TORONTO TRANSIT COMMISSION

BUSINESS CASE ANALYSIS

for a Smartcard Fare Collection System

Final Report
May 2007

PARSONS

TORONTO TRANSIT COMMISSION

BUSINESS CASE ANALYSIS
for a
SMARTCARD FARE COLLECTION SYSTEM

FINAL REPORT
May 2007

PARSONS

TABLE OF CONTENTS

LIST OF EXHIBIT

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

ACAT	Advisory Committee on Accessible Transit
AFC	Automated Fare Collection
AVM	Add Value Machines
AVMs	Automated Vending Machines
BART	Bay Area Rapid Transit
CAD	Canadian Dollars
CCS	Central Computer System
CCTV	Closed-Circuit Television
CNIB	Canadian National Institute for the Blind
CR/DB	Credit / Debit
CSCDB	Customer Service Complaints Data Base
CSIF	Canadian Strategic Infrastructure Fund
CTA	Chicago Transit Authority
DCU	Driver's Control Unit
EDS	Electronic Data Systems
FMMS	Fare Media Management System
FSVM	Full Service Vending Machines
GEC	General Engineering Contractor
GTA	Greater Toronto Area
GTAFS	Greater Toronto Area Fare System
GTTA	Greater Toronto Transportation Authority
HHD	Hand Held Device

IAT	Installation Acceptance Test
ICC	Integrated Circuit Chip
IP	Internet Protocol
IT	Information Technology
ITS	Intelligent Transportation Systems
IVR	Interactive Voice Response
KCR	Kowloon Canton Railway
KMB	Kowloon Motor Bus
LAN	Local Area Network
LUL	London Underground Limited
MARTA	Metropolitan Atlanta Rapid Transit Authority
MBTA	Massachusetts Bay Transportation Authority
MDP	Metropass Discount Plan
MPOS	Multipurpose Point of Sale Device
MTA	Metropolitan Transportation Authority
MTR	Mass Transit Railway
NFC	Near Field Communication
NOC	Network Operations Control Center
NYCT	New York City Transit
PCD	Proximity Coupling Device
PCI	Payment Card Industry
PID	Photo ID
PICC	Proximity Integrated Circuit Card

POE	Power over Ethernet
POS	Point of Sale
3PCI	Three Point Consulting Inc.
RAS	Remote Access Server
RCSC	Regional Customer Service Center
RF	Radio Frequency
RFP	Request for Proposal
RIS	Regional Interoperability Standard
RSEM	Revenue Security and Equipment Maintenance
RST	Revenue Service Test
RT	Rapid Transit Trains
RTA	Chicago Regional Transit Authority
SAAT	Subject Area Advisory Team
SAN	Storage Area Network
SCIMs	Smartcard Initializing Machines
SRT	Scarborough Rapid Transit
SUB-PAK	Subway Electronic Pak
TOPS	Ticket Ordering and Processing System
TPU	Ticket Processing Units
TTC	Toronto Transit Commission
TVM	Ticket Vending Machine
TVMA	Token Vending Machine Attendant
VIP	Volume Incentive Program

VPN	Virtual Private Network Access
WAN	Wide Area Network
WAPs	Wireless Access Points
WLAN	Wireless Local Area Network
WMATA	Washington Metropolitan Area Transit Authority

EXECUTIVE SUMMARY

This report documents the results of a collaborative effort among members of the TTC Smartcard Project Team, external consulting teams, and functional area and executive staff to define a possible smartcard fare collection system for the TTC and to evaluate the potential benefits and costs it could deliver. The smartcard fare collection study for the TTC was spurred not only by business interests regarding the technology's potential, but also by the Greater Toronto Area Fare System (GTAFS) initiative. A comparison to the GTAFS was not included in this study -- the comparison was a separate activity of the TTC Smartcard Project Team.

This executive summary provides the following:

- An overview of smartcard fare collection,
- Background and conditions influencing the decision for the TTC study,
- Business goals and evaluation criteria,
- An overview of the TTC Smartcard System and
- The final assessment.

GENERAL OVERVIEW OF A SMARTCARD FARE COLLECTION SYSTEM

A smartcard fare collection system is an automated way to sell, collect and process fares. The fare payment system essentially (and very basically) consists of plastic reusable smartcards that look similar to credit/debit cards; however, instead of a magnetic strip that contains data, there is a memory chip embedded in the plastic. It is on this chip that customers may load monetary value or fare products such as time-based passes. Customers pay their fare simply by tapping the card to a Smartcard Reader that is on a turnstile and at the entrance of a surface vehicle. The reader either deducts the value of the fare or checks for the validity of a pass. A Smartcard Central System houses all of the related applications and databases. It provides the instructions for selling and reloading smartcards, collecting fares and gathering and reporting fare collection data. It also processes credit/debit transactions, provides customer service applications, monitors the activities of field equipment and checks for fraudulent transactions.

Customer Benefits

Smartcard systems typically make fare payment easier and faster for customers. At any number of convenient places, customers may load their smartcard with monetary value or a pass. They then pay their fare by tapping their smartcard to a reader that is on a turnstile or at any point of entry on a surface vehicle. There is no need to fumble for change or tokens or to orient the card in any special direction to a reader. The transaction time is very fast – it can be 3 to 5 times faster than swiping a magnetic card through a reader or dropping coins or tokens into an acceptor.

In addition, a smartcard system allows a transit agency to provide additional customer conveniences. First, the life of a smartcard is generally 4 years – it is reusable – which eliminates the need to buy a new one when the value runs out or when the pass on it expires. Second, a smartcard system most often includes devices and applications that provide customers with convenient access to purchasing or reloading a smartcard. A system typically includes devices such as vending machines placed in subway stations and platforms, point of sale devices installed at transit agency Customer Service Centres and/or 3rd Party sales locations and applications that provide customers the added conveniences of ordering or reloading a card by phone or web.

Smartcard systems also allow a transit agency to expand the number of services offered to customers. Customers, who choose to register with the transit agency, may receive the added security of balance and negative protection and/or the added convenience of automatic reload service. Balance protection allows a customer to retain the value of their card if it is lost or stolen. Negative protection allows a

customer to complete a trip even if the value on their card is not adequate (the system will allow negative value and then recoup it when the customer reloads). Automatic reload links a smartcard to a customer's credit/debit card and will automatically add value or a new pass to the card when the value amount has reached a set level or the pass has expired.

Business Benefits

A smartcard system provides business advantages such as automated data collection and reporting, enhanced revenue and system security and greater flexibility to change fare policies. Each sale or reload of a card and each fare payment transaction are collected and transmitted to the central system. Reports are available to show what was purchased or reloaded, the amount, what type of fare medium was used, the customer classification, when and where paid, etc. and since smartcard system data collection does not rely on manual entries, opportunities for errors are greatly reduced. The reporting system provides a comprehensive list of financial, ridership, revenue, maintenance and other types of reports. They can be pre-designed and formatted and delivered on a regular basis via email or the system can process reports on an Ad Hoc basis.

A smartcard system provides mechanisms to protect a transit agency from fare misuse and fraudulent transactions. A Fraud Analysis system analyzes transactions collected by system and reports anomalies such as value loads by unauthorized devices, card balance irregularities, card distribution and sales anomalies. A smartcard system also provides the capability of hotlisting or cancelling cards in violation of established transaction rules. In addition to monitoring use of credit/debit and smartcards, a smartcard system monitors field equipment for failures as well as attempts to tamper with or break into the machines. In addition, some methods of fare evasion and misuse are eliminated with an all smartcard system. Fare media forgeries and duplication (such as forging tokens or duplicating printed media) are eliminated and passing back fare media to friends can be controlled with system instructions to disallow the use of a pass for a configurable period of time. Encoding transfers to smartcards also eliminates the ability to misuse transfers.

A smartcard system provides greater flexibility for changing fare policies. Fare tables and business rules will reside in the Central System. These fare tables and business rules may be changed at any time to execute new strategic initiatives and policies. The changes can then be downloaded to field equipment in a timely manner.

Disadvantages

A smartcard system also has disadvantages in terms of financial and personnel resources. The system most likely requires a significant capital commitment and annual operating costs may increase. Transit agencies not only struggle with redirecting capital from other important projects, but are also challenged by supporting complex backend systems with uniquely skilled information technology personnel and by providing the facilities and additional personnel for expanding customer services and related support.

Risks

There are also risks associated with a smartcard fare collection system. The primary risks include those associated with preserving and protecting financial and customer data. Smartcard systems process, collect and store very sensitive data such as authorizing and processing credit/debit sales, collecting fare payment transactions and storing customer personal information. There are many risks inherent with managing fare payment processing and related data systems including threats of both internal and external theft, the wrongful and illegal use of this data and the liability and public relations concerns of not adequately safe-guarding the release of customer information. While many transit agencies have addressed these issues adequately, the risks are ever-present in a system like this and require resources for defining processes, policies and executing the right security precautions.

Regardless of these risks, smartcard fare collection is expanding rapidly through the industry. In North America, smartcard contracts total nearly $1.1 billion (CAD) and planning and deployment of the

technology are currently underway across 17 major metropolitan areas. This technology is viewed by many transit leaders as the means for achieving many critical strategic initiatives such as improving the customer experience, controlling revenue, adapting more quickly to market changes, and also leveraging the technology to realize operating efficiencies or other revenue opportunities. There are examples of transit agencies expanding the use of their card outside transit and other agencies teaming with the bankcard and wireless industries to explore opening the fare collection system to accept credit/debit and cell phone payments at the turnstile and farebox.

BACKGROUND AND CONDITIONS INFLUENCING THE DECISION FOR THIS STUDY

In 2000, the TTC completed a review of smartcard fare collection technology. This review was conducted within only three years of one of the very first high profile launches of a smartcard system in Hong Kong --- the Octopus® card --- and within a year after the first North American smartcard launch – Washington D.C.'s SmarTrip®. Also, in 1999, GO Transit had just announced the start of planning to replace their aging fare collection system with smartcard technology.

The TTC smartcard study, completed in 2000, included visits to various international cities where smartcard systems were either being planned or had already been implemented. The staff gathered information regarding equipment and systems, features and functions, transaction and productivity statistics, capital and operating costs, customer and agency benefits and risks. After weighing the information and data that had been collected during the visits and as a result of interviews and analyses, there were two key findings presented to the members of the Toronto Transit Commission – 1) the cost of procuring and implementing a smartcard fare collection system did not yet justify the advantages and 2) the technology was still new and evolving; therefore, it would be prudent to be cautious and wait for the technology to mature and for industry standards to be defined.

During this same time period, GO Transit and a number of the other transit properties recognized that, unlike the TTC, they would need to replace their aging fare collection equipment at some point in the near future. As a result, since 2001, MTO, GO Transit and the 905 transit agencies have been working on a project to implement a farecard system within the GTA. MTO has signed various agreements with these transit agencies to develop a common set of business rules and formalize this partnership for a period of at least ten years. MTO recently awarded a $250 million contract with Accenture for a ten-year period to develop, build, operate and maintain the Greater Toronto Area Fare System (GTAFS). These business rules do not reflect all of TTC's business needs, and the contract does not include TTC's smartcard system requirements.

However, from 2004 to the present, the concept of a farecard system has been an important part of various Federal and Provincial funding and legislative announcements:

- In March 2004, the Federal, Provincial and City of Toronto governments made a joint $1.05 billion funding announcement [called the Canadian Strategic Infrastructure Fund (CSIF)] of which $140 million was ear-marked for TTC's portion of an "integrated GTA ticketing system".
- In October 2004, the Province of Ontario announced dedicated gas tax funds for public transportation. One of the conditions established by the Province for receiving this funding was TTC's participation in the GTAFS.
- In 2006, the Province passed legislation that created the Greater Toronto Transportation Authority (GTTA). This legislation gives the GTTA authority to manage and implement the GTAFS project.

Subsequent to the CSIF and gas tax funding announcements, the TTC established a Smartcard Project Team. The two member, full-time Smartcard Project Team was established to not only more actively participate in the GTAFS project planning, but also to re-examine smartcard fare collection technology, the capital requirements for such a system, operating and revenue impacts and the advantages and opportunities it might deliver to the TTC.

Not only had the state of the technology evolved considerably since the release of the TTC's 2000 review of smartcard fare collection, but cost factors had also changed. The TTC had a responsibility to customers and tax payers to re-evaluate the state of the technology and its potential impacts before moving ahead and agreeing to participate in the initiative.

Principles Guiding the Study

The Smartcard Project Team set out on their mission of defining, in concept, how a smartcard fare collection system would work for the TTC and its customers. They were guided by the following principles:

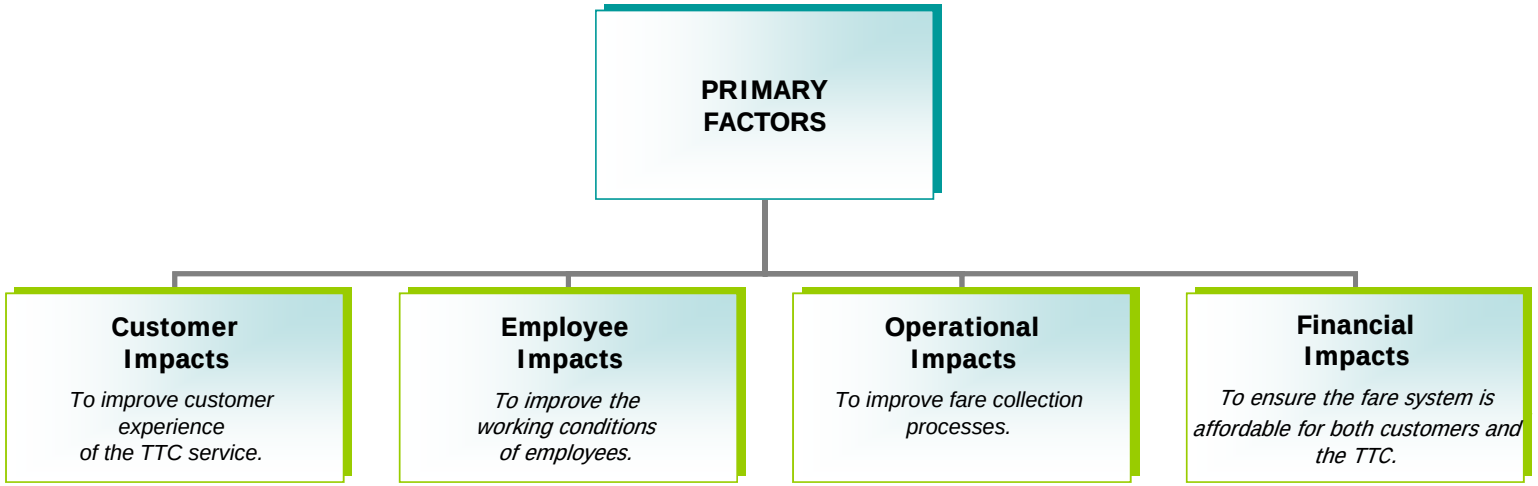
- The study should be grounded by research and the experience of peers;
- The study should be based on proven technology and methodologies;
- The estimates and other measures should be reasonable and defensible;
- The model should be defined, first and foremost, for the benefit of the TTC and its customers,
- The TTC Smartcard System should not require a change in current fare policies
- The system should be flexible enough for future fare policy options, system enhancements and potential partnering with financial institutions and,
- The staff should be deeply involved in reviewing concepts and have the final word in the design of the model system.

GOALS AND EVALUATION CRITERIA

The team evaluated the state of the current fare collection system – its strengths and weaknesses. This process concluded that the current TTC fare collection system has no significant operating weakness, it is easy to manage, fairly reliable and operating costs are very low compared to the industry. The system is not complex for either employees to administer or for customers to pay a fare, so there is no extraordinary sense of urgency -- such as aging equipment issues or even high fare evasion -- to transition to a new system. However, there are definite limitations to the current system such as customer service expansion constraints, transferring between transit systems within the GTA, the ability of the system to generate information for management, the flexibility of the system to implement new fare policies and products, and for leveraging new opportunities.

It was from this evaluation that business goals and criteria were defined for guiding the design of the smartcard system concepts and assessing the advantages and disadvantages. These goals and criteria are presented in Exhibit A: *Business Goals and Assessment Criteria*.

Exhibit A: Business Goals and Assessment Criteria



- ✓ Does the system improve customer convenience and the flexibility to purchase fares?
- ✓ Does the system enable the TTC to expand customer assistance?
- ✓ Will the system reduce the time it takes to board a vehicle or enter a turnstile?
- ✓ Is the system's fare media easier to use?
- ✓ Does the system improve customers' understanding of how to pay a fare or to transfer?
- ✓ Does the system enable the TTC to offer services and benefits that support customers?
- ✓ Does the system improve customers' regional mobility?

- ✓ Does the system enhance the safety and security of front-line employees?
- ✓ Does the system enable vehicle operators to focus on their primary responsibility?

- ✓ Does the system improve response to equipment failures?
- ✓ Does the system provide better data for analyses and planning?
- ✓ Does the system improve the reliability of fare collection equipment?
- ✓ Is the technology proven?
- ✓ Is the technology still advancing?
- ✓ Does the system provide future possibilities?

- ✓ Does the system allow the TTC to respond more effectively to market demands and changes?
- ✓ Does the system improve revenue security and controls?
- ✓ Does the system provide greater flexibility for executing new fare policies and pricing?
- ✓ Is there adequate new/additional funding available for this initiative
- ✓ Does the system decrease operating costs?
- ✓ Does the system increase fare revenue?

In addition to evaluating the strengths and weaknesses of the existing system, the Smartcard Project Team set out to interview representatives of other transit agencies who were planning or had already implemented smartcard fare collection systems – they gathered lessons learned and best practices. They researched and collected information about most current (and proven) equipment and systems – the features, functions and costs. They also reviewed the state of the TTC's infrastructure -- the communications' network and in-the-field electrical power -- and evaluated the requirements for supporting a more robust smartcard fare collection system.

The Team also enlisted the support, guidance and assistance of the PARSONS Corporation and Three Point Consulting, Inc. This collaboration gave the study and analyses depth of experience and resources as well as providing the checks and balances necessary to challenge and refine elements of the concepts as they were being defined.

Concepts and impacts to operations were presented to and reviewed by TTC staff. Staff was invited to evaluate the concepts and impacts against the business goals, the practical applications within the TTC as well as the realities of the productivity metrics used to measure costs. Staff provided necessary insight for defining the final TTC Smartcard System and for estimating the capital costs and the impacts to the operating budget.

THE TTC SMARTCARD SYSTEM

The TTC Smartcard System that was defined for the purpose of assessment for this study can be generally called an all smartcard fare collection system. This means that no other technology, such as magnetics, is deployed within this concept. Current automation, mechanical and many manual processes of the existing system are eliminated, replaced with smartcard equipment and systems.

The proposed system features plastic smartcards and paper limited use smartcards, Smartcard Readers at all turnstiles and on board Surface Vehicles, and a Central System that provides instructions for collecting fares; tracks, collects and reports transaction data; provides customer service applications, fraud analysis, credit/debit processing and device monitoring.

Fare Media

A plastic smartcard will replace all existing TTC fare media -- tickets, tokens and passes -- and will be the primary option for customers to pay their fare as they enter Subway turnstiles or board Surface Vehicles.

Customers will learn two new terms – E-Purse and E-Pass. The E-Purse encoded on the memory chip of a smartcard will "hold" dollar values and an E-Pass will be a general term applied to encoded time-based products such as Day Pass, monthly and weekly Metropasses. Customers will be able to load money into their E-Purse and load any type of E-Pass the TTC offers.

For customers who do not have a smartcard, the TTC Smartcard System will retain the ability to pay for single trips by cash. For cash paying customers, they will continue to drop their coins/currency in the Surface Vehicle farebox upon boarding. In the Subway, cash customers will use coin/currency to purchase paper limited use smartcards from full service vending machines. These cards will provide electronic access through the turnstiles.

Also, in the proposed TTC Smartcard System, paper transfers will be discontinued. Instead, transfers will be electronically encoded on the plastic smartcard and the paper limited use smartcard. Surface Vehicle cash customers will receive a paper limited use smartcard transfer from the operator instead of a "punched" paper transfer. This paper limited use smartcard transfer will be electronically encoded with validity period at the time it is issued to the customer.

Sales and Reload

In the TTC Smartcard System, many of the existing sales channels, as well as new and even more convenient channels, will be equipped for customers to conveniently obtain and load their smartcards. The following provides a description of each channel.

- *Full Service Vending Machines (FSVM)*: Customers will find Full Service Vending Machines in all subway entrances. These machines will sell and reload smartcards and also sell paper limited use smartcards (Single Trip and Day Pass (E-Pass)). Customers will be able to pay with cash or credit/debit cards. Accepting credit/debit cards will not only reduce cash in the system, but will meet an ever-increasing market demand.

- *Add Value Machines (AVM)*: Customers will also find Add Value Machines in all subway stations and also on Surface Vehicle Platforms. Add Value Machines will reload smartcards and accept credit/debit only – no cash. The machines are expected to speed the card reload process and reduce queuing but also provide expanded convenience to surface vehicle customers.

- *Station Collectors:* Automation of all sales and reloads through vending machines could provide the opportunity for the TTC to move toward a more enhanced customer service focus in the subway.
- *Web Services*: In the proposed TTC Smartcard System, customers will be able to order and reload their smartcards through any computer with internet access. New card orders will be mailed directly to their home or place of business.
- *Automatic Reload:* Customers will have the option to register for Automatic Reload. This links a customer's smartcard serial number to a credit or debit card. The system will then automatically add value or a pass when the card's balance falls below a predetermined threshold or a pass expires. When a customer authorizes automatic reloads, they will never need to worry about reloading their card again. The reload will occur automatically.
- *Customer Centres*: In the TTC Smartcard System, three Customer Centres, strategically located within the City of Toronto, will sell and reload smartcards as well as perform a full range of account management services for customers.
- *3rd Party Ticket Agents:* In the TTC Smartcard System, most Ticket Agents will be able to sell and reload customer smartcards. Ticket Agents will be equipped with special TTC Point of Sale devices. Maintaining the 3rd Party network, allows the TTC to continue to serve "bus-only" customers who do not travel via or purchase their fare media at subway stations.

- *Customer Call Centre:* In the TTC Smartcard System, the duties of the TTC Call Centre will be expanded to provide many smartcard services by phone. Customers may choose to be assisted by an operator or through an automated Interactive Voice Response system.

A Concession customer, who has a smartcard classified as "concession" (meaning the chip in the card has been encoded with this classification), may reload value or a concession pass through any of the channels described above. A concession customer, who does not have a concession smartcard, may still be able to purchase a concession-priced single trip. This single trip will be encoded onto a paper limited use smartcard at a full service vending machine. All concession fare media (whether smartcard or paper limited use smartcard) will be colour-coded to aid visual inspection and control misuse of the cards.

In the proposed TTC Smartcard System, Wheel-Trans customers may pay their fare with either a smartcard (with value in the E-Purse) or with cash and they may reload their card through any of the channels described above.

Customer Services

In the proposed TTC Smartcard System, any customer may choose to register their card by giving the TTC personal information which links the customer with the unique serial number of their smartcard. This registration will enable the following services:

- *Receipts for Federal Tax Credits* will be available to registered customers. Customers may receive periodic receipts of fare purchases necessary for reporting and receiving Federal Tax Credits by downloading this information from Web Services or by calling the TTC Call Centre or visiting a Customer Centre.
- *Automatic Reloads* links a customer's smartcard serial number to a credit or debit card. The system will then automatically add value to the E-Purse or an E-Pass when the card's balance falls below a predetermined threshold or a pass expires.
- *Balance Protection* provides the security of retaining the E-Purse value and/or time remaining on an E-Pass at the time the TTC is properly notified of a lost, stolen or damaged smartcard. The lost or stolen card can be hotlisted (blocked from use in the system) and the remaining value and/or time transferred to a replacement card.
- *Negative Protection* provides the benefit of one completed trip if there is not enough E-Purse value on a customer's smartcard. This allows the customer to complete their trip. Then, when the customer reloads their smartcard, the system will debit the amount of the negative balance.

THE TTC SMARTCARD SYSTEM ASSESSMENT

The proposed TTC Smartcard System was evaluated against the goals and related criteria established in the early stages of the study. They were defined after mapping the current fare collection system, identifying the strengths and weakness and after interviewing staff and management about their expectations of a smartcard system. Tables B, *The TTC Smartcard System Assessment,* presents a summary of the assessment by goal.

Table B: The TTC Smartcard System Assessment

GOAL	YES	NO	MIXED	COMMENT
Will the TTC Smartcard System improve the customer experience of the TTC?	√			• *It improves customer convenience and the flexibility to purchase fares*. The system will expand channels for customers to obtain and reload a card • *It enables the TTC to expand customer assistance*. Installing ticket vending machines in all Subway Stations enables the TTC to redefine the duties of the Station Collectors from selling and inspecting fare media to providing customer assistance in other ways. In addition, the TTC plans to expand Call and Customer Centre services. • *It reduces the time it takes to board a vehicle or enter a turnstile*. A smartcard can be read in a fraction of a second compared to swiping a magnetic card (like a TTC Metropass) or inserting a token into turnstile. Customers will no longer need to line up at a Collector's booth to pay with a ticket and/or show a paper transfer. Smartcards and paper limited use smartcards will enable multiple-door boarding on surface vehicles. • *The fare media is easier to use*. Tapping a smartcard to a reader is easier than trying to orient a magnetic pass through a swipe reader or taking coins/tokens out of a purse or pocket to drop in acceptors • *If communicated effectively, the system should improve customers' understanding of how to pay a fare or to transfer*. • *It enables the TTC to offer services and benefits that support customers*. The TTC Smartcard System will give customers the security of Balance and Negative Protection and the convenience of Automatic Reloads. • *It could improve customers' regional mobility*. The TTC Smartcard System will present the opportunity to be interoperable with the Greater Toronto Area Fare System.
Will the TTC Smartcard System improve working conditions of employees?	√			• *It enhances the safety and security of front-line employees*. As a customer boards, they will tap the card to the Smartcard Reader. The reader validates the product. This validation will no longer rest on the Operator, thereby reducing intervention and reducing the opportunities for disputes and conflict. Expanded fare purchase options (Call Centre, Web Services, Autoload) and the introduction of debit/credit accepting vending

GOAL	YES	NO	MIXED	COMMENT
				machines will reduce the amount of cash within the subway system, thereby improving the safety of employees. Station Collectors will no longer sell fare media and handle cash reducing their risk of assault and robbery. • *It enables vehicle operators to focus on their primary responsibility*. Reducing visual inspections of fare media will enable vehicle operators to focus on their responsibility of safely transporting people.
Will the TTC Smartcard System improve fare collection processes?			√	• *It improves response to equipment failures*. The TTC Smartcard System will include a field device monitoring system. This system will provide continuous monitoring, reporting, troubleshooting, and automated response capabilities. • *It provides better data for analyses and planning*. The automated data collection will improve accuracy and integrity of data and the reporting system will allow service planners and decision-makers to run analyses of many different factors. • *It is not known whether the reliability of fare collection equipment will be improved*. Currently, there are no significant reliability issues with the TTC's existing fare collection equipment; however, the reduction of cash in the system and replacement of older cash-only token vending machines with debit/credit only add-value machines should improve equipment reliability for the longer-term. Current token vending machines can be out-of-service for long periods of time unless a customer reports the failure and/or regular maintenance is required. • *The technology is proven.* Smartcard fare collection has been applied throughout the industry for 10 years. There are currently 17 smartcard projects in various stages of planning and deployment in North America alone. • *The technology is still advancing*. The technology has evolved over the last decade to better meet the requirements of public transit, but it is now being deployed throughout other industries such as bankcard and wireless. As a result, it is very likely the technology will continue to evolve and advance. • *It provides future possibilities*. Transit agencies are piloting new smartcard programs with both bankcard and wireless industries. Building partnership and relationships with these industries hold great promise for improved efficiencies and customer service.

GOAL	YES	NO	MIXED	COMMENT
Will the TTC Smartcard System be affordable to both customers and the TTC?			√	• *It allows the TTC to respond more effectively to market demands and changes*. The smartcard infrastructure, an automated, software driven technology, provides the ability to react quickly and to leverage opportunities. • *It improves revenue security and controls*. Some current forms of evasion and misuse will be eliminated in the smartcard system (such as fare media forgeries, duplication, transfer misuse and pass back of Metropasses); however, the sale of Concession paper limited use smartcard single trips at Full Service Vending Machines may increase the risk of non-qualified Concession fare purchases. There is also the opportunity to misuse Concession smartcards. It will be easier within the smartcard system to misuse concession cards. This is one of the reasons fare enforcement will be stepped up in the smartcard system. A Fraud Analysis system will analyze transactions collected by the system and report anomalies such as value loads by unauthorized devices, card balance irregularities, card distribution and sales anomalies. The system will also provide the capability of hotlisting (blocking or cancelling) cards in violation of establishing transaction rules. • *It provides greater flexibility for executing new fare policies and pricing*. Fare table and business rules will reside in the TTC Smartcard Central System. Fare tables and business rules may be changed to execute new strategic initiatives and policies and then downloaded to field equipment in very timely manner. • *It is not known whether there is adequate new/additional funding available for this initiative*. The capital cost estimate for this project is $248.9 million. This cost is higher than the $140 million estimated in 2000, which formed the basis for the March 2004 Federal, Provincial and City funding announcement. • *The system does not decrease operating costs*. The annual fare collection operating costs are estimated to increase by $11.5 million. • *It is not known whether the system will increase fare revenue*.
CONCLUSION				**The TTC Smartcard System achieves the goals of improving customer experience, employee working conditions and fare collection processes; however, it is not known whether new/adequate funding can be obtained.**

The proposed TTC Smartcard System, as defined through research, interviews and staff input, builds on the strengths of the existing system, addresses the weakness and delivers compelling strategic and very tangible benefits and advantages to both the TTC customers and the organization, as a whole. It will improve the customer experience of the TTC, improve the working conditions of employees and provide many operational advantages. Yet, even so, there are two very significant barriers -- the large capital cost ($248.9 million) of preparing for and implementing the system as well as the estimated ($11.5 million) increase in the annual operational cost after implementation. If the capital cost is not solved with new and adequate funding, then the project is not achievable.

The following report presents the details of the TTC's smartcard fare collection study.

1.0 INTRODUCTION

The City of Toronto, located in the Province of Ontario, Canada, is the fifth largest city in North America, falling just behind Chicago, Los Angeles, New York City and Mexico City. The metropolitan area of Toronto is home to nearly 2.8 million residents and to the public transportation agency that serves them, the Toronto Transit Commission.

The Toronto Transit Commission (the TTC) operates an integrated transit system which includes buses, streetcars, subways and light rail and a specialized service, Wheel-Trans, for people with physical disabilities who have difficulty using the conventional transit services. The TTC operates 138 bus routes, 11 streetcar routes, 3 subway lines and 1 Intermediate Capacity line and there are 70 subway and RT stations, 44 bus/streetcar platforms and 28 commuter parking facilities. The system covers 195 million kilometers of service annually and, in 2006, it provided 444.5 million trips and collected $744.3 million in fares and fare-related revenue. It has nearly 11,000 employees and an annual operating budget of over $1.0 billion of which fare revenue covers 75 percent. Wheel-Trans provided 1.9 million passenger trips for over 43,000 Wheel-Trans registrants with a revenue fleet of 160 TTC-owned and operated accessible buses and approximately 100 contracted accessible taxis and sedan taxis.

Apart from transporting people, collecting fare revenue is one of the most important business functions of any transit agency. Over the last few decades, transit leaders have come to view it as more than just fareboxes and vending machines, but as a vital business strategy for improving the customer experience, securing revenue, responding to market changes and building new partnerships. In this regard, smartcard fare collection technology has offered compelling possibilities and, since the late 1990's, there have been many advances in the technology and a dramatic move to deploy these systems. In October 2006, the Province of Ontario announced a $250 million contract awarded to design, build, operate and maintain a smartcard fare collection system for the transit providers of the Greater Toronto Area (GTA). The GTA Fare System does not, as yet, incorporate TTC's business requirements (see Chapter 2, *Project Background,* for more details about this project).

In light of its own business needs and interests and the GTA smartcard initiative, the TTC launched a comprehensive study of smartcard technology. This document is the product of this study. The purpose of the study is to provide an overview of the state of smartcard fare collection technology, present a model relevant to the TTC's requirements with capital and operating cost estimates and an assessment of the advantages this technology delivers to both the TTC and its customers. It is intended that this document provide the information necessary to make an informed decision about whether or not to transition the TTC to smartcard fare collection technology.

The principles guiding the preparation of this study were clear – it should be grounded by research and the experience of peers; it should be based on proven technology and methodologies; the estimates and other measures should be reasonable and defensible; the model should be defined, first and foremost, for the benefit of the TTC and its customers, the TTC Smartcard System should not require a change in current fare policies, but be flexible enough for future fare policy options, system enhancements and potential partnering with financial institutions and, finally, TTC staff should be deeply involved in reviewing concepts and design of the model system.

Including this introduction, this document features twelve chapters:

- Chapter 2, *Project Background,* reviews the events leading to the launch of this study.
- Chapter 3, *Overview of a Smartcard Fare Collection System*, reviews the progression of transit fare collection, provides an overview of smartcard fare collection technology and summarizes the advantages of the technology.
- Chapter 4, *Experience of Other Cities and Transit Agencies*, provides a brief overview of Hong Kong's Octopus system, the Transport of London's Oyster® project, Washington D.C.'s SmarTrip

program and more in-depth review of the smartcard deployment experiences of three North American transit authorities.

- Chapter 5, *Emerging Trends*, provides the highlights of recent smartcard initiatives that, if proven successful, may recast the conventional model of deploying smartcard fare collection.
- Chapter 6, *Overview of the TTC's Current Fare Collection System*, updates the October 2000 TTC Fare Collection Study's overview and appraisal of the TTC's existing fare collection system.
- Chapter 7, *Goals and Evaluation Criteria of the TTC Smartcard System*, reviews the goals and criteria for guiding the development and assessment of the TTC Smartcard System.
- Chapter 8, *Overview of the TTC Smartcard System*, describes the process by which the TTC Smartcard System was defined, presents an overview of the system and summarizes the ways in which it is anticipated the system will improve the customers' experience.
- Chapter 9, *Concept of Operations,* provides the concept for operations as defined by the TTC Smartcard System.
- Chapter 10, *Cost Impacts*, presents the estimated fiscal impacts of procuring, installing and implementing the TTC Smartcard System
- Chapter 11, *The TTC Smartcard System Assessment*, evaluates the TTC Smartcard System against the criteria provided in Chapter 7.
- Chapter 12, *Project Management and Next Steps*, presents a recommended project management model and next steps.

2.0 PROJECT BACKGROUND

In November 2000, the Commission received and approved a staff report entitled "TTC Fare Collection Study". The report concluded, at that time, that TTC should not proceed with procurement of a smartcard-based automatic fare collection (AFC) system for the following reasons:

- Unlike many other cities which have been forced to adopt new fare collection technology because existing fare systems were old and failing, the TTC's fare collection system was in good condition and was not in need of replacement;
- The TTC's fare collection system achieved many of the customer convenience, security, efficiency and reliability benefits which other cities had been seeking with adopting AFC technology;
- Based on experience elsewhere, it is conservatively estimated that it would cost approximately $140 million to install a "bare bones" AFC system throughout the TTC subway and surface networks, that operating costs would rise by approximately $2 million annually; therefore, there was no business justification to implement an AFC system in Toronto;
- Despite much interest and activity around the world pertaining to smartcard systems, there were very few smartcard-based AFC systems in revenue service in major multi-modal transit systems; many cities were still in the developmental or testing stages at that time; and
- AFC technology was still evolving and improving rapidly, and it would be prudent for the TTC to wait for smartcard technology to mature and become more standardized.

The report's findings and analysis relied on the operating experience obtained from six major multi-modal metropolitan transit systems which had, or were in the process of implementing or testing AFC systems. During 2000, TTC staff visited Berlin, Paris, London, New York, Chicago and Washington, and obtained first-hand transit-specific information, and data, regarding the reasons for implementing AFC systems and the resulting effect on passengers, operations, costs, benefits and risks.

During this same period, GO Transit and a number of the other GTA transit properties were also assessing their fare collection systems. In 1999, GO Transit began work on a replacement smartcard-based fare collection system. Recognizing that most of the 905 transit agencies had, or would soon have, a similar need to replace their aging registering fareboxes, GO Transit initiated the GTA Fare System project, and invited all GTA transit agencies to participate in an investigation of the feasibility of developing a GTA-wide smartcard-based fare collection system.

Over 2002 and 2003, GO Transit led and managed an extremely-intensive collaborative effort, involving all GTA transit operators, to examine the customer, operator, logistical, and financial implications of establishing a common smartcard-based GTA fare system. The vision was to develop a GTA smartcard system that would allow customers to use the same smartcard for fare payment on all participating transit systems, and would accommodate the differing fare policies of each of the GTA transit operators. Although, the TTC staff was part of this collaborative effort, they could not commit to the initiative, because they still could not justify the expense of replacing their fare collection system.

The results of the study were released in January 2003, *Regional Feasibility Study of Integrated Mobility Systems in the Greater Toronto Area*. The study concluded that a smartcard system would achieve the goal of seamless mobility within the region, deliver many advantages to agencies, their customers, as well as meet the Province of Ontario's commitment of investing in advanced transit technologies. The following provides a general description of the GTAFS design and concept of operations[1].

- The common fare card of the GTAFS would be a Proximity Integrated Circuit Card (PICC), better known as a "smartcard".
- A customer would purchase a smartcard and load value onto the card.
- The appropriate fare would be deducted by a turnstile or farebox Smartcard Reader.
- Loading value onto the card would occur at a number of access points.

[1] http://www.tc.gc.ca/programs/environment/UTSP/aseamlessfarecollectionsystem.htm

- Each GTA transit service provider would install a system of on-board and back office equipment and software to accommodate and administer the GTA Fare System.
- A centralized system would link GTA transit service providers, acquire all smartcard transaction data, hold the fare card travel values (purchased by consumers) in a separate bank account, and allocate revenue to each GTA transit service provider based on transaction data.
- Customer services and technical support would be centralized.

Although some savings in farebox maintenance costs were identified, the transit operators concluded, they could not financially sustain the cost of a regional central processing system. Additional funding from the Provincial Government was required to cover the capital and operating costs of such a central processing system.

In June of 2004 the Province of Ontario assumed leadership/sponsorship of the GTA Fare System Project. MTO has signed various agreements with the participating transit agencies to formalize this partnership for a period of at least ten years.

As part of this process, MTO and the 905 transit agencies agreed to a common set of rules as to how their smartcard system would operate. These rules formed the basis for a $250 million contract that MTO has signed with Accenture for a ten-year period to develop, build, operate and maintain the Greater Toronto Area Fare System (GTAFS). This contact does ***not*** include a possible future TTC smartcard system, and the business rules for the GTAFS do not reflect all of TTC's business needs. The TTC's only current commitment with the Province related to the GTAFS is to allow Smartcard Readers to be installed on two turnstiles at each of five subway stations that interface with GO Transit and the 905 transit agencies. These readers will facilitate the flow of cross-boundary transit riders onto the TTC system at these points.

The concept of a GTA-wide farecard system has been an important part of various Federal and Provincial funding and legislative announcements:

- In March 2004, the Federal, Provincial and City of Toronto governments made a joint $1.05 billion funding announcement, of which $140 million was ear-marked for TTC's portion of an "integrated GTA ticketing system". Staff from the Federal and Provincial Governments, currently negotiating an agreement with the TTC and the City on the joint Federal, Provincial and City of Toronto funding agreement, the Canadian Strategic Infrastructure Fund (CSIF), has identified the TTC undertaking of a farecard (smartcard) system as a necessary component of the overall agreement.
- In October 2004, the Province of Ontario announced dedicated gas tax funds for public transportation. One of the conditions established by the Province for receiving this funding was TTC's participation in the GTAFS.
- In 2006, the Province passed legislation that created the Greater Toronto Transportation Authority (GTTA). This legislation gives the GTTA authority to manage and implement the GTAFS project.

Subsequent to the CSIF and gas tax funding announcements, the Commission in December 2004 agreed to the TTC's full participation in the GTAFS process. At that time, the Commission established a project team to continue to work with the GTA Fare System initiative, to conduct an independent review of the TTC's requirements for a smartcard system and to prepare a business case that would outline the needs and requirements for such a system at the TTC.

The TTC's Smartcard Project Team defined its goals, its criteria for assessment and began developing concepts of design and operation. In the summer of 2006, augmenting their own efforts, the TTC enlisted two Professional Services groups – PARSONS Corporation to assist with the study and preparing the business case and Three Point Consulting Inc. (THREE POINT) to survey the industry for costs of equipment and systems.

- **PARSONS Corporation** is based in Pasadena, California, USA and offers an array of professional services in many industries including public transportation and specifically in the area of fare collection systems. Their most recent/current projects include the Breeze® Smartcard system in Atlanta, the CharlieCard® and CharlieTicket® Smartcard/Magnetic system in Boston, the

regional SmarTrip project in Washington D.C. and Baltimore, the PATH SmartLink® system for the Port Authority of New York/New Jersey and the Fare Collection business case for Philadelphia. The firm's responsibilities include support, analyses, and guidance throughout project initiation, planning, design reviews, testing, installation, and implementation. The firm assists with preparing business requirements and specifications and other support includes vendor and system development oversight, configuration management, document control, change order preparation, system security reviews, overall project planning and preparation.

- **Three Point Consulting, Inc.** (THREE POINT) was founded in June 2002 by transit automatic fare collection and smart card industry professionals specifically to provide transit operators with direct, cost-effective access to leading industry expertise in regional automatic fare collection and transit smart card program implementation. Since its formation, THREE POINT has provided consulting resources with extensive experience and expertise in fare collection systems design and technology, smart card technology, smart card program operations and program definition and implementation. THREE POINT served as the primary author of the Regional Interoperability Standard (RIS), the definitive transit smart card standard, sponsored by the Port Authority of New York and New Jersey ("PANYNJ") which has been adopted by the American Public Transportation Association (APTA) as the official baseline for its Universal Transit Farecard Standards. Such successes have established THREE POINT as the leading transit smart card system design and implementation boutique consulting firm in North America.

  THREE POINT's unique approach provides its clients with a comprehensive team that can develop solutions from all three of the requisite program management disciplines: technology, business and operations. This multi-dimensional approach, from which THREE POINT derives its name, is fundamental to program success. THREE POINT provides expertise in each of these important areas through its network of leading industry experts. For the Toronto Transit Commission (TTC), THREE POINT completed a comprehensive review and analysis of fare collection system procurement contracts issued during the past half decade and provided a functioning model that consolidates pricing information from the contracts in a manner that allows TTC to estimate its own equipment and systems development costs using a virtually unlimited variety of system configuration assumptions.

The Smartcard Project Team's goal was to complete reexamination and present the final Business Case to the Toronto Transit Commission for review and decision by mid 2007. In the meantime, the Province of Ontario announced that they had awarded a ten year, $250 million contract to Accenture to design, build operate and maintain the Greater Toronto Area Fare System. This report defines the TTC's smartcard business requirements but does not address whether or not the GTAFS can be modified to accommodate them.

Chapter 3, *Overview of a Smartcard Fare Collection System*, reviews the progression of transit fare collection, provides an overview of smartcard fare collection technology and summarizes the advantages the technology.

3.0 OVERVIEW OF A SMARTCARD FARE COLLECTION SYSTEM

In Chapter 2, *Project Background*, it was briefly noted that the Greater Toronto Area transit coalition's study[2] concluded that smartcard technology would provide '*the best platform for enabling seamless mobility within the region…'* In this chapter, *Overview of a Smartcard Fare Collection System*, the primary components of a smartcard system are reviewed, their features and functions summarized and the related services and conveniences presented. In addition, it summarizes the advantages a smartcard fare collection system may deliver a transit agency.

3.1 FARE COLLECTION – EVOLUTION AND SMARTCARD REVIEW

This section reviews the evolution of fare collection and presents an overview of smartcard technology.

Fare Collection Background

In the 20th century, with the exponential growth in demand for automobiles and influence of its related industries, cities moved to pave over rail lines and expand roadways. Funding for subsidizing public transit was restructured, generally reduced and shared with the expanded construction of roads, highways, and freeways.

As a result of this societal and economic shift away from public transit, management was confronted with difficult challenges - competition for the first time, pressure to operate services more efficiently and a political climate not always favorable.

The transit industry could not be cavalier about fare collection methods or about customer service. There became a competitive imperative and a fiscal need to develop fare collection systems and processes that improved customer convenience, secured revenue and enabled agencies to more quickly respond to market changes and opportunities. Transit leadership began to view fare collection as not just about fareboxes, faregates and fare media, but to view it as an important business strategy.

Transit has generally followed the banking industry, adopting the same technologies. Fare collection has evolved from selling paper tickets and metal tokens to selling pre-paid fares with magnetically encoded fare media. Magnetic technology provided the banking industry with a way to make credit transactions much more efficient – from cumbersome and time-consuming paper handling, to the swipe of a card with personal account information. This same technology was applied by the transit industry to sell and process pre-paid fare products – from cumbersome handling of tickets and tokens, to the swipe of card with encoded fare products.

This technology gave transit agencies a platform for making much needed improvements to fare collection, customer service and public image. They could now replace their manual fare collection systems with a more advanced automated technology. Cash, metal tokens and printed tickets and passes could be replaced with magnetic fare media which helped reduce fare forgeries, improve throughput and customer convenience as well as the overall customer experience. Transit agencies could now leverage this new technology to reposition the industry both financially and competitively.

In the 1970's, smartcard technology began to emerge. Smartcards were first introduced for the purpose of replacing door locks with electronic locking systems. A smartcard had the look and feel of the familiar, ubiquitous credit card, but, unlike the magnetically encoded credit card, the smartcard contained a silicon memory chip that stored identification data. If the card was passed by or touched to a reader, the identification data could be validated and entry allowed.

As the number of credit card transactions increased and magnetic technology matured, vulnerabilities of the technology began to become apparent. Credit card fraud was on the rise. At the same time,

[2] Regional Feasibility Study of Integrated Mobility Systems in the Greater Toronto Area

smartcard technology was getting noticed for its much more advanced methods of data security. So in response to the increasing threat of credit card fraud, European governments issued mandates directing financial industries to adopt the more secure smartcard technology by 2004.

While the financial industry began to slowly and cautiously move to smartcard technology, it seemed the transit industry was more ready to embrace it and do so quickly. As first-generation magnetic fare collection systems began to mature, become more unreliable and more vulnerable to evasion and fare media misuse, transit industry leaders looked to smartcard technology as their next step. One of the earliest adopters of smartcard technology for public transit and the most well-known is Hong Kong's, Octopus Card Limited. This project was launched in 1997 followed by a multitude of other transit smartcard fare collection projects.

