Incompatible operating systems/devices in parking and transportation can be avoided through the regional adoption of standards. The Vancouver region can gain substantially from the adoption of the ISO/IEC 14443 international standard. For example, transportation service providers would gain the ability to leverage the infrastructure and services of the financial industry. In Vancouver, this means clarifying institutional roles and engaging in a strategic planning process that brings the region's service providers together to agree on a binding standard. Doing so will not only ensure convenience through interoperability, but also form a institutional framework that will establish Vancouver as an international leader in the governance of regional electronic payment and access systems for parking and transportation.

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