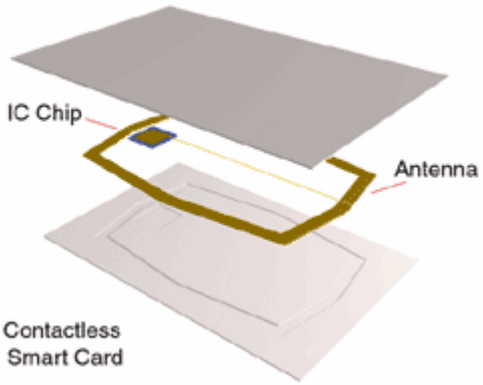
Primary Components of Smartcard Fare Collection

The basic components of smartcard fare collection include the Proximity Integrated Circuit Card (PICC) or the smartcard, the Proximity Coupling Device (PCD) or the Smartcard Reader and the Central System where the logic and processing reside. The following provides an overview of each:

Smartcard

A smartcard typically looks like a credit card. Embedded in the plastic is an integrated circuit chip (ICC) and antenna. The chip enables the storage of read only data (such as the card's unique serial number, cardholder classification – Adult, Senior, Student or Child -- card expiration, etc.) and other changeable data (such as fare types - monthly or weekly pass and/or dollar value, etc). While the ICC is typically packaged as a plastic card, it can also be packaged in other forms, including paper, key fobs, and, most recently, cell phones. Exhibit 3.1-1, *The Illustrated Smartcard*, shows the construction of a card with the ICC and antenna.

Exhibit 3.1-1: The Illustrated Smartcard



Source: AlphaCard at www.alphacard.com

Smartcards are secure, compact and intelligent devices for carrying data. They typically hold 2,000 to 8,000 electronic bytes of data (the equivalent of several pages of data). Because those bytes can be electronically coded, the effective storage capacity of each card is significantly greater than a magnetic strip card.

The international standard, ISO 14443, defines the physical characteristics, radio frequency and signal interface, initialization process and data transmission protocols It describes three types of cards – type A, B and C. The primary difference among these types is the modulation methods (defines the signal

between card and reader), bit and bite coding schemes and anti-collision (how the cards react when more than one card touches a reader at the same time).[3]

There are two types of smartcards – one that requires contact with the Smartcard Reader and another type that does not require contact (generally called "contactless"). Most smartcard fare collection systems rest on contactless technology because the transactions are faster than contact technology, there is less wear and tear on the smartcards and contactless readers require less maintenance.

Exhibit 3.1-1, *The Illustrated Smartcard*, is the typical design of a "contactless" smartcard. Below are images of smartcards -- Washington Metropolitan Transit Authority (SmarTrip), Chicago Transit Authority (Chicago Card Plus) and Metropolitan Area Rapid Transit Authority (Breeze Card).

A full-featured plastic smartcard is typically deployed for transit applications; however, within the last few years, transit agencies have begun deploying what is commonly known as a "limited use card". This product is a lower cost version of the plastic smartcard with decreased memory capacity and typically manufactured with low-cost materials. The limited use card is intended to replace short-term fare types such as single trip tickets and day passes.

Smartcard Reader

Smartcard Reader on bus

Smartcard information is processed by a Smartcard Reader by way of remote contactless radio frequency (RF) interface. Both the reader and the card have antennae, and the two communicate using radio frequencies. The range is typically one to ten centimeters for non-battery-powered cards. In fact, if the card is within the configured proximity of the Smartcard Reader, the communication can actually be transmitted without taking the card out of a wallet or a purse. This contactless transmission of data between a smartcard and the Smartcard Reader can be 3 to 5 times faster than the transmission between a magnetic card and its reader. A smartcard transaction generally equates to about 1/3 of second. Typically, an agency will specify readers that are capable of communicating with the smartcard types defined in the ISO 14443.

Smartcard Reader on turnstile

A contactless smartcard and a Smartcard Reader require proper "security keys" before processing can begin. Within each reader is a Security Access Module. It is this module that will authenticate the card. If the card is initialized with the proper keys (a process completed before it enters the distribution or sale chain), when it is touched to the system's Smartcard Reader, the card will send, via RF, encrypted data to the reader. The reader's security access module will decrypt the data and send its own encrypted packet of data back to the card. The card's keys will decrypt this packet of data. Once this cycle is completed, the card is authenticated and the transaction is allowed to be completed.

[3] APTA's Universal Transit Farecard Standards Program is developing interface standards to promote interoperability between smartcards, Smartcard Readers, Central System and Regional Central System.

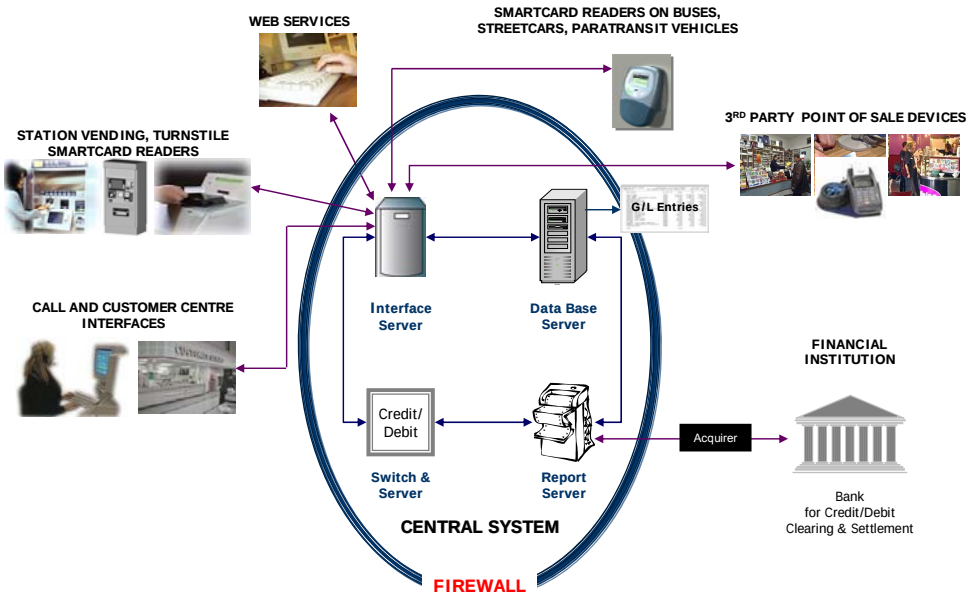
Central System

The smartcard Central System is where the software programs controlling the functionality of the fare collection system operate. This is the nexus for fare collection instructions, fare rules and where transactional data are gathered and processed for interpretation and action. Below lists the primary programs, typical of transit smartcard systems:

- *Smartcard tracking and customer service support*: These are the functions for tracking and monitoring smartcard usage.
- *Fare tables*: These are where transit fare types, pricing and the conditional rules are defined.
- *Operational instructions*: These are the instructions that control and manage the variable data such as fare pricing, business rules for fare use and other conditional instructions.
- *Financial management*: This application provides the secure bridge between a credit/debit transaction and the bank and also provides the processes for revenue reconciliation.
- *Data transport framework*: This application controls the process for moving data between the Central System and the field devices (such as the vending machines and Smartcard Readers).
- *Data acquisition instructions*: This application controls the process for handling data received from devices. This application also has a built-in feature for recovering data that is lost from malfunctioning, lost or destroyed devices.
- *Hotlist (card cancelling or blocking) management and instructions*: This application provides options and instructions for reacting to various types of smartcard management requirements for cancelling or blocking a card for rejected transactions, expiration, fraudulent transactions or in response to a report of a card loss or theft.
- *Fraud analysis rules*: This application provides the instructions for protecting the integrity of the system. It analyzes data collected by the system and reports anomalies.
- *Data summarization instructions*: These control the processes for organizing data in support of standard and Ad Hoc reporting.
- *Reporting framework*: Provides standard reports and the processing of Ad Hoc queries.

Exhibit 3.1-2, *Central System,* shows the relationship between the central system and the field devices.

Exhibit 3.1-2: Central System



Vending Machine

Breeze Vending Machine Tour

1. Display Screen
Follow the instructions on this screen and press the button next to your choice.
2. Coin Slot
Insert coins or tokens in the coin slot to pay your fare.
3. Bill Acceptor
Insert bills in the bill acceptor to pay your fare.
4. Credit/Debit Card Reader
Insert your credit card in this slot. For debit cards, enter your PIN using the keypad. (This feature may not be available until later this fall.)
5. Breeze Target
When refilling your Half-Fare or Paratransit Breeze Card, touch it to the target to add your selected value.
6. Take your Breeze Card, change, and/or receipt from the bin at the bottom of the machine.
7. Audio Plug
For the hearing impaired, an audio plug is available for headphones. Volume can be adjusted using the dial.

In addition to the three primary components of a smartcard fare collection system -- the smartcard, the Smartcard Reader and the Central System – there is another component that is not as vital, but just as ubiquitous in a smartcard fare collection system - a vending machine. These machines can be found in just about any rail or subway station of a transit agency that has launched smartcards as a fare payment option. The vending machines are controlled by instructions from the Central System and generally enable customers to load (or reload) monetary value (E-Purse value) and/or passes (E-Passes) to their smartcard. In some cases, vending machines also dispense smartcards. They often accept both cash and credit/debit cards for payment or they may be cashless (accepting credit/debit only). The machines may be monitored remotely for failures or restocking requirements and sales are transmitted to the Central System for reporting. Vending machines are very efficient and convenient channels for selling and reloading smartcards. Other channels for the TTC Smartcard System will be described in Chapter 9, *Concept of Operations,* Section 9.2*, Distribution, Sales and Reload*.

3.2 CUSTOMER SERVICES AND CONVENIENCES

Smartcard fare collection technology provides a platform for delivering new services and improving customer convenience. As mentioned in the section describing smartcards, each smartcard is given a unique serial number. This serial number is stored in the Central System's database. These unique serial numbers and applications of the Central System combine to enable a transit agency to offer customers new services and expanded convenience. The following describes these services and conveniences:

Smartcard System Services

Registration: First, the unique serial number of a smartcard, along with the Central System's database and customer service applications, enables the agency to offer account registration. This means a customer may give the transit agency personal information to link with the serial number of their smartcard. Registration is by customer choice. They may remain anonymous if they so choose; however, registration will enable a customer to receive the following services:

- *Automatic Reloads* links a customer's smartcard serial number to a credit or debit card. The system will then automatically add value or a pass when the card's balance falls below a predetermined threshold or a pass expires. When a customer authorizes automatic reloads, they will never need to worry about reloading their card again. The reload will occur automatically.
- *Balance Protection* provides the security of retaining the E-Purse value and/or time remaining on an E-Pass at the time the agency is properly notified of a lost, stolen or damaged smartcard. The lost or stolen card can be hotlisted (blocked from use in the system) and the remaining value and/or time transferred to a replacement card.

- *Negative Protection* provides the benefit of one completed trip if there is not enough E-Purse value on a customer's smartcard. This allows the customer to complete their trip, and then when the customer reloads their smartcard, the system debits the value of the negative balance.

Conveniences

The Central System applications allow a transit agency to expand the ways in which customers may purchase and reload their smartcard. The following describes the sales and reload channels typically deployed in a smartcard fare collection system.

- *Web Services*: The smartcard Central System provides for web services. This typically includes processes for ordering, reloading, and registering smartcards from any computer with access to the internet. Customers may also use the web service to check the balance remaining on their smartcard as well as review their transaction history. All web transactions are automatically uploaded to the Central System for processing and updating the customer database.
- *Call Centre*: Transit agencies may also expand their call centre support to offer smartcard account management services. Operator-assisted call centres are linked to the Central System's customer service application for the purpose of processing customer requests for smartcards, account registration, card replacements, reloads and other account services.
- *Remote Sales*: Point of sale devices may be installed in an agency's customer service centre or 3rd Party Ticket Agent venues for the purpose of offering additional channels for purchasing and reloading smartcards. All transactions are automatically uploaded to the Central System for processing.

In addition to the above conveniences, smartcards are easier for customers to us. They do not require motor skills or eye-hand coordination to tap at a reader. CTA conducted a study of people with disabilities and sight impairments. The study found that this customer segment prefers to use smartcards over cash, tokens and magnetic media.

3.3 BUSINESS ADVANTAGES, DISADVANTAGES AND RISKS

In addition to expanding the opportunities to improve the customer experience through added services and conveniences, a smartcard system provides many other business advantages.

- *Greater reliability*. New technology will create a more robust system; less prone to breakdowns and abuse. Los Angeles County Metropolitan Transportation Authority estimated average daily failures for magnetics are nearly 30 times greater than smartcard devices.
- *Improves quality of data and provides more reporting capabilities.* The tap of a smartcard automatically records and reports the customer classification, fare type and/or amount deducted from value on the card and other transaction information (See Chapter 9.0, *Concept of Operations*, Section 9.7, *Data Systems and Reporting*, for more details on the data elements collected). Point of sale device transactions, turnstile entries and surface boardings (made with smartcards) will be automatically transmitted and reported. Automatic data collection and transmission reduces opportunities for errors and improves the integrity of the data. More accurate data and available reporting may improve service planning and management analyses.
- *Improves employee safety:* Surface Vehicle operators no longer must visually inspect fare media. The technology reduces operator intervention which, in turn, reduces opportunities for fare disputes. Automating fare sales and reloads eliminates the requirement for employees to handle fare media and money.
- *Improves revenue security.* The smartcard system will monitor, detect and report transaction anomalies. The electronic application of fare products onto a memory chip eliminates the ability to forge or duplicate fare products as is currently possible with metal tokens and printed fare

media. In addition, memory chips are significantly more secure and less vulnerable to corruption than magnetic strips.

- *Provides greater flexibility for changing fare policy and pricing.* Fare tables and business rules will reside in the Central System. These fare tables and business rules may be changed at any time to execute new strategic initiatives and policies. The changes can then be downloaded to field equipment in a timely manner.
- *Facilitates regional mobility:* A variety of fare products may be loaded to a smartcard allowing customers to use one card to access services of any transit provider participating in a regional smartcard system.
- *Expands future opportunities.* Smartcard technology provides a platform for software upgrades and implementing new applications as made available. Other industries, such as bankcard and wireless (mobile phones), are deploying smartcard payment options. Transit agencies may leverage their smartcard infrastructure to build synergistic partnerships within these industries.

Disadvantages and Risks

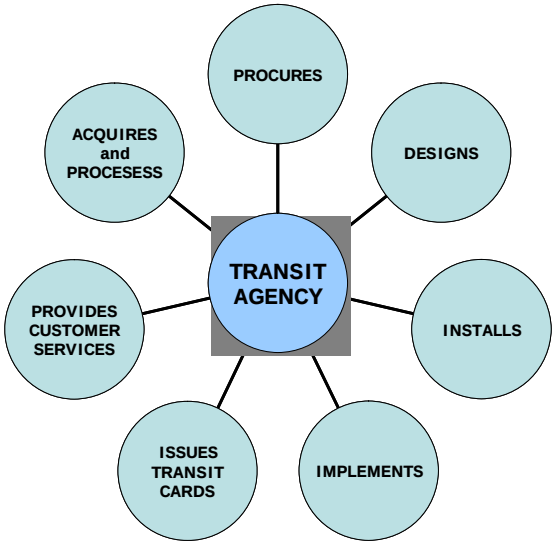
A smartcard system also has disadvantages in terms of financial and personnel resources. The system most likely requires a significant capital commitment and annual operating costs may increase. Transit agencies not only struggle with redirecting capital from other important projects, but are also challenged by supporting complex backend systems with uniquely skilled information technology personnel and by providing the facilities and additional personnel for expanding customer services and related support.

There are also risks associated with a smartcard fare collection system. The primary risks include those associated with preserving and protecting financial and customer data. Smartcard systems process, collect and store very sensitive data such as authorizing and processing credit/debit sales, collecting fare payment transactions and storing customer personal information. There are many risks inherent with managing fare payment processing and related data systems including threats of both internal and external theft, the wrongful and illegal use of this data and the liability and public relations concerns of not adequately safe-guarding the release of customer information. While many transit agencies have addressed these issues adequately, the risks are ever-present in a system like this and require resources for defining processes, policies and executing the right security precautions.

3.4 CONVENTIONAL MODEL OF SMARTCARD FARE COLLECTION

The conventional model of a smartcard fare collection system can be generally described as *transit-agency-centric*. This means that the transit agency is typically responsible for procuring, installing and managing the fare collection equipment and systems; branding and issuing its own transit-specific smartcards, providing customer and account management services and acquiring fare payment transactions. Exhibit 3.4-1 *Transit Agency Centric Model of Deployment*, portrays the conventional model of deploying smartcard fare collection system.

Exhibit 3.4-1: Transit-Agency-Centric Model of Deployment



Chapter 4, *Transit Smartcard Systems*, explores smartcard initiatives of six transit agencies. Most represent the transit-agency-centric model of deployment – one represents a design, build, operate and maintain agreement public/private financing initiative with a contractor. Chapter 5, *Emerging Trends*, describes recent initiatives that hold promise for moving an agency beyond the conventional transit-centric model to decreasing or eliminating the transit agency's role as smartcard issuer and transaction acquirer and becoming more like a retail merchant who accepts various "cards" for payment in an open payment system.[4]

[4] Smart Card Alliance, Transit and Contactless Financial Payments: New Opportunities for Collaboration and Convergence, October 2006, page 4.

4.0 EXPERIENCE OF OTHER CITIES AND TRANSIT SYSTEMS

Chapter 3, *Overview of a Smartcard Fare Collection System*, mentions the shift to smartcard fare collection following the high profile launch of Hong Kong's Octopus system in 1997. Since then, many transit agencies have followed suit. The most notable North American smartcard deployments can be found in Washington D.C., Baltimore, Chicago, Boston, Atlanta, San Francisco/Bay Area, Los Angeles, New Jersey, Houston, Minneapolis, Ventura, and (soon) Central Puget Sound, San Diego and Phoenix. In Canada, Montreal is in the process of implementing a smartcard-based fare collection system and the Province of Ontario announced that they had awarded a ten year, $250 million contract to Accenture to design, build operate and maintain the Greater Toronto Area Smartcard Fare System.

The deployment of smartcard fare collection technology has resulted in some dramatic changes in strategic business and policy decisions. As will be presented in Chapter 5, *Emerging Trends*, the industry is beginning to leverage the technology to explore strategic business opportunities with bankcard and wireless industries and as for policy decisions, some transit agencies – Chicago Transit Authority, Massachusetts Bay Transportation Authority and Metropolitan Atlanta Rapid Transit Authority -- are now executing policies that offer attractive incentives for using smartcards and disincentives for using cash.

In addition to changes in strategic business and policy decisions, the deployment of smartcard fare collection technologies has sparked a change in internal cultural attitudes. Leaders of some of the highest ranking transit authorities are declaring that they will leverage this new technology to change the way the public views public transit by changing the way it views itself. They believe cutting edge technologies will reverse defeatist attitudes apparent in its own culture – from believing public transit is an out-of-date, declining industry losing out to the automobile to an almost revivalist spirit of renewal, innovation and competition.

This chapter provides a brief overview of Hong Kong's Octopus system, London's Oyster project, Washington D.C.'s SmarTrip as well as a more in-depth review of the experiences of three North American transit authorities.

4.1 OCTOPUS CARDS LIMITED, HONG KONG[5]

The Mass Transit Railway (MTR) network adopted a system of magnetic plastic cards when it started operations in 1979. These cards were either used as single journey tickets or as stored value tickets. The Kowloon Canton Railway (KCR) adopted the same magnetic cards in 1984, and the stored value version was renamed *Common Stored Value Tickets*. In 1989, the *Common Stored Value Tickets* system was extended to Kowloon Motor Bus (KMB) buses providing a feeder service to MTR and KCR stations and to Citybus, and was also extended to a limited number of non-transport applications, such as payments at photo booths and for fast food vouchers.

The MTR Corporation eventually decided to adopt more advanced technologies and, in 1993, announced that it would move towards using contactless smartcards. To gain wider acceptance, MTR Corporation partnered with four other major transit companies in Hong Kong to create a joint-venture business to operate the Octopus system in 1994. The Octopus system was officially launched in 1997, after three years of trials. Three million cards were issued within the first three months of the system's launch. The primary reason for the quick acceptance was that the MTR and KCR required that all holders of the *Common Stored Value Tickets* replace their tickets with Octopus cards in three months or have their tickets made obsolete, thus forcing their base commuters to switch quickly.

The system was launched with in-station vending machines that accept cash and debit and credit card payments for reloading Octopus cards, but in 1999, reloading the smartcard was expanded to include

[5] http://en.wikipedia.org/wiki/Octopus_card

convenience stores equipped with Octopus point of sale devices. At the same time, automatic reload services were also introduced.

Smartcard Readers were installed on turnstiles and surface vehicles to accept fare payment from the Octopus card on which both money value and monthly passes can be stored. The transit providers still accept cash on the bus, but customers are offered discount incentives to use the smartcard.

The Central System of each transit provider collects the transaction data from the field devices and transmits to a Central Transaction Clearinghouse for reconciliation and revenue settlement among all service providers. This is completed every 24 hours. Each Central System tracks card history, blocks lost or stolen cards and monitors field devices.

In 2000, the Hong Kong Monetary Authority granted a deposit-taking company license to Octopus Ltd., removing previous restrictions that prohibited Octopus from generating more than 15 percent of its revenue from non-transit related functions. This change allowed the Octopus card to be more widely expanded beyond the fare payment application. In 2003, the Hong Kong Government replaced all of its 18,000 parking meters with a new Octopus card operated system and Octopus is now accepted as payment at fast food restaurants, convenience stores, school shops, off street parking, residential access control, sporting venues, drug stores, cinemas, department stores and more.

According to Octopus Cards Limited, there are currently over 14 million cards in circulation, used by 95 percent of the population of Hong Kong, generating over 10 million daily transactions worth a total $4.0 billion (CAD) a year.

According to an Octopus spokesperson[6], customer benefits include:

- Seamless, regional mobility
- Discounted fares
- Ease of use
- Improved reliability
- Secure payment
- Multiple channels for reloading value, including automatic reloads
- Balance protection

Operator benefits include:

- Reduced maintenance costs vs. magnetics (72% reduction for MTR)
- Reduced capital replacement costs vs. magnetics
- Reduced cash handling costs (KMB reduced costs by 80% 50 tons to 10 tons processed/day)
- Improved fare policy flexibility
- Improved throughput and faster boarding time (but not enough to reduce bus frequency)
- Fraud reduction (forged coins)
- Improved management information
- Expanded marketing opportunities
    - Octopus has become an expected customer service
    - Immediate effect of installation on bus routes = +4% before/after increase in ridership (riders wait for an Octopus equipped bus)

Future plans include:

[6] TTC Transit Smartcard research

- To provide Octopus consultancy services and to become a system vendor.

4.2 TRANSPORT OF LONDON

In the early 1990's, Transport of London was faced with revenue and customer service issues. It needed to address increasing fare evasion (only the subway stations in central London had turnstiles/faregates, so many people we not paying), to reduce the queuing for ticketing, and to improve the speed of throughput in the Underground stations. Transport of London identified two strategies for solving these issues: 1) gate the Underground network. This would deter and reduce fare evasion; 2) implement smartcard technology. This would reduce queuing for ticketing and improve station throughput.

While it was imperative to solve these critical issues, the Underground's capital investment program was fully committed to cover safety and other infrastructure renewal projects. In light of this constraint, an alternative funding vehicle needed to be created -- one that would enable Transport of London to accelerate the initiatives without tapping its capital program. This led to developing and initiating a Private/Public funding program.

The Private/Public Financing Initiative called for the contractor to finance and operate the system and payment to the contractor would come from fare revenue collected. The request for proposals was issued around 1995 by London Regional Transport, the holding company for London Underground Limited (LUL) and London Buses. One consortium was determined to have the technical expertise and financial backing necessary to perform to the contract and deliver PRESTIGE (the smartcard project). Negotiations took place over three years and finally awarded in 1998.

The consortium (called TranSys) was comprised of Electronic Data Systems (EDS) at 37.5% stake, Cubic Transportation Systems at 37.5% stake, International Computers, Ltd. for 20% stake, and WS Atkins for 5% stake. There were nearly 30 banks involved in the financing of the project.

PRESTIGE is the contract to design, finance, build, operate, and maintain the smart card fare collection system over a 17 year period. The value of the contract is $2.6 billion (CAD) with a $442 million (CAD) capital investment by the contractor.[7] The contractor receives approximately $166 million (CAD) annually paid out of fare revenues received. The payments are performance-based resting on system availability and the success of the smartcard program.

The contract calls for providing and installing smartcard equipment which included faregates, ticket office machines, smart card readers on ticket vending machines, communications network, and computer and back office systems. The contractor is also required to perform several services including managing and monitoring the smart card fare collection system, marketing and distributing smart cards, managing the retail network, and providing call center services.

The scope of the contract includes providing equipment and fare collection for 8,000 buses, 275 stations, and 2,600 retail outlets. In all, there are 16,000 smart card devices in the system.

Performance measurements include:

- Device availability
- Reliability and time to fix failures

Transport of London made the decision to assume smartcard customer services as they believed the contractor did not perform to the standard they expected or desired for their customers.

[7] Matt Newsome, Regional Program Manager, CUBIC, Implementation of London's Oyster® Card, APTA Fare Collection Workshop, 2006.

Since the contract started in 1998, TranSys has distributed 5.3 million Oyster cards; they currently process 5.1 million Oyster transactions per day, and load nearly 400,000 fare products onto Oyster cards per week.[8]

According to a Transport for London spokesperson[9], customer benefits of Oyster include:

- Faster ticket purchase, reduced queuing
- Faster entry/exit through turnstiles
- Faster boarding on buses
- Easier access to a wider range of tickets
- Stored value - flexibility
- Integrated "seamless" travel

Operator benefits include:

- Reduced fraud
- More efficient ticket selling
- More trips made due to convenience
- Reduced survey costs

Lessons learned:

- Define firm requirements (specifications)
- Don't underestimate "softer" issues: customer education, marketing, staff training
- Be watchful of changes to scope:
- Launch incrementally
- Test and trial are extremely important

4.3 WASHINGTON AREA METROPOLITAN TRANSPORTATION AUTHORITY SMARTRIP

The Washington Metropolitan Transportation Authority (WMATA) operates the second largest rail transit system and the fifth largest bus network in the United States. In 2006, WMATA provided 206 million rail trips and 131 million bus trips.

In May 1999, WMATA launched a contactless smartcard called SmarTrip, with the objective of making transit travel easy, simple and attractive for customers. Over eight years later, over 2 million SmarTrip cards have been issued and used to pay fares throughout the MetroRail and MetroBus systems and to pay fees at Metro-operated parking facilities. WMATA reports that the SmarTrip success has rested on the improved customer experience in terms of transaction speed, durability, reload convenience and the security of balance protection services. Customers can add to the card's value online, at station ticket vending machines or at select retail outlets

WMATA's deployment represented the transit-agency-centric conventional model with the Authority procuring, installing and managing the fare collection equipment and systems; branding and issuing its own transit-specific smartcards, providing customer and account management services and acquiring fare payment transactions. It eventually outsourced the c SmarTrip account management services – card fulfillment, registration, reload and replacement to ACS and, then, later to ERG.

[8] Matt Newsome, Regional Program Manager, CUBIC, Implementation of London's Oyster® Card, APTA Fare Collection Workshop, 2006

[9] TTC Transit Smartcard research

WMATA is the lead agency in promoting contactless smartcards as payment option for transit in the National Capital region and contracts are in place throughout Washington, D.C., Northern Virginia, and the state of Maryland to expand the system's architecture to 15 additional operators. Once the system is expanded, the customer service center will also expand to provide the smartcard account management service along with the reconciliation and settlement of fare revenue region-wide.

At the time of the initial deployment there were no ISO standard for smartcards and readers; therefore, WMATA had to rely on a sole source supply for smartcards, which makes the expense greater than if they could shop for cards from multiple suppliers. However, the system has been working reliably and is stable, so before there were regional considerations, this was not regarded as a significant limitation. It is recognized that the system will have to be upgraded with new card readers that will accept ISO standard cards in order to allow new options such as limited use paper smart cards and bank issued contactless cards to be accepted.

In the long term, WMATA's goal is to move away from the conventional model of being card issuer and transaction acquirer. The Authority wishes to open the system to bankcard transactions at both the turnstile and fareboxes. WMATA's co-branding initiative will be reviewed in Chapter 5, *Emerging Trends*.

4.4 THREE NORTH AMERICAN TRANSIT AUTHORITIES

This section provides an in-depth review of smartcard fare collection deployments of three North American transit authorities. These three agencies not only represent the most recent implementations of smartcard fare collection technology, but also they have chosen to install equipment/systems – smartcard readers on turnstiles, vending machines, retail sales (and internal) point of sale devices -- and to deploy strategies and services that are very similar to those specified by the TTC Smartcard System such as providing expanded customer service support, account registration, automatic reloads, balance protection and web services. One has deployed an all-smartcard system (using plastic smartcard and paper limited use smartcards") which is what the TTC Smartcard System defines. These three Authorities have also been excellent resources throughout the preparation of this study. They have been willing and available to provide best practices, productivity metrics and lessons learned on such topics as Call and Customer Centres, credit/debit processing, system reliability, project management, managing Central Systems and related security issues. Their projects are referenced throughout the document.

Each of the three made the decision to replace or upgrade their failing fare collection system and views deploying smartcard technology as a strategic imperative. Two are doing so incrementally by running magnetics in parallel with smartcards while one authority made the decision to step out and be the first in North America to deploy an all smartcard system.

Chicago Transit Authority, for instance, introduced smartcards three years ago and recently instituted fare policies that encourage and reward smartcard use. The CTA president's goals are to drastically reduce cash and to convert the majority of customers to paying their fare with smartcards. He believes the advantages of smartcard technology are extremely compelling – it improves throughput, dwell time, system reliability; provides greater fare flexibility and even lowers customers' awareness of cost per trip. He believes it's these kinds of changes that will enable public transit to finally compete with the automobile.

For all three authorities, the decision to replace/upgrade their fare collection system was not based on qualitative concerns only, but also on concerns about the increasing cost of maintaining and operating their aging/failing systems, the questionable data integrity, and the cumbersome reporting methods.

The authorities selected for this review are Chicago Transit Authority, Metropolitan Atlanta Rapid Transit Authority (MARTA), and Massachusetts Bay Transportation Authority (MBTA).

4.4.1 SUMMARY OF KEY STATISTICS

Table 4.4-1, *Peer Key Statistics*, provides each authority's primary statistics.

Table 4.4-1: Peer Key Statistics

KEY STATISTICS (FY '05)	CTA[10]	MARTA[11]	MBTA[12]
Annual ridership* – rail (surface/subway/trolley)	182,000,000	70,900,000	56,455,100
Annual ridership* – heavy rail	Does not operate heavy rail	Does not operate heavy rail	120,657,200
Annual ridership* – bus	288,000,000	71,500,000	109,885,900
Annual ridership* – trackless trolley	N/A	N/A	3,482,700
Annual fare revenue (CAD)	$475,500,000	$122,500,000	$244,400,000
Annual operating budget (CAD)	$1,100,000,000	$340,700,000	$989,000,000
Annual capital budget (CAD)	$766,150,000	$497,000,000	$624,000,000
Buses/Vans/Trackless Trolleys[13]	2,000	666	1,454
Rail cars (Trolley, Light, and Heavy)	1,190	338	1,085
Bus Routes	151	120	204
Rail stations	144	38	275
Pay-for-parking facilities	18	9	64

*unlinked trips

Regional Partners

CTA: PACE (suburban bus) and METRA (commuter rail). PACE and CTA are 100% magnetic and contactless smartcard compatible.

MARTA: Cobb County Transit, Clayton County Transit, Gwinnett County Transit, Georgia Regional Transit Authority, Georgia Rail. There are plans to implement smartcard technology compatible with MARTA.

MBTA: Currently, none, but the Authority is planning for future expansion regionally.

Table 4.4-2, *Fare Collection System Time to Plan and Build-Out* summarizes the number of years each phase of each Automatic Fare Collection (AFC) project took.

[10] http://www.chicagotransitauthority.com/welcome/overview.html
[11] http://www.ajc.com/today/content/epaper/editions/today/news_3408d29aa19f017a0028.html
[12] http://www.mbta.com/insidethet/capital.asp#
[13] MBTA is the only peer with trackless trolleys

Table 4.4-2: Fare Collection System Time to Plan and Build Out

AFC SYSTEM IMPLEMENTATION PHASE			
	CTA	**MARTA**	**MBTA**
Finalizing RFP Package	3 Years	3 Years	3 Years
Design, Build, and Test	5 Years	2 Years	3 Years
System Build-Out	9 years (phased)	7 months	2 years

4.4.2 CHICAGO TRANSIT AUTHORITY

What decision did CTA make and why?

In early 1991, CTA made the decision to move out of its cash and token based system in which agents collected fares in the rail station to an automated fare collection (AFC) system based on read/write magnetics. This new system would enable the processing of stored value magnetic strip fare media. In the first phase (1997), the Authority upgraded bus fareboxes with magnetic read/write Ticket Processing Units (TPU), installed new turnstiles and introduced magnetic fare media; in the second phase (1999), automated vending machines (AVMs) were installed in every rail station, ticket agents were taken out of the sales booths and transitioned to customer assistants. Finally, tokens were discontinued. In the 2000 TTC Fare Collection Study, it was reported that CTA had spent nearly $225 million (CAD) on the new automated fare collection system. Since then, it is estimated the Authority has spent an additional $119 million (CAD) in equipment, fare media and system upgrades to launch the Chicago Card along with infrastructure modifications of approximately $14.3 million (CAD).

Although the core system was based on read/write magnetics, the project plan included the eventual deployment of smartcards. They had procured equipment with Smartcard Readers and the software necessary to process smartcard transactions. After a limited trial period, in late 2003, the third phase was launched and the Chicago Card, a stored value smartcard was introduced. In early 2004, the Chicago Card Plus, an account based smartcard allowing for pay-per-use, 30-Day Pass and automatic reloads, was launched.

Philosophy and Goals

CTA president, Frank Kruesi, shows his CTA TransitCard in1999.

In the early 90's CTA's ridership was declining dramatically, revenues dropped, and costs were climbing. The Authority's deficit was ballooning, so the response was to cut service. Unfortunately, cutting service wasn't enough. The system was out-of-date and deteriorating rapidly not only causing the rise in costs, but affecting public image and support. Clearly, the system needed to be transformed from the inside out – cutting service was merely treating the symptom, not the disease.

The president of CTA, Frank Kruesi, is very vocal about what plagues transit. In a speech to attendees of the APTA Fare Collection Workshop in Atlanta in March 2006, he stated that the attitude of defeatism within the transit industry is pervasive and insidious and has manifested itself as a failure to innovate. He also said that he feels strongly that transit leadership of today must influence change in these old, defeatist attitudes: that today's leaders must understand the advantages and possibilities technology delivers, and use it to control the experience of the customer. Consistent with this philosophy, his specific goals for deploying smartcard technology are to improve throughput, dwell time, and reliability which, ultimately, affect customer convenience and ease-of-use. He declared that by embracing technological advances, only

then can transit more effectively compete with the automobile, change perceptions, and, ultimately, change the culture of defeatism and decline to one of entrepreneurialism, innovation, and success.

The goals Mr. Kruesi set are now in the process of being achieved. First, since the transaction time for collecting a fare from a smartcard is faster than processing cash or magnetics, CTA recently instituted new policies encouraging fare payment with Chicago Card and discouraging cash and TransitCard use. Plus, CTA instituted innovative programs that speed bus boarding and rail entry for Chicago Card customers. *Go Lanes* allow Chicago Card customers to board buses and enter rail stations more quickly (the Go Lane program is described in more detail in the Customer Convenience and Ease of Use section.

System Components and Fare Payment Methodology

The following describes the fare collection equipment either replaced or upgraded, the systems and backend processing, technologies, fare media, and fare collection methodologies deployed by CTA.

KEY SYSTEM FEATURES

408	Automated Vending Machines
1,000	Faregates (with magnetic and Smartcard Readers
2,500	Registering fareboxes (with added magnetic and Smartcard Readers)
8	Garages
144	Rail Stations

Plus 65 *Touch-n-Go* devices and other back-office computers and equipment.

- ***Equipment.*** CTA chose a phased deployment of automated fare collection equipment starting with installing new turnstiles that read/write to magnetic fare media and were capable of reading/processing contactless smartcard fare media. In 1997, they began selling magnetic fare media through their internal and external sales outlets. Two years later, CTA installed cash only automated vending machines (AVMs) for the purpose of selling and reloading magnetic passes. The AVMs were also capable of reloading smartcards. Starting early 2000, the Authority added Smartcard Readers to bus fareboxes and procured and installed (in select visitor centers) vending machines that accepted both cash and credit/debit cards. Later, they procured cashless vending machines to install in strategic locations. Table 4.4-3, *CTA's Fare Collection Equipment, Technologies and Systems*, lists CTA's automated fare collection equipment and years deployed. No AFC equipment was purchased for parking lots.
- ***Technologies.*** CTA's automated fare collection system is rooted by read/write magnetics and contactless smartcard technologies. Table 4.4-3, *CTA's Fare Collection Equipment, Technologies and Systems*, describes the functionality of the equipment.
- ***Systems.*** Table 4.4-3, *CTA's Fare Collection Equipment*, *Technologies and Systems*, provides a summary of data collection, management, processing, and reporting systems and fare card production equipment.

Table 4.4-3: CTA's Fare Collection Equipment, Technologies and Systems

RAIL STATIONS	BUS	SYSTEMS
Tri-pod barrier (1997) • Takes magnetic fare media and smartcards. ***High Barrier Gate* (1997)** For unattended stations. • Takes magnetic fare media,	***Registering farebox* (1985)** • Counts/registers fares • Does not validate coins or currency ***Ticket Processing Unit* (1997)** Attached to farebox to	***High Speed Encoder* (1997)** Encodes magnetic fare media. ***Station Controller* (2002)** Manages data flow to/from devices and monitor functions.

RAIL STATIONS	BUS	SYSTEMS
smartcards and coins ***Hinged Swing Gate* (1997)** Accessible • Takes magnetic fare media and smartcards ***Automated Vending Machine (1999)*** • Vends magnetic fare media • Reloads magnetic fare media and smartcards • Accepts cash only ***Visitor Pass Vending Machine (2004)*** • Vends magnetic fare media • Reloads magnetic fare media and smartcards • Accepts credit/debit and cash ***Express Vending Machine (NTP, 2005)*** • Vends magnetic fare media • Reloads magnetic fare media and smartcards • Accepts credit/debit only	process magnetic fare media ***Cubic Transportation Systems (Cubic) Smartcard Reader* (2000) –** Attached to farebox to process contactless smartcards	***Network Manager* (2002)** To upload/download information from/to station controllers at rail stations and depot computers at bus garages. ***Database* (2002)** • Sybase controls flow • Oracle warehouses • Hummingbird 8.51 for reports ***Web and Chicago Card Plus Account database* (2003)** • Outsourced development and hosting • Account management services are performed in house ***Point of Issue Machines* (2002)** – For internal card fulfillment to initialize and encode smartcards ***Touch-n-Go Devices* (2005)** – For card fulfillment and reloading through retail outlets. ***High Production Encoding Machine* (2005)** – For initializing and encoding smartcards in high volume

CTA took steps to procure validating fareboxes -- released an RFP and were planning to issue a contract in January 2006. To date, the contract has not been issued.

- ***Fare Media.*** CTA's automated fare collection system features magnetic and contactless smartcard fare media. Table 4.4-4, *CTA's Fare Media*, describes the features and functions of the fare media deployed by CTA. It should be noted that as of January 2006, CTA introduced a radical shift in policy. The policy follows the same principle as many transit agencies abroad are moving to adopt – most notably London. The approach is to reward the customer who chooses to use electronic fare media and discourage the use of cash.

Table 4.4-4: CTA's Fare Media

MAGNETICS	CONTACTLESS SMARTCARD
Paper: Prior to recent fare policy, cash paying customers received paper magnetic card processed by Ticket Processing Unit for transfers. On it was printed expiration, date, vehicle number, rider type.	***GO Card*®**: Proprietary to Cubic, an expanded version of the ISO/IEC 14443 type B standard. Cubic's Smartcard Readers can only read this card. • Chicago Card: Stored value only. Reload at AVM or "Touch and Go" sites. • Chicago Card Plus: A registered, account based card that allows both Pay-Per-Use

MAGNETICS	CONTACTLESS SMARTCARD
	and 30 day pass. Automatic reloading by credit/debit card linked to account.
Plastic: Stored value and passes are made of polyester; special fare media such as University Passes, Employee ID cards, and Reduced Fare Permits, made of three layer material (PVC, polyester, PVC). The three layer card makes it more durable and conducive to printing photo, etc. All are reload able at the AVMs.	
High coercivity; More resistant to alteration or erasure	

- ***Methodology***

  Table 4.4-5, *CTA's Fare Payment Methodology*, provides a general overview how the AFC system processes a fare:

Table 4.4-5: CTA's Fare Payment Methodology

CUSTOMER FARE MEDIA	ACTION	SYSTEM
	Taps or inserts at CTA (or PACE) farebox or CTA turnstile 	Deducts appropriate fare or trip, encodes transfer. First transfer, system deducts $0.25, second transfer, system allow free.  Or checks for valid pass
	Drops into farebox or purchases a TransitCard at the AVM 	System collects full fare and allows entry. No transfers encoded or issued. AVMs accept coins and bills only. Visitor AVMs accept coins, bills and credit/debit. Express machines accept credit/debit only. 
 	Transfers to PACE. Taps or inserts at PACE farebox.	If first transfer from CTA, system collects $0.25. If second transfer, free.

CUSTOMER FARE MEDIA	ACTION	SYSTEM
METRA Monthly pass, may purchase a magnetic Full Fare Link Up pass.	Transfers to CTA by inserting Full Fare Link Up pass in CTA farebox or turnstile.	System checks for valid pass and allows entry.

The following describes how customers pay parking fees:

- Customer drops daily fee in a slot box.
- A select number of parking spaces may be reserved for a monthly fee; however, the daily rate applies. The monthly permit only reserves the space.

Transition Plan

The plan is considered a "phased deployment", rolling out incrementally over several years. The RFP was issued in 1992 and contract awarded to Cubic in 1993. Table 4.4-6, *CTA's Phased Deployment Timeline*, reflects the milestone events of CTA's phased deployment.

INTENTIONALLY LEFT BLANK

Table 4.4-6: CTA's Phased Deployment Timeline

1996	1997	1999	2000	2001	2002	2003	2004	2005	2006
Installed TPUs on fareboxes	Turned on all new AFC equipment	Installed Automated Vending Machines in all rail stations	Installed smart card readers on fareboxes	Started smart card trial	Upgraded network manager	Launched Chicago Card	Launched Chicago Card Plus	Installed Touch-n-Go Devices	Announced fare policy changes that favor Chicago Card
Installed new turnstiles in rail stations	Started selling magnetic fare cards through sales outlets	Started selling and reloading magnetic fare meda at AVMs			Improved hotlist capacity				
Installed High Production Encoder		Shifted employees from ticket booths to in station Customer Assistance			Installed Point of Issue Equipment	Design, developed, Chicago Card + Application.			
		Discontinued tokens							

Advantages

The following summarizes CTA's experience of the ways in which smartcards improved the customer experience and internal business functions:

- ***Customer ease of use and convenience.*** In 2001, CTA collaborated with the Chicago Regional Transit Authority (RTA) to initiate a fare media trial to evaluate convenience and ease of use. Both agencies issued smartcards to a select group of disabled riders (including sight impaired). Together, these two agencies distributed smartcards to over 1,000 disabled customers. The results found overwhelming support for the smartcard by people with disabilities, including people with sight impairments. Table 4.4-7, *Results of Smartcard Pilot with Disabled Riders*, summarizes the findings.

Table 4.4-7: Results of Smartcard Pilot with Disabled Riders

MEDIA	ADVANTAGES	DISADVANTAGES
Token	Identifiable by touch/weight Less refined motor skills required for depositing into farebox	Difficult for people with some muscular disabilities to grasp Cumbersome to carry for multiple rides Difficult depositing into a TVM.
Magnetic Fare Card	Easy to carry	Requires fine motor skills to insert into transport or swipe reader
Contactless Smartcard	Easy to carry Do not need to remove from wallet, holder, or glove Specific motor skills not required for payment of fare Auto reload is a convenient benefit Protected value if the card is lost of stolen is an attractive benefit to this community	Sight impaired may require audio announcement to be informed of amount debited and remaining stored value or rides on card

CTA found that smartcards allow the Authority to launch initiatives specifically designed to improve customer ease of use and convenience. The following describes the initiatives:

- *Autoload:* Registered Chicago Card Plus customers may link their Chicago Card Plus with a credit card and automatically reload their card with value and/or a 30 day pass,
- *Web Accounts:* Chicago Card Plus customers are able to reload their card and view their transaction history through a personal web account

- *Go Lane:* Chicago Card and Chicago Card Plus customers may board CTA buses without standing in the same line[14] as cash and TransitCard customers. Plus, in every rail station, there are dedicated Chicago Card and Chicago Card Plus turnstiles for quicker throughput.

- *Touch-n-Go:* Special point-of-sale touch pads are installed at select retailers. They allow Chicago Card customers to check their balance and add value to their card.

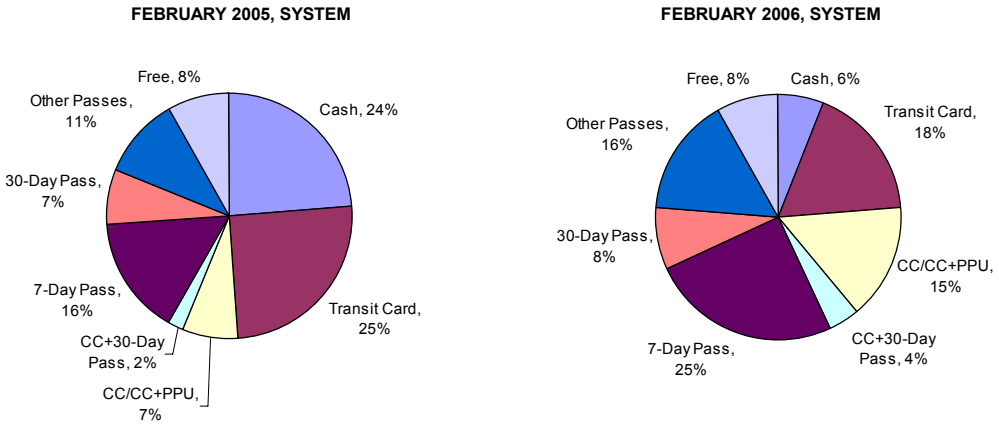
- ***Data flow and integration of different modes. Ridership, revenue, financial reporting of all modes.*** During the phased deployment of the system, the network manager was upgraded. This serves to upload the information from and download information to each of the station controllers at the rail stations and to the depot computer located in each garage. In addition to ridership information, alarms and maintenance data are sent to the Network Manager and the Network Manager provides fare table revisions and hot lists. As a result of this upgrade, the data collection and reporting have all improved.
- ***Fare policy flexibility.*** Smartcards enable CTA to enact fare policies that meet the Authority's goals of improving throughput, dwell time, and reliability. Increasing the number of customers using smartcards ultimately reduces the time it takes to process cash and TransitCards at the farebox and turnstiles. Recently CTA changed its fare policy to drive customers to the Chicago Card and Chicago Card Plus.

  - The Authority offers more discounted fare programs to Chicago Card customers (they receive discount on full fare for bus and rail, plus 10% bonus on stored value of $20 or more). TransitCard customers receive discount on full fare for bus, but not on rail and no bonus on stored value. Cash customers receive no discounted fares.
  - Customers who pay with cash may not purchase a transfer – they must pay full fare each time they board a vehicle. Chicago Card and TransitCard customers may purchase a transfer for $0.25.

[14] A Smartcard reader was installed to the left (as viewed from the doorway) of each (low-floor) bus farebox. This allows Chicago Card customers to board to the left of the cash and TransitCard customers. Since transaction time is considerably faster for Smartcards, customers, who choose to pay with a Smartcard, get the added benefit of a dedicated "speed lane".

After 30 days, the fare policy change resulted in reducing the percentage of cash customers from 23% to 6% and TransitCards from 25% to 19%.[15] Exhibit 4.4-8, *Distribution of CTA Revenue by Fare Media,* compares fare payment by fare media type from February 2005 to February 2006.

Exhibit 4.4-8: Distribution of CTA Revenue by Fare Media



LEGEND:
CC and CC+: Chicago Card and Chicago Card Plus
PPU: Pay Per Use

SOURCE: Rick Halvorsen, TranSystems and Chicago Transit Authority, 2006 APTA Fare Collection Workshop

Future Plans

The CTA vision includes expanding the program so riders can use the same card to do their ATM banking, pay for taxis, and make purchases at retail stores, gas stations, and other transit outlets. CTA believes smartcard technology provides the foundation for realizing this vision. To date, their smartcard is good for transit services only.

4.4.3 METROPOLITAN ATLANTA RAPID TRANSIT AUTHORITY

What decision did MARTA make and why?

MARTA made the decision to replace its current fare collection system (tokens, magnetically encoded TransCards and paper transfers) with one based on smartcard technology, so in 2003, the Authority awarded a fare collection contract to Cubic Transportation Systems. The new smartcard system replaces all bus, paratransit van, and rail equipment rooted by read/write magnetics and, the current plan is to discontinue the magnetic swipe TransCard passes and tokens by July 2007. The new fare media are plastic smartcards and paper limited use smartcards. The equipment/system costs were approximately $78.7 million (CAD) with facility modifications of approximately $64.3 million (CAD).

[15] Chicago Transit Authority, 2006 APTA Fare Collection Workshop, Report on Chicago Card and Chicago Card Plus Initiatives, March 21, 2006.

Philosophy and Goals

Both the faregate and farebox systems were stretched beyond their usable life, becoming significantly unreliable and causing a rise in customer complaints, theft, fare abuse and evasion. The Authority estimated revenue losses due to fare abuse, evasion, and vandalism of $10 million annually. The Faregate Maintenance team had to fabricate parts in order to repair faregate failures, primarily the transport systems, and on average, three faregate cabinets required repair from vandalism daily. Voltage to the magnetic card reader on the bus farebox was often too low, making the reader inoperable. Also, dirt and dust impaired its ability to read an encoded card. In fact, bus operators had adopted the practice of inserting envelopes in the readers to prevent customers from swiping their passes -- magnetic passes became "flash passes". In addition, coin and bill acceptors often jammed and failed not only at the farebox but at the token vending machines.

Nathaniel P. Ford, Sr., MARTA's former General Manager/CEO, desired to dramatically change the way MARTA conducted business and to change its image from "*militaristic/archaic to innovative and new*". [16] While many warned him that an all smartcard system would be a risky, complex endeavor and unproven in North America, he viewed its possibilities as an imperative for not only improving the customers' experience of MARTA, but for changing the way the broader community and the world viewed MARTA. Mr. Ford often quotes Rodney Slater, the former United States Secretary of Transportation, when questioned about the unproven nature of the project. He states, *"never let perfection stand in the way of progress."* This was his mantra as he led his team down the path to making MARTA the very first all smartcard system in North America.

MARTA's publicly stated goals included the following:

- ***Better service*.** Modern technology will free up the front line staff to focus on serving the customer better.
- ***More convenience*.** Customers will have more convenient channels for purchasing and reloading cards.
- ***Greater reliability and adaptability*.** New technology will create a more robust system; will be less prone to breakdowns and abuse (like magnetics) and more adaptable to technological advances.
- ***Enhanced service.*** More accurate ridership information will improve service planning to better meet customer needs.
- ***Increased revenue/lower costs***. Reducing opportunities for fare media abuse will increase MARTA's operating revenue. Leveraging strategic marketing alliances will create new revenue streams. Reducing cash, eliminating tokens will reduce costs.
- ***Fare flexibility*.** Fares are more easily changed.

System Components and Fare Payment Methodology

The following describes the fare collection system components and backend processing, technologies, fare media, and fare collection methodologies deployed by MARTA.

[16] APTA Fare Collection Workshop, Key Note, March 2006

KEY SYSTEM FEATURES

329	Breeze Vending Machines (with Smartcard Readers)
604	Entry/Exit Gates (w/Smartcard Readers and temporary magnetic card readers)
570	Validating Breeze Fare Boxes (w/Smartcard Readers)
125	Smartcard Readers (for PTransit Vans)
3	Garages
38	Rail Stations

Plus Ticket Office Machines and other back-office support computers and equipment.

- ***Equipment*.** MARTA chose to replace all rail and bus fare collection equipment, parking gate entry and fee collection equipment and token vending machines with smartcard enabled equipment. MARTA also chose selection buttons for the vending machines instead of touch sensitive screens. Table 4.4-9, *MARTA's Fare Collection Equipment, Technologies, and Systems*, lists the equipment.
- ***Technologies.*** The foundation of MARTA's new automated fare collection system is contactless smartcard technology. Table 4.4.9, *MARTA's Fare Collection Equipment, Technologies, and Systems*, describes the functionality of the equipment.
- ***Systems.*** The contactless smartcard technology is driven by a central (NextFare™) business management system, database applications, and a reports server. Table 4.4-9, *MARTA's Fare Collection Equipment*, *Technologies and Systems*, provides a summary of data collection, management, processing, and reporting systems and fare card production equipment.

INTENTIONALLY LEFT BLANK

Table 4.4-9: MARTA's Fare Collection Equipment, Technologies and Systems

RAIL STATIONS	BUS/PARATRANSIT VAN	PARKING	SYSTEMS
Ticket Vending Machine • Vends both paper and plastic smartcards • Reloads plastic and paper smartcards • Shows balance remaining • Allows for paying parking fee • Accepts tokens, coins/currency, credit/debit. Gives change. ***Ticket Office Machine*** • For RideStore employees to sell and reload smartcards ***Paddle gates –*** • Approx 6' high, both standard and wide aisle • Paddles are made of clear Lexan • Beam logic opens and closes gates	**BUS** ***Validating Farebox –*** • Accepts and validates coins/currency • Accepts tokens • Reads, processes magnetic fare media • Reads, processes, reloads smartcards ***Receiver vaults, mobile safes, garage computers, probes*** **PARATRANSIT VAN** ***Smartcard Reader –*** • Installed near cash drop box.	***Entry/Exit Turnstiles*** • Activated by smartcards • Capable of dispensing Limited Use Smartcards ***Cashier Stations (like Ticket Office Machines)*** • Collects and process parking fees	***Central Server*** ***Satellite workstations*** ***Local servers*** ***High Production Encoding Machines*** ***Revenue Processing Equipment, Motorized Money Carts*** ***Hummingbird Reporting System*** ***Card5 Card Personalization Software, Card Color Graphics Printers, cameras*** ***HP Open View System Monitoring*** ***NextFare Business Management System*** - Transit App mgt - Card production mgt - Hot List[17] mgt - Credit/Debit clearing - Revenue collection - Web Services - Revenue mgt - Card mgt - Key mgt - Fraud analyses - Asset/Maintenance mgt - Cash reconciliation - Bank interface - Autoload - Prepaid benefits

[17] A process for blocking the use of a Smartcard in the system.

- ***Fare Media.*** MARTA will replace all magnetic fare media, tokens, and paper transfers with plastic smartcards and paper limited use smartcards (aka limited use tickets by MARTA). Only customers prepossessing either smartcard or limited use ticket will be entitled to a free time-based transfer. Four transfers are allowed in three hours after the first boarding. There are no re-entries allowed at rail stations and no reboarding the same bus route. The system tracks the customer's boardings/entries and disallows any that break the transfer rules.

  The plastic smartcard – "Breeze Card" -- is intended for the regular commuter, the paper limited use smartcard – "Breeze Ticket" -- is intended for the occasional rider. MARTA chose to procure Philips Electronics' MIFARE® smartcards – Mifare Classic was selected for the plastic Breeze Card and Mifare Ultralight was selected for the paper, limited use Breeze Ticket. The memory capacity of the plastic Classic is 1K and of the memory of the paper Ultralight is 512 bits; the specs claim the Classic can endure 100,000 write transactions while the Ultralight can endure 1,000. [18] Both Mifare products are compliant with Parts 2 and 3 of the ISO/IEC 14443 type A standard.

  MARTA's initial quantity of cards ordered through Cubic was 1.2 million for the plastic Mifare Classic and approximately 6 million for the paper Mifare Ultralight at a negotiated cost of $2.47 per card and $0.44 per card respectively. Later, MARTA ordered an additional 22 million limited use tickets. All cards and tickets were capitalized.

  The estimated annual operating expense of the plastic Breeze Cards compares favorably to the current annual expense of procuring magnetic fare media. MARTA estimates that if they issue 500,000 plastic cards to their base of customers, then the annual operating expense will be approximately $310,000 ($0.62 x 500,000). This is well under the current $500,000 per year MARTA spends on magnetic fare media.

  The cost of the paper Breeze Ticket is another story. MARTA determined that if they do as they originally planned --- replace paper and magnetic transfers with the paper Breeze Ticket, coupled with selling them as single rides through the vending machine and issuing them as parking tickets --- the annual cost of this fare media could exceed $10 million! As a result, MARTA's executive management recommended and its Board of Directors approved key policy decisions to mitigate this cost.

  - Customers paying cash will not qualify to receive a transfer. Instead, they must pay full fare with each boarding. Only customers prepossessing a plastic Breeze Card or a paper Breeze Ticket may receive an encoded transfer.
  - Customers may purchase a Breeze Ticket from a Breeze Vending Machine only and a $0.50 surcharge will be levied with each purchase of this type of card.
  - No discount fare programs will be available to load onto a Breeze Ticket.

  Although not yet addressed, upon future launch of the new parking system, customers may also have to pay a surcharge when pulling a paper Breeze Ticket from a parking dispenser to enter a parking facility.

- ***Methodology***

  Table 4.4-10, *MARTA's Fare Payment Methodology*, provides a general overview how the Automated Fare Collection (smartcard) system processes a fare.

[18] American Public Transportation Association Trends in Electronic Fare Media Technology, Version 1.50, February 14, 2004, page 32.

Table 4.4-10: MARTA's Fare Payment Methodology

CUSTOMER FARE MEDIA	ACTION	SYSTEM
MARTA customers paying a fare upon boarding fixed route bus or entering rail.		
Contains stored value or 10 or 20 trip pass. 	Taps the Breeze Fare Box reader or the reader on the Entry Gate 	The system deducts appropriate fare or trip and encodes a transfer.
Contains a time-based pass. 	Taps the Breeze Fare Box reader or the reader on the Entry Gate. 	The system checks for valid pass.
Contains both stored value and a pass. 	Taps the Breeze Fare Box reader or the reader on the Entry Gate. 	The system checks for valid pass first. If expired, it deducts appropriate fare from stored value and encodes a transfer.
	Drops coins or tokens in Breeze Fare Box.  Must purchase either a plastic or paper Breeze Card/Ticket before entering the rail Breeze Entry Gate 	No change card or transfer issued.

Transition Plan

The installation plan was considered very aggressive by most peers who have implemented new systems, but Mr's Ford's mantra *"never let perfection stand in the way of progress"* drove the project schedule. MARTA's entire fare collection system, except for parking equipment and systems, was replaced with the new smartcard equipment/systems within an eleven month period; however, temporary magnetic swipe readers were installed on the new entry gates. The primary purpose of the readers is to enable the faregate entry with magnetic fare media. At such time the system functions to MARTA's expectations and performance standards, all customers will be transitioned to smartcards and the magnetic readers removed.

MARTA released a request for proposal in 2002, an equipment provider was selected, then a protest from Thales ensued. The contract was finally awarded Cubic late 2003. System design, manufacture, and testing was completed late 2005. MARTA started equipment installation in December 2005 and completed installation as of October 2006 (11 months). Table 4.4-11, *MARTA's Project Timeline*, represents MARTA's schedule of milestone events.

Table 4.4-11: MARTA's Project Timeline

November 2005	Issued new Breeze Card IDs to 26,000 qualified Senior/Disabled (Half Fare) and Paratransit customers
December 2005	First station installed with Breeze equipment and started selling single trip Breeze Tickets out of vending machine
January 2006	Started station by station installation roll out
February 2006	Started installing bus fareboxes
May 2006	Installed readers on Paratransit vans. Distributed Breeze Cards to employees
September 2006	Breeze Card rolled out to general public
October 2006	Completed equipment installation
December 2006	Began accepting credit/debit at Breeze Vending Machines
May 2007	Implemented $0.50 Breeze Ticket surcharge
July 2007	Will start new fare policy for cash customers (pay for each boarding), no transfers.

Advantages

The following summarizes what MARTA expects from a smartcard fare collection system:

- ***Customer ease of use and convenience.***
  - *Provide more sales/reload channels:* Customers have many new channels for purchasing and reloading smartcards (including vending machines, web, automatic reloads, fareboxes).
  - *Allow card registration and balance protection*: Registered customers can replace their lost or stolen card, retaining its value.
  - *Offer more flexibility:* Customers may choose from a variety of fare programs, all reloadable on one card.
  - *Improve reliability:* Contactless fare media means that customers no longer experience the frustration of farecards captured at faregates.
  - *Better serve special needs:* Senior, disabled, paratransit customers are no longer required to carry two cards (in the old system, they had to carry a photo ID and magnetic permit. Now the Breeze Card is both photo ID and concession card). In addition, seniors/disabled no longer have to renew annually. In the old system, they had to renew to receive their annual magnetically encoded permit. They had to because the permit wore out and the magnetic system did not allow for a permit encoded for a longer period.
- ***Data flow and integration of different modes.***
  - *Eliminate manual collection of data:* Token machines had to be recorded manually.
  - *Automate reconciliation of coin and currency:* In the old system, the tapes of farebox coin and currency counts had to be manually entered into a spreadsheet and reconciled against the GFI report. For token vending machines, employees had to take readings and record manually. The readings were submitted for reconciliation against "said to

contain" (which have been manually calculated). The working fund was manually audited. The new system automates all of these functions.

- ***Ridership, revenue, financial reporting of all modes.***
  - *Improve data integrity:* Classification of fare types (other than cash) is no longer limited by programmable keys on a farebox. The system classifies and reports fare types.
  - *Improve accuracy:* Automating manual processes for reconciling and reporting revenue improves the accuracy of information. Various device and transaction reports also improve the ability to research and resolve variances.
  - *Improve financial reporting:* While MARTA's smartcard system was not designed to integrate directly with MARTA's financial system, the reports generated by the system aid MARTA's accounting department with general ledger entries. For example, the system offers a Stored Value Liability report which shows liability increases and decreases for selected date parameters.
  - *Enable regional integration:* The new system will include a rules engine for allocating revenue, a bank interface for distributing funds, General Ledger for tracking revenues as it enters and leaves the system and the reporting package necessary to support the agencies' revenue analyses.
- ***Fare policy flexibility.***
  - *Enable adaptability and improve responsiveness*: MARTA wishes to be in a position to institute strategic fare pricing such as off-peak discounts, distance based fares, loyalty programs, etc. Smartcard technology provides MARTA the platform for adapting or responding more quickly to changing market demands and opportunities.
- ***Cost controls.***
  - *Reduce revenue loss:* The new 6' high paddle gates replacing the standard tripod turnstiles will deter faregate jumpers and the more secure smartcard will eliminate fare media counterfeiting, forgeries, and modifications that occurred with tokens and magnetic media. In addition, since there are no moving parts to a solid state smartcard system, reliability will improve and more revenue captured. Currently, MARTA is experiencing better-than-expected reliability and ridership counts have increased because they believe they are now capturing more accurate data.
  - *No labor cost reduction:* While the cost of equipment maintenance and revenue servicing should drop, implementing a smartcard system required additional costs for systems and database management, data collection and reporting, as well as customer service and account management.

Project Funding:

The MARTA project is primarily funded through the "local capital" budget. The source of local capital is a one cent sales tax levied by two counties and the city of Atlanta. Fifty percent of this tax goes to the capital budget and the other half goes to the Authority's operating budget. Since the project was initiated, however, MARTA has been able to obtain federal grants for about $30 million. MARTA receives no funding from the State of Georgia.

Lessons Learned:

- Project plans are only a tool, they must be flexible
- The plan is not the project
- Become a partner with your contractor
- Manage to the spirit not the letter of the contract

- Build an instant feedback loop
- Listen to the customers and people doing the work
- Manage by walking around
- Don't let perfection stand in the way of progress!

Future Plans

MARTA wishes to leverage this technology to expand opportunities for creating new revenue streams and making the system even more convenient and seamless such as using the card to purchase products outside of transit and opening the system to accept bankcards for fare payment.

4.4.4 MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

What decision did MBTA make and why?

MBTA had an aging system (early 1970's technology – token based) that was beyond state of good repair. Increasing fare evasion, inability to collect useful data and lack of revenue accounting and auditing tools were key factors. Offering new fare media products to customers was almost impossible. These were the driving forces that led to the decision to introduce a new fare system. MBTA asked Volpe National Transportations Systems Center (Volpe) to conduct a peer review of Automated Fare Collection (AFC) Systems.

The AFC Project at Massachusetts Bay Transportation Authority (MBTA or "T") in Boston was initiated in September 2000 starting with the Volpe assessment of the optimum approach to migrate from cash and tokens to a modern electronic payment system. It boiled down to two questions: should the new system be built on magnetic and smartcard technologies or should the new system be built on smartcard technology only? Volpe recommended magnetic ticket and smartcard technology to better accommodate cash fare customers (at the time paper limited use smartcards were not being used in the United States); to enable a smoother transition for customers and to better meet the system's varied operational requirements. The dual equipment/system costs were approximately $100 million (CAD) with $111 million (CAD) in infrastructure, facility modification costs.

MBTA reached a symbolic milestone with the inauguration of its new Automated Fare Collection System on May 17, 2005. The dedication of the Airport Station introduced a new era of electronic payments and improved customer convenience over tokens. They called their new system ticket system Charlie and introduce the CharlieCard (smartcard) and the Charlie Ticket (magnetically encoded).

Philosophy and Goals

The philosophy was to introduce major changes in the aging infrastructure of the station management system. It included information technology (IT) related improvements together with AFC and station monitoring improvements. The new AFC system was just one component of a bigger plan for improving the overall customer experience of T Riders. Other initiatives included review and hardening of station security and related system wide improvements.

The case for implementing a new fare collection system rested on MBTA's goals to improve:

- The condition of the fare collection system – old equipment was beyond useful life and difficult and costly to maintain.
- Total customer service experience – station cleanliness, fare collection system improvements, clearer signs and announcements and other such items.
- The ability to offer new fare products with equitable fare structure.

- The enforcement of fare compliance – current system susceptible to fare evasion.
- Intermodal fare integration

System Components and Fare Payment Methodology

KEY SYSTEM FEATURES

500	Fare Vending Machines (w/Smartcard and magnetic readers)
640	Faregates (w/Smartcard and magnetic readers)
1700	Validating Fareboxes (on buses and Greenline Vehicles)
14	Garages
81	Subway Stations

Plus Ticket Office Machines and other back-office computers and equipment.

Equipment. Key elements of the system are shown in the text box above. The vending machines and faregates in stations plus associated station controller equipment formed the basis of the new system. The fare media are magnetic ticket cards called CharlieTicket and smartcards called CharlieCards.

The system with over 3,000 field devices was installed and in service as of January 2007. This included the Central Computer System (CCS), back office smartcard initializing machines (SCIMs) and photo ID (PID) equipment. The CCS included the capability to issue financial, maintenance, ridership and other reports. There is also a provision in Scheidt & Bachmann's contract to provide web based programs for corporate pass sales.

Before full launch, MBTA conducted a 12 month pilot test for its farebox. The primary reason was that the Contractor had a prototype farebox and a new entrant to the farebox market. In parallel, it established a very aggressive pro-active plan to get the Blue Line equipped with the new AFC system in a six month period during the second half of 2005. Experience based on peer reviews indicated that the transition phase needs to be aggressive, a tight timeline needs to be adhered and at least 6 to 8 station changeover needs to be implemented. Expectations are usually high and progress needs to be seen by the public in some measurable form. The MBTA selected the Blue Line as a starting point as its ridership and operational characteristics were most suitable – it had used this line for several other startups and trials, including the procurement of its new rail cars. Today over 1 million CharlieCards have been issued.

- ***Technologies.*** MBTA chose touch sensitive screens for the vending machine customer interactive display, wireless data transfer at bus garages, use of high coercivity magnetics for CharlieTickets and 1K Mifare Cards for smartcard applications represents the technology. In addition, MBTA has equipped several retailers with Point of Sale devices for the purpose of selling and reloading the CharlieCards.
- ***Systems.*** The S&B system in Boston is based on a Central Computer System (CCS) with several report producing features. Almost all fare system devices are monitored by the CCS – a basic requirement of the Contract.
- ***Fare Media.*** MBTA introduced a very aggressive program to discontinue tokens. Tokens are accepted by the vending machine and the farebox, but token sales are quickly reducing. Magnetic fare media, cash and MIFARE® Classic 1K smartcard (the initial bid was for 800,000 cards at $1.89 per card; MBTA later procured an additional 1.2 million cards at around $1.00 each).
- ***Methodology.*** Table 4.4-12, *MBTA's Fare Payment Methodology*, provides a general overview how the AFC system processes a fare:

Table 4.4-12: MBTA's Fare Payment Methodology

CUSTOMER FARE MEDIA	ACTION	SYSTEM
CharlieTicket Used on the Bus  Farebox Slot	Insert your CharlieTicket with the Charlie picture towards you and the magstrip to the right.  Remove your CharlieTicket and enter the bus.	The Farebox checks the validity of the ticket, deducts the fare (for Stored Value Card) and returns it with balance remaining – no printing in the farebox. If a Pass is encoded, the Month/Week is checked and the ticket is returned. Transfers: Bus/Bus free (most cases) Bus to Rail: The step up transfer charge is taken off at the rail gate or can be paid in advance on the bus
CharlieCard (Smartcard)  **Currently being tested for Adults passengers—over 50K issued to Senior/Disabled/Blind users*	On Bus -- Tap card over orange target on the farebox. Enter bus.  On Rail – Tap card over orange target on the fare gate. Enter rail If CharlieTicket – Insert ticket in the slot which says TICKET.	Checks for stored value or Pass and processes the card accordingly – deducting value from the card for stored value
Monthly Passes – Can be purchased at vending machine – get Charlie Ticket or obtain a CharlieCard (smartcard) from outlet – in future.	Insert pass into slot that says TICKET Tap Card to target for CharlieCard.	System reads pass and returns to customer for Charlie Ticket or opens the Gate for CharlieCard.
Cash $1, $5, $10 or $20's	Insert the bill in any orientation into the slot that says BILLS on the farebox. At rail stations – insert the bill in any orientation into the Fare Vending Machine to buy a CharlieTicket or to load value to it or a CharlieCard.	The farebox can issue a "Change Card" – for overpaid amount with cash fares. This feature was tested in the pilot and now discontinued. for operational reasons.

CUSTOMER FARE MEDIA	ACTION	SYSTEM
Credit /Debit Cards	The Fare Vending Machines accept coins, bills , current MBTA tokens and credit/debt cards for payment and issue a CharlieTicket. The same media can be used to load the value on to a CharlieCard too.	

Transition Plan

Forward Funding legislation allowed for financing associated with subway, bus and green line operations first. As a result, the transition strategy was to address the "core system" needs first, but to ensure that as the system design and implementation progressed, it allowed for seamless integration of the Commuter Rail System, parking and other services.

The system transition for the "core system" and major milestones to date are listed in Table 4.4-13: *MBTA's Project Timeline.*

MBTA released its request for proposals in 2001 and issued Notice to Proceed to Scheidt and Bachman in 2004. Table 4.4-13, *MBTA's Project Timeline*, provides the project's transition timeline.

Table 4.4-13: MBTA's Project Timeline

January 2005	Silver Line bus farebox pilot
Spring 2005	Reduced fare photo ID outreach began
May 2005	Blue Line subway installation began. Airport and Aquarium stations opened with new system
February 2006	Other subway lines installation began
Spring 2006	Pilots promoting CharlieCard use started
Summer 2006	Bus & light rail farebox installation began
December 2006	Completed subway and bus installation
January 2007	CharlieCard rolled out to general public

Advantages

The following summarizes MBTA's expectations (and current experience) of the ways in which smartcards will improve the customer experience and internal business functions:

- ***Customer ease of use and convenience.*** The CharlieCard system provides all the benefits associated with smartcards discussed for CTA and MARTA. In addition, the system will significantly improve and simplifying the fare media sale logistics through their employer network. Initial indications are that Senior/Disabled persons like the CharlieCard as it is easy to use.

- ***Data flow and integration of different modes.*** Data is obtained in a timely fashion (almost real time). There is a one day lag with data to the farebox, but the new system's ability to audit accuracy using the "Said to Contain "data and correlating it to the actual physical counts of the money gives a strong tool for ensuring revenue integrity. The data system will eventually give a better picture of the linked trips and trips by fare media type.
- ***Ridership, revenue, financial reporting of all modes.*** The system provides a means to collect boarding data and support the needs of the planning / ridership department. It also enables intra-regional fare collection.
- ***Fare policy flexibility.*** The new AFC System has given many ways to change fares in response to market demands. Proposed changes are posted on the website: http://www.mbta.com/ .

Funding Strategy:

In late 1999, the Governor signed into law legislation reforming the finances of the MBTA. This new law, known as *Forward Funding* established a new funding mechanism. The Forward Funding legislation enabled the MBTA to establish a new credit structure and issue bonds under its own independent credit rating backed by a dedicated revenue source. The MBTA receives income from 20% of the state sales tax, or a base amount of $645m, and assessments from cities and towns served by the MBTA.

Lessons Learned

- Don't let technology dictate system design – specify performance requirements that will work for your agency
- AFC touches every facet of customer service & all operating units of the organization
- Use focus groups to gather feedback
- Monitor customer and employee patterns of usage and make adjustments as necessary
- Be prepared to take some risks
- Ensure support from top management and adequate project resources
- Synchronize public messaging with the roll out

4.5 SUMMARY OF DECISION DRIVERS AND GOALS

The primary decision drivers for deploying a new smartcard fare collection system were common to all three authorities. The decision drivers included:

- The system was aging and becoming more difficult and costly to repair
- Loss of revenue from fare evasion was increasing
- Data collection was cumbersome and the quality of data was a problem
- Revenue accounting and reconciliation were compromised
- Increasing customer complaints were affecting public image and support

The goals for a smartcard system included:

- Improve customer experience and convenience
- Improve fare collection system reliability
- Enhance data quality, analyses and service planning
- Reduce loss from fare evasion
- Improve fare policy execution and flexibility
- Provide a foundation for expanding customer services/offers, developing new revenue opportunities and taking advantages of other fare payment options (such as accepting credit and debit cards at the turnstile or farebox smartcard readers).

This chapter reviewed the experience of six transit authorities with deploying a smartcard fare collection system. All but one of the deployments represent the proven conventional *transit-agency-centric* model with the agency responsible for procuring, installing and managing the fare collection system; branding and issuing transit-specific smartcards, providing customer and account management services and acquiring fare payment transactions. The other model represented was Transport of London's Public/Private funding initiative -- a smartcard system design, build, operate and maintain contract. Chapter 5, *Emerging Trends*, provides the highlights of recent initiatives that, if proven successful, may recast the conventional model of deployment.

5.0 EMERGING TRENDS

In the previous section, Hong Kong's Octopus Card Limited joint venture is described as one of the earliest transit smartcard deployments. This project not only defined the transit-agency-centric model of smartcard deployment, but also proved that the card could be expanded to include other applications besides transit. Today the Octopus card can be used for payment at convenience stores, supermarkets, fast-food restaurants, on-street parking meters, car parks, and many other point-of-sale applications such as service stations and vending machines. Approved merchants are equipped with Octopus readers and the purchase transactions are relayed from the readers to MTR's headquarters and then on to a central clearing house system for settlement. In this case, MTR has chosen to continue to be the smartcard issuer, acquirer and processor. According to the March 26, 2007 issue of the American Public Transportation Association's Passenger Transport, of the 10 million daily transactions, more than 25 percent are for non-transport applications. This sector has grown 50 percent over the last year.

In North America, smartcard contracts total nearly $1.1 billion (CAD) and planning and deployment of the technology are currently underway across 17 major metropolitan areas. All of these implementations are the conventional model of transit-agency-centric with the transit agency as both the issuer of their own branded smartcard and the acquirer and processor of the fare payment transactions. The transit-agency-centric deployment has meant that each agency has had to develop and execute strategies and tactics for getting their cards into the hands of customers. These include selling smartcards through vending machines, distributing cards through corporate partners, equipping retail partners with point of sale devices, providing web services and deploying "smartcard ambassadors" throughout the system to distribute the transit smartcards. In addition, many agencies have had to augment this distribution effort with fare policies that award customers who use smartcards to pay their fare. Further, agencies will often expand their customer operations -- such as their call and customer centres – in order to provide Balance Protection, Automatic reload and other account management services All of these activities require time and resources and may detract from the primary mission – transporting people.

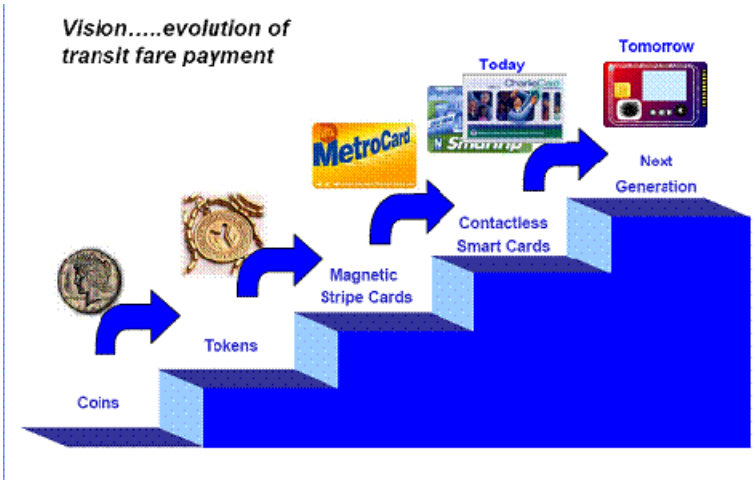
As there is more experience with deploying smartcard fare collection systems and greater understanding of their requirements (as mentioned above), some transit agencies are now moving to improve operating efficiencies and the customer experience by looking beyond the conventional model of transit-agency-centric to decreasing or eliminating their role as smartcard issuer and transaction acquirer and becoming more like a retail merchant in an open payment system.[19] It is believed that leveraging the banking industry's backend system for acquiring and processing fare payment transactions, transit may improve operating efficiencies. Further, it is believed that the customer experience may improve if the system is open to accepting credit/debit cards at the turnstile or farebox Smartcard Reader.

Convergence

Public transit's foray into smartcard technologies has positioned it well for forging synergistic and strategic relationships with both existing and emerging industries. Public transit's fare collection evolution has paralleled changes in commerce and the financial industry's competitive imperatives. Retail industries are demanding more efficient and secure payment technologies and credit card companies are responding with expanding smartcard technologies that include Smartcard Readers, smartcards and key fobs. At the same time, internet commerce has spawned an exponential growth in micro payments – transactions under $5.00 (such as $0.99 purchase of songs from iTunes) – a $1.3 trillion market. This phenomenon has resulted in new business rules and fee schemes for credit/debit purchases.[20]

[19] Smart Card Alliance, Transit and Contactless Financial Payments: New Opportunities for Collaboration and Convergence, October 2006, page 4.

[20] Changing rules and fee schemes include: No consumer signature required for transactions under $25, receipt is only required if requested, the merchant generally has full chargeback protection, and decreasing processing rates are on the rise.



Source: I-95 Corridor Coalition Meeting, December 14, 2004

Couple commerce changes with the proliferation of cell phones. Cell phone technology has positioned the Wireless Industry for taking some market share from the Bankcard Industry. In the near (if not current) future, cell phones will be enabled to process purchases as easily, if not easier, than credit/debit cards. This shift could lead to transit customers paying their fares with their cell phone.

Visionary leaders in public transit see the possibilities smartcard technologies deliver. Relationships are now under construction and, within a few years, public transit will, once again, define new payment technologies. The following describe three pilot programs now underway:

WMATA and Citibank® Co-Branding

The paths of the transit and financial industries' have converged, creating synergies and opportunities for unique collaboration. In 2004, Washington Metropolitan Area Transportation Authority (WMATA) and Citibank collaborated on a co-branded card that combined both a Metro SmarTrip® card and a Citibank credit card.

The co-branded card works like a smartcard. It has a transit application which stores up to $300 in Metro transit value and a credit card application that allows customers to shop and dine. At this time, there is no annual fee and cardholders received 5% statement credit on MetroRail/bus/parking purchases made within the first six months of opening the account.

The pilot was initiated to answer the following questions:

- Does a co-branded card improve consumer convenience?
- Can transit effectively leverage existing bank infrastructure? At this point, WMATA is not leveraging the bank's billing systems; however, card distribution system is proving effective.
- Will it help promote interoperability between transit agencies? As soon as SmarTrip is fully implemented regionally, customers may use the co-branded card throughout the regional system.

While WMATA has been pleased with the results of the pilot, the Authority's plan is to move away from the SmarTrip application. In the end, WMATA wants to accept bankcards at the turnstile and on board buses. WMATA's technology is over 10 years old and they see that the industry is moving out of being the card issuer and acquirer.

NYCT and MasterCard PayPass®

In 2006, the Metropolitan Transportation Authority (MTA) and New York City Transit (NYCT) teamed with Citibank to launch a demonstration project aimed at enabling customers to pass through turnstiles and by fareboxes quickly and reliably with just a touch of their personal credit card (or key fob) without the added step of buying or loading a magnetic MetroCard.

The demonstration project uses Citibank's MasterCard *PayPass* smartcard technology. It included installing *PayPass* readers on to select turnstiles. Prior to this, there were no Smartcard Readers on NYCT turnstile – only magnetic swipe readers. It was later decided to expand the pilot to include testing *PayPass* readers on board target bus routes.

According to Steve Frazzini, Vice President, MetroCard Operations, the goals for implementing a credit card based fare collection system include the following:

- Reducing operating costs such as
  - Distributing fare media
  - Maintaining vending equipment
  - Collecting and counting coins and currency
  - Setting up and managing a back end system – leveraging the banks' existing infrastructure and services.
- Improving customer service
  - Eliminating the added step of purchasing and/or reloading transit-specific fare media (MetroCards)
  - Meeting market demand. Customers like to use credit cards. 67% of revenue generated through the vending machines is credit/debit. 80% of New York population carries a credit card.
- Reducing capital outlay
  - The estimated cost for deploying a transit specific smartcard system on the city subways and buses is $300 million.[21]
- Negotiating favorable rates
  - The potential for increased revenue for the banks could result in more favorable rates.

Ultimately, according to Mr. Frazzini, a successful pilot could mean that NYCT can get out of the business of fare collection. *"We don't have to own this."* Let transit focus on what it does best -- transporting people -- and let the banks do what they do best – managing payment systems.

Exhibit 5.0-1, *Understanding the Billing*, explains how a NYCT customer will be billed for their fare payments.

[21] Metro New York, *New PATH Card Good To Go*, Patrick Arden, February 22, 2005

Exhibit 5.0-1: Understanding the Billing[22]

On your credit or debit card statement, you will see your subway trial purchases listed in one of the following ways.

Pre-Pay Fares Option

When you purchase your subway fares with this option, the merchant's name on your statement will read "MTA SUBWAY PRE-PAY."

Sale Date	Merchant ID	Merchant Name	Amount
04/10	67326420015	MTA SUBWAY PRE-PAID	20.00
		URBN OUFIT	86.99

Pre-Pay purchases will appear as charges of $20.00. Each time your Pre-Pay balance is reloaded your statement will show a $20.00 charge.

Pay-As-You-Go Fares Option

When you purchase your subway fares with this option, the merchant's name on your statement will read "MTA SUBWAY PAYASUGO."

Sale Date	Merchant ID	Merchant Name	Amount
04/10	67326420017	MTA SUBWAY PAYASUGO	10.00
		NTNAL WHOLESALE	8.99

Pay-As-You-Go purchases often will be displayed as several fares represented by a single charge. So 5 rides may appear as a $10 charge rather than 5 individual $2 charges.

For information about and demonstration of the NYCT/MasterCard pilot, a web site was designed for this purpose. Go to http://www.mastercard.com/us/paypass/subway/index.html.

According to NYCT, it costs the agency 28 cents on the dollar to sell fare media out of a sales booth; 8 cents on the dollar for a cash transaction at a vending machine; 7 cents on the dollar for a credit card transaction at the vending machine. Fee structures for processing credit/debit fare payment transactions at the turnstile or farebox promise to be as efficient, if not more so, than processing credit/debit at vending machines. Each turnstile transaction is not processed as one, but aggregated with others and processed as a group. The group is considered one transaction and charged as such. Plus, in an effort to enter the market of micropayments (transactions valued at under $5.00) and to respond to the pressure of influential internet merchants (such as iTunes™), credit/debit fee structures are changing to make it more attractive for transit agencies to accept credit/debit payments at the turnstile or farebox.

[22] http://www.mastercard.com/us/paypass/subway/about/statement.html

Fare Payment with Cell Phones


Cell phone with Smart chip

Cingular Wireless announced in December 2006 that it's teaming with cell phone maker Nokia and financial institutions Citigroup and MasterCard Worldwide to trial new phones that have MasterCard PayPass contactless payment capability.[23] The participants in the trial will receive a Nokia handset with 'near field" communication" (NFC) technology and the MasterCard PayPass payment function built in. Using the phone, trial participants will be able to make purchases wherever MasterCard's PayPass is accepted by simply holding their phone near the card reader. The payment is then deducted from the cell phone subscriber's account.

New York City Transit is expanding their pilot described in the above section to now include paying fares with a cell phone. Customers may use their cell phone, enabled with NFC and MasterCard PayPass, to pay their fare when entering the PayPass equipped turnstiles at NYCT stations. The NYCT/PayPass pilot has been extended through May 2007.

Further, a recent press release announced that Bay Area Rapid Transit (BART) is also planning to test a program that would allow customers to pay fares with their cell phone. A BART spokesperson said that 1,000 of its 1,700 turnstiles are equipped with readers that could be used with compatible cell phones or smartcards.

What about the TTC's Business Case?

While there are pilots demonstrating financial and wireless industry interest in transit fare collection, at the time of this writing there were no full-scale models to develop a concept of operations and to fully assess the costs and benefits to the TTC. As outlined in Chapter 1, *Introduction*, one of the principles guiding this study was to base the business case on proven technologies and methodologies. Therefore, given this principle, this business case could not rely on incomplete and limited information from pilots that are still currently under review, so it did not focus on exploring the possibilities of emerging opportunities and/or the integration with the GTAFS.

Instead, this study was built on the proven conventional model – *transit-agency-centric*. It has as its focus the TTC as the smartcard issuer, the collector of fare payment transactions, the provider of customer services and account management services and the acquirer of fare payment transactions. Regardless of current trends, the GTAFS project, and other downstream possibilities, the TTC must have the infrastructure upon which to build these strategic relationships and to realize the future opportunities. However, as for the actual deployment of fare payment forms, whether its the TTC's own plastic smartcard or third party bankcards, cell phones or a combination, the TTC, after viewing today's horizon, now sees what is possible and can, in its specifications, leave open the option of leveraging alternative forms and methodologies as they evolve and are proven.

[23] http://209.85.165.104/search?q=cache:f-vH19W7Ev4J:en.wikipedia.org/wiki/Near_Field_Communication+Near+Field+Communications&hl=en&ct=clnk&cd=3&gl=us

6.0 OVERVIEW OF THE TTC's CURRENT FARE COLLECTION SYSTEM

This chapter updates the October 2000 TTC Fare Collection Study's overview and appraisal of the TTC's existing fare collection system. The appraisal focuses on the existing system in relation to customer and employee experience, revenue and ridership accountability, business strategy, fiscal impacts, and regional integration.

6.1 CUSTOMER AND EMPLOYEE EXPERIENCE

This section presents a review and appraisal of the TTC fare and transfer strategies, fare media distribution and sales, and fare payment and enforcement.

Fare and Transfer Strategies

The TTC's fare strategy is categorized as *flat* vs. differentiating. This means the TTC fares are not differentiated by distance, time of day or mode, but are a fixed price. The advantages to a flat fare strategy are primarily simplicity and ease of use for customers as well as ease of administration, monitoring and enforcement for the TTC.

The fare collection system is built with a mix of automated, mechanical and manual collection and inspection systems and processes. As a result, there is a mix of fare media. In addition to paying with cash, other payment options include pre-paid fare products. Exhibit 6.1-1, *TTC Fare Media and Prices,* lists the current TTC fare types and prices and Table 6.1-2, *2006 Ridership by Fare Type*, summarizes the 2006 ridership by fare type.

Exhibit 6.1-1: TTC Fare Media and Prices

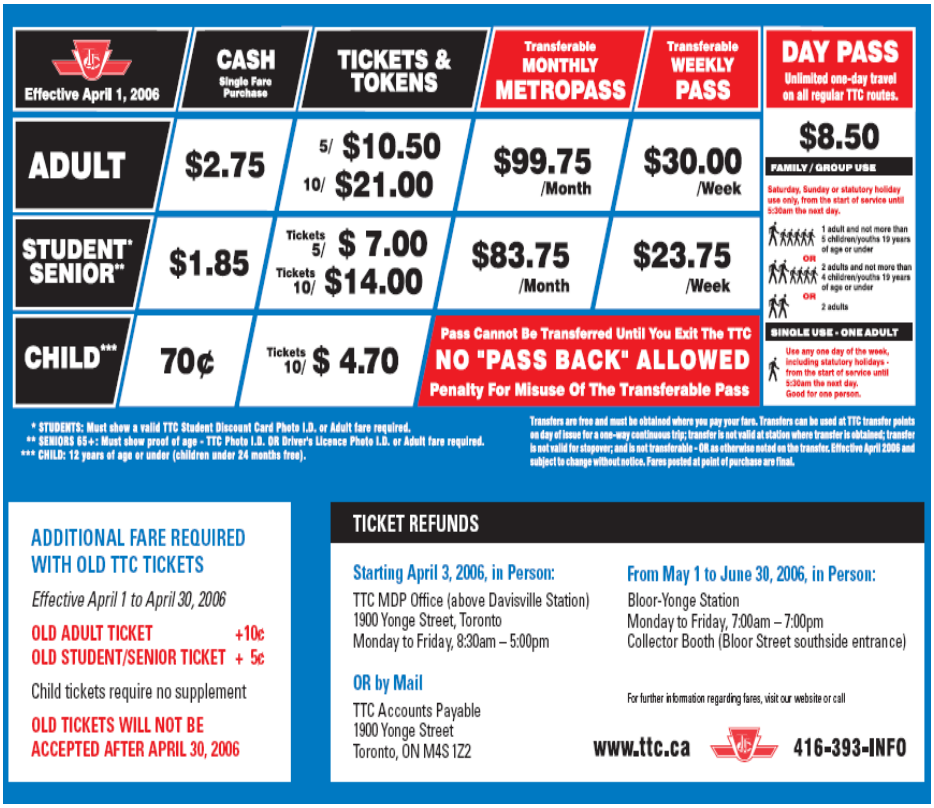
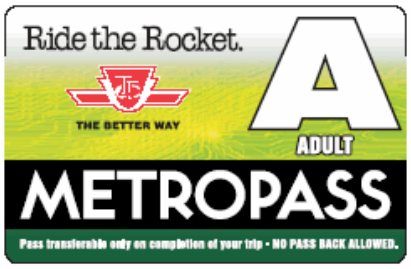


Table 6.1-2: 2006 Ridership by Fare Type

FARE TYPE	PERCENT 2006 RIDERSHIP
Tickets (Adult, Senior, Student and Children)	26.6%
Token (Adult)	16.9%
Monthly Metropasses (Adult, Senior, Student and Children)	41.4%
Weekly Pass (Adult, Senior, Student and Children)	1.3%
Cash (Adult, Senior, Student and Children)	11.3%
Day Pass	2.1%
Other (GTA Pass, Annual/Premium Passes)	1.4%

Tickets and Tokens, good for one trip (includes transfer), may be purchased in sets of five or ten. The sets of five and ten are sold at the base price. Tickets are printed paper for visual inspection by Station Collectors and Surface Vehicle Operators and tokens are custom-designed metal for dropping in and activating a Subway turnstile or dropping into Subway or Surface Vehicle fareboxes.



Monthly passes, good for unlimited travel on all regular TTC services for a calendar month, are available for purchase at Adult, Senior and Student prices. Metropasses are now transferable, but any Student or Senior presenting a Student or Senior Metropass must show a qualified photo ID, if requested. The passes have magnetic strips with encoded pass information and may be swiped at a magnetic card reader at any equipped turnstile or parking gate to allow entry. They may also be "flashed" at a Station Collector or Surface Vehicle Operator for visual validation. There are no magnetic readers at the Station Collector's passimeter or on board a Surface Vehicle.

Weekly passes, good for unlimited travel on all regular TTC services for a calendar week, are available for purchase at Adult, Senior and Student prices. Like the monthly pass, they, too, have magnetic strips with encoded pass information and may be swiped at a magnetic card reader at any equipped turnstile. They may also be "flashed" at a Station Collector or Surface Vehicle Operator for visual validation.

Day/Family passes are good for unlimited travel on regular TTC services from start of service through 5:30 AM the next day on any day. On Saturdays, Sundays or statutory holidays, the pass allows up to six people to travel on just one pass. Day/Family passes are printed on card stock with scratch off month/day. They are visually validated by Station Collectors and Surface Vehicle Operators.

Transferring from mode to mode is free for a one-way, continuous trip. Paper transfers from Subway to Surface Vehicles are taken from Transfer Issuing Machines which are generally located within a few metres of the Subway entry turnstiles. The customer merely pushes a button and a transfer is date/time stamped and issued. Transfers from a Surface Vehicle to the Subway or to another Surface Vehicle are time-punched paper transfers issued by the Surface Vehicle Operator. Both types of transfers require visual

validation by the Station Collector and/or Surface Vehicle Operator. Customers transferring at subway and Rapid Transit Trains (RT) stations with integrated surface route terminals do not require a paper transfer.

Fare Media Distribution and Sales

Fare products are distributed to and sold by Station Collectors, 3rd Party Ticket Agents, via Token and Pass Vending Machines and through the Metropass Discount Plan and through the Volume Incentive Program.

Station Collectors sell fare media inside most Subway entrances through "Collector Booths", located adjacent to entry turnstiles. Although the Collector booths are alarmed and secure, there are risks associated with having employees handle cash. In addition, Station Collectors, while present in the staffed entrances, their ability to provide expanded customer assistance is constrained because they need to remain inside the booth selling and inspecting fares.

Token Vending Machines are located at most unattended entrances and dispense two, five or ten tokens. The machines are also located in higher volume stations to reduce queuing at the Station Collector's booth during peak periods of the day. The machines accept cash payment only – no credit/debit cards -- and at the time of this writing, there were 107 Token Vending Machines in the TTC Subway system. Revenues are collected and tokens and change replenished on a regular basis.

Pass Vending Machines are located at select stations. These machines dispense monthly and weekly Metropasses and accept only debit card payment. At the time of this writing, the TTC was in the process of installing 10 Pass Vending Machines in the TTC Subway system. Monthly and weekly Metropasses, tied to a fixed calendar period, are replaced with new passes near the end of each validity period.

3rd Party Ticket Agents are external to the TTC. There are approximately 1,200 3rd Party Ticket Agents located throughout the City of Toronto. Ticket Agents can order fare media at any time, but there are minimum order quantities and monthly sales quotas. Typically, supplies of fare media are paid for upon delivery, but, in some cases, agents are issued credit. Ticket agents not only benefit from the foot traffic generated by the sales of TTC fare media, but also receive a 1 percent commission on sales. In order to keep inventories of weekly and monthly passes current, deliveries to Ticket Agents are ongoing. These deliveries are labour intensive.

Metropass Discount Plan is a program that allows the TTC customers to enroll in a 12 month pass purchase program. The incentives to do so include an 8 percent discount on the cost of each month's pass and free parking at the TTC lots. Monthly passes are delivered, by mail, to each enrollee by the Metropass manufacturer. Customers not only enjoy considerable savings, but also the added convenience of receiving their next month's pass by mail.

Volume Incentive Pass (VIP) Program: The VIP program is similar to the Metropass Discount Plan with some additional features and flexibility to better meet the needs of corporations and institutions. The program provides a price discount to corporations and institutions based on a commitment to purchase a minimum monthly volume of passes for a one-year period. The TTC delivers the passes to the organization and collects the fees. The organization then distributes the passes to their employees and/or students.

Table 6.1-3, *Fare Media Sales by Sales Channel*, summarizes the TTC's 2006 revenue by each sales channel.

Table 6.1-3: Fare Media by Sales Channel

SALES CHANNEL	PERCENT 2006 REVENUE
Station Collectors	57%
3rd Party Ticket Agents	30%
Vending Machines	6%
Metropass Discount Plan	7%

Fare Payment

Fares are paid or validated upon entering the Subway system or upon boarding a Surface Vehicle.

There are three points of fare payment or validation in the Subway system:

- Mechanical turnstiles (for dropping tokens or swiping Metropasses) or
- Station Collector (for visual validation of Metropass, Day/Family Passes, transfers and Photo IDs of concession products) or
- Farebox at the Station Collector's booth (for dropping cash, tickets, tokens).

Note: As mentioned previously, transfers are obtained through a Transfer Issuing Machine located just beyond the point of entry.

On the TTC buses, there are two points of fare payment or validation:

- Farebox (for dropping cash, tickets and tokens) or
- Operator (for visual validation of Metropasses, transfers and issuance of a transfer)

On the TTC streetcar, if a customer enters the front door, there are three possible points of fare payment or validation:

- Farebox (for dropping cash, tickets and tokens), or
- Operator (for visual inspection of Metropasses, transfers and issuance of Proof of Payment/Transfer) and,
- If customer is requested to present proof-of-payment by a Special Constable

If a customer enters through the rear door of a Streetcar, there is no point of fare payment and one possible point of fare validation -- by a Special Constable, if requested.

Fare Enforcement

As described in the previous section, the fare collection system is built with a mix of automated, mechanical and manual collection and inspection systems and processes. Fare enforcement is also function of this mix.

- Fare enforcement for magnetic media is automated at the Subway turnstile. If a Metropass is not valid and a customer attempts to swipe it at the magnetic reader on the turnstile, the turnstile will not activate. Fare enforcement of magnetic media on a Surface Vehicle or at a Station

Collector's booth is by visual inspection. If the media looks unusual or if printed dates are not valid, the customer will be stopped and required to pay the fare or, in some cases cited.

- Fare enforcement for tokens at the Subway turnstile is mechanical. If something other than a TTC token is dropped into the turnstile's slot, the turnstile will not activate. At the Surface Vehicle farebox, enforcement is by visual inspection once dropped in the farebox.
- Fare enforcement for printed fare media requires visual inspection in both the Subway and on board a Surface Vehicle. If the media looks unusual or if printed/scratched off dates/times are not valid, the customer will be stopped by the Station Collector or Surface Vehicle Operator or Special Constable and required to pay the fare or, in some cases cited.

The TTC's Internal Audit Department, with the assistance of Transit Special Constables, conducts a fare evasion study annually. Tests are conducted throughout the system and fare evasion rates are currently estimated to be 1.6% of total revenues. The following describes the focus of the audits:

- *Proof of Payment*: The team records the total number of customers on the Streetcar, and the number of customers with invalid fare media. The process for doing this is to direct the Operator to announce a fare inspection. The auditors record the number of customers perceived to be evading a fare by counting the number of people who exit the Streetcar immediately after the announcement is made.
- *Illegal Entry*: Plain clothes auditors observe and count the number of people entering the Subway station via driveways used by Surface vehicles. This number is reflected as a percentage of all paying customers using those same stations.
- *Transfers*: Surface transfers, given to Station Collectors, are checked for proper time, date and validity for connecting routes.
- *Metropasses*: Checked for forgeries.
- *Foreign and Fraudulent Receipts*: Farebox revenues are sampled for counterfeit tickets, tokens, bills and foreign coins and slugs.

It is important to note that printed fare media (tickets and Metropasses) can be duplicated for illegal distribution, metal tokens can be forged (and, in fact, have). The TTC recently introduced/issued an up-graded bi-metal token to address this issue. In addition, unless a customer is spotted by an employee, the TTC fare collection system has no means to control passes that are passed back to friends who then use them a second time to flash at the Station Collector for entry.

Several transfers can be taken from the Transfer Issuing Machine by any individual and doled out to non-paying individuals. In addition, directional transfers are difficult to understand and explain and time of validity is not always clear. This situation causes a high number of transfer disputes which, according to the TTC's Operator Assault Task Force's 2005 Report of Findings, is one of the leading causes of assaults on Operators.

6.2 REVENUE AND RIDERSHIP ACCOUNTABILITY

Fare revenue reporting is also a function this mix of automation, mechanical and manual collection. Most revenue and ridership data rely on manual entries. This not only makes reporting and reconciliation inefficient, but it also makes it prone to errors; however, there are a number of "checks and balances" to detect, reduce, and correct the errors typically associated with any manual system.

- Most Station Collectors accept cash only and while cash from sales by Station Collectors is transported directly to a bank for counting, the only method for reconciling Collector sales is to conduct a manual reconciliation comparing bank receipts to the issuance of 'float" and fare media consignments. The TTC currently accepts debit or credit payments at 10 stations.

- Token Vending Machines also accept cash only and there is no remote sales reporting. Reconciliation of these machines rests on the comparison of the manual entry of each Token Vending Machine's sales recorded by a Token Vending Machine Attendant and the cash counts from the machines. Sales are tracked by the machines and collected when stocked and emptied on a scheduled basis.
- Likewise, entries through turnstiles are not automatically or remotely reported; therefore, the reconciliation of tokens extracted is dependent on the manual recording of entries taken from the mechanical counters inside each turnstile.

Pass Vending Machines, however, accept debit payments only, so these sales transactions are processed automatically by the machines and reconciled against bank settlement reports.

Surface Vehicle Operators do not sell fare media or touch cash; however, they are expected to observe and inspect the cash dropped in the farebox. For this purpose, there is a clear glass window displaying the cash, ticket or token deposited. Then, at the end of the service day, the locked and specifically designated farebox vault is removed for counting and processing. This same procedure is applied to the handling of farebox vaults at Station Collector booths and the token boxes in the turnstiles. There is no automated method of counting ridership or recording ridership by type. There is an assumption of ridership by the amount of cash collected and an estimate of ridership by fare type by sampling ticket types.

6.3 BUSINESS STRATEGY AND FISCAL IMPACTS

Fare policy is a business strategy that is vital to every transit agency. The level of fare revenue and cost recovery rests on the ability to develop the right fare policies and pricing in response to business and market changes. A fare collection system is the means for executing such policies and pricing. The TTC's existing fare collection system, with its mix of fare media and automated, mechanical and manual methodologies can be a barrier to executing new fare policies or pricing in an efficient and timely manner. It relies on fare media that is either not easily purged from the system or commits the agency to a level of pricing for an extended period of time. This inflexibility is costly in terms of time, labour and public perception.

Further, if there were ever a business need to change fare strategy (for example, from flat fares to differentiated pricing), the current system which mixes automated technology with mechanical and manual collection will not easily support such a strategic initiative. It relies on visual inspections and manual collection of fares which would make differentiated pricing extremely cumbersome, if not impossible, to execute.

Out-of-date technology, coupled with inconsistent application of this technology (such as magnetic readers on turnstiles, but not on Surface Vehicle fareboxes), does not allow the TTC to improve the security of revenue. As mentioned previously, there are multiple ways to evade or misuse fares. These methods combine to result in not only loss of revenue, but also the very high cost of employee safety. According to a recent news article, Metropass, ticket and token fraud costs the TTC nearly $7.5 million annually and, in 2006 a fake token manufacturing ring was estimated to have cost the TTC $10 million over two years.[24] In addition, as mentioned previously, the 2005 Report on Operator Assaults found that both transfer and fare disputes are the main causes of assaults and that seven out of ten Operators state that they have been assaulted during their career.

Further, out-of-date technology, mechanical and highly manual systems do not position the TTC for future opportunities. The agency cannot take advantage of the emerging opportunities discussed in the previous chapter such as leveraging the infrastructure of financial and bankcard institutions or capitalizing on the promise of new wireless technologies.

[24] *The Globe and Mail*, TTC cracking down on counterfeit passes, Friday, September 15, 2006, page A14.

Regardless of these issues, the TTC's fare collection system is fairly inexpensive to operate and the equipment and processes are not complex for employees to maintain or to administer.

The TTC does not have the same decision drivers as those expressed by the transit authorities reviewed in the previous chapter. The TTC does not have as high a cost of fare evasion. Currently it is estimated to be about 1.6 percent of revenue, about half that of many transit authorities[25]. The magnetic system is fairly inexpensive to maintain (the Metropass readers are swipe-read only; hence, there are few moving parts and no "transport mechanism" to maintain. Further, since the TTC fare collection system is not built on this technology (solely), its reliability is not as significant an issue as other authorities whose systems (both Subway and Surface) are dependent on magnetics. The TTC's cash collection, as a percent of ridership, is much lower than most transit agencies (11 percent in 2006 as compared to 20 – 30 percent), and continues to decline in 2007, so there is not as strong a sense of urgency to move customers from cash to pre-paid options.

As noted, the cost to collect a $1.00 in fares is relatively inexpensive for the TTC. The system and its processes are simple and inexpensive to operate. Table 6.3-1, *Fare Sales and Related Collection Costs – 2006*, summarizes the TTC's fare sales, collection, and processing costs for 2006. It shows that it costs the TTC just under $0.08 to collect a $1.00 in fares. A recent PARSONS survey of peer agencies, conducted for the Southeastern Pennsylvania Transportation Authority (SEPTA) found costs ranging from $0.08 (lowest) to $0.16, so the TTC is at the lower end of the range.

Table 6.3-1: Fare Sales and Related Collection Costs – 2006[26]
(Millions)

FARE MEDIA SALES/CASH

TOTAL SALES/CASH	**$**	**768.5**

FARE COLLECTION RELATED COSTS:		**Total**
REVENUE OPERATIONS	$	10.5
CONTRACTED SERVICES		0.6
TREASURY SERVICES		1.8
SPECIAL CONSTABLE SERVICES		0.1
STATION COLLECTORS		34.7
REVENUE/SECURITY EQUIPMENT MAINTENANCE		3.2
FARE MEDIA EXPENSES		7.7
TOTAL COSTS	**$**	**58.6**

[25] In a February 2002, Transit Cooperative Board Research Program study – A-24, fare evasion rates were collected from 18 transit agencies. The average was 3.15%. Lowest reported was .3%, highest was 15%. The TTC, at this time, reported 2.4%.
[26] Fare media sales include fare media purchased but not yet used; therefore, $768.5M does not represent the 2006 fare revenue reported. Fare Collection Related Costs include all departmental labour, fringes and non-labour expenses.

The following summarizes the line items represented in Table 6.3-1, *Fare Related Revenues and Costs – 2006*:

Revenue Operations: Responsibilities and costs include

- Fare media procurement and inventory control
- Fare media distribution to Station Collectors, 3rd Party Ticket Agents and special bulk purchasers (such as CNIB, Canada Post, War Amps, convention planners);
- Unsold fare media collection and shredding
- Revenue collection:
    - Token vending machine (includes restocking)
    - Surface Vehicle farebox
    - Parking gate revenue collection
    - Turnstile and booth/crash gate farebox
- Revenue processing including separating and counting tickets, tokens and cash for accounting, deposit or recycling.
- Divisional costs also include vehicle maintenance, fuel and maintenance on the Patten building

Contracted Services: Services include:

- Armed guard escorts for Token Vending Machine Attendants
- Armoured car services for collecting cash from Station Collector booth drop vaults and delivering to bank

Treasury Services: Responsibilities and costs include

- Manage the sales through the Metropass Discount Program
- Facilitate the 3rd Party Ticket Agent billings and account receivables
- Divisional costs include banking fees for counting the cash from Station Collector booth drop vaults and point of sale fees such as credit or debit transaction fees at Station Collector booth or Pass Vending Machine.

Special Constables: Responsibilities and costs include

- Protection for armoured car services

Station Collectors: Responsibilities and costs include

- Sell and inspect fare media at Subway Stations
- Business function costs also include uniforms, allowances (travel, balance, deposit, shortage) supervision, divisional clerks and administration

Revenue Security and Equipment Maintenance: Responsibilities and costs include

- Maintain and repair fareboxes
- Maintain and repair subway turnstiles, subway station equipment and SRT turnstiles
- Divisional costs also include supervision

6.4 REGIONAL FARE INTEGRATION

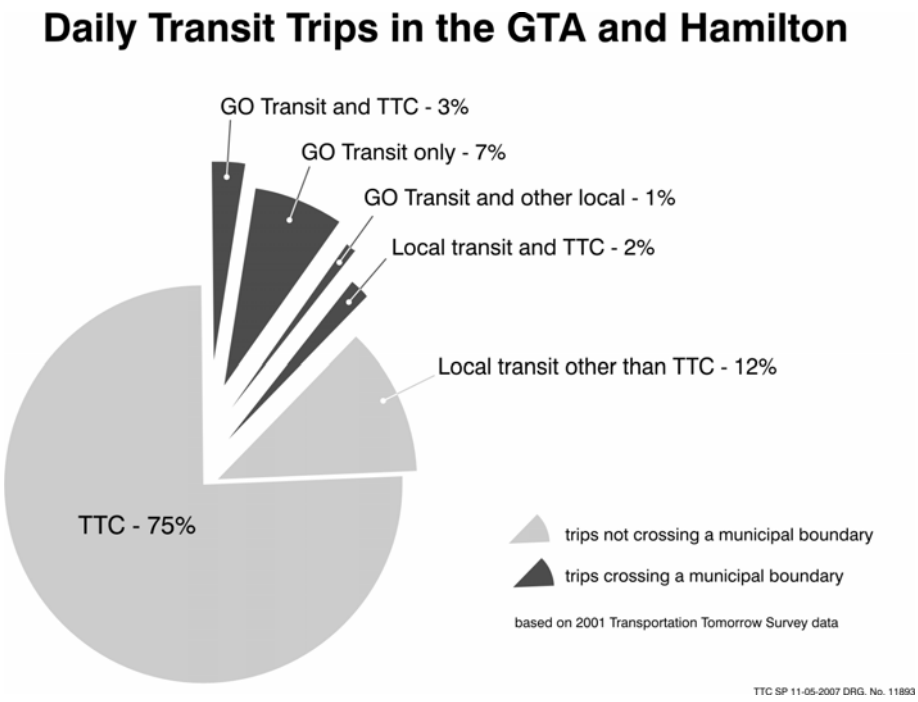
The TTC currently has a limited degree of fare integration with other transit operators in the Greater Toronto Area. The Toronto municipal boundary acts as a fare zone boundary and customers using local transit services are required to pay a second fare either at the boundary or upon entry to the TTC system. Unlike TTC, GO Transit has a differentiating fare strategy – charging by distance traveled – while other GTA operators have a flat fare strategy. The following summarizes some of the successful integration efforts.

TTC – GO Transit – TTC: Customers who ride the TTC immediately before and after a GO train or GO bus can use the TTC transfer from their first ride to board the second TTC vehicle.

Greater Toronto Area (GTA) Weekly Pass: The GTA Pass is accepted on all TTC, Mississauga, Brampton, and York Region Transit Routes. Pass holders are not required to pay an additional fare when crossing into another municipal boundary.

Exhibit 6.4-1, *Daily Transit Trips in the GTA*, shows the distribution of the total daily transit trips by operator within the region. The TTC carries the lion-share of all transit trips in the Greater Toronto Area with only 5% of the total ridership crossing the TTC service boundary.

Exhibit 6.4-1: Daily Transit Trips in the GTA



6.5 SUMMARY OF FARE COLLECTION SYSTEM STRENGTHS AND WEAKNESSES

The following reviews the strengths and weaknesses of the TTC's current fare collection system:

Strengths

- It is fairly inexpensive to operate - $0.08 to collect $1.00
- Fare evasion is low - 1.6 percent of revenue
- Manual processes are simple to administer
- Reliability and maintenance are not issues
- Fare payment is easy to understand
- The MDP program is an attractive savings and a convenient way for customers to obtain each month's pass

Weaknesses

- The system is a mix of automation, mechanical and manual processes
  - Requires a mix of fare media to support fare types and the mix of processes
  - The mix is a barrier to fare policy execution and pricing flexibility
- Manual processes require fare media sales and validation by Station Collectors and fare media validation by Surface Vehicle Operators
- Customer assistance is limited in the Subway
  - Station Collectors are constrained by fare media sales and the Collector's Booth
  - Queuing at a Station Collector booths can cause customer delays
- There are opportunities for fare evasion and misuse
  - Magnetic readers are not deployed on Surface Vehicles. This requires visual validation of Metropasses
  - Visual validation presents opportunities for fare media duplication (such as duplicating tickets and Metropasses)
  - Metal tokens can be forged
  - Multiple transfers can be taken from Subway Transfer Issuance Machines and issued to others
  - There is no point of fare collection at the rear door of a streetcar
- There are employee safety and security risks associated with cash handling, fare media sales and distribution and revenue collection.
- Data collection is primarily a manual estimating process is subject to standard sampling errors
- Field equipment cannot be remotely monitored for more efficient revenue collection, repairs or restocking supplies
- Out-of-date, mechanical and manual fare collection system does not position the TTC for future opportunities

The existing fare collection system is a mix of automation, mechanical and manual processes. This presents limitations, but fare payment is easy to understand, simple to administer and the system is inexpensive to operate and maintain in comparison to other transit agencies. While there is fare evasion and misuse, as a percent of total revenue collected, it is low.

Therefore a concept for a smartcard fare collection system should build on the existing strengths while and improving or mitigating the current weaknesses. Chapter 7, *Goals and Evaluation Criteria of the TTC Smartcard System*, reviews the goals and the criteria for developing and evaluating the TTC Smartcard System.

7.0 GOALS AND EVALUATION CRITERIA FOR THE TTC SMARTCARD SYSTEM

Fare collection touches just about everyone in an agency from the front-line employee, accounting clerk, back office programmer, call center operator, service planner, to the highest ranking decision-maker. Just as important, it touches every customer and influences their experience of transit service – from understanding fares and how to pay, expectation of equipment reliability, ease of mobility, to the perception of their value to a transit agency and its provision of security, benefits, services and assistance. It also influences the way the community-as-whole perceives transit – from its contribution to the vitality and attractiveness of a city, its response to market and societal changes, to its ability to innovate and advance.

Important steps in the process of building a business case for a smartcard system include mapping the existing system and critically examining its strengths and weaknesses. It is from this mapping exercise that goals of a smartcard fare collection system can be defined and evaluation criteria established. These then guide the system's conceptual design and define functional expectations. As stated previously, fare collection is more than fareboxes, faregates and fare media, it is an important business strategy. It is a strategy that must improve current conditions and deliver new possibilities.

Chapter 6, *Overview of the TTC's Current Fare Collection System*, examined the TTC's current system and presented its strengths and weaknesses. The results of the examination were used to define the goals and evaluation criteria of the TTC Smartcard System which will be assessed in Chapter 11, *The TTC Smartcard System Assessment*.

Table 7.0-1, *Goals and Evaluation Criteria of the TTC Smartcard System*, lists the primary factors, the goals and criteria guiding the conceptual design and expectations of the TTC Smartcard System.

INTENTIONALLY LEFT BLANK

Table 7.0-1: Goals and Evaluation Criteria of the TTC Smartcard System

PRIMARY FACTORS	GOALS	BASIS FOR EVALUATION
Customer Impacts	*To improve customer experience of the TTC service.*	Does the system improve customer convenience and the flexibility to purchase fares? Does the system enable the TTC to expand customer assistance? Will the system reduce the time it takes to board a vehicle or enter a turnstile? Is the system's fare media easier to use? Does the system improve customers' understanding of how to pay a fare or to transfer? Does the system enable the TTC to offer services and benefits that support customers? Does the system improve customers' regional mobility?
Employee Impacts	*To improve the working conditions of employees.*	Does the system enhance the safety and security of front-line employees? Does the system enable vehicle operators to focus on their primary responsibility?
Operational Impacts	*To improve fare collection processes.*	Does the system improve response to equipment failures? Does the system provide better data for analyses and planning? Does the system improve the reliability of fare collection equipment? Is the technology proven? Is the technology still advancing? Does the system provide future possibilities?
Financial Impacts	*To ensure the fare system is affordable for both customers and the TTC.*	Does the system allow the TTC to respond more effectively to market demands and changes? Does the system improve revenue security and controls? Does the system provide greater flexibility for executing new fare policies and pricing? Is there adequate new/additional funding available for this initiative Does the system decrease operating costs? Does the system increase fare revenue?

As mentioned, these goals and criteria will be used to assess the TTC Smartcard System. This assessment will be presented in Chapter 11, *The TTC Smartcard System Assessment.* The next chapter describes the process by which the TTC Smartcard System was defined, presents an overview of the system and summarizes the ways in which it is anticipated the system will improve the customers' experience.

8.0 THE TTC SMARTCARD SYSTEM OVERVIEW

As described in Chapter 2, *Project Background*, a two member, full-time Smartcard Project Team was established in 2004 to not only more actively participate in the Greater Toronto Area Fare System (GTAFS) project planning, but also to reexamine smartcard fare collection technology, the capital requirements for such a system, operating and revenue impacts and the advantages and opportunities it could deliver to the TTC.

In 2000, the TTC had completed a similar, but less in-depth study. They concluded then that there was no compelling business case for implementing a smartcard system; however, four years later, given the GTAFS initiative, advancements in smartcard technology, and the emerging trends within the transit industry, it was time to re-examine the case for smartcard fare collection.

The Smartcard Project Team set out on their mission of defining, in concept, how a smartcard fare collection system would work for the TTC and its customers. They were guided by the goals defined after mapping the existing fare collection system (see Chapter 7, *Goals and Evaluation Criteria of the TTC Smartcard System)* and the principles outlined in Chapter 1, *Introduction*. The principles are listed below:

- The study should be grounded by research and the experience of peers;
- The study should be based on proven technology and methodologies;
- The estimates and other measures should be reasonable and defensible;
- The model should be defined, first and foremost, for the benefit of the TTC and its customers,
- The TTC Smartcard System should not require a change in current fare policies
- The system should be flexible enough for future fare policy options, system enhancements and potential partnering with financial institutions and,
- The staff should be deeply involved in reviewing concepts and have the final word in the design of the model system.

The following sections describe the process by which the concept for the TTC Smartcard System was defined, present a general overview of the system and summarize how it is anticipated to improve the experience of the TTC customers.

8.1 PROCESS FOR BUILDING THE CONCEPT FOR THE TTC SMARTCARD SYSTEM

The Smartcard Project Team interviewed TTC staff to understand the current fare system's strengths and weaknesses -- mapping the current system, documenting the fare collection processes and operating costs. They interviewed the TTC management to more clearly define the vision and business goals for improving fare collection conditions. They surveyed representatives of other transit agencies who were planning or had already implemented smartcard fare collection systems – they gathered lessons learned and best practices. They researched and collected information about equipment, systems, technologies – the features, functions and costs. They evaluated the state of the TTC's infrastructure -- the communications' network and in-the-field electrical power -- and evaluated the requirements for supporting a more robust smartcard fare collection system.

The Team also enlisted the support, guidance and assistance of the PARSONS Corporation and Three Point Consulting, Inc. The three teams collaborated on building out the elements of the business case, including concept of operations and cost impacts. This collaboration gave the study and analyses depth of experience and resources as well as provided checks and balances necessary to challenge and further refine and define concepts. The collaboration drew from the strengths of all participants and the process was interactive and iterative.

A number of system concepts were considered – the characteristics, processes, equipment, features and functions framed – reviewed and discussed. The resulting concept was determined to best meet the goals and basis for evaluation listed in the previous chapter.

The following sections provide a general overview of the TTC Smartcard System from the perspective of the TTC customers. This overview is the introduction and foundation for Chapter 9, *Concept of Operations*. In Chapter 9, the operations of the TTC Smartcard System, its processes and impacts are described in even greater detail.

8.2 THE TTC SMARTCARD SYSTEM

This section presents an overview of the TTC Smartcard System and its impacts on the customers.

Fare Media

The following describes the fare media that will be available to the TTC customers and how the current fare types will be applied.

A plastic smartcard will replace all existing TTC fare media -- tickets, tokens and passes -- and will be the primary method for customers to pay their fare as they enter Subway turnstiles or board a Surface Vehicle.

***What is a smartcard*?** A smartcard is a durable, plastic card resembling a credit card. Embedded in the plastic is a tamper-proof microprocessor capable of storing data and responding to commands from fare collection devices and an antenna for communication to/from the devices. It is a contactless, proximity card (meaning it only has to come within a configurable distance of a device to operate – typically 1 to 10 centimeters). The plastic smartcard has a reasonable life of approximately 4 years.

Customers will learn two new terms – E-Purse and E-Pass. The E-Purse encoded on the memory chip of a smartcard will "hold" dollar values and an E-Pass will be a general term applied to encoded time-based products such as Day Pass, monthly and weekly Metropasses. Customers will be able to load money into their E-Purse and load any type of E-Pass the TTC offers.

For customers who do not have a smartcard, the TTC Smartcard System will retain the ability to pay for single trips by cash. For cash paying customers, they will continue to drop their coins/currency in the Surface Vehicle farebox upon boarding. In the Subway, cash customers will use coin/currency to purchase paper limited use smartcards from full service vending machines. These cards will provide electronic access through the turnstiles.

***What is a paper Limited Use Smartcard*?** The paper Limited Use Smartcard is similar to the plastic smartcard in that the fare media contains a microchip capable of storing data; however, the memory capacity is smaller and the form is typically a less durable paper-based product. It, too, responds to commands from fare collection devices and has an antenna for communication to/from the devices, making it a contactless, proximity card. Since it has a relatively short-life, it is typically used as fare media for short-term products such as Single Trip, Day Passes and Transfers for Surface Vehicle cash customers.

Also, in the TTC Smartcard System, paper transfers will be discontinued. Instead, transfers will be electronically encoded on the plastic smartcard and the paper limited use smartcard. Surface Vehicle cash customers will receive a paper limited use smartcard transfer from the operator instead of a "punched" paper transfer. This paper limited use smartcard transfer will be electronically encoded with validity period at the time it is issued to the customer. Customers transferring from the Queen streetcar to the Yonge subway will no longer have to join the line at the Collector's booth to hand in a paper transfer.

They will be able to use their new smartcards or paper limited use smartcard transfers at any one of the turnstiles to enter the station.

Table 8.2-1, *Fare Media Application in the TTC Smartcard System,* summarizes how the current fare types will be applied in the TTC Smartcard System.

Table 8.2-1: Fare Media Application in the TTC Smartcard System

CURRENT TTC FARE TYPE	THE TTC SMARTCARD SYSTEM
Single Trip with Cash	Full Service Vending Machines will accept coins/currency to purchase a paper limited use smartcard or smartcard → Subway Drop coins/currency in farebox → Surface Vehicles
Transfer	Electronically written to the smartcard or paper limited use smartcard
Tickets	Smartcard –>E-Purse value equivalent to the number of tickets purchased
Tokens	Smartcard –> E-Purse value equivalent to the number of tokens purchased
Monthly Metropass	Smartcard –> E-Pass[27]
Day Pass	Smartcard –> E-Pass or Paper limited use smartcard –> E-Pass
Weekly Pass	Smartcard –> E-Pass
GTA Pass	Smartcard –> E-Pass
Special Passes (e.g. employee; councilor; CNIB)	Smartcard –> E-Pass

Sales and Reload of Smartcards – Adult Class

In the TTC Smartcard System, many of the existing sales channels, as well as new and even more convenient channels, will be equipped for customers to conveniently obtain and load their smartcards. The following provides a description of each channel.

- *Full Service Vending Machines (FSVM)*: Customers will find Full Service Vending Machines in all subway entrances. These machines will sell and reload smartcards and also sell paper limited use smartcards (Single Trip and Day Pass (E-Pass)). Customers will be able to pay with cash or credit/debit cards. Accepting credit/debit cards for purchase is not only an added convenience, but also meets an ever-increasing market demand.

- *Add Value Machines (AVM)*: Customers will also find Add Value Machines in all subway stations and also on Surface Vehicle Platforms. Add Value Machines will reload smartcards and accept credit/debit only – no cash. The machines are intended to not only speed the card reload process and reduce queuing but also provide expanded convenience to surface vehicle customers.

[27] It is also possible to encode rolling period E-Passes instead of fixed period. Rolling period means the clock starts upon first use of the pass instead of starting on a fixed calendar date.

- *Station Collectors:* Automation of all sales and reloads through vending machines could provide the opportunity for the TTC to move toward a more enhanced customer service focus in the subway. Every station will still have a Station Collector for customer service and safety and the option will exist that Station Collectors may no longer be required to sell fare media. Collectors will also have the option of no longer being required to remain inside their booths.
- *Web Services*: In the TTC Smartcard System, customers will be able to order and reload their smartcards through any computer with internet access. New card orders will be mailed directly to their home or place of business.
- *Automatic Reload:* Customers will have the option to register for Automatic Reload. This links a customer's smartcard serial number to a credit or debit card. The system will then automatically add value or a pass when the card's balance falls below a predetermined threshold or a pass expires. When a customer authorizes automatic reloads, they will never need to worry about reloading their card again. The reload will occur automatically.
- *Customer Centres*: In the TTC Smartcard System, three Customer Centres, strategically located with the City of Toronto, will sell and reload smartcards as well as perform a full range of account management services for customers.
- *3rd Party Ticket Agents:* In the TTC Smartcard System, most Ticket Agents will be able to sell and reload customer smartcards. Ticket Agents will be equipped with special TTC Point of Sale devices. Maintaining the 3rd Party network, allows the TTC to continue to serve "bus-only" customers who do not travel via or purchase their fare media from subway stations.

- *Customer Call Centre:* In the TTC Smartcard System, the duties of the TTC Call Centre will be expanded to provide many smartcard services by phone. Customers may choose to be assisted by an operator or through an automated Interactive Voice Response system.

Table 8.2-2, *Sales and Reload Channels – Adult Class*, describes the channels for purchasing and reloading an Adult class smartcard.

Table 8.2-2: Sales and Reload Channels – Adult Class

SALES CHANNEL	THE TTC SMARTCARD SYSTEM
Full Service Vending Machines (credit/debit/cash)	Installed at all Subway entrances. Machines will dispense both smartcards and paper limited use smartcards and reload smartcards.
Add Value Machines (credit/debit only)	Installed at all Subway entrances and Surface Vehicle platforms. Machines will reload smartcards.
Station Collectors	*Will no longer be required to sell) fare media.* Introduction of station vending machines will automate the sale/reload of fare media and remove the requirement that Collectors do this current activity.
TTC Web Services	Will process new smartcard orders and reloads.
Automatic Reload (aka Autoload)	System will automatically reload E-Purse Value or E-Pass if authorized by customer.
TTC Call Centre – Interactive Voice Response	Will process smartcard reload requests.
TTC Customer Centre(s)	Three centres will be available to sell and reload smartcards.

SALES CHANNEL	THE TTC SMARTCARD SYSTEM
3rd Party Ticket Agents	Will sell and reload smartcards
TTC Call Centre – Operator-assisted	Will process new smartcard orders.

Sales and Reload of Smartcards – Concession Class

All of the smartcard reload channels described in the previous section will also be available to customers with Concession class smartcards; however, to reload discounted Concession passes at any point of sales devices (such as vending machine or 3rd Party or Customer Centre devices) or to request a Concession pass for their smartcard via the phone or through Web Services, the smartcard issued to the customer must have been encoded as a Concession class card. The TTC Smartcard System will not encode a Concession pass onto an Adult class of smartcards --- only if the smartcard is classified as a Concession card will the system allow a Concession pass to be encoded.

Customers (Senior, Student or Child) must show proof of qualification to receive a smartcard encoded as (Senior, Student or Child) Concession class. Seniors will do so by mail or by visiting a TTC Customer Centre. Students and Children will either receive their smartcards through their school from a TTC contractor or by mail or by visiting a Customer Centre. The following provides a description of each how each channel will serve Concession customers.

- *Full Service Vending Machines (FSVM)*: The FSVM will not dispense Concession class smartcards – only Adult class – however, Concession customers will be able to receive a Concession smartcard through a special distribution program or through the Customer Centre or by mail. However, Concession customers, who do not have a Concession smartcard, will be able to purchase single trips, at the Concession price, through the FSVM. The Concession single trips will be encoded on paper limited use smartcards and will be visually distinguished by colour and a printed code indicating the type of Concession card (Senior, Student, and Child).

- *Add Value Machines (AVM)*: Customers with Concession smartcards will also find Add Value Machines in all subway stations, and also on Surface Vehicle Platforms. Add Value Machines will reload Concession smartcards with either E-Purse value or Concession class E-Passes and accept credit/debit only – no cash.
- *Web Services*: In the TTC Smartcard System, Concession customers will be able to reload their Concession class smartcards through any computer with internet access; however, Concession customers will not be able to order a Concession class smartcard via web because they must show proof of qualification.
- *Automatic Reload:* Customers with Concession class smartcards will also enjoy the convenience of automatic reloads, if they so choose. The system will automatically reload E-Purse value or Concession E-Passes and charge their credit/debit card.
- *Customer Centres*: In the TTC Smartcard System, three Customer Centres, strategically located with the City of Toronto, will sell and reload Concession smartcards as well as perform a full range of account management services for customers.

- *3rd Party Ticket Agents:* Customers, with Concession class smartcards, will be able to reload E-Purse value or Concession E-Passes at any 3rd Party Ticket agent equipped with a TTC point of sale device.
- *Contractors:* Currently the TTC contracts with a firm to facilitate and coordinate the processing and issuing of high school student photo identification cards. In the new system, the TTC intends to expand this service to include elementary schools. Subcontractors will issue zero value smartcards, pre-encoded with either child or student classification. Once a child and student receive their smartcard, they will activate the card by calling or submitting by mail the

school name, Student ID and a PIN. They may then, load their smartcard with E-Purse value or Concession priced E-Passes at any of the several sales channel.

- *Customer Call Centre:* Customers prepossessing a Concession class smartcard may choose to reload their card by call and being assisted by an operator or by the automated Interactive Voice Response system.

It should be noted that many of the new automated channels for reloading a Concession smartcard will be an even greater service and convenient to the disabled and senior communities. These channels will mean they do not have to go out of their way to reload their card or to interact with a vending machine. In addition, the TTC Smartcard System will be designed to meet all standards defined for people with disabilities and during the design phase, the TTC plans to work very closely with the Advisory Committee on Accessible Transit (ACAT) to ensure as many accessibility features as possible are included.

Table 8.2-3, *Sales and Reload Channels – Concession Class*, describes the channels for purchasing and reloading a Concession class smartcard.

Table 8.2-3: Sales and Reload Channels – Concession Class

SALES CHANNEL	THE TTC SMARTCARD SYSTEM
Full Service Vending Machines (credit/debit/cash)	Installed at all Subway entrances. Machines will sell and dispense paper limited use smartcards for Concession priced Single Trip tickets and reload E-Purse Value and Concession E-Passes to Concession class smartcards.
Add Value Machines (credit/debit only)	Installed at all Subway entrances and Surface Vehicle platforms. Machines will reload Concession class smartcards with E-Purse Value or Concession E-Passes.
Station Collectors	*Will not be required to sell fare any fare media.*
TTC Web Services	Will process requests for reloading E-Purse Value and/or Concession E-Passes to Concession class smartcards.
Automatic Reload (aka Autoload)	System will automatically reload E-Purse Value or Concession E-Pass if authorized by customer. Smartcard must be Concession class card to receive Concession E-Pass.
TTC Call Centre – Interactive Voice Response	Will process Concession smartcard reload requests.
TTC Customer Centre(s)	Three centres will be available to sell and reload Concession smartcards.
3rd Party Ticket Agents	Will be equipped to reload Concession smartcards

Sales and Reload – Wheel-Trans

Wheel-Trans customers will use value stored in their smartcard E-Purse to pay their fare. Each Wheel-Trans vehicle will be equipped with two Smartcard Readers (front and rear entrance) and the customer will merely tap the smartcard to reader. The system deducts the appropriate fare. The customer may still pay cash, if desired.

Current Wheel-Trans customers are registered with the TTC. These customers will be mailed their new smartcard and new customers will receive their smartcard through the Wheel-Trans registration process. Most of these customers will receive a smartcard encoded with the Adult classification; however, some may be eligible for Senior, Student or Child Concession class smartcards. Qualifying customers will receive the appropriate class of card.

During detailed design, one of the Wheel-Trans specific parameters will likely be for the "system" to deduct the appropriate fare when the Wheel-Trans trip is book/dispatched. In so doing, the customer will not have to "tap" when they board a Wheel-Trans vehicle. This process would also enable them to pay for their attendant in advance, if they have one.

TTC Smartcard Services

As reviewed in Chapter 3, *Overview of a Smartcard Fare Collection System,* smartcard fare collection technology provides a platform for delivering new services to customers. The unique serial number of each smartcard and the software applications of the Central System combine to enable the TTC to provide many new customer benefits and offers.

Any customer may choose to register their card with the TTC by giving the TTC personal information which links the customer with the unique serial number of their smartcard. This registration will enable the following customer services:

- *Receipts for Federal Tax Credits* will be available to registered customers. Customers may receive receipts of fare purchases necessary for reporting and receiving Federal Tax Credits by downloading this information from Web Services or by calling the TTC Call Centre or visiting a Customer Centre.
- *Automatic Reloads* links a customer's smartcard serial number to a credit or debit card. The system will then automatically add value to the E-Purse or an E-Pass when the card's balance falls below a predetermined threshold or a pass expires.
- *Balance Protection* provides the security of retaining the E-Purse value and/or time remaining on an E-Pass at the time the TTC is properly notified of a lost, stolen or damaged smartcard. The lost or stolen card can be hotlisted (blocked from use in the system) and the remaining value and/or time transferred to a replacement card.
- *Negative Protection* provides the benefit of one completed trip if there is not enough E-Purse value on a customer's smartcard. This allows the customer to complete their trip. Then, when the customer reloads their smartcard, the system will debit the amount of the negative balance.

Using the Smartcard

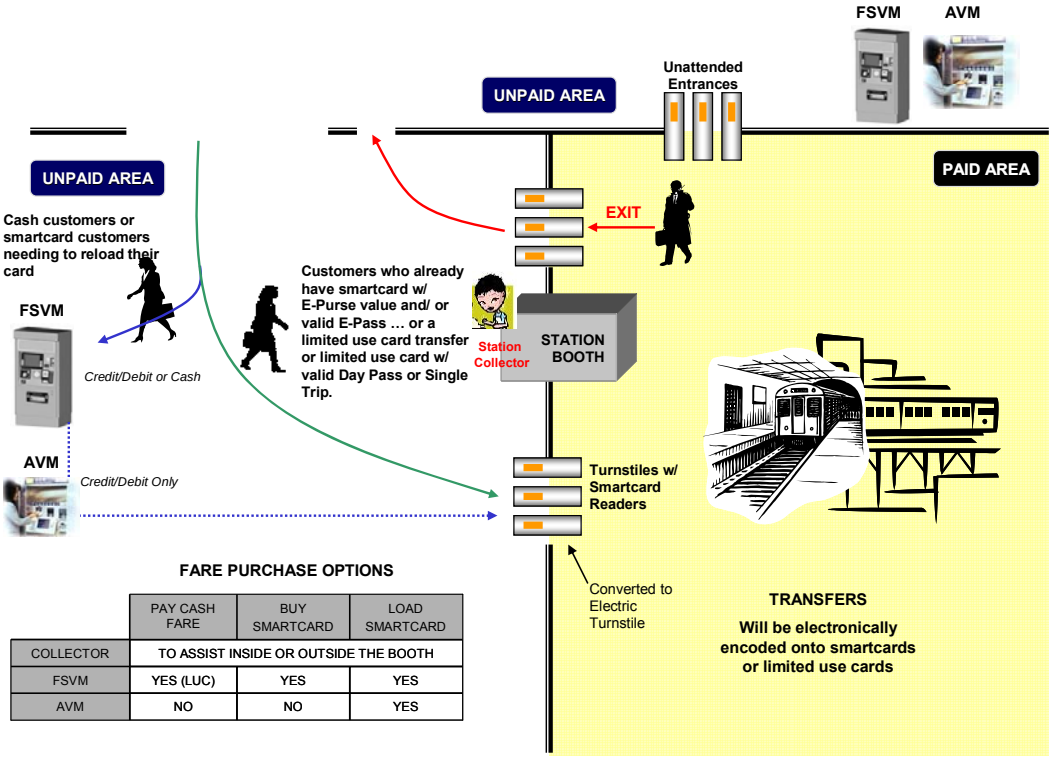
For the purpose of this business case analysis~~,~~ turnstiles and Surface Vehicle fareboxes will not be replaced, but Smartcard Readers will be added to each entrance turnstile and installed near the Surface Vehicle farebox. Farebox replacement will be considered during detailed design as an alternative to retrofitting the existing mechanical fareboxes. When a customer waves or taps their card at any TTC Smartcard Reader, the system will validate the customer's E-Pass or Transfer or deduct the appropriate fare from the value in the customer's E-Purse.

The transaction at the reader is very fast. It takes no more 1/3 of a second. This can be 3 to 5 times faster than reading a magnetically encoded card or dropping a token in the acceptor or cash in the farebox. In addition, handling a smartcard is much easier than handling any other type of fare media especially for people with disabilities. As reviewed in Chapter 4, *Experience of Other Cities and Transit Agencies*, CTA found that people with limited or restricted motor skill and sight impairments prefer using a smartcard over magnetic fare media, tokens and cash. The card is much easier for this segment of

ridership to use because they neither have to take the card out of a holder or wallet nor do they need to orient the card to the reader in any special direction.

Exhibits 8.2-4 and 8.2-5, *Fare Payment*, provide top-level overviews of how customers will use their smartcard to pay their fare in the Subway and on Surface vehicles.

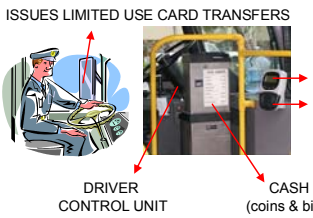
Exhibit 8.2-4: Fare Payment in Subway Stations



FARE PURCHASE OPTIONS

	PAY CASH FARE	BUY SMARTCARD	LOAD SMARTCARD
COLLECTOR	TO ASSIST INSIDE OR OUTSIDE THE BOOTH		
FSVM	YES (LUC)	YES	YES
AVM	NO	NO	YES

Exhibit 8.2-5: Fare Payment on Surface Vehicles



Fare Payment	Cash Customers	Smartcard Customers	Limited Use Card Customers
Coins	Yes – Not registered		
Bills	Yes – Not registered		
Transfers	Operator issues Limited Use Transfer	Electronically encoded	Electronically encoded
Day Pass		Validated by Smartcard Reader	Validated by Smartcard Reader
Single Trip			Validated by Smartcard Reader
E-Purse Value		Decremented by Smartcard Reader	
E-Pass (Smartcard)		Validated by Smartcard Reader	
Electronic Transfer		Validated by Smartcard Reader	Validated by Smartcard Reader

Note:

Assumes existing fareboxes are not replaced, but Smartcard Readers are installed to enable smartcard/limited use card processing.

In the case of Wheel-Trans, Smartcard Readers will be installed at each entrance of the vehicle. The Wheel-Trans customer will tap their card to pay their fare from their E-Purse value or pay a cash fare – paid to the operator.

Transfers

In the TTC Smartcard System, paper transfers will be discontinued. Instead, transfers will be electronically encoded on the plastic smartcard or the paper limited use smartcard. So at the point the customer first taps their card to a reader and a fare is deducted from their E-Purse value or it recognizes a single trip, the system will encode a transfer with a validity period.

Surface Vehicle cash customers will receive a paper limited use smartcard transfer from the operator instead of a "punched" paper transfer. This paper limited use smartcard transfer will be electronically encoded with validity period at the time it is issued to the customer.

The system will track the usage of the transfer and if it not used properly or if it has expired, the system display will inform the customer that they may not use the transfer for entry or boarding or that the transfer has expired and they must pay a new fare. This means that checking the validity of a transfer is no longer the responsibility of the vehicle operator. This type of automated interface will be less personal, reducing operator/customer conflicts and the number of customers who may feel they are being singled out indiscriminately.

Balance Enquiries

Customer may check the balance and transaction history on their card through any number of means.

- Vending machines (Full Service Vending Machines and Add Value Machines) will be capable of providing smartcard balance and some transaction history.
- Smartcard Reader displays will provide balance remaining.
- Call and Customer Centre representatives will have access to a customer file and, if requested, provide balance and history. The Interactive Voice Response system will be capable of providing balance and history in automated form.
- Web Services will display balance and transaction history.
- Hand Held devices carried by Station Collectors, Route Supervisors and Special Constables will display balance and limited transaction history.
- Driver Control Units will display balance and limited transaction history, if requested by the customer.

8.3 SUMMARY OF IMPROVING THE CUSTOMER EXPERIENCE

A fully automated smartcard only system will improve the customers' experience of the TTC. As listed in Chapter 7, *Goals and Evaluation Criteria of the TTC Smartcard System*, the TTC wants and expects a smartcard system to provide the following benefits and advantages to their customers:

- *Improve customer convenience and flexibility to pay a fare:* The system will expand channels for customers to obtain and reload a card. These will include debit and credit accepting vending machines in all Subway Stations and Surface Platforms, Call and Customer Centres, Web Services and Automatic Reload services. The automated reload channels will be especially more convenient for people with disabilities. They may reload their card from their phone or by web or authorize automatic reloads instead of interacting with a vending machine or traveling to a sales outlet. Debit/credit capability will be a significant improvement to customer convenience, because this is a very limited option at TTC. Both CTA and MARTA offer all of these services. MBTA will offer all within the next year.

- *Enable the TTC to expand customer assistance:* Installing vending machines in all Subway Stations enables the TTC to redefine the duties of the Station Collectors from selling and inspecting fare media to providing customer assistance in other ways. In addition, the TTC plans to expand Call and Customer Centre services. Both CTA and MBTA redefined the duties of in-station ticket sellers to more customer-focused responsibilities. The ticket sellers now assist customers at the vending machines and turnstiles.
- *Reduce the time it takes to board a vehicle or enter a turnstile:* Studies have shown that using smartcards can speed boarding time and throughput at turnstiles. A smartcard can be read in a fraction of a second compared to swiping a magnetic card (like a TTC Metropass) or inserting a token into turnstile. Customers will no longer need to line up at a Collector's booth to pay with a ticket and/or show a paper transfer, they can use any turnstile, so subway boarding should be faster. Smartcards and paper limited use smartcards will enable multiple-door boarding on surface vehicles and this will also speed up boarding time.
- *Improve ease-of-use:* Tapping a smartcard to a reader is easier than trying to orient a magnetic pass through a swipe reader or taking coins/tokens out of a purse or pocket to drop in acceptors. CTA found that people with disabilities prefer using a smartcard over magnetic fare media, tokens and even cash.
- *Improve customers' understanding of how to pay a fare or to transfer:* The current TTC fare payment processes are very easy to understand. Transition to a smartcard system will require effective information and outreach campaigns to teach customers how to use smartcards. This will take time and effort; however, transit agencies, with smartcard systems, have executed very effective tactics for communicating how to use a smartcard. "*Tap and go*" is a simple process compared to "tickets go in the farebox, tokens go in farebox and/or turnstile, pass is swiped or flashed". Plus, the current paper transfers can be confusing. Electronically encoding a transfer's validity period on a smartcard should be easier for customers.
- *Enable the TTC to offer services and benefits that better support customers:* The TTC Smartcard System will give customers the security of Balance and Negative Protection and the convenience of Automatic Reloads. Balance protection upon loss of smartcard will be a significant bonus for customers. Plus, the system will make more customers eligible for Federal Tax credits and will generate annual receipts to submit for these credits.
- *Improve customers' regional mobility:* The TTC Smartcard System will present the opportunity to be interoperable with the Greater Toronto Area Fare System which will enable TTC customers to more easily and seamlessly transfer between Transit Providers. However, further discussions/analyses are required to determine if the GTAFS can be modified to meet the TTC's business needs. Smartcard systems can facilitate inter-regional interoperability. MARTA's Breeze system is currently being rolled out to the customers of regional operators.

Privacy and Protection

Customers have the choice to submit their personal information to the TTC and register their smartcard for a variety of services; however, if they wish to remain anonymous, this choice is available also. Privacy of information is of utmost important to everyone; therefore, the TTC will not only need to develop policies and procedures to protect a customer's information and to guide how it is to be used, but will also need to make it very clear to customers how their information will be protected. The MBTA 'wrote the book" on establishing and communicating their privacy policies and are very willing to share this information with other transit agencies.

In addition to privacy of personal information, standards have been developed to protect customers from theft of credit/debit card account use. The payment card industry has defined these standards and many are (or will be) built into any fare collection system specifying acceptance of smartcards. In addition, the

TTC Information Technology division will need to understand the requirements and to ensure the proper system safeguards are in place.

This chapter provided a general overview of the TTC Smartcard System from the perspective of the TTC customers. In Chapter 9, *Concept of Operations*, the system is defined in greater detail. It will describe the system's processes, the equipment features and functions, the infrastructure requirements and the operational impacts. The *Concept of Operations* is the foundation for estimating capital and operating costs and projecting revenue impacts.

9.0 CONCEPT OF OPERATIONS

This chapter describes the concepts for operating the TTC Smartcard System. It is presented by breaking the system's operation into eight business functions as listed below:

- Smartcard/Paper limited use smartcard Management
- Distribution, Sales and Reload
- Fare Payment and Enforcement
- Customer Services, Smartcard Account Management
- Revenue Collection and Reconciliation
- Operations and Maintenance of Field Devices
- Data Systems and Reporting
- System Architecture and Security

For each business function, the processes were defined, the technology and relevant equipment and systems described and, by applying the "map" and context of the existing fare collection system (see Chapter 6, *Overview of the TTC's Current Fare Collection System)*, functional impacts evaluated. In parallel, TTC staff of each affected functional area reviewed, confirmed and/or refined elements until the concept represented practical application within the TTC environment, adequately met its business goals and staff's expectations.

The conceptual processes for operating the TTC Smartcard System were also guided by the principles listed in the *Introduction* and below:

- *Grounded by research and the experience of peers*. As processes were developed or equipment identified, peers were interviewed about their experience -- lessons learned, best practices, practical application, equipment features and functions, productivity metrics -- and asked a multitude of other questions. All involved in this study wish to thank Chicago Transit Authority, Metropolitan Atlanta Rapid Transit Authority, Massachusetts Bay Transportation Authority, Washington Area Metropolitan Transit Authority, Central Puget Sound and Maryland Transportation Authority for their generous contributions to our knowledge, understanding and to the quality of this analyses.
- *Based on proven technology and methodologies*. As mentioned in Chapter 5, *Emerging Trends*, this study could not rely on incomplete and limited information from pilots that are still currently under review or feature equipment or applications that have not yet been fully developed or market tested. To do so would put the project implementation at risk. The concept of operations had to be built on a solid foundation of proven technology, existing equipment and tried and true processes.
- *Defined, first and foremost, for the benefit of the TTC and its customers*. The conceptual designs were not influenced by the plans and strategies of other regional entities. Service and commitment to the TTC, as an organization, and to the expectations of its customer could not be compromised for initiatives formed from the plans of other entities. It was imperative that the goals of the TTC and the experience of its customers be the central focus. If other entities can be served by the TTC Smartcard System, then this will be considered icing on the cake.
- *The concepts should not require changes in current fare policies*. A smartcard system has to first serve the current policies. This would be the only reasonable basis for evaluating improvements delivered by a smartcard system and to ensure that no customer segment was being served in a compromised way.
- *The system should be flexible enough for future fare policy options and system enhancements.* As described Chapter 3, *Overview of a Smartcard Fare Collection System*, a smartcard system is driven by a Central System. This is where software applications reside and instructions are

delivered to field equipment. The TTC expects a smartcard system to be an improvement over the existing system when it comes to executing new initiatives. This is a strategic imperative.

- *TTC staff should be deeply involved in reviewing concepts and design of the model system*. The processes, equipment and operational impacts were discussed and reviewed by key staff members at each step.

Defining the concept of operations and evaluating the functional impacts were necessary steps for estimating capital and operating costs as well as assessing the advantages/disadvantages to the TTC and its customers. Devices listed in this section are selected by virtue of what is most appropriate to the practical application of the TTC requirements and expectations of function and performance. As mentioned previously, devices and systems were only selected if they had been proven by use in the industry.

The following sections define the concept of operations for each of the eight business functions and the final section of Chapter 9 provides a possible installation and implementation schedule for the TTC Smartcard System.

INTENTIONALLY LEFT BLANK

9.1 SMARTCARD/LIMITED USE CARD MANAGEMENT

As described in Chapter 8, *Overview of the TTC Smartcard System*, the TTC will replace paper tickets, metal tokens, and magnetically encoded passes with plastic smartcards and replace cash fares in the subway, scratch-off Day/Family Passes, and paper transfers with paper limited use smartcards. Replacing existing fare media with "smart" media enables the TTC to manage one type of fare media rather than managing a mix of different fare media as it does now.

Both smartcards and paper limited use smartcards will require inventory management and, in the case of smartcards, special preparation before entering the distribution and sales channels. These processes fall under the first of eight smartcard business functions described in this chapter, *Concept of Operations*. The first business function is called Smartcard/Limited Use Card Management and its concept of operations will be described in this section.

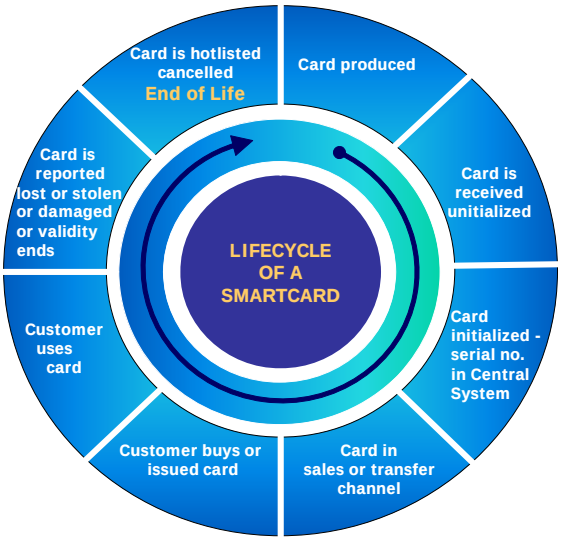
9.1.1 THE LIFECYCLE OF SMARTCARDS AND LIMITED USE CARDS

In Smartcard/Limited Use Card Management, after receiving the cards from the manufacturer, each will be recorded in the TTC's smartcard Central System[28], assigned a customer classification (such as Adult, Senior, Child, Student) and prepared for entry in the sales channel. Thereafter, each smartcard may be tracked, monitored, controlled and cancelled, if necessary.

Paper limited use smartcards are treated differently. Their life starts at the point of issue to the customer -- not before -- and typically ends within 24 hours of issue or at the end of the fare type or transfer's validity period -- whichever comes first.

Exhibit 9.1-1, *The Lifecycle of a Smartcard*, portrays the typical lifecycle of a smartcard.

Exhibit 9.1-1: The Lifecycle of a Smartcard



[28] Central System is the "brain" of the fare collection system and later described in detail in Section 8.8, System Architecture and Security.

Smartcard/Limited Use Card Management activities will include:

1. Procuring smartcards/paper limited use smartcards
2. Receiving and managing smartcards/paper limited use smartcards
3. Initializing smartcards
4. Packaging and delivering smartcards/paper limited use smartcards to sales channels[29] and paper limited use smartcard transfers to Surface Divisions
5. Tracking the delivery of smartcard batches and hotlisting, if necessary.

The following sections describe Smartcard and Limited Use Card Management functions in greater detail.

9.1.2 PROCURING SMARTCARDS AND LIMITED USE CARDS

In the TTC Smartcard System, smartcards will replace all existing TTC fare media such as tickets, tokens, passes. Once the new system is launched and existing fare media discontinued, it is estimated that nearly 1.7 million customers will adopt smartcards as their payment option. This number is based on the estimated customer base by fare type and assumptions about the rate of smartcard adoption. However, in addition to 1.7 million cards, an additional supply will be required to issue to employees, to cover card replacements if lost or stolen, to replace manufacturer defects, and to maintain supplies in vending machines. It is estimated that the TTC will require nearly 3.1 million smartcards to support the first four years of system implementation.

Paper limited use smartcards will replace paper transfers currently issued by Surface Vehicle operators to cash paying customers on Surface vehicles. Paper limited use smartcards will also be available to customers who wish to purchase a single trip or Day Pass in the subway system. Single trip and Day Pass paper limited use smartcards will be dispensed by Full Service Vending Machines. It is estimated that the TTC will require just over 44 million paper limited use smartcards to support the first four years of system implementation.

The quantities of fare media required for the first four years are typically built into the primary fare collection equipment/systems contract and recognized as an expense of the capital project. After this, a request for proposals for providing subsequent supplies of smartcards and paper limited use smartcards will need to be prepared and published.

Type of Smartcard/Limited Use Card

The TTC smartcards will need to be compliant with ISO 14443 A, B or C[30]. Type A is a standardized version of the ISO 14443, Type B is the standardized version of a product originally developed by Mifare® (Philips) and Type C is the standardized version of a product originally developed by Sony for its FeliCa card. Today, ISO 14443 is the only recognized and accepted worldwide standard. Compliance to this standard was stipulated by Transport for London for its Oyster Card system, Metropolitan Atlanta Rapid Transit Authority for its Breeze Card and Massachusetts Bay Transit Authority for its CharlieCard system. In order to be compatible with the regional fare collection system, the TTC will specify the same type of smartcard as the GTAFS (including configuration for format, the data elements etc.). At the time of this writing, it was understood that GTAFS will be ordering plastic cards with memory capacity of 4K and compliant with Parts 2 and 3 of the ISO/IEC 14443 type A standard.

[29] Limited Use Cards are available for purchase through vending machines. Surface operators will issue Limited Use Cards as transfers to cash only customers.

[30] ISO 14443 is a part of ISO 7810 which is an international standard defining formats for identity or identification cards. ISO 14443 defines the standards for cards with an embedded chip (or proximity card) loop antenna. It consists of four parts including the description of three types of cards – A, B and C. The main differences between these types concern modulation methods, coding schemes and protocol initialization procedures.

At the time when technical specifications for the cards are prepared, the TTC will assess the current state of the standards and determine whether it makes good business sense to require compliance with the other standards such as APTA's UTFS initiative or the Port Authority of NY & NJ's Regional Interface Specification (RIS) initiative.

The TTC's paper limited use smartcard is assumed to have the capabilities of the Mifare Ultralight limited use card, which would be applicable for the TTC's requirements. The memory capacity of this limited use card is small, good for no more than one type of fare product, and the specifications claim the Ultralight can endure up to 1,000 [31] transactions. This card is compliant with ISO 14443 type A standard and is currently used in 35 cities in Europe and, now, MARTA in Atlanta.

Cost of Smartcards and Limited Use Cards

Based on recent smartcard purchase costs, an estimated $2.45 per card will be assumed for the purpose of the business case. –According to a recent report issued by the American Public Transportation Association, the cost of paper limited use smartcards is anticipated to drop due to decreasing costs of paper and silicon as well as increase in market demand. The report projected the cost to drop to between $0.15 and $0.20. The average per card cost of $0.20 will be assumed for this business case.

Typical Life of a Card

A smartcard has the average life expectancy of about 4 years when in use. This 4 year life is not the average life of the electronic capability -- its memory chip can endure 100,000 read/write transactions. Since the average annual number of transactions per TTC smartcard issued is estimated to be about 350, the card's chip will last a very long time! The 4 year life expectancy is based solely on the physical appearance and durability of the plastic. Graphics fade and plastic cracks.

A paper limited use smart card has a relatively short life. Again, this life is not a function of its capability so much as the material out of which it's generally constructed. Paper deteriorates very rapidly -- but even more important than the material, since there are so many of these cards distributed over the course of a year, if the life is not cut short, the system will require significant data capacity to store and keep record of the millions of paper limited use smartcards issued as transfers and single Trip tickets and Day Passes. MARTA cancels the paper limited use smartcards after 90 days from the point of issue. The TTC's system will cancel a transfer at the end of the validity period and the single trip ticket would likely be canceled when used or within 24 hours from the point of issue. In the case of the Day Pass, the plan is for the pass to become valid at the point of first use (first time the paper limited use smartcard is read by a Smartcard Reader) and canceled at the end of that revenue service day. The appropriate validity period for a paper limited use smartcard will be defined during detailed design. For example, if the paper limited use smartcard were to be used for a 2-day or 3-day pass product, then the system rules will be defined to accommodate the appropriate validity period.

9.1.3 RECEIVING AND MANAGING THE INVENTORY OF SMARTCARDS

Many transit agencies choose to receive and manage their own fare media inventory. It is true for MARTA and Chicago Transit Authority (CTA) and is merely a preference of the transit agency. In the cases of MARTA and CTA, these agencies wish to monitor the rate of card issuance and have quick, easy access to the fare media when it's necessary to restock vending machines or re-supply sales channels. WMATA, on the other hand, contracts these services to an outside firm -- they are included in their contract for a Regional Customer Service Center (RCSC). The WMATA SmarTrip program is expanding to 14 regional operators and WMATA did not wish to assume the additional burden of managing multiple agency inventories.

[31] American Public Transportation Association Trends in Electronic Fare Media Technology, Version 1.50, February 14, 2004, page 32.

Supplier Responsibilities

The following list provides a general overview of the responsibilities of a card manufacturer:

- To produce smartcards to the TTC specifications and to assign a unique serial number to each.
- To package and identify smartcards according to type. It is currently planned to issue differently coloured cards – for Adult and Concession customer classifications.
- To produce paper limited use smartcards to the TTC specifications and to assign a unique serial number to each.
- To package paper limited use smartcards according to the TTC's requirements. Paper limited use smartcards are generally packaged in rolls (of 1,000 cards each) for dispensing through Vending Machines and in boxes of singles for issuing as transfers. Also, the plan is to issue differently coloured paper limited use smartcards to distinguish Adult cards from Concession cards. This colour distinction is for paper limited use smartcards sold through vending machines only. This distinction is not necessary for the transfers.
- To closely manage the physical inventory of smartcards and paper limited use smartcards in stock at their warehouse until receipt by the TTC.
- To package boxes/cases per the TTC specifications.
- To maintain spares inventory for replacing defective cards.

The TTC's Responsibilities

The following list provides a general overview of the responsibilities of the TTC after receipt of card supplies:

- To properly confirm quantities and types delivered, it is recommend that the TTC purchase three card counting machines – to ensure that batches of cards sent in boxes are physically counted periodically. The shiny cards have a propensity to slip and fall to the ground in a production environment. They will need to be recounted and re-boxed.
- To ensure proper, timely and secure storage of the smartcards and paper limited use smartcards.

9.1.4 INITIALIZING AND ENCODING SMARTCARDS

Generally initialization is defined as the process of taking a raw manufactured card and encoding it with minimal information identifying it as belonging to one transit authority or another. In other words, initialization formats cards with the "electronic security keys" necessary to operate within its system. When a card is initialized with these keys, any system device reading the card will recognize certain field values are correct and authorize its use in the system.[32] Many transit agencies choose to initialize their inventory of smartcards in house because, for security reasons, they prefer to limit the distribution of these keys to outside parties (such as card providers).

During the initialization process, the serial number of each smartcard is recorded in the Smartcard Central System's database. This allows the smartcard to be tracked, monitored, and hotlisted "cancelled", if necessary.

Paper limited use smartcard *transfers* and paper limited use smartcards to stock vending machines will not be initialized prior to entering the distribution and sales channels. Instead, the cards will be initialized at the Smartcard Reader upon being issued as a transfer and by the vending machine at the point of

[32] If the card is initialized with the proper keys, when touched to a system reader, it will send encrypted data to the reader. The reader's security access module will be able to decrypt the data and send its own encrypted packet of data back to the card. The card's keys will decrypt. Once this cycle is completed, the card is recognized and the transaction is allowed to be completed.

purchase. It is impossible to pre-initialize paper limited use smartcards that are packaged in rolls and the paper limited use smartcards issued as transfers will be delivered directly to the various TTC Surface Divisions.

Encoding Customer Classification, Product or Value

At the same time a card is initialized, it is possible to perform a secondary process called "encoding". The encoding process will assign a customer classification such as Adult, Senior, Student and Child. The encoding process may also add E-Purse value or E-Pass, if desired. The TTC will encode a customer classification (Adult or Concession – Senior, Student, Child) at the time each card is initialized. This will enable Concession customers to purchase products or pay a fare at the Concession rates and Adult customers to purchase products or pay a fare at Adult rates. The appropriate classification will be encoded onto colour-coded cards – one colour for Adult class cards and another to indicate Concession class cards.

While the primary plan is to supply sales channels with zero value smartcards to be encoded with value or passes at the point of sale, there may be a need to pre-encode the cards with value or passes prior to entering the sales chain (see Section 9.2, *Distribution, Sales and Reload*). If so, this function may be performed at the initialization and encoding stage of smartcard management.

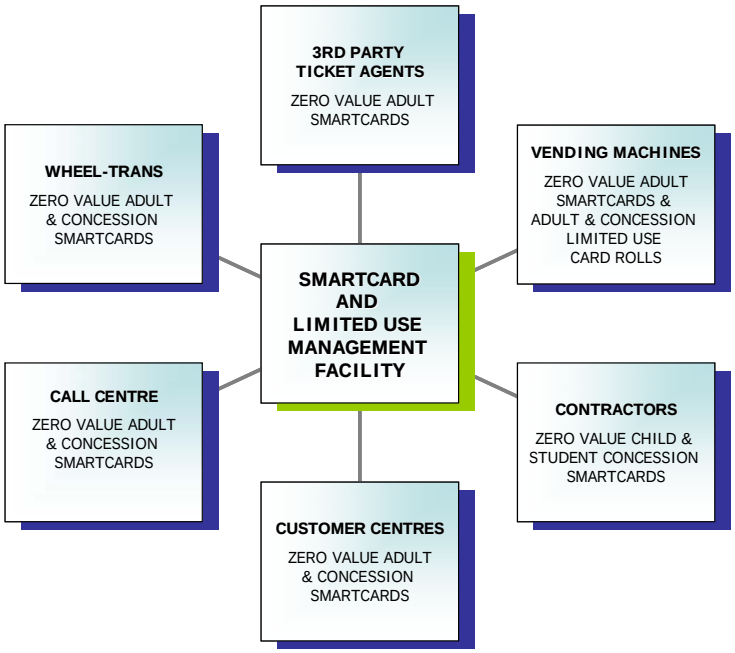
Quality Assurance/Checks

Keeping the initialization process in-house gives the TTC the opportunity to conduct a quality assurance check on the cards delivered from the manufacturer before they reach a transit customer. There are rudimentary checks as part of the Initialization process to weed out faulty cards. It gives the agency a higher degree of quality assurance and, above all, control.

9.1.5 PACKAGING AND DELIVERING SMARTCARDS/LIMITED USE CARDS TO SALES CHANNELS

The functional area assigned the responsibility for initializing smartcards will no doubt also be assigned the responsibility for packaging and delivering batches of smartcards and rolls of paper limited use smartcards to the sales channels (reference Section 9.2, *Distribution, Sales and Reload*). In the TTC Smartcard System, sales channels include 3rd Party Ticket Agents, Subway station vending machines, the TTC Customer Centres, the TTC Call Centre, Wheel-Trans division and to Contractors enlisted to distribute Concession smartcards to elementary and high school children. Exhibit 9.1-2, *Smartcard/Limited Use Card Deliveries to Sales Channels*, presents an overview the sales channel to which fare media will be delivered.

Exhibit 9.1-2: Smartcard and Limited Use Card Deliveries to Sales Channels



Smartcard packaging for delivery will depend on the requirements of each sales channel. Ticket Agents, TTC Customer Centers (including the former MDP Office), Call Centre, Wheel-Trans and Contractors will most likely wish to receive smartcards in boxes of varying quantities, while for sale through vending machines smartcards are typically packaged in "magazines" of 400 each. Paper limited use smartcards for selling through vending machines are typically packaged in rolls of 1,000 each.

Each surface division will receive supplies of paper limited use smartcard transfers directly from the card manufacturer. Once the supplies arrive, transfer dispensers will be prepared for each operator or bus. Each dispenser will probably hold 800 transfers. Dispensers will be refilled as necessary.

9.1.6 TRACKING AND MONITORING DELIVERIES

Initializing smartcards before delivery to sales channels allows the TTC to track and monitor the cards. If, at any time, smartcards are lost or stolen in route to a sales channel, batches can be hotlisted (cancelled).

9.1.7 INITIALIZING AND ENCODING EQUIPMENT

The following describes the high production initialization/encoding machine purchased by the Massachusetts Bay Transportation Authority (MBTA) and is suitable for the TTC's estimated card volumes:

The *Initialization/Encoding* machines function as summarized below:

- Enter card production jobs through a workstation with access to Smartcard Central System,
- Load cards in a stacker at one end,
- Send smartcards through the initialization and/or encoding system (quality assurance tests performed simultaneously),

- Print any special copy on cards (such as name of a special convention group) if desired. Initializing and encoding machines come with various colour ribbons for printing,
- Receive the initialized/encoded cards in a stacker at the other end.

Production jobs are entered via workstation, where certain parameters such as the batch size to be initialized, number of batches to be produced and other information are entered. Orders for smartcards will be entered into the Central System. These orders will be reviewed and processed by the employee authorized to operate an Initializing and Encoding Machine. Exhibit 9.1-3, *Bulk Card Order Process*, portrays the process for ordering smartcards.

Exhibit 9.1-3: Bulk Card Order Process

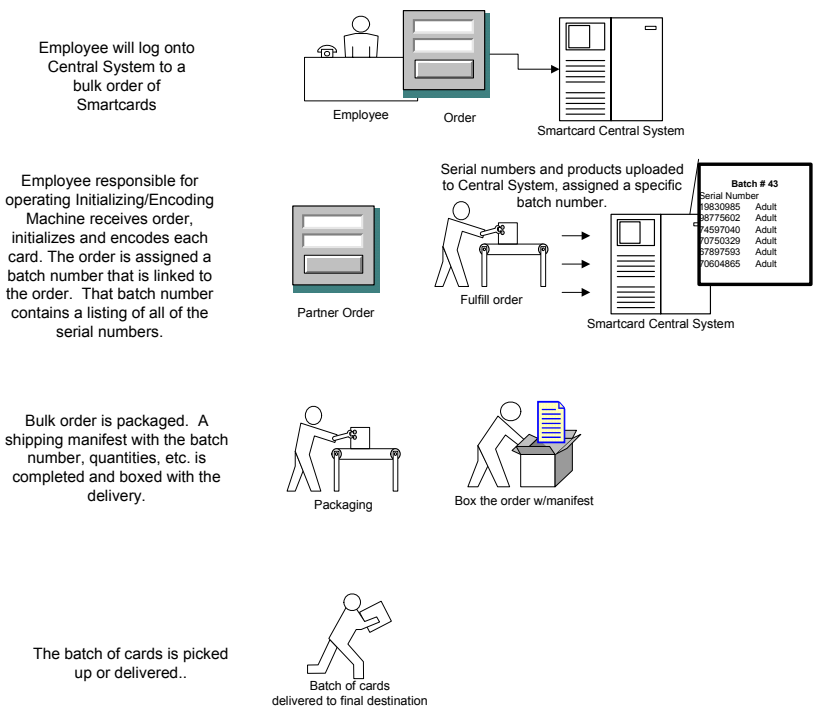
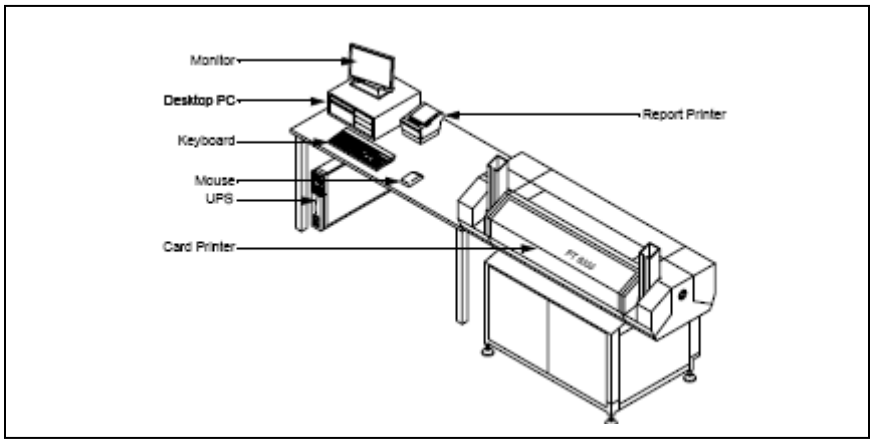


Exhibit 9.1-4, *MBTA'S Point of Issue Machine,* provides a schematic diagram of Boston's Smartcard Point of Issue Machine.

Exhibit 9.1-4: MBTA's Point of Issue Machine



Source: Massachusetts Bay Transportation Authority

Boston purchased one High Production Initializing and Encoding machine and two smaller machines (also known as Point of Issue Machines). The large unit is advertised to have a production rate of at least 900 cards/hour and one smaller unit, 300 smartcards per hour for a total of 900 + 300 = 1,200 cards per hour for production rate. When everything is running perfectly, actual experience is that the units are producing about 1,100 cards per hour – slightly under the specified requirement.

Exhibit 9.1-5: High Production Encoding Machine

Given the TTC's demand estimates, one high speed Smartcard Initialization and Encoding Machine and one Point of Issue machines should suffice. MARTA procured six high production initializing and encoding machines. The original intention was to use the machines to initialize and encode both their plastic smartcards and their paper limited use smartcards. Later, they changed direction and made the decision to not initialize and encode paper limited use smartcards. They now have more machines than necessary.

9.1.8 EQUIPMENT REQUIREMENTS

Table 9.1-6, *Equipment Requirements for the Smartcard/Limited Use Card Management*, provides a list of equipment required for performing the functions described in this section. Equipment quantities were determined by estimating the TTC's smartcard requirements, researching equipment productivity metrics and interviewing peer agencies. Smartcard and Limited Use Card quantities represent estimated requirements for the first four years of implementation (these are not annual totals).

Table 9.1-6: Equipment Requirements for Smartcard/Limited Use Card Management

	Quantity
Smartcards	3.1 million
Limited Use Cards	44.0 million
Smartcard Initialization/Encoding Machine	1
Workstations	2
Point of Issue Machine	1
Smartcard magazines (Back up)	788
Limited Use Card Transfer Dispensers	3,012
Card Counting Equipment	3

Notes:

- *Smartcard magazines*: Back up to the magazines that come with each Full Service Vending Machine. Four back ups per FSVM.
- *Paper limited use smartcard Transfer Dispensers*: One for each surface vehicle, plus 50% for back up.
- Software applications and data transport systems necessary for operating the Smartcard Initialization/Encoding Machine and Point of Issue Machine are presented in Section 9.8, *System Architecture and Security.*

9.1.9 FUNCTIONAL IMPACTS

Comparing the processes for Smartcard/Limited Use Card Management to the TTC's current processes for managing fare media exposed the most likely impact to current operations. The following summarizes the impacts related to this business function.

- Increased cost of fare media. The initial procurement of smartcards and paper limited use smartcards will be capitalized. After this, the cost of this fare media will be included in the annual operating budget. Smartcards may be expensed over the card's reasonable 4 year life ($2.45/4 = $0.61 each per year), and transit agencies typically have the customer purchase the card to help ensure customers look after it and reuse it. So potentially the cost of the smartcard may be offset; however, the full cost of paper limited use smartcards (estimated $0.20 each before taxes) will be expensed when taken out of inventory. Given the estimated annual quantity required, the cost of this fare media may have a significant impact on the annual operating budget.
- Increased labour for initializing and encoding smartcards. This is a new activity for the TTC.
- Decreased labour for fare media distribution activities. If Collectors are no longer required to sell fare media, labour required for delivering fare media will be reduced. Plus, reusable, reloadable smartcards will reduce labour requirements for restocking vending machines and deliveries to bulk sellers and 3rd Party Ticket Agents. Decreased labour for picking up unsold fare media.

Smartcards have no shelf-life like the current monthly and weekly Metropasses; therefore, the TTC will not have to collect unsold fare media as they do today.

- Decreased labour for shredding unsold fare media. There will be no need to shred smartcards.

Functional area cost estimates are featured in Chapter 10, *Cost Impacts*, Section 10.3, *Projected Operating Cost*.

INTENTIONALLY LEFT BLANK

9.2 SMARTCARD DISTRIBUTION, SALES AND RELOAD

As described in Chapter 8, *Overview of the TTC Smartcard System,* the TTC will replace paper tickets, metal tokens, and magnetically encoded passes with smartcards. Customers will either load their smartcard with E-Purse value (money value equaling the value of one or multiple trips) or with E-Pass (time-based, unlimited trips); paper limited use smartcards will be used to replace the Subway single trip cash, the Day/Family Pass, and paper transfers (issued by Surface Vehicle operators to cash customers).

As other transit agencies have learned, one of the most important steps for successfully transitioning customers to a new fare payment option is to not only maintain familiar and popular channels but also expand opportunities for obtaining and reloading the card. Upon the launch of the smartcard system, the TTC will provide an expanded network of sales and reload channels.

To the extent possible, the existing channels such as 3rd Party Ticket Agents, through which 30% of customers currently buy their tickets, tokens and passes will continue to distribute, sell and even reload the TTC fare media; Subway sales will be fully automated to improve customer convenience, allow for cash, debit/credit purchases from vending machines, and to reduce line-ups.

In addition to the familiar channels, new ones will be established to make it even more convenient to buy and reload smartcards. These will include full service vending machines at all station entrances, add-value machines at all station entrances, including surface vehicle platform transfer areas, web and call centre services.

All sales channels will be equipped to sell and reload Adult class smartcards. Concession class smartcards will be distributed by select contractors and available to students and children in school and through walk-in TTC Customer Centres. Wheel-Trans will distribute Adult or Concession class smartcards to their qualifying customers. Seniors will be able to go to a Customer Centre or submit by mail, with notarized proof of eligibility. The customer classifications will be encoded onto the card at the time of Initialization as described in Section 9.1, *Smartcard/Limited Use Card Management* and Adult and Concession smartcards will be distinguished by colour. Once a customer qualifies and receives a Concession class smartcard, they will be able to reload their card through any sales channel (vending machine, 3rd Party, Call Centre, Customer Centre, or Web Service).

Paper limited use smartcards will be available for the purchase of an Adult or Concession single trip or a Day Pass through Subway station Full Service Vending Machines. The paper limited use smartcards will also be colour coded to distinguish between Adult and Concession.

The following sections describe how each Smartcard Distribution, Sales and Reload channel will work in the TTC Smartcard System.

9.2.1 SALES/RELOAD CHANNELS

Subway Stations: As an improvement to the availability and convenient purchase of smartcards, in the new fare collection system, vending machines will be installed in every station. Full Service Vending Machines (FSVM) will be capable of dispensing plastic smartcards as well as reloading cards with E-Purse value and/or E-Passes. They will accept cash or credit/debit card payment. These machines will also sell paper limited use smartcards encoded with either a Single Trip or Day Pass. Customers will not be able to reload paper limited use smartcards.

In addition to FSVMs, Add Value Machines (AVM) will be available in all Subway station entrances and Surface Vehicle transfer areas. These machines will be available for reloading customer smartcards – they will not dispense smartcards. They will accept credit/debit only – no cash. Exhibit 9.2-1, *Breeze Vending Machine*, shows MARTA's Breeze Vending Machine and Exhibit 9.2-2, *Add Value Machine*. These vending machines are similar, in concept, to the FSVM and AVM, respectively.

Automation of all sales and reloads through vending machines will provide the opportunity for the TTC to move toward a more enhanced customer service focus in the subway. If Station Collectors are no longer required to sell fare media, they would be able to provide improved customer assistance since they would no longer be required to remain inside their booth.

3rd Party Ticket Agents: Maintaining 3rd Party Ticket Agents for the distribution, sale and reload of smartcards will be especially important for transitioning the TTC's customers to the new fare payment option. Revenue from 3rd Party Ticket Agents represents about 30 percent of the TTC's total annual pre-paid fare revenue. In the TTC Smartcard System, the plan is to install Point of Sale devices at select Ticket Agents outlets. It will be through this device that a Ticket Agent will sell and encode a smartcard with E-Purse value and/or an E-Pass. The introduction of new alternative sales channels will also allow the TTC to rationalize the third party ticket network.

Metropass Discount Program: Each Metropass Discount Plan (MDP) customer will be set up with a personal account in the customer database in the Smartcard Central System. MDP customers will receive their initial smartcard by mail, as now, but in the new system, there will only be this initial mailing, not a mailing every month. Instead, the system will be set up to either automatically load the E-Pass at the start of each month or the MDP smartcards will be pre-encoded with one Metropass good for twelve months…no monthly automatic reloads required. Once the MDP employees set up the customer accounts and mail the smartcards, these employees will perform smartcard customer service activities as described in Section 9.4, *Customer Services, Smartcard Account Management.*

VIP: The institutions and major employers will distribute new smartcards, registration forms for autoload or, if justified, they may have a point of sale device like the 3rd party agencies to reload value.

INTENTIONALLY LEFT BLANK

Exhibit 9.2-1: Breeze Vending Machine (FSVM)

Breeze Vending Machine Tour

1. Display Screen
Follow the instructions on this screen and press the button next to your choice.

2. Coin Slot
Insert coins or tokens in the coin slot to pay your fare.

3. Bill Acceptor
Insert bills in the bill acceptor to pay your fare.

4. Credit/Debit Card Reader
Insert your credit card in this slot. For debit cards, enter your PIN using the keypad. (This feature may not be available until later this fall.)

5. Breeze Target
When refilling your Half-Fare or Paratransit Breeze Card, touch it to the target to add your selected value.

6. Take your Breeze Card, change, and/or receipt from the bin at the bottom of the machine.

7. Audio Plug
For the hearing impaired, an audio plug is available for headphones. Volume can be adjusted using the dial.

Exhibit 9.2-2: Add Value Machine (AVM)

TTC Call Centre: The TTC's Call Centre will provide a variety of smartcard account services including receiving and processing new card orders (Adult class only) and smartcard reload requests (all classes). Reloading a smartcard may also be processed via the automated Interactive Voice Response (IVR) system (see Section 9.4, *Customer Services, Smartcard Account Management,* for details).

TTC Customer Centres: Three storefront walk-in TTC Customer Centres will be strategically located with the City of Toronto. The Centres will offer a full range of smartcard services including selling/reloading Adult and Concession smartcards and processing card orders submitted through the mail and TTC's web-services. Regular business hours will be (Monday – Friday, 7 AM – 7PM). MARTA has similar operations, called RideStores, located within or near seven high volume rail stations.

TTC Web Services: The TTC Web Services will be another improvement to the availability and convenient purchase/reload of smartcards. In the new fare collection system, web services will enable customers to order and reload a smartcard with E-Purse value and/or E-Passes from the convenience of their own home or office computer. In this situation, the method of payment will be credit/debit. The card order will be automatically uploaded to the TTC's customer database (residing at the Smartcard Central System). The order will be fulfilled by the TTC's Customer Centre and mailed to the customer.

Automatic Reloads: Another convenient method for reloading smartcards will be the automatic reload service. In the TTC Smartcard System, customers may register for automatic reload. This service links a customer's smartcard serial number to their credit/debit card. When the E-Purse value on their smartcard reaches a specified threshold or when an E-Pass expires, the fare collection system will automatically direct reloading of value or a new E-Pass and charge the credit/debit card accordingly.

Contractors: Currently the TTC contracts with a firm to facilitate and coordinate the processing and issuing of high school student photo identification cards. Upon launch of the new fare collection system, the TTC intends to expand this service to include elementary schools. The subcontractors will issue zero value smartcards, pre-encoded with either child or student classification. Once the children and students receive their card, they will activate the card by submitting the school name, student ID and PIN. They may then, load this card with E-Purse value or Concession E-Passes at any sales channels.

9.2.2 EQUIPMENT REQUIREMENTS

Table 9.2-3, *Equipment Requirements for Smartcard Distribution, Sales and Reload*, provides a list of equipment required for performing the functions described in this section. Equipment quantities were determined by estimating the number of 3rd Party Ticket Agents who may be willing to provide smartcard sales and reload services and the TTC strategy of providing 2 Full Service Vending Machines and 4 Add Value Machines per staffed entrance; 1 each per unattended entrance and 1 Add Value Machine per platform. MARTA averages 9 full service vending machines per station while MBTA averages 6.

There are more cashless Add Value Machines than Full Service Vending Machines because once the TTC reaches critical mass distribution of plastic smartcards, the majority of transactions will be to reload cards, rather than to purchase cards. Add Value Machines will offer speedy reload services. Also installing more Add Value Machines will encourage credit and debit transactions thereby reducing labour intensive cash collection and processing. Offering credit/debit payment responds to customer demand and adapts to the growing use of credit/debit cards in Canada.

Table 9.2-3: Equipment Requirements for the Smartcard Distribution, Sales and Reload

	Quantity
Point of Sale Devices (3rd Party Ticket Agents)	1,006
Full Service Vending Machines	203
Add Value Machines	407

Notes:

- Quantities of smartcards and paper limited use smartcards are presented in Section 9.1, *Smartcard and Limited Use Card Management*
- Equipment for Customer and Call Centres are presented in Section 9.4, *Customer Services, Smartcard Account Management*
- Software applications for Web Services and Automatic Reload are presented in Section 9.8, *System Architecture and Security*

- Software applications and data transport systems necessary for sales and reload presented in Section 9.8, *System Architecture and Security*
- Six each of Point of Sale, FSVMs, and AVMs were added for Quality Assurance/Develop Lab (IT), Maintenance, and Training

9.2.3 FUNCTIONAL IMPACTS

Comparing the processes for Smartcard Distribution, Sales and Reload to the TTC's current processes for distributing and selling fare media exposed the most likely impacts to current operations. The following summarizes the impacts related to the changes in business processes:

- Decreased labour for mailing monthly passes to customers registered in the annual MDP program.
- Reduced cost of conducting surveys to evaluate the trip multiple of the Metropass.
- Increased telecommunications' costs for 3rd Party Ticket Agent transactions.
- Reduced labour cost of managing a "second booth" and crash gates in subway – due to full automation

In addition to the impacts noted above, one-time labour costs will include:

- Informing and educating Ticket Agents about the change.
- Negotiating new sales agreements.
- Installing and testing Point of Sale devices.

Functional area cost estimates are featured in Chapter 10, *Cost Impacts*, Section 10.3, *Projected Operating Cost*.

INTENTIONALLY LEFT BLANK

9.3 FARE PAYMENT AND ENFORCEMENT

This section will review the fare media that will be deployed in the TTC Smartcard System, how the various types of fares (such as ticket and tokens) will be applied to this new fare media, and how customers will pay their fares. This section also describes fare enforcement and the possible deterrence and/or risk of fare evasion in the smartcard system.

9.3.1 GENERAL OVERVIEW OF FARE PAYMENT

As presented in Chapter 8, *Overview of the TTC Smartcard System*, existing fare media (including paper transfers) will be discontinued and replaced with new "smart" fare media called smartcards and paper limited use smartcards. Both have a memory chip embedded inside their material and customers will purchase and load the fare types authorized for either card.

Smartcards

If customers choose to use a smartcard to pay fares, they will load the card with E-Purse value -- money value equaling the value of one trip or multiple trips – or with an E-Pass – a time-based, unlimited trip product. Any fare paid with the E-Purse of a smartcard will be automatically encoded with a transfer. Then, to pay their fare, they will tap their smartcard to a Smartcard Reader on a Subway turnstile or on a Surface Vehicle. The system will deduct the appropriate fare from the card's E-Purse or validate the E-Pass.

Before entering sales channels, the TTC smartcards will be encoded with a customer classification – Adult or Senior or Student or Child (See Section 9.1, *Smartcard/Limited Use Card Management*, for more details). Adult and Concession class cards will also be distinguished by color. The encoding will enable the system to recognize the customer classification and deduct the appropriate fare or validate the E-Pass; the colour coding will enable further visual inspection by front-line employees.

The TTC will continue the school distribution program, but expand it to include elementary schools in addition to high schools. Children and students will be issued a smartcard encoded with a Child or Student classification. After their card is activated (see Section 9.2, *Distribution, Sales and Reload*), children and students will be able to load their card with E-Purse value or Concession E-Passes through any sales channel. Then, to pay their fare, they'll tap their smartcard to a Smartcard Reader on a Subway turnstile or on a Surface Vehicle, the system will recognize the Concession Classification and deduct the appropriate Concession fare from the card's E-Purse or validate the Concession E-Pass.

Limited Use Cards

If customers choose, they may purchase a paper limited use smartcard from the Full Service Vending Machine for fare payment. They will be limited to buying either an Adult or Concession Single Trip or an Adult Day Pass on this short-term fare media. Inside the vending machine there will be two rolls of paper limited use smartcards – one roll will contain paper limited use smartcards to be used for Concession Single Trip tickets and one roll to be used for Adult Single Trip ticket and Day Passes. Each roll of paper limited use smartcards will be coloured to visually distinguish the two different customer classifications – Concession versus Adult. When, for example, a customer selects a single trip "Child's" ticket, the vending machine will draw from the roll of Concession paper limited use smartcards, encode the product and print a letter code indicating Child (could be the letter C) and dispense the single trip Child's ticket. When a customer selects an Adult fare Single Trip, the vending machine will draw from the roll of Adult paper limited use smartcards, encode the single trip product and dispense the card --- it will not be necessary to print a code indicating Adult (the color of the paper limited use smartcard will be enough to visually distinguish it from Concession). Any customer purchasing a paper limited use smartcard will then pay their fare by tapping the card to a Subway turnstile or to a Surface Vehicle Smartcard Reader. Any paper limited use smartcard encoded with a single trip will also include a transfer.

Cash

Customers choosing to pay cash on a Surface Vehicle will drop the appropriate Adult or Concession fare into the farebox (Concession cash customers must be prepared to show proof-of-qualification prior to paying Concession cash fare). Any cash customer requesting a transfer from a Surface Vehicle operator will be issued a paper limited use smartcard encoded as a transfer.

Subway customers, who do not have a smartcard and wish to buy a single trip or Day Pass (without buying a smartcard), may do so by purchasing a paper limited use smartcard with either product encoded on it at the Full Service Vending Machine. If a customer wishes to purchase a Concession Single Trip ticket, they will make the appropriate selection at the vending machine. The vending machine will dispense a Concession paper limited use smartcard.

It's important to note that, in the TTC Smartcard System, automation of fare sales and fare collection in the Subway system will enable the TTC to move toward providing more enhanced customer services. This could involve having Station Collectors assist customers with vending machines.

In addition, neither the existing Surface Vehicle fareboxes nor Subway turnstiles will be replaced (except the turnstile adjacent the Collector's booth. It will be replaced with an electronic turnstile with Smartcard Reader). Smartcard Readers will be installed onto the existing entry turnstiles and on the Surface Vehicles near the fareboxes in order to process smartcard fare payments. In the case of Streetcars, Smartcard Readers will be installed both near the front and the rear doors of the vehicles. Customers may pay their fare with a smartcard or paper limited use smartcard at either entrance. Cash customers must board through the front door to drop coins/currency in the farebox and to receive a paper limited use smartcard transfer.

The following sections describe the Fare Payment and Enforcement activities relevant to the TTC Smartcard System.

9.3.2 FARE MEDIA

The following lists the types of fare media customers may use to pay their fares in the TTC Smartcard System:

- Smartcards or
- Limited Use Cards

In addition, customers may pay for their Surface trip with cash. They will do so by dropping the cash fare in the Surface Vehicle farebox. If a cash customer requires a transfer, they will be issued a paper limited use smartcard encoded with a transfer by the Surface Vehicle Operator.

9.3.3 FARE MEDIA OPTIONS FOR FARE TYPES OF TODAY

Table 9.3-1, *Fare Types/Fare Media Options*, describes how the TTC's fare types of today will be available within a smartcard system.

Table 9.3-1: Fare Types/Fare Media Options

FARE TYPES	FARE MEDIA OPTIONS
Cash – Adult Single Trip	Cash: in surface farebox (or to Wheel-Trans operator) Paper limited use smartcard: Single trip purchased on paper limited use smartcard at FSVM.
Multiple trips (Adult tickets/tokens)	Smartcard: E-Purse value loaded on smartcard at any sales channel
Week/Month Metropass (Adult)	Smartcard: Weekly or monthly E-Pass loaded on smartcard at any sales channel. Note: the smartcard system will provide the flexibility to switch from a fixed calendar week/month pass to a 7 or 30 day rolling period pass, if the TTC desires to do so.
MDP Program	Smartcard: Fixed month E-Pass.
Day Pass	Paper limited use smartcard or Smartcard: Day Pass sold on paper limited use smartcard purchased at FSVM only or loaded on smartcard at any sales channel
Concession cash or Single Trip	Cash: in surface farebox Concession paper limited use smartcard: As single trip purchased at FSVM only.
Concession tickets	Concession Smartcard: E-Purse value loaded on smartcard at any sales channel.
Concession Week or Month Metropass	Concession Smartcard: Fixed Week or Month Concession E-Pass loaded on Concession smartcard at any sales channel.
Transfer	Paper limited use smartcard: On Surface Vehicles, upon request by (Adult or Concession) cash paying customers, paper limited use smartcard transfer is issued by Driver. Driver takes paper limited use smartcard from a dispenser, transfer is selected through Driver Control Unit, paper limited use smartcard tapped to Smartcard Reader for date/time information. Adult or Concession paper limited use smartcard or smartcard: In Subway, transfer is automatically encoded onto paper limited use smartcard or smartcard at time of tap at turnstile Smartcard Reader. On Surface, transfer is automatically encoded onto paper limited use smartcard or smartcard at time of tap at the Surface Smartcard Reader.

Concession

In order to load a Concession E-Pass onto a smartcard, a Concession customer must have shown proof of qualification, been issued a smartcard encoded with a Concession Classification, and must have activated this card. The smartcard system will not load a Concession E-Pass onto a regular, Adult Class smartcard.

Concession customers, who do not have a Concession smartcard, may purchase a Concession paper limited use smartcard single trip from the FSVM to enter a turnstile or drop the appropriate Concession cash fare in the Surface Vehicle farebox.

Transfers

In the TTC Smartcard System, paper transfers will be discontinued. Instead, transfers will be electronically encoded on the plastic smartcard or the paper limited use smartcard. So at the point the customer first taps their card to a reader and a fare is deducted from their E-Purse value or it recognizes a single trip, the system will encode a transfer with a validity period.

Surface Vehicle cash customers will receive a paper limited use smartcard transfer from the operator instead of a "punched" paper transfer. This paper limited use smartcard transfer will be electronically encoded with validity period at the time it is issued to the customer.

The system will track the usage of the transfer and if it not used properly or if it has expired, the system display will inform the customer that they may not use the transfer for entry or boarding or that the transfer has expired and they must pay a new fare. This means that checking the validity of a transfer is no longer the responsibility of the vehicle operator. This type of automated interface will be less personal, reducing operator/customer conflicts and the number of customers who may feel they are being singled out indiscriminately.

The system will provide the flexibility to support time-based transfers, if desired. Both the Massachusetts Bay Transportation Authority (MBTA) and the Metropolitan Area Rapid Transit Authority (MARTA) are providing time-based transfers primarily for the purpose of making it easier for customers to understand and easier for operators to explain.

9.3.4 FARE PAYMENT METHODS

Table 9.3-2, *Fare Payment Methods*, describes the methods by which customers will pay fares in the TTC Smartcard System.

Table 9.3-2: Fare Payment Methods

FARE PAYMENT OPTIONS	FARE PAYMENT PROCESS
Cash – Single Trip	Surface: Drop cash in farebox (or to the Wheel-Trans operator) Subway: Purchase (Adult/Concession) Single Trip or Day Pass limited use smartcard at FSVM.
E-Purse value (Pay-as-you-Go)	Tap smartcard at Smartcard Reader (on Surface Vehicle or on turnstile). The Reader deducts appropriate fare depending on the customer classification encoded on the smartcard – Adult, Senior, Student or Child. For customers registered for Balance/Negative Protection, if value is not adequate, system will allow the smartcard to go negative to be repaid at time of reloading card. If Surface Vehicle customer wishes to pay fares for multiple people, customer informs the operator. The operator will

FARE PAYMENT OPTIONS	FARE PAYMENT PROCESS
	initiate by entering the number of fares in the Driver's Control Unit[33]. The customer will then tap card once to deduct total fare amount for all fares from their E-Purse value.
E-Pass	Tap smartcard at Smartcard Reader (near farebox or on turnstile). The Reader will check for a valid pass. The smartcard E-Pass will be blocked for use for a short period of time. The purpose is to disallow passing back a pass for another customer to use.
Day Pass	Either paper limited use smartcard or smartcard, tap at Smartcard Reader (near farebox or on turnstile). The Reader will check for validity – pass back will not be allowed for a short period of time.
Transfers	
Subway to Surface Vehicle transfer	Paper limited use smartcard/Smartcard is tapped to Surface Vehicle Smartcard Reader. Reader checks validity of transfer. If transfer is invalid on the smartcard, the Smartcard Reader will automatically deduct fare from E-Purse. If value is inadequate and customer is registered, the system will allow negative value and repay at time customer reloads card. If the transfer is invalid on the paper limited use smartcard, the system will reject the card. Customer will be required to pay cash fare.
Surface Vehicle to Subway	Paper limited use smartcard/Smartcard is tapped to turnstile Smartcard Reader. Reader checks validity of transfer. If transfer is invalid on the smartcard, the Smartcard Reader will automatically deduct fare from E-Purse. If value is inadequate and customer is registered, the system will allow negative value and repay at time customer reloads card. If the transfer is invalid on the paper limited use smartcard, the system will reject the card. Customer will be required to purchase another fare at the vending machine.
Surface Vehicle to Surface Vehicle	Paper limited use smartcard/Smartcard is tapped to Smartcard Reader of the 2nd Surface Vehicle. Reader checks validity of transfer. If transfer is invalid on the smartcard, the Smartcard Reader will automatically deduct fare from E-Purse. If value is inadequate and customer is registered, the system will allow negative value and repay at time customer reloads card. If the transfer is invalid on the paper limited use smartcard, the system will reject the card.
Concession Fares w/out Concession Smartcard	Children or Seniors boarding a Surface Vehicle without a Concession smartcard, will pay a Child or Senior cash fare at the farebox. In the subway, if they wish to purchase a Concession fare type, they will select the appropriate

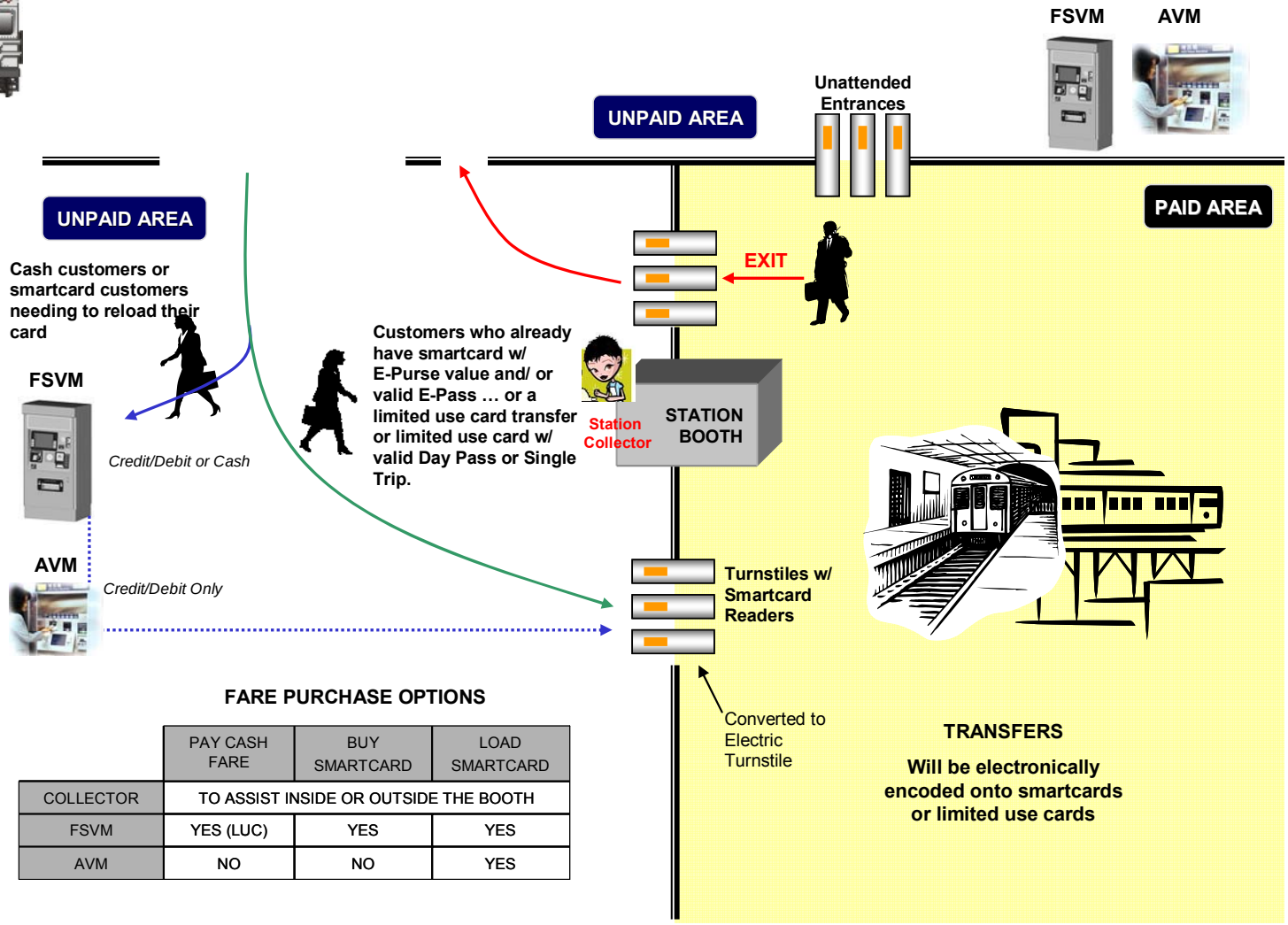
[33] Provides an interface between the vehicle operator and the Smartcard Reader. Operator can check smartcard transaction details.

FARE PAYMENT OPTIONS	FARE PAYMENT PROCESS
	Concession paper limited use smartcard single trip available for purchase at a Full Service Vending Machine. The Concession customer will then tap the paper limited use smartcard with the Concession fare type at the turnstile's Smartcard Reader to gain entry. If a student boards a Surface Vehicle and does not have a Concession smartcard, but has a TTC photo ID, they will pay the Student Concession cash fare at farebox. If no ID, they will be expected to pay the Adult cash fare. If a student enters the subway and does not have a Concession smartcard, but has a TTC photo ID, they may purchase a Concession Single Trip paper limited use smartcard at the Full Service Vending Machine; however, if the student does not have a TTC photo ID, then they will be expected to purchase an Adult Single Trip or Day Pass paper limited use smartcard.

Parking Fee Payment: To pay a parking fee at a TTC commuter parking facility, customers may pay with cash (as they do now) or with a smartcard. If a customer has a smartcard, they will tap it at the parking Smartcard Reader. The system will check for a qualifying E-Pass. If there is one on the card, parking will be free. If not, the system will deduct the appropriate parking fee from the value contained in the card's E-Purse.

Exhibit 9.3-3, *Fare Payment Process in Subway Stations* and Exhibit 9.3-4, *Fare Payment Process on Surface Vehicles,* present how customers will pay fares in the Subway and on Surface Vehicles.

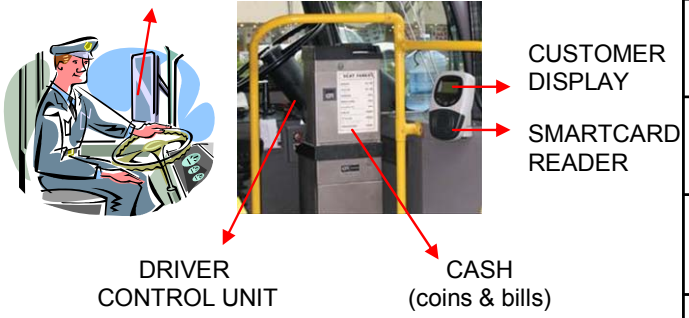
Exhibit 9.3-3: Fare Payment Process in Subway Stations



FARE PURCHASE OPTIONS

	PAY CASH FARE	BUY SMARTCARD	LOAD SMARTCARD
COLLECTOR	TO ASSIST INSIDE OR OUTSIDE THE BOOTH		
FSVM	YES (LUC)	YES	YES
AVM	NO	NO	YES

Exhibit 9.3-4: Fare Payment Process on Surface Vehicles



Fare Payment	Cash Customers	Smartcard Customers	Limited Use Card Customers
Coins	Yes – Not registered		
Bills	Yes – Not registered		
Transfers	Operator issues Limited Use Transfer	Electronically encoded	Electronically encoded
Day Pass		Validated by Smartcard Reader	Validated by Smartcard Reader
Single Trip			Validated by Smartcard Reader
E-Purse Value		Decremented by Smartcard Reader	
E-Pass (Smartcard)		Validated by Smartcard Reader	
Electronic Transfer		Validated by Smartcard Reader	Validated by Smartcard Reader

Note:

Assumes existing fareboxes are not replaced, but Smartcard Readers are installed to enable smartcard/limited use card processing.

The TTC is currently weighing the cost/benefits of replacing existing fareboxes, but this decision will be made after additional operating experience has been gathered from transit peers and during the detailed design review phase. It was noted in Chapter 4, *Experience of Other Cities and Transit Agencies,* that CTA had planned to replace fareboxes. Presumably the reason for doing so is to first evaluate how the ChicagoCard and the new fare policies perform before release of the farebox request for proposal. If cash can be significantly reduced at the farebox, then procuring replacement fareboxes may not be worth the added capital cost or resulting increase in operating expense.

9.3.5 FARE ENFORCEMENT

On Surface Vehicles, operators will continue to monitor all fare payments. Visually distinct colours for adult vs. concession cards will assist/alert Operator to request photo id as a concession card is being presented to the smartcard reader. Distinct audible tones and lights from the Smartcard Readers will also alert the Operator to request photo id if none is presented. If a smartcard or paper limited use smartcard is invalid, the system will alert the operator with distinct audible tones and lights. Also, the colour coded cards will help operators visually monitor Concession fare use. In the Subway, customers must have a smartcard with E-Purse value, E-Pass, or a paper limited use smartcard with Single Trip, Day Pass or electronic transfer to activate a turnstile. If invalid, the turnstile will not activate and distinct and audible tones will alert Special Constables and Station Collectors. The Drivers Control Unit (DCU) will have special button, so that an Operator can register a "no payment received" if a customer walks by the farebox without paying. This will provide Operators with a "silent", yet effective, means of recording fare evasion, so that Special Constables can be dispatched appropriately, and help reduce Operator assaults.

Hand Held Devices

Hand Held Device

In the TTC Smartcard System, Hand Held inspection devices will be available for use by Station Collectors, Special Constables and Route Supervisors. These devices will read both smartcards and paper limited use smartcards on Buses, Streetcars or in the paid areas of the Subway. They will be used to inform employees whether or not a fare was paid. If a customer is suspected of evading fare payment, their card will be tapped to the reader on the Hand Held device. The reader will display the last transaction, time, and place. It will also check validity of an E-Pass or Transfer. If a fare has not been paid, the device may be used to deduct a fare from E-Purse value on a smartcard or, in the case of an expired E-Pass or paper limited use smartcard Transfer, the customer will either be issued a citation or escorted to a vending machine.

These devices may also be used to provide customer assistance. If a customer has a question about their card, the employee may use the Hand Held device to check for hotlist codes or to check balance and transaction history.

Fare Forgeries and Misuse

Some current forms of evasion and misuse will be eliminated in the smartcard system while the sale of Concession paper limited use smartcard single trips at Full Service Vending Machines may increase the risk of non-qualified Concession fare purchases. The introduction of concession smartcards also increases risk, which will be dealt with through controlling the distribution of concession cards and increased fare enforcement. The following discuss the most prevalent types of fare evasion and how the smartcard system will address each.

- Forgeries: A smartcard system will eliminate the currently existing opportunities for fare media forgeries such as duplicating tickets and Metropasses and manufacturing metal tokens. Discontinuing printed paper tickets, "flash" passes and metal tokens and, instead, electronically encoding fare types onto a smartcard or paper limited use smartcard chip will reduce the risk of revenue loss from duplication and forgeries.

- Transfer Misuse and Disputes: Since paper transfers will be discontinued and electronically issued by the smartcard system onto either a smartcard or paper limited use smartcard, the misuse of transfers and disputes should diminish substantially. Customers will no longer be able to "pick up" printed transfers and use throughout the day or issue to friends and, if there is a dispute about an electronic transfer, the Surface Operator's Drivers Control Unit, Station Collectors' Hand Held Units and vending machines will provide a list of the last few transactions of the complaining customer's smartcard. This will assist the Surface Operator or Station Collector address these disputes.

- Pass Backs: The system will not allow customers to pass their smartcard E-Pass or their paper limited use smartcard Day Pass back to a friend for use. The agency can configure the amount of time that the system will reject reuse of an E-Pass or Day Pass. Typically it is 30 minutes.

- Concession Fare Misuse: The TTC will require Concession customers to prove qualification prior to receiving a Concession class smartcard. The system will not allow a smartcard classified as Adult to be loaded with a Concession E-Pass. In addition, Concession class smartcards and paper limited use smartcards will be distinguished from Adult smartcards by colour-coding. Further, paper limited use smartcards will be printed with a Concession classification code (such as S for Senior, C for Child and T for Student) prior to dispensing at the Full Service Vending Machine. If a Surface Operator, Special Constable, or Station Collector sees a customer using a Concession card who should not, it can be confiscated. Plus, when a Concession smartcard is tapped at any Smartcard Reader, both the display light and the audible tone, will be distinctly different from those of an Adult smartcard. These distinct features may also call attention to misuse.

  Even so, providing customers with the availability to purchase Concession Single Trips at a Full Service Vending Machine provides an opportunity for unqualified riders to underpay. If the TTC is not closely monitoring these purchases, non-qualified customers may take advantage of this opportunity to purchase a lower priced fare. The TTC Smartcard System will monitor the sales and usage closely through sales reports as well as by closed circuit television. Changes to selling Concession fares at the vending machine will be made, if necessary.

Fraud Analysis

The smartcard system will provide mechanisms to protect the TTC from fare misuse and fraudulent transactions. A Fraud Analysis system will analyze transactions collected by the system and report anomalies such as value loads by unauthorized devices, card balance irregularities, card distribution and sales anomalies. The system will also provide the capability of hotlisting or cancelling cards in violation of established transaction rules.

9.3.6 EQUIPMENT REQUIREMENTS

Surface vehicles will be equipped with the hardware and electronics needed to process fare payment from smartcards. The TTC will continue to use the existing fareboxes, but will make the necessary changes in order to process smartcard fare payment. The Surface vehicles will require a *Surface Vehicle Electronic Pak* (Surface Vehicle-Pak). This Pak will include the Smartcard Reader, appropriate electrical and mechanical kits with design considerations for power supply and in-vehicle wireless antenna for data transfer. Farebox replacement will be considered during detailed design as an alternative to retrofitting the existing mechanical fareboxes.

Another aspect of this design is the LED type display for customers and a Driver Control Unit (DCU). All Smartcard Reader processes will be monitored by the DCU. It will show the Operator the last few transactions, whether there is adequate E-Purse value or whether a transfer is valid, or when an E-Pass expired. It will also be where the Operator will initiate the purchase of multiple fares if requested by a customer.

The TTC will also continue to use the existing Subway turnstiles; however, they will be adapted with Smartcard Readers and the manually controlled turnstile at the Collectors booth will need to be replaced with an Electronic turnstile with Smartcard Reader. The *Subway Electronic Pak (SUB-PAK)* will include Smartcard Reader, the electronics, customer display and appropriate electrical and mechanical kits.

All Smartcard Readers will be capable of reading ISO 14443 and Type A, B or C smartcards (the TTC will deploy smartcards and paper limited use smartcards compliant with this standard. See Section 9.1, *Smartcard/Limited Use Card Management* for more details. Within each reader, Security Access Modules[34] will recognize the keys on the TTC smartcards/paper limited use smartcards and enable the processing of each.

Table 9.3-5, *Equipment Requirements for Fare Payment and Enforcement*, provides a list of equipment required for performing the functions described in this section. Equipment quantities were determined by collecting inventory counts of Surface Vehicles and Subway turnstiles; plus, the number of Collector booth turnstiles. The number of Hand Held devices was derived by estimating quantities required for Station Collectors, Route Supervisors and Special Constables.

Table 9.3-5: Equipment Requirements Fare Payment and Enforcement

	Quantity
Surface (including Wheel-Trans)	
Surface Vehicle Electronic Pak (Smartcard Readers)	2,422
Driver Control Unit	2,014
Subway	
Subway Electronic Pak (Smartcard Readers added to turnstiles)	368
Electronic turnstile (replaces turnstiles adjacent to Collector booths)	134
Commuter Parking	
Smartcard Readers (Parking)	40
Enforcement	
Hand Held Devices	460

Notes

- Software applications and data transport systems necessary for Fare Payment/Enforcement presented in Section 9.8, *System Architecture and Security*
- Six each of Paks, Turnstiles, Hand Held Devices were added for Quality Assurance/Develop Lab (IT), Maintenance, and Training

9.3.7 FUNCTIONAL IMPACTS

Changes in fare payment and enforcement primarily affect the TTC customers; therefore, there are no significant operational impacts related to changes in fare payment and enforcement processes; however, there will be increased labour for periodic or required security blitzes. Functional impacts related to customer service, revenue collection and reconciliation, and maintenance are discussed in other sections of this document.

[34] A module in the form of software or hardware such as an integrated circuit for the purpose of storing a security scheme. *Trends in Electronic Fare Media Technology*, APTA, UTFS Program, February 14, 2004.

9.4 CUSTOMER SERVICES, SMARTCARD ACCOUNT MANAGEMENT

Since smartcards have such a long life and can store many valuable products, the TTC Smartcard System will be designed to encourage smartcard reuse.

As described in Section 9.2, *Distribution, Sales and Reload*, the TTC will offer new levels of customer services and benefits including expanded opportunities for buying and reloading the TTC smartcards, the convenience of Automatic reload and the security of Balance and Negative Protection.

In addition, the TTC will provide several other important smartcard account management services as well as make it easy and very convenient for smartcard customers to check their balance and transaction history.

None of these services are required or typically offered to customers who choose to pay their fares with paper limited use smartcards. The intention is to encourage the adoption of the long-life, reusable plastic smartcard and discourage the use of the short-life, paper limited use cards. As described and discussed in both Chapter 8, *Overview of the TTC Smartcard System* and in Chapter 9, *Concept of Operations*, Section 9.1, *Smartcard/Limited Use Card Management,* paper limited use smartcards have small memory capacity, are less durable and are meant for short-term fare types such as a single trip and Day Pass.

This section describes the smartcard services the TTC intends to offer customers who choose to pay their fare with a smartcard and the expanded support the TTC plans to provide in the TTC Smartcard System.

9.4.1 SMARTCARD SERVICES

The following describes the services the TTC plans to extend to smartcard customers.

Account Registration generally refers to linking a card serial number to an individual customer. The Smartcard Central System contains a customer database into which personal information is entered such as name, mailing address, phone number, email address, answers to security questions and any other data a transit agency is required to collect. The TTC may choose to add a field that indicates customer's desire to receive marketing materials. Once a customer submits this information and the data is entered, a customer account will be registered in the Smartcard Central System. In the TTC Smartcard System, the TTC will offer registration to customers who wish to receive Balance and Negative Protection, and Automatic Reload services.

As mentioned previously, customers have the choice to submit their personal information to the TTC and register their smartcard for a variety of services; however, if they wish to remain anonymous, this choice is available also. Privacy of information is of utmost important to everyone; therefore, the TTC will not only need to develop policies and procedures to protect a customer's information and to guide how it is to be used, but will also need to make it very clear to customers how their information will be protected. The MBTA 'wrote the book" on establishing and communicating their privacy policies and are very willing to share this information with other transit agencies.

Balance Protection provides a registered customer the added security of retaining the E-Purse value and/or time remaining on an E-Pass at the time the TTC is properly notified of a lost, stolen or damaged smartcard. The lost or stolen card will be hotlisted (or blocked from use in the system), the customer will purchase a new card and the remaining value and/or time remaining on a pass will transfer to this replacement card.

Negative Protection provides a registered customer the benefit of one completed trip if there is not enough value in their E-Purse. This allows the customer to complete their trip, then next time the customer reloads the smartcard, the system will debit the value of the negative balance.

Automatic Reloads (aka, Autoload) links a customer's smartcard serial number to a credit or debit card. If a customer elects to authorize Autoload, value will be reloaded to an E-Purse or an E-Pass will be

added automatically. A smartcard can be configured to automatically add value to an E-Purse when the balance falls below a predetermined threshold (aka threshold autoload) or to automatically add an E-Pass when another on the card expires. The smartcard system's Autoload function directs the reload when the customer taps their card at any one of the Smartcard Readers in the field.

9.4.2 CHANNELS FOR SMARTCARD CUSTOMER SUPPORT AND ACCOUNT MANAGEMENT

The TTC plans to expand internally to support the unique customer conveniences a smartcard system delivers. In addition to providing customers with convenient channels for buying and reloading a smartcard (See Section 9.2, *Distribution, Sales and Reload*, for further discussion on smartcard sales and reload channels), the TTC plans to provide customers with a variety of customer support and account management services through any one of the following channels.

Customer Call Centre: The TTC's Customer Call Centre will be expanded to provide both operator - assisted and automated smartcard services and support. Depending on the resources required, the Centre may be located at the TTC Headquarters. Operator-assisted support will be available Monday through Friday 8AM to 6PM. In addition, the TTC will provide automated services 24 hours/7days per week through Interactive Voice Response (IVR). Customers may call on a ` phone or pick up the TTC-specific customer service phone installed at subway unattended entrances. MARTA provides similar Call Centre customer support. Breeze (smartcard) Specialists are on hand to assist callers who require Breeze account services and smartcard support.

Customer Centre: In the TTC Smartcard System, the TTC will open three Customer Centres for the purpose of providing a variety of customer support and account management services. The facilities will be strategically located with the City of Toronto and open during business hours -- Monday through Friday, 7AM to 7PM. The MDP office will be transformed into one of these three TTC Customer Centres. The functions currently performed by the MDP office will be redefined to address the customer service functions required to support a smartcard system. The Centres will be about 1,500 square feet with space for a customer lobby, at least four customer service stations and at least one of the Centres will be allocated enough additional space for a back-office work area. This back-office space will be set up as a work area for processing the TTC Web Service smartcard orders, receiving and processing smartcard-related mail, and researching, resolving and responding to smartcard related complaints and disputes. The San Diego Metropolitan Transit Services has a similar Centre located near a business intersection in downtown San Diego. The size of this centre is approximately 600 square feet, the walk-in volume is high, but the employees do not perform other back-office functions. In Atlanta, MARTA operates RideStores located in or very near to high volume rail stations. Two are approximately 800 square feet featuring a customer lobby, the others are about half the size, but customers stand at windows inside the rail station – no lobby.

Web Services: The TTC will provide Web Services offering a full range of services for TTC customers with a computer and access to the internet. The orders and information submitted by a customer will be automatically uploaded to the Smartcard Central System's customer database. Any transactions requiring new or replacement smartcards will be processed by the Customer Centre.

Mail: The TTC will promote a mailing address and provide the forms necessary for customers who wish to request services by mail. In the TTC Smartcard System, customers may order a new smartcard, authorize autoload, register their smartcard, request account changes, and/or submit complaints or smartcard disputes (such as inaccurate card balance or too much deducted from their card, failed reload).

9.4.3 SMARTCARD CUSTOMER SUPPORT AND ACCOUNT MANAGEMENT ACTIVITIES

The following section describes the customer support and account management services the TTC will extend to customers.

Responding to general smartcard inquiries: The TTC will provide answers to questions regarding the smartcard program at the Customer Centres, through the Call Center, Web Services and mail. Augmenting this support, smartcard materials will be produced to provide customers with information such as where to purchase, how to use, reload, automatic reloads, balance and negative protection, etc.

Fulfilling new card orders*:* In addition to making cards available to buy at vending machines and 3rd Party Ticket Agents, customers may buy smartcards by walking into any one of the TTC Customer Centres, calling the TTC Call Centre, or ordering by way of TTC's Web Services or mail. Most transit agencies that have implemented a smartcard system charge a new card issuance fee.

Registering customer accounts for Balance and Negative Protection*:* In the TTC Smartcard System, the TTC will offer smartcard registration to any smartcard customer. As additional incentives and security for registering, the TTC will provide Balance and Negative protection services. Customers may register by calling the Call Centre, visiting any one of the TTC's Customer Centres, TTC's Web Services, and by mail.

Providing smartcard balance and transaction history*:* In addition to being able to check balance and transaction history at each type of vending machine in the rail stations, customers may also check their balance and transaction history with a Customer Service Representative in any TTC Customer Centre, by calling the TTC's IVR system or visiting Web Services.

Replacing smartcards*:* In the TTC Smartcard System, customers who have registered their Adult or Concession class smartcard, may report their card lost or stolen through the TTC Customer Centre, by calling the TTC Call Centre, or by reporting via Web Services. Their smartcard will be hotlisted and replaced with a new card with any E-Purse value or remaining time on an E-Pass from the old card transferred to the new one. Many transit agencies charge a fee for replacing a card. Many transit agencies require the customer purchase a new card.

Processing changes to a registered account*:* The TTC will provide customers with the ability to make changes to their registered account. Changes may include name, address, and credit/debit card information. The changes may be processed through a TTC Customer Centre, through Web Services, by calling the Call Centre or submitting by mail.

Authorizing Automatic Reloads: In the TTC Smartcard System, any registered customer, who chooses to do so, may authorize Automatic Reloads of their smartcard. They may authorize Autoload by walking into any one of the TTC Customer Centres or submitting by way of the TTC's Web Services or mail.

Reloading E-Purse value and/or E-Passes*:* In addition to reloading smartcards at any vending machine, 3rd Party Ticket Agents, and through automatic reloads, reloading a smartcard will also be available by walking into any TTC Customer Centre, calling the TTC's Call Centre IVR system, or submitting via the TTC's Web Services. If a customer reaches an operator in the TTC's Call Centre and wishes to reload their smartcard, the operator will be capable of processing this request. Customers will be encouraged to reload through other, more automated TTC channels (such as IVR, Web Services or vending machines).

Processing and researching customer complaints and disputes*:* The TTC customers, who have general complaints or specific disputes related to the smartcard system, will be able to submit their issue for research and resolution by walking into any TTC Customer Centre, calling the Call Centre, or submitting via the Web Service or by mail.

Issuing Concession photo IDs and smartcards*:* In the TTC Smartcard System, the TTC will expand the school fare media distribution program to include both elementary and high school students. At this time, the contractor will issue each Child and Student a smartcard pre-encoded with the Child or Student Concession classification (See Section 9.1, *Smartcard/Limited Use Card Management,* for further explanation of pre-encoding Concession classifications and see Section 9.2, *Distribution, Sales and Reload,* for how these cards will be used for reloading, Section 9.3, *Fare Payment and Enforcement*, for

how these card will be used for fare payment). In addition, the TTC will continue to offer photo identification services for customers who wish to obtain one. These services will be made available at the TTC Customer Centre.

Seniors will qualify by demonstrating proof of age by either visiting a TTC Customer Centre or mailing a notarized application. Once qualified, the customer will receive a smartcard encoded with the Senior Concession classification. (See Section 9.1, *Smartcard/Limited Use Card Management,* for further explanation of pre-encoding Concession classifications and see Section 9.2, *Distribution, Sales and Reload,* for how these cards will be used for reloading, Section 9.3, *Fare Payment and Enforcement*, for how these card will be used for fare payment).

Autoload Management: Designated positions within the TTC Customer Centre will be responsible for managing automatic reload services. These services will include reviewing Autoload reports for rejected charges and identifying *due-to-expire* credit/debit cards. Customers will need to be contacted for rejections (same process as MDP but more customers) and to renew expired credit cards. (new process MDP does not deal with credit card payments).

Token and Ticket Conversion: To encourage conversion to smartcards and to discontinue the use of tickets and tokens, TTC will convert customers' tickets and tokens to E-Purse value on a smartcard. Customers may take their tickets or tokens to any TTC Customer Centre to redeem for equal value on a smartcard. The TTC intends to offer an extended period of time for customers to continue to use the current fare media before they are removed from service. Then, at that time, they may convert the value of their tickets and tokens to E-Purse value on a smartcard.

Table 9.4-1, *Customer Service Functions by Customer Service Channel*, presents the customer service functions to be performed through each TTC internal customer service channel.

Table 9.4-1: Customer Service Functions by Customer Service Channel

Customer Action	Call Centre		Customer Centres	Web Services	Mail
	IVR	Operator			
General smartcard inquiries	●	●	●	●	●
Buy a smartcard	Not available	●	●	●	●
Register for Balance and Negative Protection	Not available	●	●	●	●
Card balance and transaction history	●	Not available	●	●	Not available
Replace lost, stolen, damaged card	Not available	●	●	●	Not available
Process changes to account	Not available	●	●	●	●
Activate Autoload	Not available	Not available	●	●	●
Reload E-Purse value and/or E-Pass	●	●	●	●	Not available
Receive/resolve smartcard related complaint	Not available	●	●	●	●
Photo identification services	Not available	Not available	●	Not available	Not available
Ticket/Token Conversion	Not available	Not available	●	Not available	Not available
Automatic Reload Account Management	Not available	Not available	●	Not available	Not available

Bullet = service available or performed

9.4.4 CUSTOMER SERVICE EQUIPMENT – FOR CUSTOMER SERVICE CHANNELS

Each customer service functional area will require special equipment to perform their assigned customer service functions. Table 9.4-2, *Equipment/Systems Required by Customer Service Channels*, provides a list of the equipment or systems required by each Customer Service area. Following this table is a description of each equipment's or system's functionality.

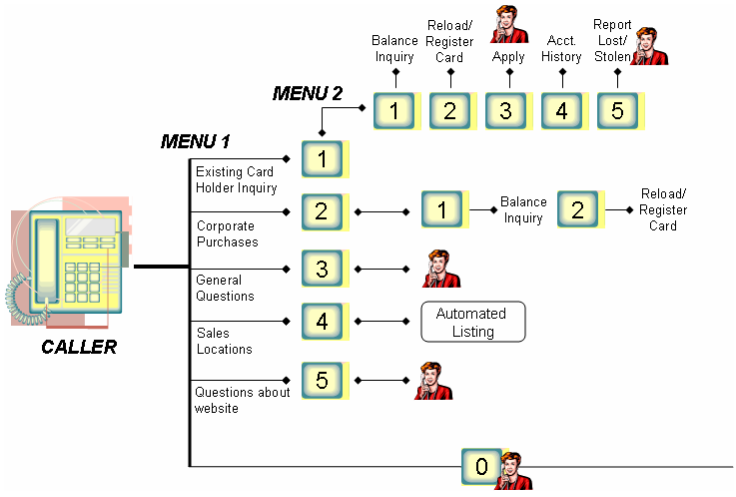
Table 9.4-2: Equipment/Systems Required by Customer Service Channels

EQUIPMENT	CALL CENTRE	CUSTOMER CENTRE (FRONT COUNTER/LOBBY)[35]	CUSTOMER CENTRE (BACK OFFICE)[36]
Interactive Voice Response System	•	Not necessary	Not necessary
Workstation w/SC Central System Customer Database Access and printer	•	Not necessary	•
Web Services	Not necessary	Not necessary	•
Multipurpose Point of Sale Device (workstation with Smartcard Reader and access to Central System)	Not necessary	•	Not necessary

Bullet = this piece of equipment is required for this customer service area

Interactive Voice Response: An IVR system will enable the TTC to automate smartcard customer support services through the Call Centre and provide select services 7 days a week, 24 hours a day. This automated telephone system allows callers to receive answers to common inquiries about the smartcard system, retrieve customized information such as account balance, transaction history and enables a customer to reload or register for autoload and/or replace a card. The IVR system will also direct a caller to an operator for services that cannot be automated. An IVR can be a cost effective tool and provide customer support in an efficient and timely manner. Exhibit 9.4-3, *Starbucks IVR Model*, represents the Starbucks' Card IVR services and flow. This is a relevant model for the services the TTC could offer through this system.

Exhibit 9.4-3: Starbucks IVR Model



[35] For processing walk-in customer service requests such as new card, reload, replacement, autoload registration, account change.
[36] For processing web card orders/replacements and mail in autoload registration, account change, and to research complaints and disputes.

Workstation with Customer Database Access: This is a typical desktop computer configured with access to the Smartcard Central System. Call Centre and Customer Centre employees, with security authorization and the right authentication, will access the customer service module by using the configured workstation. They will use the Customer Service functions and graphical user interfaces to perform customer support and account management services listed in Table 9.4-1, *Customer Service Functions by Customer Service Channels*. A typical menu of Customer Service functions that can be performed directly through this module of the Central System include:

- New card order processing
- Account registration
- Autoload activation/deactivation
- Account information (including balance and transaction history)
- Card reloads/value adjustments

The printer allows the employee to print labels, receipts, or other correspondence.

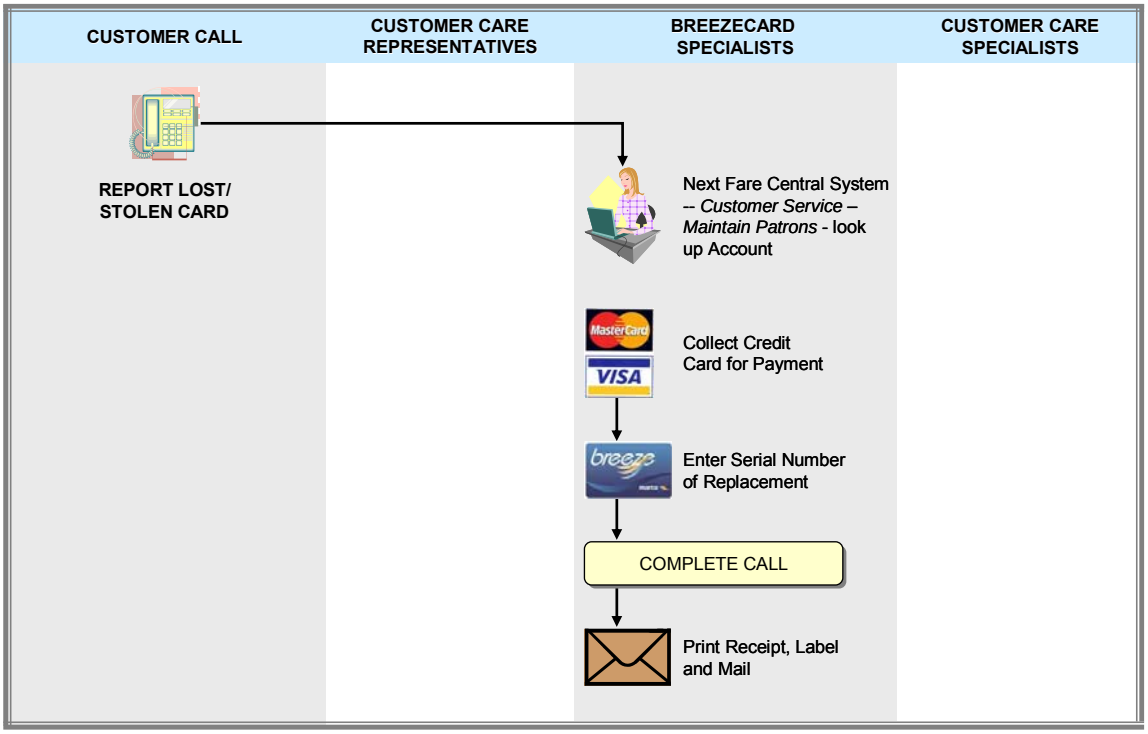
The TTC will likely designate a group of operators as "Smartcard Specialists" to provide smartcard support and account services. At MARTA, the plan was to enable all operators to provide these services, but labour contracts disallowed it. MARTA now has a separate group with smartcard specific skill sets. When customers call with general inquiries, all operators are able to answer the questions; however, if customers require very specific smartcard services such as order a new card, register, replace or reload a card, make account changes, etc. they are transferred to the "Specialists".

Exhibit 9.4-4 *Replacement Card Flow via Call Centre*, provides an example of a transaction processed through MARTA's Call Centre using a workstation with access to the Central System[37]. This is only intended to be representative of the process flow of one transaction and to demonstrate the division of skills within MARTA's Call Centre.

INTENTIONALLY LEFT BLANK

[37] Unfortunately, due to confidentiality requirements with MARTA, we are unable to include a picture of the graphical user interface by which the operator performs this service; however, it is a very simple process.

Exhibit 9.4-4: Replacement Card Flow via Call Centre



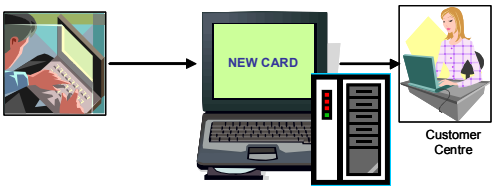
Web Services: The web is a very convenient way for customers to order smartcards, reload, register for automatic reloads, to check balance and transaction history, and to perform other functions. It is also very efficient for the TTC because the services may be offered 24/7 without employees performing most of the requests. All web transactions will be automatically uploaded to the Smartcard Central System for processing and updating the customer database. The only activities requiring employee intervention will be to process and mail a new or replacement card order and to research any complaints/disputes that are transmitted through the website.

Transit agencies will typically purchase the web services module from the equipment provider, but will customize it to their own requirements. They'll either pay the provider for this service or develop in-house. Chicago Transit Authority outsourced the design/development to Fathom Solutions. This company developed the site with its graphical user interfaces. Exhibit 9.4-5, *Web Services Flow*, depicts how a customer could use the TTC's website for performing various functions and requesting services/support and how each transaction flows through the TTC's system.

Exhibit 9.4-5: Web Services Flow

CARD ORDER

A Customer will log into the TTC website to order a new Smartcard - enter name, address, and telephone number and credit card information. When submitted, info will be uploaded to Central System database. A Customer Centre employee will enter serial number of new card and mail.

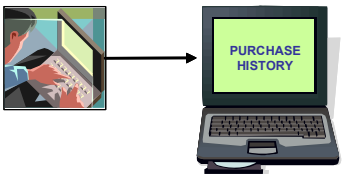


ACCOUNT REGISTRATION

A Customer will log into the TTC website to register their S/Card. Customer will enter their contact info. along with the S/Card serial number then submit. Info is uploaded to the Central System database.

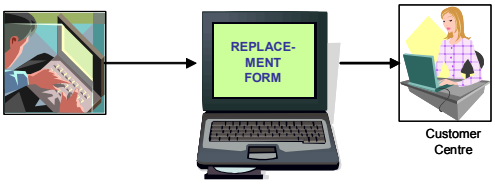
BALANCE/TRANSACTION QUERIES

A Customer will log into the TTC website and enter card serial #. Under Purchase History it will indicate date/time, transaction type, e-purse value and/or e-pass info.



REPLACEMENT

A Customer will log into the TTC website. Only registered S/Cards can be replaced. Customer enters serial number, requests replacement and provides Credit card info. A Customer Centre employee will enter serial number of replacement card and mail. Remaining e-purse value and time on e-pass will transfer to replacement.

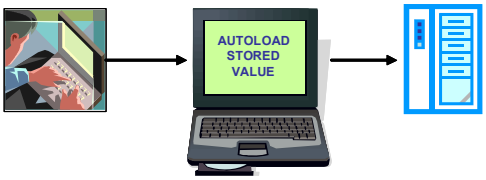


ACCOUNT CHANGES

A Customer will log into the TTC website – enter serial number, select the edit option. updates profile. New info is uploaded to the Central System.

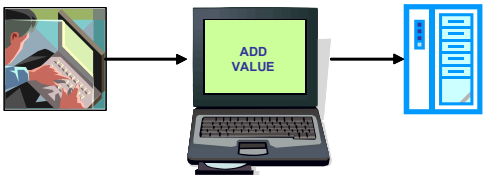
AUTOLOAD

A Customer will log into the TTC website, register card and set thresholds. To discontinue customer will select cancel option. Info is uploaded to Central System.



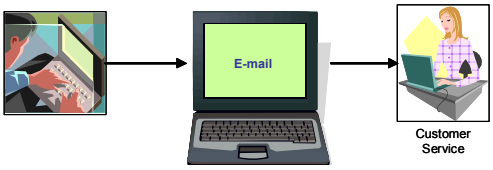
RELOAD

A Customer will log into the TTC website. Select reload S/Card. Then select E-purse value or e-pass. Confirm cr/db information then submit. Info is uploaded to Central System. Next time customer taps card to a smartcard reader, value/pass loaded.

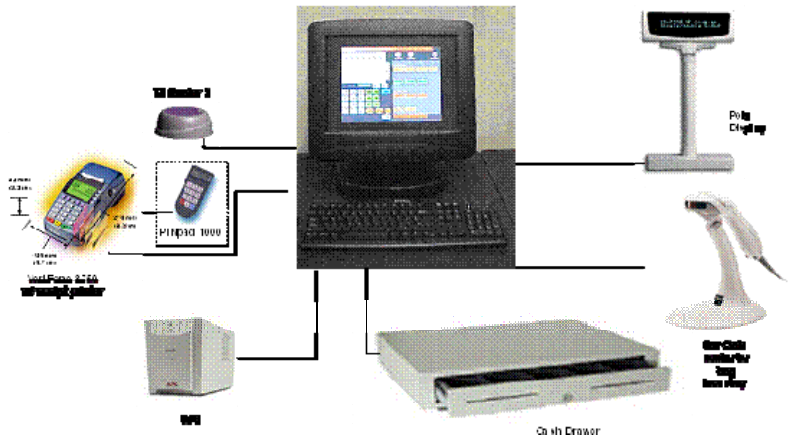


INQUIRY OR COMPLAINT SUBMISSION

A Customer will log into the TTC website. Submit complaint by email. Customer Centre will research, resolve, and respond.



Multipurpose Point of Sales Device: This is a combination of the simple point of sale device that a 3rd Party Ticket Agent will use and a desktop workstation. This device will enable a Customer Centre employee to provide a full range of smartcard services for walk-in customers. The employee will quickly reload a card by selecting the product on the device, collecting payment, and tapping the card to the reader or an employee can access the Central System database and register a customer for Autoload or replace a lost card or update a customer's account. The employee will be able to perform any of the functions listed in Table 9.4-1: *Customer Service Functions by Customer Service Channel.*



Example of Multiple Point of Sale Device

9.4.5 CUSTOMER SERVICE EQUIPMENT – IN-THE-FIELD

Other customer service devices, located in-the field include:

Customer Service Phones: Customer service phones will be installed in every unattended station entrance for the purpose of providing customer assistance and support when necessary. Calls will be directed to the TTC's Call Centre. Attended entrances will be staffed, so the phones will not be necessary.

9.4.6 EQUIPMENT REQUIREMENTS

Table 9.4-6, *Equipment Requirements for Customer Services, Smartcard Account Management*, provides a list of equipment required for performing the functions described in this section. Equipment quantities were determined by estimating the number of staff required for the Call and Customer Centres. These estimates are discussed in Chapter 10, *Cost Impacts,* Section 10.1, *Summary of Demand Estimates*.

Table 9.4-6: Equipment Requirements for Customer Services, Smartcard Account Management

	Quantity
Workstations (Customer and Call Centres)	28
Multipurpose Point of Sale (Customer Centres)	31
Customer Service Phones (in unattended Subway entrances)	43
Non Fare Collection Equipment	
Interactive Voice Response (IVR)	1
Customer Services furniture and office equipment	53
Telephone/ACD Equipment	24

Notes:

- Software applications and data transport systems necessary for Customer Services, Smartcard Account Management are presented in Section 9.8, *System Architecture and Security*
- Six each of Multipurpose Point of Sale were added for Quality Assurance/Develop Lab (IT), Maintenance, and Training

9.4.7 FUNCTIONAL IMPACTS

Comparing the processes for *Customer Services, Smartcard Account Management* to the TTC's current processes for providing Call Centre and MDP services exposed the most likely impacts to current operations. The following summarizes the impacts related to expanding services for smartcard account management:

- **Increased Call Centre call volume for**
  - Operator-assisted
    - Smartcard inquiries
    - New card orders
    - Card registration
    - Replacement cards
    - Account changes
    - Smartcard complaints/disputes
  - Interactive Voice Response System
    - Cost for system
    - Call volume for IVR
      - Smartcard inquiries
      - Smartcard balance and transaction history inquiries
      - Smartcard reloads
  - Cost for T-1 lines
  - Facility and other office costs

- **Additional Customer Centre Services (three locations)**
  - Walk in services
    - Smartcard inquiries

  - New card orders
  - Card registration
  - Balance and transaction history inquiries
  - Replacement cards for lost, stolen, damaged
  - Account changes
  - Autoload authorizations
  - Smartcard reloads
  - Smartcard complaints/disputes
  - Ticket and Token conversion
  - Automatic Reload account management
  - Photo identification
- Back office services
  - Inquiries by web
  - New card orders via web
  - Replacement cards via web
  - Smartcard complaints/disputes via web
  - Smartcard inquiries by mail
  - Autoload authorizations by mail
  - Account changes by mail
  - Smartcard complaints/disputes by mail
- Facilities and other office costs

Functional area cost estimates are featured in Chapter 10, *Cost Impacts*, Section 10.3, *Projected Operating Cost*.

INTENTIONALLY LEFT BLANK

9.5 REVENUE COLLECTION AND RECONCILIATION

This section describes Revenue Collection and Reconciliation activities within a smartcard system. Revenue Collection is defined as the process of removing coins and currency from fare collection equipment. Although much of the existing Subway fare collection equipment (such as Collectors' fareboxes and Token Vending Machines) will be removed thereby no longer requiring collection services, new equipment will be installed and will either require cash collection or require restocking other supplies.

It should be noted that since existing Surface fareboxes will not be replaced, the process for collecting coins and currency from the boxes will not require change; therefore, this process was not assessed in this study. In addition, the process of counting coins and currency drawn from equipment will not change in the smartcard system either.

Revenue Reconciliation activities include matching the revenue -- coin, currency, and credit/debit sales transactions -- removed (or settled) from vending machines, workstations and multipurpose point of sale devices -- to reported counts and sales receipts of these devices. Revenue Reconciliation also includes the process of reviewing the sales of Point of Sale devices of 3rd Party Ticket Agents, invoicing and monitoring receivables.

9.5.1 REVENUE COLLECTION

The TTC's Revenue Collection crews will need *to provide a secure and efficient method for removing coins and currency from fare collection equipment*. Activities will include the replenishment of vending machine change-making hoppers[38] (Full Service Vending Machines), smartcard magazines and receipt tape rolls (Full Service Vending Machines and Add Value Machines), and paper limited use smartcard rolls (Full Service Vending Machines).

System Monitoring

An important tool for supporting Revenue Collection activities will be the System Monitoring program (also described in Sections 9.6, *Operations and Maintenance of Field Devices* and 9.8, *System Architecture and Security*). The Revenue Operations division will be given access to this system for the purpose of monitoring the status of vending machine consumables – whether smartcards, cash/bill boxes, and receipt tape need to be replenished or coin hoppers refilled. The system will also monitor the usage rate of each consumable and calculate the point at which any one of the items will be depleted. This remote monitoring system will enable Revenue Operations to schedule Revenue Collections and prepare supplies accordingly.

Table 9.5-1, *Fare Collection Equipment Comparisons,* compares the equipment requiring revenue servicing between the current system and the TTC Smartcard System.

[38] Assuming change will be given to customers.

Table 9.5-1: Fare Collection Equipment Comparisons

EQUIPMENT REQUIRING SERVICING	CURRENT SYSTEM	SMARTCARD SYSTEM	SMARTCARD PROCESS
Turnstiles	490	0	N/A
Token Vending Machines	107	0	N/A
Pass Vending Machines	10	0	N/A
Full Service Vending Machines	0	197	Remove cash boxes, replace coin hoppers, smartcard magazines, receipt tape (when necessary)
Add Value Machines	0	401	Will not require revenue collection. Do not dispense smartcards , but will require receipt tape (when necessary) – this is currently a TTC maintenance activity.
Station Collector Drop Vaults	133	0	N/A
Transfer Issuing Machines	244	0	N/A
Fareboxes (Surface)	1,848	1,848	Same as now
Wheel-Trans	160	160	Same as now
Fareboxes (Subway)	133	0	N/A
Customer Service Centre (formerly called MDP office)	1	3	Same as now except 2 more locations
Total Devices Requiring Revenue Collection	**3,126**	**2,609**	**17% decrease in equipment requiring revenue collection**

9.5.2 REVENUE RECONCILIATION

The TTC's Revenue Reconciliation staff will need to compare coin and currency counts against the expected revenue as reported by the Central System. The "said to contain counts" of each vending machine at the point cash boxes are removed and the cash receipts at the time each Customer Service Representative (Customer Centre) logs off their Multipurpose Point of Sale device will be transmitted to the Central System (see Section 9.8, *System Architecture and Security* for data transmission details). The Central System's reporting program will issue a reconciliation report for each device for the purpose

of comparing against the coin and currency processed by Revenue Operations and the bank. The Surface Farebox (coin and currency) reconciliation process will be completed as it is today.

In addition to reconciling coin and currency drawn from Subway and Surface equipment, the following reconciliation activities will also need to be performed.

Vending Machines - Credit/Debit

Both types of vending machines – Full Service Vending Machines and Add Value Machines – will accept credit/debit payments. Immediately, upon swipe or entry of a credit/debit, the system will encrypt the account number.[39] The credit/debit transactions will be reported to the Central System and settled with the bank. After the close of each business day, the TTC will receive from the Credit/Debit processor credit/debit settlement reports by device. These reports will be reviewed and compared to the credit/debit transactions reported for each device by the Central System.

The Payment Card Industry (PCI) has defined standards to safeguard credit/debit transactions against system hacking and both external and internal theft. These standards include guidelines for firewall and stored data protection, system security parameters and encrypting transmissions. Fare collection system specifications must include requirements for PCI compliance.

3rd Party Point of Sale Devices – All sales

Each 3rd Party Point of Sale device will transmit smartcard sales and reloads to the Central System. The TTC will run reports of the sales/reloads by 3rd Party Ticket Agent and either generate an invoice or initiate an electronic funds transfer for payment. These will need to be reconciled against what is owed and recorded in Accounts Receivable.

Automatic Reloads – Credit/Debit

After the close of each business day, credit/debit transactions for automatic reloads will be settled and reported by the Credit/Debit processor. These will be compared against the automatic reloads reported by the Central System for that day. Any rejected reloads will need to be investigated and resolved.

Call Centre – Credit/Debit

The TTC customers may load their card by calling the TTC's Interactive Voice Response (IVR) System. This IVR system will be linked to the customer database residing on the Central System. When a customer enters the serial number of their smartcard, the IVR system will search and located the card number in the database. The customer will enter the amount of E-Purse value or select an E-Pass. The IVR system will prompt for credit/debit card payment. Once information is properly entered and submitted, the transaction will be processed through the Central System and on to the bank for settlement.

In addition to the IVR credit/debit sales, customers may choose to reach customer service operators through TTC's Call Centre. These operators will process new orders as well as replacement cards. The payment for E-Purse value or E-Passes will be by credit/debit only. Like with IVR, once the information is properly entered and submitted, each transaction will be processed through the Central System and on to the bank for settlement.

The TTC will review and reconcile the daily credit/debit bank settlement reports against the transactions reported by the Central System.

[39] Encryption is the process of converting sensitive information (such as an account number of a credit or debit card) into an unintelligible form except by the authorized holders of a specific cryptographic key. Encryption protects the sensitive information against unauthorized disclosure.

Website – Credit/Debit

Customers may order, reload, and replace smartcards via the TTC Web Service by using a credit/debit card for payment. When a customer properly enters and submits their order, the information will be automatically uploaded to the Central System and processed. An employee at the Customer Centre will fulfill the new or replacement card order.

The TTC will review and reconcile the daily credit/debit settlement reports against transactions reported by the Central System.

Customer Centre – Credit/Debit and Cash

Customers may walk in to a Customer Centre to purchase zero value smartcards or smartcards loaded with E-Purse value and/or E-Passes. They may also reload or replace smartcards. Customers will have the option of paying cash or credit/debit for any transaction at a Customer Centre. The device Customer Centre employees will use is the Multipurpose Point of Sale device (described in 9.4, *Customer Services, Smartcard Account Management*) to process walk-in orders. This device will operate online and communicate directly to the Central System. Once information is properly entered, the transactions will be processed through the Central System. All smartcards sold and loaded at the Multipurpose Point of Sale device will be ready to use in either subway or surface systems. The subway devices will receive the directed load instructions real-time; however, surface vehicles may not receive this information until data is transmitted at the end of the shift (see Surface section above).

The TTC will review and reconcile the daily cash count and the credit/debit settlement reports against the cash and credit/debit transactions reported by the Central System.

Table 9.5-2, *Reconciliation Activities*, compares the reconciliation activities between the current system and the smartcard system.

Table 9.5-2: Reconciliation Activities

RECONCILIATION ACTIVITY	CURRENT SYSTEM	SMARTCARD SYSTEM	NEW ACTIVITY
Turnstiles	490	0	Collect entry numbers from Central System reports (automated)
Token Vending Machines	107	0	N/A
Pass Vending Machine	10	0	N/A
Full Service Vending Machines	0	197	Compare coin/currency counts and cr/db settlement against Central System reports. Reports will be automated.
Add Value Machines	0	401	Compare cr/db settlement reports against Central System. Reports will be automated.

RECONCILIATION ACTIVITY	CURRENT SYSTEM	SMARTCARD SYSTEM	NEW ACTIVITY
Station Collector Drop Vaults	133	0	N/A
Fareboxes (Surface)	1,848	1,848	Cash reconciliation = Same as now
Wheel-Trans	160	160	Cash reconciliation = Same as now
Fareboxes (Subway)	133	0	N/A
3rd Party Point of Sale Devices	N/A	1000	Check sales of each POS, invoice/initiate transfer. Monitor settlement.
Automatic Reload	N/A	Est 360,000 customers will authorize automatic reloads	Compare cr/db settlement reports against Central System autoload reports. Resolve rejections.
Call Centre – Credit/Debit (both Operator Assisted and IVR)	N/A	Both Operator Assisted and IVR	Compare cr/db settlement reports against Central System reports. Reports will be automated.
Website	N/A	Yes	Compare cr/db settlement reports against Central System reports. Reports will be automated.
Customer Centre (aka MDP Office)	1	3	Compare coin/currency counts/cr/db settlement reports against Central System. Reports will be automated.

9.5.3 EQUIPMENT REQUIREMENTS

Table 9.5-3, *Equipment Requirements for Revenue Collection and Reconciliation*, provides a list of equipment required for performing the functions described in this section. Monitoring equipment quantities were determined by estimating how many employees will be monitoring field devices and quantities for back up hoppers, bill and coin boxes were a function of the number of Full Service Vending Machines and the experience of peer agencies.

Table 9.5-3: Equipment Requirements for Revenue Collection and Reconciliation

	Quantity
Monitoring Equipment	
Workstations (Revenue Collections)	2
Vending Machine Collections	
Coin Hoppers (Back up)	788
Bill Boxes (Back up)	197
Coin Boxes (Back up)	197

Notes:

- Back ups to coin hoppers, bill and coin boxes that come with each vending machines
  - Coin hoppers: 4 per FSVM (nickel, dime, quarter, dollar coin)
  - Bill boxes: 1 per FSVM
  - Coin boxes: 1 per FSVM
- Monitoring software application is presented in Section 9.8, *System Architecture and Security*

9.5.4 FUNCTIONAL IMPACTS

Comparing the processes for revenue collection and reconciliation to the TTC's current processes for exposed the most likely impacts to current operations. The following summarizes the impacts related to the changes in business processes:

- Decreased labour as a result of the reduction in the numbers of Subway equipment (Token Vending Machines, Turnstiles and Collector Booth fareboxes) requiring cash, currency and token collections.
- Increased labour for restocking smartcards and paper limited use smartcard rolls in Full Service Vending Machines.
- Increased labor for collecting revenues from two additional Customer Centres.
- Decrease in the cost of Armoured Car Services.
- Increased labour to review credit/debit settlement reports.
- Decreased labour for reconciling Station Collectors sales and inventories of fare media.
- Increased labour for managing Automatic reloads (included in Customer Services, Smartcard Account Management).
- Increased labour for reconciling two additional Customer Centres.
- Increased labour for Armed Guards for Station Revenue Attendants.

Functional area cost estimates are featured in Chapter 10, *Cost Impacts*, Section 10.3, *Projected Operating Cost*.

9.6 OPERATIONS AND MAINTENANCE OF FIELD DEVICES

The typical life of fare collection field equipment ranges from 15 to 20 years. A smartcard system has fewer moving parts than most magnetic systems, so reliability is typically much greater and failure rates much lower. In addition, to the extent customers switch from paying a fare by cash to paying a fare with a smartcard and reloading or (automatically reloading) their card by credit or debit, life of expectancy hardware could become even longer.

The TTC's Smartcard System will have several in-the-field devices such as Surface and Subway Smartcard Readers, Full Service Vending Machines, Add Value Machines, and Driver Control Units that will require daily upkeep and regular maintenance. The following sections describe general operating characteristics of Subway vending machines, Surface Vehicle Smartcard Readers and Driver Control Units. It also describes the various levels of maintenance programs for field equipment, remote monitoring systems, types of warrantees and allowances for spares.

9.6.1 OPERATIONS – VENDING MACHINES

Vending machines are the self-serve point of sale devices in Subway/RT stations for the sales and reload of smartcards and the sales of paper limited use smartcards. The machines will be installed in every station and available to customers during all hours stations are open.

Exhibit 9.6-1, *Breeze Vending Machine*, represents the standard features and characteristics of a full service vending machine.

INTENTIONALLY LEFT BLANK

Exhibit 9.6-1: Breeze Vending Machine (Example of Full Service Vending Machine)

Breeze Vending Machine Tour [40]

1. Display Screen
Follow the instructions on this screen and press the button next to your choice.

2. Coin Slot
Insert coins or tokens in the coin slot to pay your fare.

3. Bill Acceptor
Insert bills in the bill acceptor to pay your fare.

4. Credit/Debit Card Reader
Insert your credit card in this slot. For debit cards, enter your PIN using the keypad. (This feature may not be available until later this fall.)

5. Breeze Target
When refilling your Half-Fare or Paratransit Breeze Card, touch it to the target to add your selected value.

6. Take your Breeze Card, change, and/or receipt from the bin at the bottom of the machine.

7. Audio Plug
For the hearing impaired, an audio plug is available for headphones. Volume can be adjusted using the dial.

Vending machine options to consider and decisions to make include:

Touch Sensitive Screen or Selection Buttons. The TTC will have the option of touch sensitive screens or selection buttons. The decision is generally driven by agency preference and assumptions about what customers are generally used to and prefer. This decision can be made during design phases.

People with Disabilities. All field equipment will be designed to meet all standards defined for people with disabilities. During detailed design, TTC will have the benefit of working with their Advisory Committee on Accessible Transit (ACAT) to ensure as many accessibility features as possible are included in device design. Based on European (British) standards for people with disabilities (see footnote below), the maximum height of any interactive element will be 1200mm and the minimum 750mm**.** The places from which the smartcard, paper limited use smartcard and change are dispensed will be large enough for people with manual dexterity impairment to be able to retrieve them without difficulty. Instructions will be set to a minimum 16 point type size**,** with a mix of upper and lower case letters and unambiguous illustrations. Printing and illustrations will be colour contrasted to their background and consideration will be given to providing a Braille version of any instructions. Push buttons will be 20mm in diameter and slightly protruding. There will be a good level of lighting around the machine; 200 lux is recommended for the interactive parts and there will be sufficient clear space in front of the machine to allow wheelchair users to maneuver **(**1850mm x 2100mm**)**. [41]

9.6.2 OPERATIONS – SURFACE SMARTCARD READERS/DRIVER CONTROL UNITS

Exhibit 9.6-2, *Surface Smartcard Reader and Driver Control Unit*, represents a Driver Control Unit (DCU) and Smartcard Reader installed on a Surface Vehicle. As is shown in the figure below the additional

[40] Source: Metropolitan Atlanta Rapid Transit Authority
[41] http://www.dft.gov.uk/stellent/groups/dft_mobility/documents/page/dft_mobility_503282-09.hcsp

equipment in the driver's area creates a challenge when it comes to adding another piece of equipment and/or devices to an already congested Operator work station/work area at the front of vehicle.

The Driver Control Unit (DCU) typically supports several functions. The primary function is to provide an interface between the vehicle operator and the Smartcard Reader. The driver will enter the appropriate information into the device to identify the route, run, and any other trip information required at the beginning of the shift. The DCU also houses the electronic components that manage the Smartcard Reader, stores the onboard transactions and communicates with the wireless access point. The DCU also has a display for visual feedback to the vehicle operator of smartcard E-Purse value, E-Pass, fare payment and, if needed, most recent transaction history.

The Smartcard Reader is essentially the communications interface between the smartcard and the DCU and has a display to inform the customer of the activity between the card and the reader. The DCU display will show the activity on the Smartcard Reader being used. As an example, if a patron uses a second reader in the vehicle, this reader will be identified on the DCU display.

Exhibit 9.6-2: Surface Smartcard Reader and Driver Control Unit

Exhibit 9.6-3, *Smartcard Reader on Surface Vehicle*, is another representation of the Smartcard Reader placement -- to the right of a farebox.

Exhibit 9.6-3: Smartcard Reader on Surface Vehicle

Exhibit 9.6-4, *Surface Configuration*, shows a current TTC Surface Vehicle configuration. As mentioned, space in the Operators' work station/work area is tight and will present challenges for placement of Smartcard Reader and DCU.

Exhibit 9.6-4: Surface Configuration

The TTC engineers will need to plan placement of the DCU and Smartcard Readers with consideration to what makes the most sense, ergonomically, for both Operator and Customer.

9.6.3 MAINTENANCE PROGRAMS

For in the field maintenance of devices, the descriptions following represent hardware maintenance only. Maintenance of a smartcard system is multifaceted. Maintenance involves both repair and preventative maintenance activities of all components of the system. Each type of fare collection equipment will require a maintenance program that is relevant to design, volume of use and function.

There are two classifications of maintenance for field equipment – routine and unscheduled. The following describes three levels of routine maintenance:

Routine

- ***Level 1 – Daily Upkeep***: On a surface vehicle the Smartcard Reader device will run a short diagnostic each day when the device is activated to insure all systems are operable before the vehicle leave the division. The Central System continuously polls field devices throughout the day to ensure they are working correctly. If a field device does not respond to the Central System, maintenance will be dispatched to check the device.
- ***Level 2 – Cycled Maintenance***: Planned maintenance programs based on the cycles, days or hours the equipment is in operation. A maintenance schedule is designed for electro-mechanical sub-assemblies such as coin validators or smartcard issuing devices. Scheduled maintenance performed diligently will maintain high reliability and reduce the number of unplanned service calls. Typically, this maintenance is cleaning, lubricating and testing the device on a routinely scheduled basis.
- ***Level 3 – Mid Life Overhauls***: Mechanical assemblies must be "Overhauled or Rebuilt" based on the manufacturers' recommendation. The cycle for overhaul is based on the number of cycles and can be years between events. Many manufacturers use the phrase *Mid-Life Overhauls*. Overhauls will extend the life of a unit at a much lower cost than purchasing a new unit.

Unscheduled

- ***Failure and In-the-Field Resolution*:** Unscheduled maintenance occurs when a device unexpectedly fails to operate. If the planned maintenance is performed as scheduled, the unexpected failure rate of devices is reduced; however, failures will occur. Most of these failures may be resolved on-the-spot such as a jammed bill transport. Once the transport is cleared of the jam, the matter is resolved.

- ***Failure and Removal:*** The second level of unscheduled maintenance is the removal and repair of faulty modules. Most equipment is designed such that modules can be easily and quickly removed and replaced. Today electronic sub-assemblies are multi-layer surface mount circuit boards that require specialized equipment to repair. Agencies find it advantageous to return these units to the manufacturer for repair. Costs vary between vendors but typically the pricing provides for "repair or replacement" of the component at a cost less than that of a new unit. Some mechanical devices are repaired by agency staff when wear items such as drive belts, pulleys and bearings become worn and require replacement. In some instances the items are returned to the manufacturer for repair.

9.6.4 REMOTE MONITORING

Field Equipment

To reduce the amount of time a device is unavailable to the customer, each piece of equipment can be monitored remotely. Residing in the Central System is a monitoring system such as HP Openview or Tivoli. This system provides continuous monitoring, reporting, troubleshooting, and automated response capabilities. This software is generally configured to send an alarm to a pager or e-mail address with the device name, location and error message. Maintenance staff in-the-field can respond immediately to the alarm. Alarms can also be segmented based on operational responsibility. As an example, the FSVM may run low on change and send an alarm to Revenue servicing staff that the machine change needs to be topped off. Currently, the Baltimore MTA is configuring their system monitoring software (in their case HP Openview) to route system alarms to the appropriate department via e-mail. E-mail can be sent any one of the devices listed above, cell phone, pager or desk top. This configuration is being developed in Baltimore at this time and appears to be a valid method for monitoring, managing and directing Maintenance and Revenue resources. This system also has the ability to be monitored anywhere in the organization that a workstation resides with network access. The TTC maintenance staff will be given the ability to login to the monitoring system from their desk top computer as well as the appropriate staff in the Operations Control Centre.

Data Transport System

The Smartcard Data Transport network will require constant monitoring to insure devices on the network are communicating with the Central System. The network is typically monitored and maintained by a Network Administrator. Organizations that manage large data networks typically operate a Network Operations Control Center (NOC) staffed and chartered to monitor and manage the health of the agency's network. The NOC uses tools such as HP Openview or Tivoli to monitor the network. Network devices such as switches, routers, firewalls, etc are intelligent addressable devices that can be configured remotely to minimize the need to travel to device locations and can be easily reconfigured to route data when a data port fails without having to dispatch a maintenance person. This service can also be contracted out to organizations that specialize in managing networks and server farms. The TTC will decide during detailed design what the most appropriate approach would be.

The balance of this chapter will outline the requirements for maintenance support by mode or function if different than the general description above.

9.6.5 MAINTENANCE SUPPORT BY MODE/FUNCTION

Subway/RT

Equipment in the Subway/RT system will require multiple levels of monitoring and maintenance. Since the Subway/RT equipment is connected real time, or within minutes of the event occurring, typically, the time the event occurs to the time the event is reported is a function of the number of events or messages being sent to the Central System at the same time. *Real Time* can be defined by how quickly a message is received once it is initiated. Network traffic can have a real impact to the time a message takes.

Agencies find they must adjust their network for optimum performance after deployment to achieve acceptable levels of reporting. The equipment located in unattended entrances can be "opened or closed" using this same monitoring system. The TTC staff can put equipment in or out of service remotely by simply sending a command from the monitoring location to the devices at a station.

Currently, the TTC monitors the operation of the subway from their Transit Control Center, equipment or facility issues are passed to another group that dispatches the appropriate maintenance group. This same protocol may be used to monitor and dispatch staff for problems that occur with field devices.

All equipment will require routine servicing/maintenance to insure equipment operates at optimal performance. The routine maintenance is specified by the original equipment manufacturer. For devices such as the Smartcard Reader it may be necessary to test the reader once a month or on an as needed basis to insure the device reads/recognizes a smartcard. Typically, vendors will recommend testing (and aligning if necessary) these devices every month.

Electro mechanical devices such as the card dispenser in the Full Service Vending Machine will require maintenance more often – the typical reliability is specified at 10,000 transactions. Additionally, mechanical devices may require an overhaul every six to twelve months where belts, pulleys and bearings are inspected and replaced. Equipment life cycle on many of these devices can be as long as 15 years. In these cases the equipment should receive a Mid-Life overhaul at approximately 7 years. The TTC will probably need to perform routine maintenance on all field devices monthly to maintain optimum performance.

Surface (including DCU)

The Smartcard Readers on Surface vehicles operate in an off line mode and cannot be monitored real time by the Data Transport network. However, these devices are monitored real time by the vehicle Operator. Operators will report the status of the onboard equipment to their dispatcher.

In the TTC Smartcard System the equipment on Surface vehicles will consist of an onboard Smartcard Reader and Driver Control Unit (DCU). These types of devices require daily pre-trip testing. Smartcard Readers may average 60,000 transactions between failures while DCUs may average 1,500 service hours between failures.

Parking

The maintenance of the parking equipment will be limited to the repair of the Smartcard Reader installed in the parking machines. These devices are all electronic or solid state. The maintenance requirement will be to remove and replace a failed device. Like the Subway/RT equipment, parking can be monitored "Real Time" through the Data Network.

3rd Party Ticket Agents, Customer Centre, Customer Call Centre

Customer Service equipment in the TTC Smartcard System, consists of Point of Sale devices and office computer equipment (workstations). The field maintenance of this equipment is the removal and replacement of failed hardware. Typically, office computers are reliable and require little maintenance; however, these devices do fail and their rate of failure can be approximated at 10,000 hours or 5 labor years (2,000 hours per year) between failures. Point of Sale devices may average 20,000 transactions between failures.

9.6.6 WARRANTEES

Typically, manufacturers will guarantee their equipment, components, and systems for one year after installation acceptance, but, for additional cost, the warrantees may be extended to 5 years or, for some equipment, the reasonable life. The decision to extend warrantees beyond the standard one-year will hinge on how complex the equipment, component, or system is.

As equipment is installed, warrantees will typically commence upon acceptance of the Installation Acceptance Test (IAT) for the device and acceptance of the Revenue Service Test (RST). Optionally, the TTC may want the warranty to begin after an In Service Test proves the equipment meets the contract specifications for reliability. In the case of rolling installation of equipment over a 4-year period, the TTC may opt to perform incremental revenue service testing on groups of devices as they are installed. Warranty will then commence on the date that RST for that group of devices has been approved.

For the purpose of the TTC Business Case, a standard one year warranty will be assumed for all equipment and assume all future software upgrades will be included in software licensing agreements (See Section 9.8, *System Architecture and Security Section,* for software).

9.6.7 SPARES' ALLOWANCE

Over the years, the allowance for spare parts was 10 percent of equipment budget; however, experience in Baltimore, PATH (NY) and Boston have proven that there is a need to increase this to at least 15 percent. Components have become more complex and sophisticated and, as a result, more costly to replace. Therefore, for the purpose of this business case, spares will be estimated at 15 percent of the equipment contract.

9.6.8 EQUIPMENT REQUIREMENTS

Table 9.6-5, *Equipment Requirements for Operations and Maintenance of Field Devices*, provides a list of equipment and/or systems required for performing the functions described in this section. Equipment quantities were determined by estimating the TTC's smartcard requirements, researching equipment productivity metrics and interviewing peer agencies

Table 9.6-5: Equipment Requirements for Operations and Maintenance of Field Devices

	Quantity
Monitoring Equipment	
Workstations (Maintenance)	5

Notes:

- System Monitoring application is presented in Section 9.8, *System Architecture and Security*
- Descriptions of software applications and data transport systems necessary for Operations and Maintenance are presented in Section 9.8, *System Architecture and Security*

9.6.9 FUNCTIONAL IMPACTS

Comparing the processes for operations and maintenance to the TTC's current processes exposed the most likely impacts to current operations. The following summarizes the impacts related to the changes in business processes:

- Increased labour as a result of increased number of field devices requiring daily upkeep, cycled maintenance, and midlife overhauls.
- Increased labour for level 3 maintenance.
- Increased labour for responding to and resolving unscheduled equipment failures.

Functional area cost estimates are featured in Chapter 10, *Cost Impacts*, Section 10.3, *Projected Operating Cost*.

9.7 DATA SYSTEMS AND REPORTING

In the TTC's Smartcard System, various functional areas such as Finance, Marketing, Revenue Operations, and other TTC divisions will be able to run financial/revenue and ridership, fraud analysis and other reports on a regular basis as well as submit requests for special ad hoc query reports as needed.

The Central System will receive, process and manage sales, revenue, transactional data from the field devices and deliver to the databases of the Reporting, Financial, and Fraud Analysis Systems contained in the Central System (see Section 9.8, *System Architecture and Security)*. These systems provide the TTC managers with access to the reports required by the TTC. Common reports include:

- Finance/Accounting reports
- Revenue
- Ridership
- Fraud analysis

…but there are many other types of reports the smartcard reporting system can provide. All reports will be defined in the design phases of the project.

In the TTC Smartcard System, the financial system contained in the Smartcard Central System will gather and process the transactions necessary to report liability and sales and will record the transactions and integrate as much as practically possible with the TTC's legacy financial system such as General Ledger.

The following sections describe what and how data is collected and reported from the field devices.

9.7.1 DATA COLLECTED AND REPORTED

In the TTC Smartcard System, the types of data collected and reported are listed below. Typically, while this data is transmitted throughout the business day, the data is not actually processed into reports until the close of the business day. This is a configurable time of day set by the TTC. Once the day is "closed" the data will be processed for the various reports required. The reports may be automatically made available by electronic means at a specified time of day.

- Cash transactions by type such as smartcard purchase, E-Purse Value, E-Pass purchase at
  - Multipurpose Point of Sale (Customer Centre)
  - Full Service Vending Machine (including paper limited use smartcards)
- Cash disbursed (change given) at
  - Multipurpose Point of Sale (Customer Centre)
  - Full Service Vending Machine
- Credit/Debit transactions by type at
  - Multipurpose Point of Sale (Customer Centre)
  - Full Service Vending Machine
  - Add Value Machine
  - Workstation (Customer Centre and Call Centre)
  - Web Service
  - Central System - Autoloads
- E-Purse value sales at
  - Point of Sale (3rd Party Ticket Agents)
  - Multipurpose Point of Sale (Customer Centre)
  - Full Service Vending Machine (including paper limited use smartcard single/round trip)
  - Add Value Machine

  - Workstation (Customer Centre)
  - IVR
  - Web Service
- E-Pass sales at
  - Point of Sale (3rd Party Ticket Agents)
  - Multipurpose Point of Sale (Customer Centre)
  - Full Service Vending Machine (including paper limited use smartcard Day Pass)
  - Add Value Machine
  - Workstation (Customer Centre)
  - IVR
  - Web Service
- E-Purse value usage/amount deducted at
  - Turnstile
  - Surface Smartcard Reader
  - Parking
  - Handheld device
- E-Pass usage at
  - Turnstile
  - Surface Smartcard Reader
  - Parking
  - Handheld device for special events
- Zero value smartcard sales at/to
  - Point of Sale (3rd Party Ticket Agents)
  - Multipurpose Point of Sale (Customer Centre)
  - Full Service Vending Machine
  - Workstation (Customer Centre and Call Centre)
  - Web Service
  - To bulk purchasers, including School Contractor
  - To MDP
- E-Purse value reload transactions at
  - Point of Sale (3rd Party Ticket Agents)
  - Multipurpose Point of Sale (Customer Centre)
  - Full Service Vending Machine
  - Add Value Machine
  - Workstations (Customer Centre)
  - IVR
  - Web Service
- E-Pass value reload transactions at
  - Point of Sale (3rd Party Ticket Agents)
  - Multipurpose Point of Sale (Customer Centre)
  - Full Service Vending Machine
  - Add Value Machine
  - Workstation (Customer Centre)
  - IVR

  - Web Service
- E-Purse value automatic reload transactions at
  - Full Service Vending Machine (if tapped prior to turnstile, Surface Smartcard Reader, or parking device)
  - Add Value Machine (if tapped prior to turnstile, Surface Smartcard Reader, or parking Smartcard Reader)
  - Turnstile
  - Surface Smartcard Reader
  - Parking
- E-Pass automatic reload transactions at
  - Full Service Vending Machine (if tapped prior to turnstile/Surface Smartcard Reader/parking)
  - Add Value Machine (if tapped prior to turnstile, Surface Smartcard Reader, or parking Smartcard Reader)
  - Turnstile
  - Surface Smartcard Reader
  - Parking
- E-Purse Value directed[42] load transactions at
  - Full Service Vending Machine (if tapped prior to turnstile/Surface Smartcard Reader/parking)
  - Add Value Machine (if tapped prior to turnstile, Surface Smartcard Reader, or parking Smartcard Reader)
  - Turnstile
  - Surface Smartcard Reader
  - Parking
- E-Pass directed load transactions at
  - Full Service Vending Machine (if tapped prior to turnstile/Surface Smartcard Reader/parking)
  - Add Value Machine (if tapped prior to turnstile, Surface Smartcard Reader, or parking Smartcard Reader)
  - Turnstile
  - Surface Smartcard Reader
  - Parking
- Electronic Transfers electronically encoded onto a smartcard or paper limited use smartcard
  - Turnstile
  - Surface Smartcard Reader

All sales, usage, load/reload data will be further broken down by smartcard and paper limited use smartcard and by customer class such as adult, Senior, Student or other classification. E-Purse value reload transactions will also include any negative protection value that is debited back to the TTC at the time of reload.

If the TTC decides to charge issuance fees or fees for services such as Balance and Negative Protection or Autoload, the system will also collect and report these transactions appropriately. In addition, if the

[42] A directed autoload is a simple direction to the field devices to load E-Purse value or E-Pass to a Smartcard. For example, this direction will be delivered by the Central System and sent down to devices if a customer calls the IVR to reload a card or submits a reload via the web. The next time the customer taps their card at a field device, the system will load their card.

TTC decides to offer 3rd Party Ticket Agents special commissions on sales at the Point of Sales devices, the commissions will be reflected appropriately on the revenue and sales reports.

9.7.2 FINANCIAL REPORTS

The following describe the standard reports that will be available to Finance/Accounting.

Sales, Liability, Revenue Reports

The collection and reporting of fare transactions as outlined in previous sections are core functions of the Central System's Financial Management software. This Financial Management System will provide the TTC's Finance/Accounting division with the user screens and reporting tools necessary to allow it to monitor, reconcile and report fare sales, liability, and revenue from a detail to a summary level as defined by the TTC in the System Design phase of the project.

Credit/Debit Reports

Additionally, the Smartcard Central System will include a Credit/Debit Interface that will operate as the conduit between all field devices that accept this form of payment and the financial institutions that provide the clearing and settlement between the various card holder banks and the TTC. The Credit/Debit interface will provide bank settlement reports that will reflect the device at which the credit/debit transaction occurred, the amount of the transaction, and the associated fees. The credit/debit interface will also provide reports listing chargebacks.

9.7.3 FINANCIAL TRANSACTIONS COLLECTED BY DEVICE

The following describes, in more detail, how the Financial System will collect and record fare payment transactions.

Surface (Bus/Streetcar)

Surface smartcard transactions will occur while the smartcard device is operating in an offline mode (not connected to the TTC data network). The Smartcard Reader on the bus or streetcar will maintain a record of all transactions that occur at the reader and transmit to the Smartcard Central System when the vehicle enters a bus or streetcar platform at a subway station, and when the vehicle returns to the division at the end of its shift[43]. Once the Central System acknowledges receipt of this data the Smartcard Reader will delete the detailed data from its memory so that the data is not double counted.

Data collected and recorded in the Financial Management System for Surface vehicles will include:

- Vehicle number
- Smartcard number
- Transaction type (as outlined in previous section)
- Route #, run #, time of day,

The Financial System in the TTC Smartcard System will collect and report:

- # of E-Purse value transactions/amount deducted
- # of E-Pass transactions
- # electronic transfers used
- # and amount of automatic or directed reloads of e-purse value or e-passes

[43] The process/equipment necessary for transmitting data to and from the Central System to the devices in the field will be described in the Field Equipment Section.

- # of Negative Protection transactions and the amount of fare the TTC gives qualifying customers if they do not have adequate value
- # of rejected transactions

While smartcard transaction and financial reporting will be more automated, the TTC will not be replacing fareboxes, so non-smartcard transactions (i.e. cash deposited in surface fareboxes) will need to be manually entered to complete financial and ridership reports.

Subway/RT

Subway transactions will occur in an online or real time mode. All devices will be connected to a Local Area Network (LAN) at the mezzanine and to the TTC Wide Area Network (WAN) in the Station Communications room. The smartcard device will upload the transactions to the Smartcard Central System as they occur or when the TTC determines.

The Financial System in the TTC Smartcard System will collect and report:

- Transactions that occur at each Full Service Vending Machine (FSVM)
  - Cash (coin/currency) collected
  - Cash dispensed
  - Credit/Debit transactions
  - Smartcards/paper limited use smartcards dispensed
  - Serial number of smartcard dispensed
  - E-Purse value / E-Pass applied to a smartcard
  - Automatic or directed reload transactions (if customer taps the reader at the FSVM before any other device)
  - Negative protection: # and amount of revenue recovered by the TTC at time customers reload their card
- Transactions that occur at Add Value Machine
  - Credit / Debit Transactions
  - E-Purse value / E-Pass applied to a smartcard
  - Automatic or directed reload transactions/amount
  - Negative protection: amount of revenue recovered by the TTC at time customers reloads their card
- Transactions that occur at each Turnstile
  - E-Purse transactions/value deducted at the turnstile
  - E-Pass transactions at the turnstile
  - Electronic transfers used
  - Smartcard/Limited Use transactions
  - Automatic or directed reload transactions/amount
  - Negative protection: # and amount of fare the TTC gives qualifying customers, if they do not have adequate value

In all cases, the Smartcard Financial System will facilitate the authorization and processing of credit/debit transactions by way of the credit/debit interface.

Parking

The Financial System in the TTC Smartcard System will collect and report:

- # E-Purse value transactions/amount deducted
- # E-Pass transactions
- # and amount of automatic or directed reloads of E-Purse value or E-Passes

Third Party Ticket Agents

Third party ticket agents will use a Point of Sale Device to sell zero value smartcards and apply E-Purse value or E-Passes to the cards. All smartcards loaded at a 3rd Party device will be ready to use within either the surface or subway system.

The Financial System will record the quantity and serial numbers within each batch of cards delivered to a Ticket Agent[44]. Finance will receive details of the initial order and collection of smartcard fees through the Central System when the batch of smartcards is delivered to the Ticket Agent[45]. The subsequent sales transaction of each smartcard to a customer will be reported from the POS device to the Financial Management System. The TTC will use the POS data collected by the Financial Management System to record sales by Ticket Agent. The methods of billing and collecting will be contingent on the terms of agreement with each Ticket Agent. Billing may be through an invoice or through automated electronic funds transfers.

The Financial System in the TTC Smartcard System will collect and report:

- # of smartcards delivered to each Ticket Agent
- Smartcards sold
- Serial number of smartcard sold
- E-Purse value / E-Passes applied
- Negative protection: # and amount of revenue recovered by the TTC at time customer reloads their card

The Financial System in the TTC Smartcard System will issue a report that will enable the Finance Division to prepare an invoice or facilitate electronic funds transfer.

In the 3rd Party Ticket Agent situation, payment methods allowed for the purchase and loading of smartcards are at their own discretion. The TTC will not be responsible for processing credit/debit transactions through 3rd Party Ticket Agent points of purchase. These transactions will be facilitated through the Ticket Agent's own cash register and/or credit/debit interface. Regardless of method of payment and how transacted, the Ticket Agent will be liable for all smartcards processed at the Point of Sale device.

Call Centre

The TTC customers may call a TTC operator to order a smartcard or to report a lost or stolen card. They may also load their card through the Interactive Voice Response (IVR) System. The only payment option for both channels will be credit/debit.

Call Centre employees will process orders and replacement cards by using a Workstation with direct access to the customer database residing in the Central system. Once information is properly entered, the transactions will be processed through the Central System and reported by the Financial Management System. The replacement card will be mailed with the balance from the old card transferred to the new (if the customer qualifies for Balance Protection).

[44] Batches by Ticket Agent will be reported to the Central System at the point of initializing smartcards through the Smartcard Initializing/Encoding Machine described in Smartcard/Limited Use Card Management Section.
[45] As Revenue Operations does now when delivering and collecting payment for fare media to Ticket Agents.

The TTC customers may load their card through the Interactive Voice Response (IVR) System. This IVR system will be linked to the customer database residing on the Central System. When a customer enters the serial number of their smartcard, the IVR system will search and located the card number in the database. The customer will enter the amount of E-Purse value or select an E-Pass. The IVR system will prompt for credit/debit card payment. Once information is properly entered, a directed value/pass load will be processed through the Central System and transmit the E-Purse value amount or E-Pass down to the devices. The subway devices will receive the directed load instructions real-time; however, surface vehicles may not receive this information until data is transmitted at the end of the shift or enroute at a bus or streetcar platform at a subway station (see Surface section above). This may be an issue since customers may wish to use their newly loaded cards immediately after calling.

The Financial System in the TTC Smartcard System will collect and report:

- # and type of customer transactions
- # and amount of Credit/debit sale
- # and amount of Negative Protection: revenue recovered by the TTC at time customer reloads their card

Customer Centre

Customers may purchase zero value smartcards or smartcards loaded with E-Purse value and/or E-Passes. They may also reload or replace smartcards. Customers will have the option of paying cash or credit/debit for any transaction at a TTC Customer Centre. The device the TTC Customer Centre employees will use is the Multipurpose Point of Sale device (described in Section 9.4, *Customer Services, Smartcard Account Management*) to process walk-in orders. This device will operate online and communicate directly to the Central System. Once information is properly entered, the transactions will be processed through the Central System. All smartcards sold and loaded at the Multipurpose Point of Sale device will be ready to use in either subway or surface systems.

The Financial System in the TTC Smartcard System will collect and report:

- # and type of customer transaction by payment method
- # of smartcards sold
- Serial number of smartcard sold
- # and amount of E-Purse value / E-Pass applied
- # and amount of automatic or directed reload transactions/amount
- # and amount of Negative Protection: revenue recovered by the TTC at time customer reloads their card

Web Service

Customers will be able to order, reload, and replace smartcards using a credit/debit card for payment. When a customer submits their order, the information will be automatically uploaded to the Smartcard Central System and processed. An employee at the Customer Centre will fulfill the new or replacement card order.

The Financial System in the TTC Smartcard System will collect and report:

- # and type of customer transactions
- # and amount of credit/debit sale
- Card fulfillment status
- # and amount of Negative Protection: # and amount of revenue recovered by the TTC at time customer reloads their card

Mail

Customers may order and receive a smartcard by mail. The only method of payment will be credit. In these cases, the order will be processed by an employee at a Customer Centre. The employee will use a workstation to enter and fill the order (see Section 9.4, *Customer Services, Smartcard Account Management,* for additional details).

The Financial system in the TTC Smartcard System will collect and report:

- # and type of customer transactions
- # and amount of credit/debit sale

Hand Held Device

The Financial System in the TTC Smartcard System will collect and report:

- # of E-Purse value transactions/amount deducted

The system will also provide a Special Constable Remittance Report for end of shift processing.

Note: All of the transactions described and collected and reported through the Financial System can be tracked back to the serial number of a smartcard stored within the Central System's database. How these numbers are initially recorded in the database is described in Section 9.1, *Smartcard and Limited Use Card Management*. A smartcard cannot be used in the system until it is initialized and the serial number recorded to the Central system.

Audits and Reconciliation

In addition to collecting and reporting transactions described above, the Financial System will enable audits and reconciliation of the transactions (as described in Section 9.5, *Revenue Collection and Reconciliation)*. The Financial System, will collect and report the transaction data from the Point of Sale, Multipurpose Point of Sale, Workstations, IVR, Web Services, and Central System (Autoloads). It will provide the necessary sales reports for reconciling cash receipts, deposits and credit/debit settlement reports.

The Financial System in the TTC Smartcard System will provide reports for the following categories:

- Revenue/Sales – Cash, credit/debit
    - By device
    - By location
    - By employee
    - By date, time
    - By serial number
    - By smartcard/paper limited use smartcard
- Reports on smartcard/paper limited use smartcard usage
    - By mode
    - By device
    - By date, time
    - By fare type (i.e. Adult; Senior; Student; Child)
    - By serial number

- By route
- By station

9.7.4 RIDERSHIP REPORTS

The Smartcard Readers on Surface vehicles and Subway Turnstiles will collect and transmit transaction records to the Central System's ridership database. The Reporting System will generate regular ridership reports as required. These reports may be run at the close of each day and emailed to the designated employees.

The Ridership Reports can reflect the following details, if desired.

- Ridership by surface route, time of day, by hour or partial hour
- Turnstile entries, by station, by time of day, by hour or partial hour
- Ridership by fare type, transfer
- Ridership summaries by route, day, week, month, year to date and comparisons to other time periods

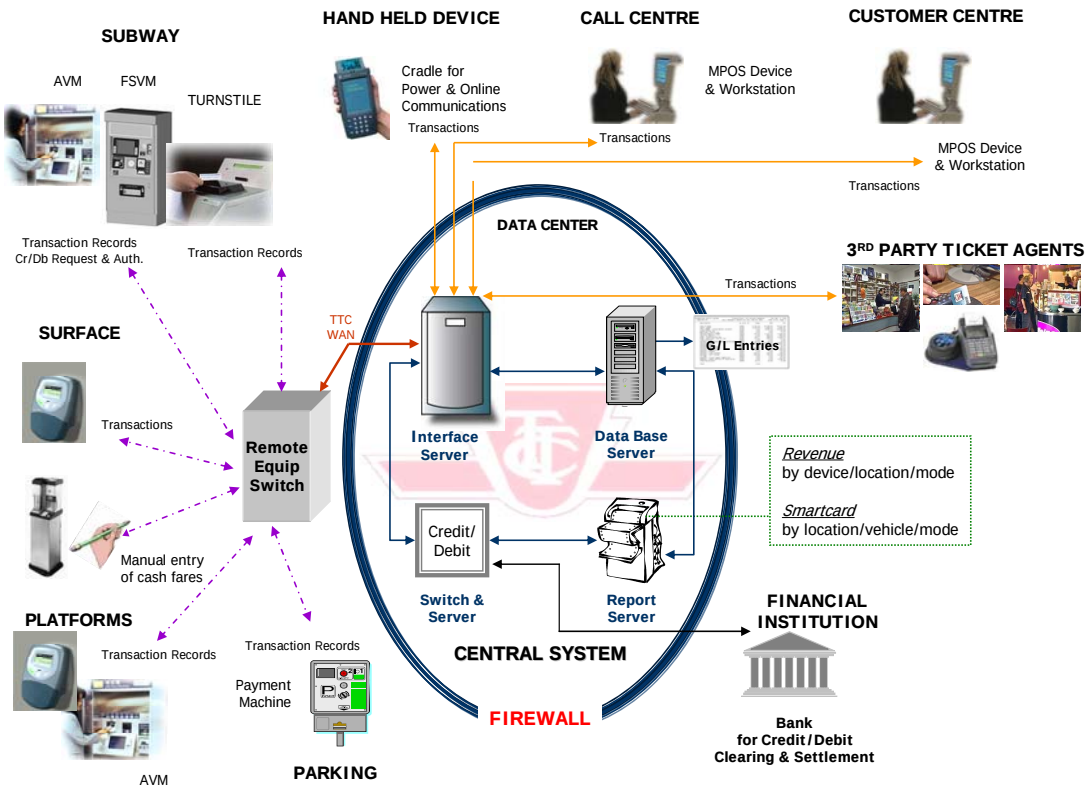
9.7.5 FRAUD REPORTS

Also residing at the Central System will be a Fraud Analysis System. This system will monitor transactions and report anomalies. These may include:

- Device tampering
- Balance irregularities due to late or lost transaction data
- Card distribution issues – monitors the location of batches of cards to be delivered to sales channels. Detects inconsistencies in the location of card distribution
- Concession usage by device to "target" enforcement blitzes

Exhibit 9.7-1, *Data Flow*, shows the flow of transactional data from each device to the Central System where the database, credit/debit switch and reporting server reside.

Exhibit 9.7-1: Data Flow



9.7.6 DEFINING REPORTING REQUIREMENTS

All reporting requirements – details, format, and schedule -- will be defined during the system design phase of the project. In many cases, significant debate on the design of reports takes place during this phase. It is recommended that the TTC identify the highest priority (the must have) reports and focus design effort and time on designing these prior to system implementation. The project is best served if an allowance for custom reports is included in the specifications and then developed after system experience is gained by staff. Another consideration in the design of reports is the report system software. The TTC may use a standard reports system such as Report Net. If there is a corporate standard for reporting systems it should be specified in the TTC Smartcard System specifications.

9.7.7 EQUIPMENT REQUIREMENTS

All software for the Central System – Reporting, Financial System, Fraud Analysis, etc – and Data Transport systems are accounted for in Section 9.8, *System Architecture and Security*. There are no specific equipment requirements related to requesting and running reports by divisions. It is assumed the employees who are currently responsible for reviewing and generating reports have desktop computers. These computers will be configured for access to the Central System reports.

9.7.8 FUNCTIONAL IMPACTS

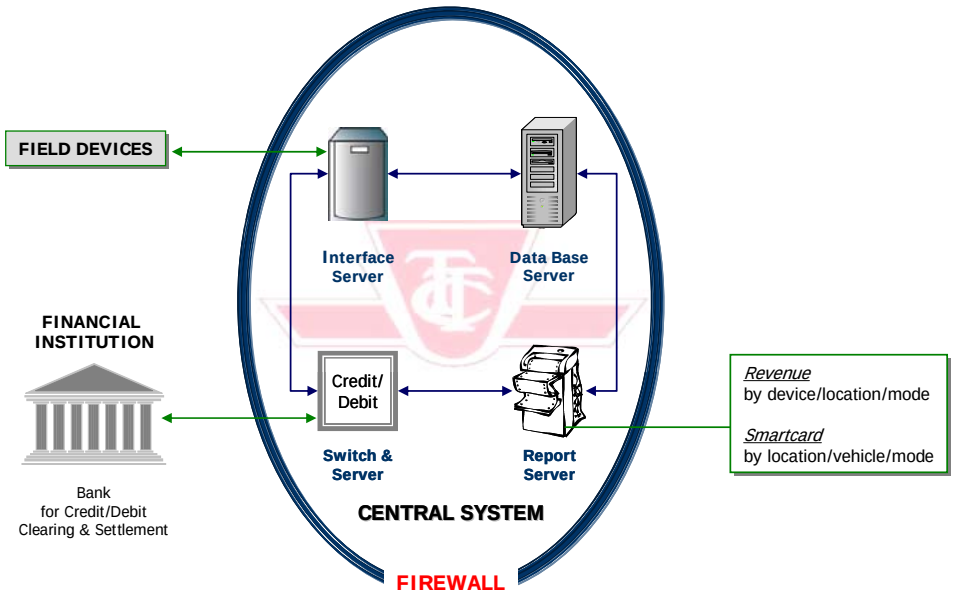
There are no specific functional impacts related to requesting and receiving reports from the system. Functional impacts associated with managing the transmission of data, data administration and the reports server will be reviewed in Section 9.8, *System Architecture and Security*.

9.8 SYSTEM ARCHITECTURE AND SECURITY

System Architecture refers to the design and composition of the structure that controls all system functionality and delivers instructions to and collects data from field and back office devices. System Security refers to the processes for securing this structure and its functions, the integrity of the data as well as protecting the overall system against unauthorized entries and fraudulent activities.

System Architecture presents an overview of the two most critical components – the *Central System* and the *Data Transport System*. The Central System is where the system instructions and data reside, the Data Transport delivers the instructions and data to and from field equipment. Exhibit 9.8-1, *Smartcard System Design*, presents a top level view of the Central System and Data Transport system.

Exhibit 9.8-1: Smartcard System Design



9.8.1 SMARTCARD CENTRAL SYSTEM

The Smartcard Central System is where the software programs controlling the functionality of the fare collection system operate. This is where the instructions and rules are defined and where transactional data are gathered and processed for interpretation and action.

The system architecture will be a modular design using the latest hardware and software versions available in the industry. Although initial design should incorporate enough capacity to support the projected smartcard usage, the modular design will allow the system to be scalable to support growth in data collection, storage and communication. Scalability in this system means the ability to add larger computing or storage capacity should the system require additional processing power and capacity downstream. In 2002, five years after installing a new fare collection system, the Chicago Transit Authority upgraded the network manager and database capacity to better support the services they wanted to offer with the introduction of the Chicago Card and Chicago Card Plus.

Using commonly accepted hardware and software insures the TTC will be able to upgrade functionality as the technology improves without a major impact to ongoing operations.

- Central System programs reside locally at the central computer. Typically the end device functionality is maintained at the Central System and "published" to the end devices when changes or upgrades occur.
- Smartcard Readers entering the industry today contain computing power and local data storage. This enables fast processing at the device and the ability to communicate with the back-end data systems.
- The Central System Database will contain all of the Smartcard System Management information as well as all of the individual card account data used for supporting the Customer Services.
- Included in the data system will be the tools to manage the system configuration and device "inventory".

The basic applications of a Smartcard Central System include the following:

- **Smartcard tracking and customer service support:** Provide the functions for tracking and monitoring card usage from the point of initialization until it is cancelled. It typically includes:
  - Sales, usage
  - Fare type details
  - Customer transaction details
  - Balance protection actions
  - Customer service support
  - Card replacement
- **Fare tables**: Define transit products/fare types offered, the characteristics, and conditional rules.
- **Operational instructions**: Controls and manages variable data such as fare tables, passback protection and other conditional instructions.
- **Financial management**: Supports the credit/debit switch and revenue reconciliation processes. In addition, the TTC Smartcard System calls for expanded Financial Management System that integrates with the TTC Financial System, esp. to General Ledger. [46]
- **Data transport framework**: Controls the process for moving data between the Central System and the devices. Manages data transfers, distributes data.
- **Data acquisition instructions**: Controls the process for handling data received from devices. This application also has a built-in feature for recovering data that is lost from malfunctioning, lost or destroyed devices.
- **Hotlist management and instructions**: Provides options and instructions for reacting to various types of smartcard management requirements for cancelling or blocking a card for rejected autoload transactions, expiration, fraudulent transactions or in response to a report of loss or theft.
- **Fraud analysis rules:** Provides the instructions for protecting the integrity of the system. It analyzes data collected by the system and reports anomalies.
- **Data summarization instructions**: Controls the process for organizing data in support of standard and Ad Hoc reporting.
- **Reporting framework**: Provides standard reports and the processing of Ad Hoc queries.

The previous list consists of the components that are basic to all smartcard management systems. The following lists the "additional functions" needed to fully support the requirements of the TTC Smartcard System:

[46] Dedicated effort will be required to ensure proper integration with the legacy Financial System. Experience shows that agencies are so consumed by the operational design and the implementation of a smartcard fare collection system, that integration with the Financial system does not receive the focus and attention it requires.

- **Autoload parameters and instructions**: Provides the ability to link a smartcard to a payment mechanism such as credit/debit card or bank account and configure the card to reload when it reaches definable thresholds (such as E-Purse value drops below a set amount or E-Pass expires). It also provides the ability to instruct devices to load a specific amount of value or pass to a specific smartcard in response to a reload order through Web Services or IVR. See Section 9.2, *Distribution, Sales and Reload* Section and 9.4, *Customers Services, Smartcard Account Management*, for additional details about Autoload.
- **Initialization and encoding instructions**: Provides the instructions for loading security keys, customer classification and other applications as required to smartcards. It will also provide the interfaces for ordering, monitoring production of and tracking batches of cards. See Section 9.1, *Smartcard/Limited Use Card Management*, for additional details about Initialization and Encoding.
- **Web services**: Provide sales, reload and other account services through the internet. See Section 9.4, *Customers Service, Smartcard Account Management*, for additional details about Web Services.
- **Point of sale instructions**: Provides device instructions for sales and reload of smartcard fare media and the reporting of revenue from sales and reloads. See Section 9.2, *Distribution, Sales and Reload* and Section 9.5, *Revenue Collection and Reconciliation*, for additional details about Point of Sale devices.
- **System monitoring**: Provides the ability to detect and report problems in the network of smartcard devices such as unauthorized entries, failures, status of consumables etc. See Section 9.5, *Revenue Collection and Reconciliation* and 9.6, *Operations and Maintenance of Field Devices,* for additional details about System monitoring. The TTC's current system monitoring tool is CA – Unicenter.
- **Credit/debit interface/switch**: Encrypts the account numbers of credit and debit cards, passes sales transactions to a payment acquirer system such as Visanet and provides all necessary reports and data storage required. See Section 9.5, *Revenue Collection and Reconciliation* and Section 9.7, *Data Systems and Reporting*, for additional details about Credit/Debit interface/switch.

During the detailed design phase of the project, the TTC's business requirements and strategies will further define the configuration of the Central System's software and, perhaps, require additional customization and development. It will be prudent for the TTC to include a budget for non-recurring engineering services for the purpose of developing unique requirements. The cost for non-recurring engineering services is listed at a capital cost in Chapter 10, *Cost Impacts*, Section 10.2, *Capital Costs*.

In addition, each transit agency has different requirements for the number of Central System servers. The Maryland Transit Administration (MTA) purchased two Central System servers – one as the primary and one for disaster recovery; Miami Dade Transit plans to purchase three – one primary server, another for disaster recovery, and one backup; MARTA bought five – two servers for production, one for disaster recovery, one backup and one for their equipment provider.

The TTC requires that their data systems be replicated five times, or provide five "environments". The Information Technology Services Department has defined the following:

1. A test environment will be established to evaluate and test software independently.
2. QA environment that allows testing of any software changes to assure it meets the intended requirements.
3. Pre-production environment for the testing of software in a mock operating environment to insure the change(s) do not affect any other components of the "production" system.
4. Production environment, the actual operating or production system that supports all end devices in revenue service or production.
5. Disaster Recovery environment. A full replica of the production environment located at a site different than the production environment as a backup in the case of a long term failure to the

Production environment. This environment can serve as a "Hot" backup which can be operated as a mirror to the Production system and takes over system processing in the case of failure. It can also be configured as a "Cold" back up that will need to be configured and set up if a Disaster occurs to the Production system.

Based on current technology standards, the TTC Smartcard System data system will likely be required to support the following software, however, this will be determined/finalized during detailed design:

- The operating system supported by the TTC IT department is Unix and Windows.
- The database must be Oracle version 10 or better at the time of implementation.
- Report Net is the standard reports system used at the TTC.
- CA – Unicenter is the Network monitoring system currently deployed at the TTC
- The TTC employs a Storage Area Network (SAN) for data storage requirements and would require that future smartcard data storage use this same architecture.

9.8.2 DATA TRANSPORT SYSTEM

There are a multitude of options available in the world of data communications. As the TTC is aware, there are two requirements for constructing an efficient data transport system. First, how will devices be addressed? Second, through what conduit will communications be delivered?

About Addresses

In smartcard systems, the method used for addressing is the Internet Protocol (IP). This is the most flexible method available and used widely by equipment providers. Every client, server and network device must have a unique IP address for each network connection (network interface). Every IP packet contains a source IP address and a destination IP address. In the smartcard network every fixed end device will have a static address that will be developed by the TTC. It is recommended that a protocol for developing addresses be developed early in the project to insure uniqueness in addressing can be maintained and simplified to allow the Network Administrator or Maintenance staff the ability to identify the correct address for the end device.

Now, About Data Transport

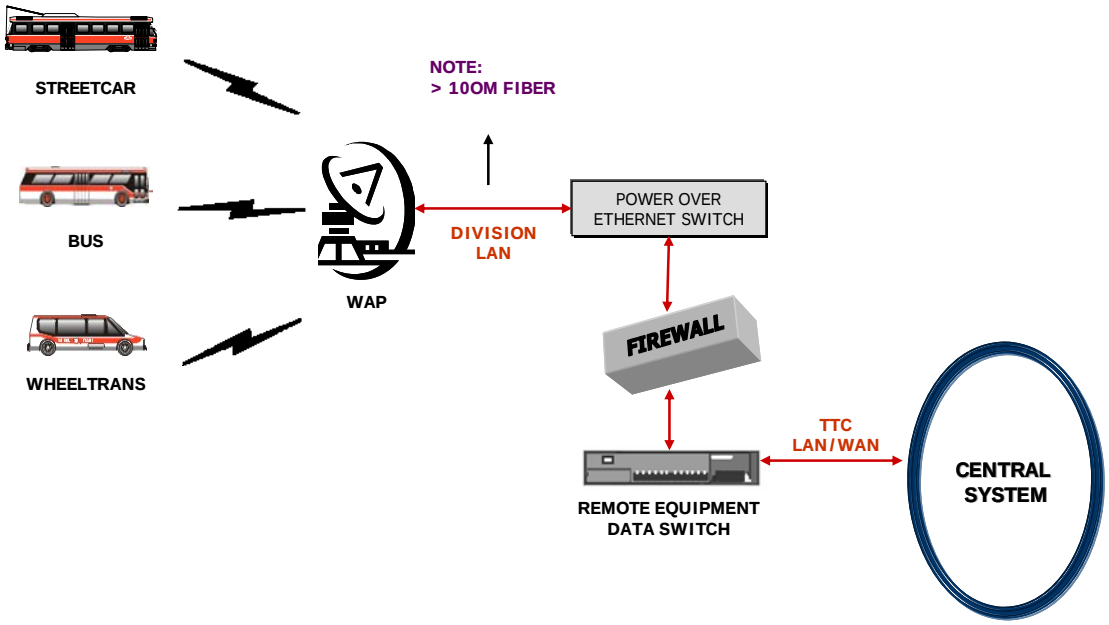
The following describe through what channels data will be transmitted from/to the Central System.

Surface

Surface Vehicle Smartcard Readers will transmit and receive data within the division via a wireless local area network device (or access point) connected to the corporate network via a standard Ethernet jack. Each device will be connected through the corporate network to a Power over Ethernet (POE) Switch designed to provide power and Ethernet connectivity for compliant devices at each division. The divisions will connect to the Central System via a WLAN Security Switch. The device can be licensed to control up to 120 access points which are distributed across the organization. This switch will provide a centralized location for the implementation of security provisions necessary to protect the transmissions of data.

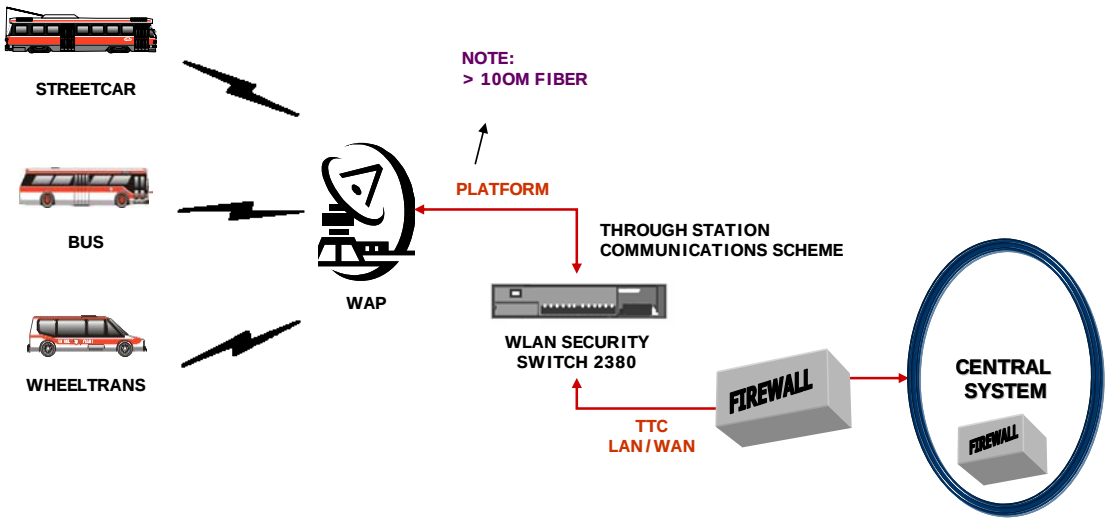
Exhibit 9.8-2, *Surface Data Transport Flow (Divisions)* shows the flow of data to/from Surface Vehicle Smartcard Readers to the Central System.

Exhibit 9.8-2: Surface Data Transport Flow (Divisions)



Surface Vehicle Smartcard Readers will also transmit and receive data to and from a wireless access points positioned at the platforms or through fibre. The data will transmit from the wireless access point, through a security switch to the station's communication scheme (see Exhibit 9.8.4, *Subway Data Transport Flow*) and on to the Central System. Data from the Central System to Surface Vehicles at the platform will flow the opposite direction. Exhibit 9.8-3, *Surface Data Transport Flow (Platforms)* shows the flow of data to/from Surface Vehicle Smartcard Readers to the Central System.

Exhibit 9.8-3: Surface Data Transport Flow (Platforms)



Subway /RT

Unlike Smartcard Readers on Surface Vehicles, smartcard devices used in the Subway/RT will be connected to the data network at all times. This will allow real time data communications and functional

instructions to and from the Central System. In this application real time means the transactions or events are sent to the Central Computer as they occur and are not held by the end device for processing later. The data transmission will be affected by network traffic (the number of messages on the network at a given time. During system implementation messaging will have to be "tuned" to ensure messages are sent and received by the end devices in a reasonable amount of time. In Baltimore tuning reduced the time messages were receive from one hour in certain instances to five minutes or less.

The number of devices and the location of each will determine the final network design, but, generally, data will be transmitted from each device to the TTC's Local Area Network (LAN) to a Wide Area Network (WAN) and then on to the TTC's Smartcard Central System for collection and processing. Data and instructions from the Central System back to the subway devices will flow in the opposite direction. The TTC has completed the installation of a functional fibre network throughout the subway system. Modifications necessary to support the TTC Smartcard System will be connections, nodes, wiring closets and data links between the turnstile fare line mezzanine (street level) to the fibre network which is at track level.

In the TTC Smartcard System, data will flow to and from:

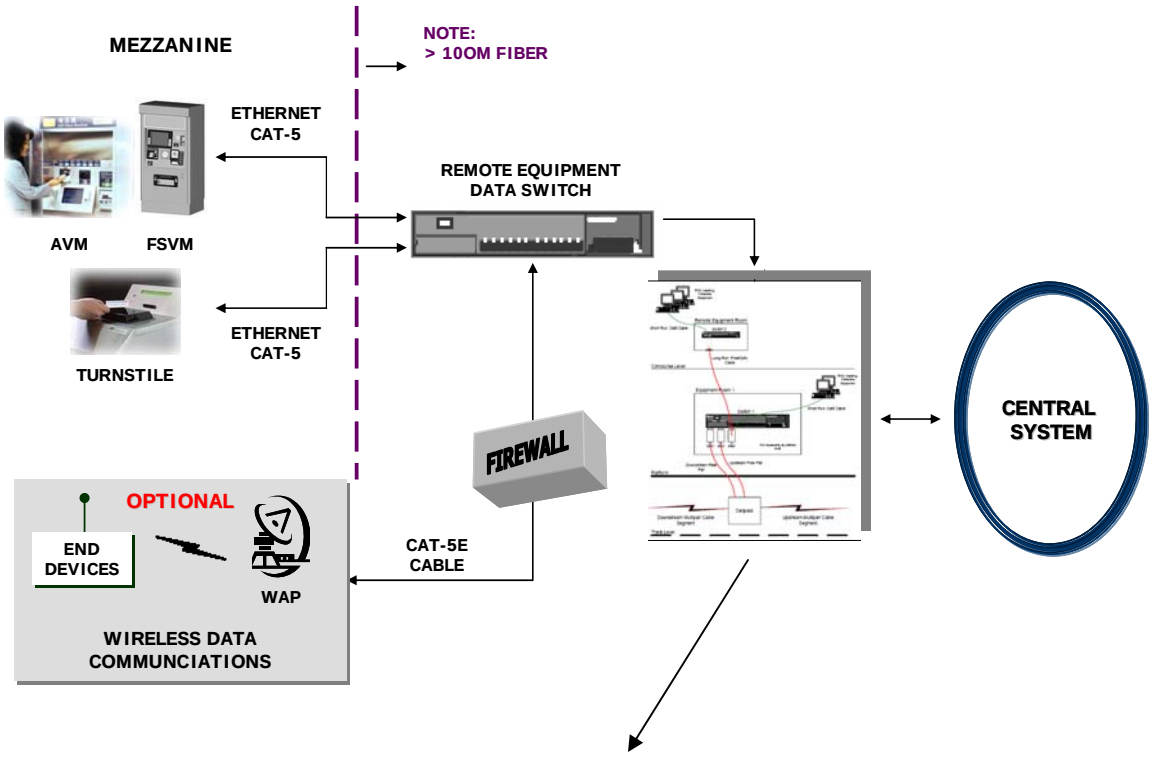
1. ***Smartcard Readers*** on every entry electronic turnstile
2. ***Add Value Machines*** located at every station entrance and platform
3. ***Full Service Vending Machines*** located at every entrance

It will be assumed that the TTC will "hardwire" devices; however, wireless may also be a viable option for communications to and from devices. At the point the TTC is ready to procure a new smartcard system, wireless communications technology may have advanced enough to make hardwiring the devices a non-option.

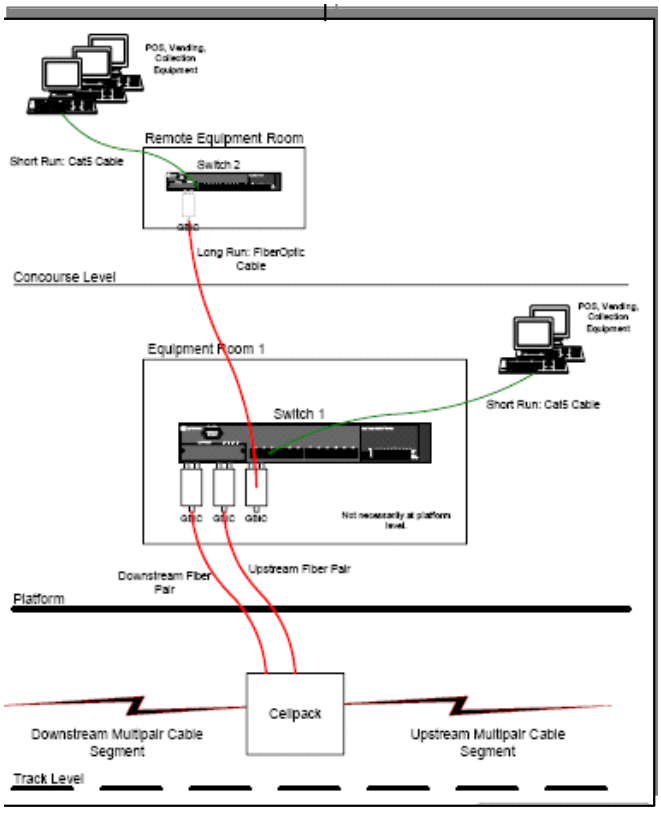
Exhibit 9.8-4, *Subway Data Transport Flow*, shows the flow of data to/from Subway smartcard devices to the Central System.

INTENTIONALLY LEFT BLANK

Exhibit 9.8-4: Subway Data Transport Flow



Enlarged for viewing (Source: the TTC)

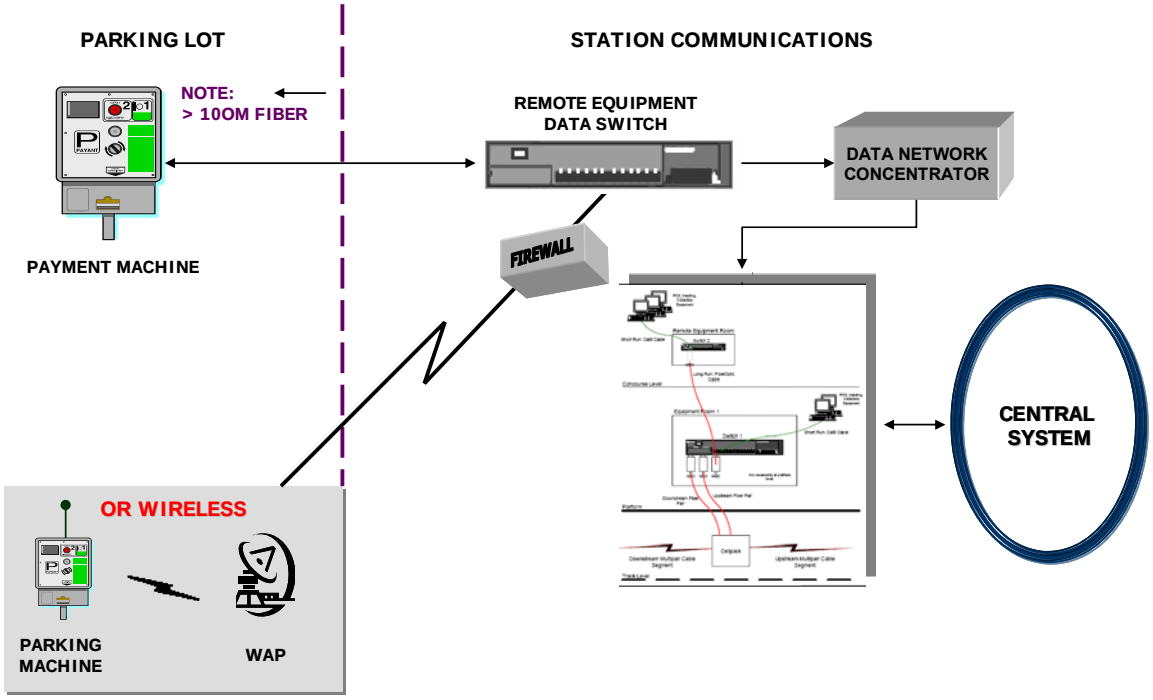


Parking

The Data Transport System design for Parking will be similar to Subway/RT communications. The parking devices used in the smartcard system will be connected to the data network at all times. All devices can be either hardwired to the nearest subway station or transmit data wirelessly using directional line-of-sight communications to/from the parking machine. Additionally, a firewall should be provided to provide secure communications and restrict access into the network, should wireless access points be used. Wireless may be applicable for some parking lots; the Subway/RT station entrance location relative to the parking lot will affect the ability and requirements for a data communication requirement.

Exhibit 9.8-5, *Parking Data Transport Flow*, shows the flow of data to/from parking Smartcard Readers to the Central System.

Exhibit 9.8-5: Parking Data Transport Flow



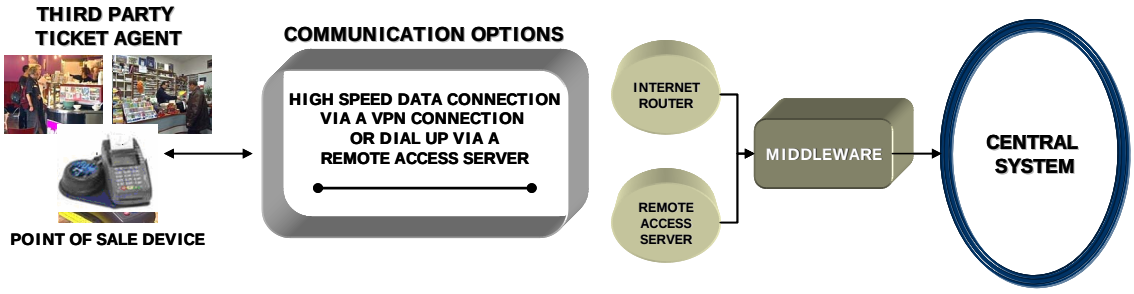
3rd Party Ticket Agents

In the TTC Smartcard System, Third Party Ticket Agents are sales outlets located off the TTC premises. The Ticket Agents will use Point of Sale devices to sell zero value smartcards and load E-Purse value or E-Passes. In order to properly track the smartcards sold and loaded, a special data transport system needs to be designed for each of these remote devices. Typically and preferably, the data will be transmitted to and from the TTC's Central System through a high speed data network; however, "dial up" modems could also be accommodated, but a Remote Access Server (RAS) would be required to allow this functionality. These types of decisions will be made during detailed system design.

To support this method, the TTC must have a Remote Access Server (RAS). The sizing of the server will be a function the number of connections to allow reasonable connection to a majority of the devices at any given time of day/week. Others will gain access via an Internet Router. The data from the router and RAS will connect to the Central System via Middleware.

Exhibit 9.8-6, *Third Party Data Transport Flow*, shows the flow of data to/from 3rd Party Ticket Agent Point of Sale devices to the Central System.

Exhibit 9.8-6: Third Party Data Transport Flow

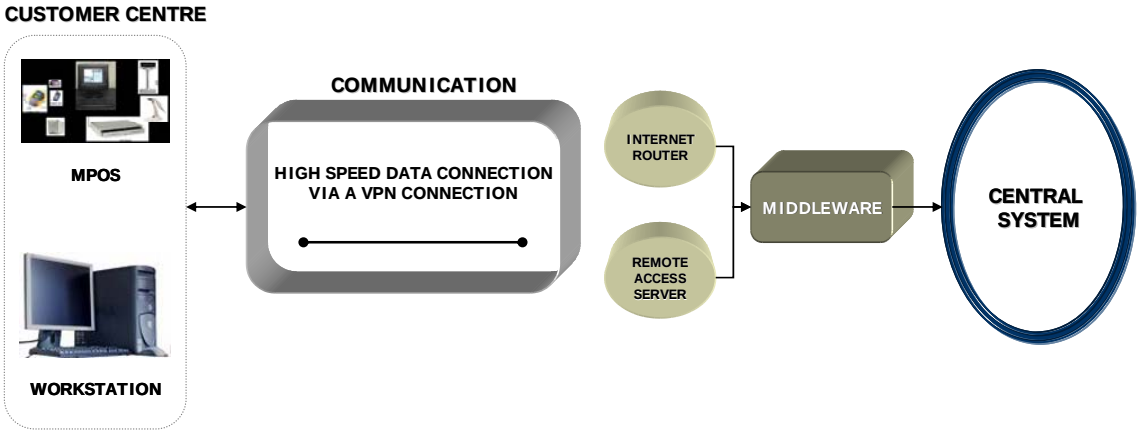


Customer Centre

The Customer Centre employees that are located off the TTC premises, will access the Central System by way of Internet Browser and Virtual Private Network Access (VPN). For those Customer Centre employees located at the TTC facility, the workstations will connect to the TTC network as would any other office PC or workstation. The facility will have to be appropriately designed to include adequate power and communications for the Centre.

In the TTC Smartcard System, the Customer Centre's Data Transport System will not require special hardware or software. Exhibit 9.8-7, *Customer Centre Data Transport Flow*, shows the flow of data to/from Customer Centre devices to the Central System.

Exhibit 9.8-7: Customer Centre Data Transport Flow



Call Centre/IVR

IVR, short for ***i**nteractive **v**oice **r**esponse*, is a telephony technology in which someone uses a touch-tone telephone to interact with a database to acquire information from or enter data into the database. IVR technology does not require human interaction over the telephone as the user's interaction is with a database that predetermines what the IVR system will allow the user access to. For example, banks and credit card companies use IVR systems so that their customers can receive up-to-date account information instantly and easily without having to speak directly to a person. IVR technology is also used

to gather information, as in the case of telephone surveys in which the user is prompted to answer questions by pushing the numbers on a touch-tone telephone.

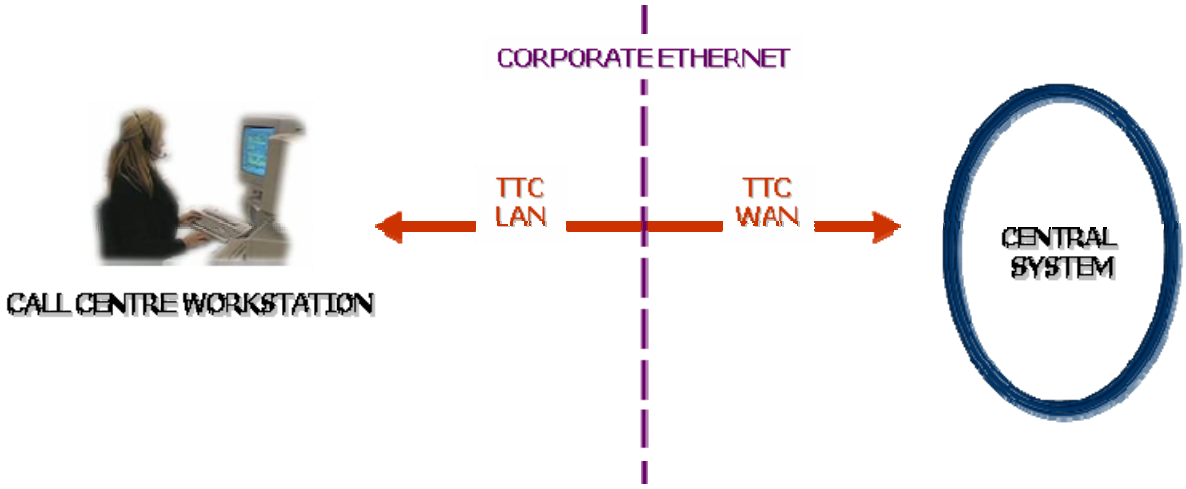
The IVR system consists of a computer system made up of the hardware and software to interface to a telephone system. Hardware would consist of a computer configured with the appropriate hardware to handle calls and the software to provide an interface to the smartcard database.

From an architecture perspective the hardware would interface to the TTC network like any other computer or server on the network. Additional hardware would be required to interface to the telephone system supporting the Customer Centre.

Assuming its location is on TTC premises, direct access to the Central System will be through the standard corporate Ethernet access point.

In the TTC Smartcard System, the Call Centre's Data Transport System will not require special hardware or software. Exhibit 9.8-8, *Call Centre Data Transport Flow*, shows the flow of data to/from Call Centre workstations to the Central System.

Exhibit 9.8-8: Call Centre Data Transport Flow



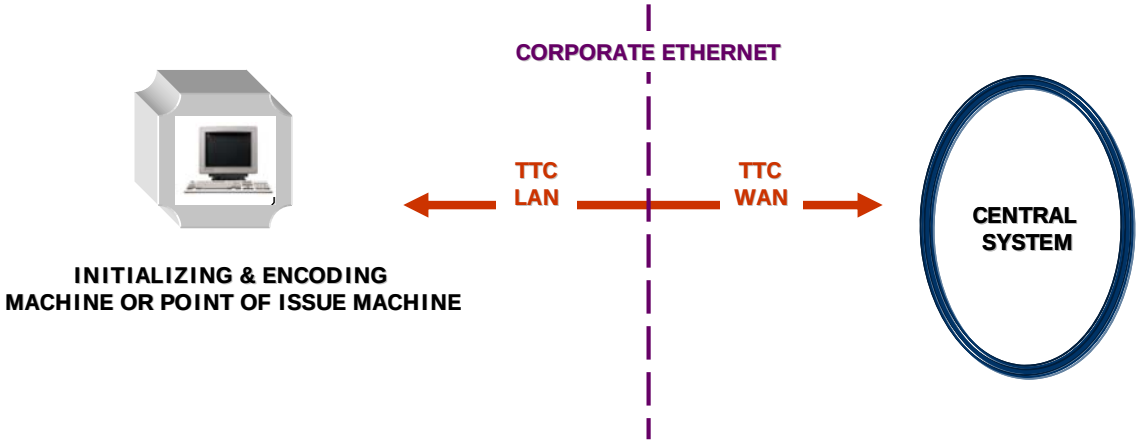
Smartcard and Limited Use Card Management (Revenue Operations)

Revenue Operations will initialize smartcards for use in the system (see Section 9.2, *Smartcard and Limited Use Card Management*, for more details). The initializing/encoding instructions and the data will be transmitted to/from the Central System via the standard corporate Ethernet access point.

In the TTC Smartcard System, the Revenue Operations' data transport system will not require special hardware or software. Revenue Operations will use standard PC workstations to log in or connect to the Central Computer Data System. It is assumed that connections to the TTC network are available in the Revenue Operations area.

Exhibit 9.8-9, *Revenue Operations' Data Transport Flow*, shows the flow of data to/from Revenue Operations' workstations to the Central System.

Exhibit 9.8-9: Revenue Operations' Data Transport Flow



9.8.3 SYSTEM SECURITY

This next section provides an overview of ways in which the smartcard system may be secured.

Device Activities

At the end devices – bus and streetcar equipment, vending machines, point of sale devices, smartcard initialization devices -- access to each device must be secured through positive identification using an employee ID smartcard and a pin code. This protects data, prevents malicious activities and allows the TTC to monitor employee access.

Payment Card Industry Data Security Standards

The TTC Smartcard System will be designed to meet the most current Payment Card Industry Data Security Standards. These standards include the requirement for automatically and immediately encrypting all credit/debit account numbers upon entry or swipe at the point of sale. Encryption is the process of converting sensitive information (such as an account number of a credit or debit card) into an unintelligible form except by the authorized holders of a specific cryptographic key. Encryption protects the sensitive information against unauthorized disclosure.

Access to the Central and Data Systems

The Central and Data Transport Systems should be secured at two levels - physical access to the rooms, if the access to the room is available to various departments and staff of the TTC it is recommended the data system be housed in a secure cabinet. IT data centers typically use a "rack mount" cabinet with doors that can be closed and locked to restrict access. Additionally these systems will require the appropriate login and password for operator access into the Central Systems and Servers software. User ID and Password access should be managed closely to control who gets access to what functions, such as a maintenance manager should be able to run maintenance reports but should not be able to access revenue data. These cabinets also allow for monitoring through data networks to a central system (i.e. CA – Unicenter).

Monitoring for Fraudulent Activities

Security must include the ability to monitor credit/debit and smartcard transactions for fraudulent use of these cards. This level of security will require staff to monitor exception reports for a variety of activities that indicate misuse of credit/debit cards and smartcards. As an example, several credit card

transactions at an FSVM machine to purchase smartcards in a short period may indicate a stolen credit card is being used, or value loads on a smartcard in several locations or machines in a short period may indicate fraudulent use of a credit card. WMATA has seen this type of situation in their magnetic Ticket Vending Machines (TVM) where a stolen credit card was used to purchase several magnetic tickets at a TVM to be sold on the street, or in some cases to verify the card is valid before the vandal used the card to go on a shopping spree at area merchants.

The Central System will be linked to each device in the station, so it will "watch" for these types of fraudulent activities. Through configuration parameters the system can block card numbers (typically credit or debit) that appear to be used fraudulently.

Physical Security in the Field

Physical security includes providing secure cabinets for data interface equipment, station controllers, and division data systems. Typically, the key to these cabinets is maintained by the Maintenance and IT departments to limit access to the data systems. Although malicious activity may not be intended, if field staff has access, they may attempt to "re-boot" a unit to restore service if there is a problem in a station or at the division. This may cause severe system problems.

Monitoring Remotely

System monitoring software, typically provided by the vendor, will enable the TTC to "observe" equipment, such as the FSVM and the AVM hardware on the TTC network used to support the smartcard system. Cabinets and rooms could be monitored using this same system however the capability is not commonly used. The monitoring system may be configured to classify certain alarms generated from field devices and route them to the appropriate personnel such as "Door Open Alarm" may be routed to Transit Control or Plant Maintenance Control for dispatching the appropriate TTC staff.

Additionally, it is recommended that all vending machines be monitored by point, tilt, and zoom CCTV. When the monitoring system detects a device alarm, the CCTV monitoring personal can be alerted and cameras remotely aimed at the device for observation and capturing images of vandalism or theft. The video from these cameras can be recorded to a Digital Video Recorder for short term storage (24-48 hours) and incidents can be captured to long term storage for investigation purposes if required. These systems are typically a part of a larger Security initiative by agencies such as MBTA in Boston and New Jersey Transit.

In the TTC Smartcard System, the Security System will require the following hardware:

- Locking cabinets
- Software (included in Central System)
- Station vending machine CCTVs

9.8.4 FACILITY MODIFICATIONS

The following summarizes the review for identifying facility upgrades, equipment and office furniture to support communication, power and service requirements of the TTC Smartcard System:

Preliminary station layouts were prepared for a sample of 10 representative subway station and 2 bus platform areas:

- Vending machine specifications from MARTA were used to estimate device "footprints" and power and communication, environmental heating and ventilation requirements.
- Architectural designs determined the space within the existing station configuration to install vending machines taking into account "reasonable" room for line-ups at the machines and passenger flow within the station concourse areas

- Estimates of distances for power and communication construction to these locations were made.
- Preliminary designs were then sent to TTC estimating to determine the appropriate facility modification "allowance" for this construction and the cost estimate to deliver power and communications to the subway station field devices.
- Two “busy” stations with existing capacity constraints were examined to help ensure the station modifications were practical, feasible and not underestimated.

The existing power and communication capabilities of each station were reviewed to determine the following:

- Adequate power supply to determine if any power upgrades were required to support the field devices
- IT wiring closet requirements within the station with an existing connection to the fibre network
- Allowances were included for connecting the station entrances to the fibre network.

On site visual reviews were conducted at garages and bus platforms areas to estimate the number of wireless access points required for data transfers.

The existing Call Center, Metropass Discount Program and Revenue Security and Equipment Maintenance facilities were also reviewed for necessary expansion requirements. All will require expansion. In addition, the Revenue Operations facility will require modification for the high speed Smartcard Initialization and Encoding Machine and the Point of Issue Machine and the smartcard Project Management Team will need office space facilities.

9.8.5 EQUIPMENT AND SYSTEM REQUIREMENTS

Table 9.8-10, *Equipment Requirements for System Architecture and Security*, provides a list of equipment and systems required for performing the functions described in this section. Equipment quantities were determined by estimating the TTC’s smartcard requirements, researching equipment productivity metrics and interviewing peer agencies.

INTENTIONALLY LEFT BLANK

Table 9.8-10: Equipment Requirements for System Architecture and Security

	Quantity
Central System	
Central System - core applications	1
Central System - add ons relevant to TTC requirements	7
Workstations (Central System)	5
Workstations (IT)	4
Servers - Network Monitoring (Windows)	4
Servers - Reports (Windows)	4
Servers - Application (Windows)	4
Servers - Backend or Database (Unix)	1
Servers - Development	3
Surface Divisions	
Wireless Access Points (Divisions)	89
Ant/Unit	89
Central Controller	2
Central Management Software	2
Planning software	1
Power over Ethernet Switch	11
Surface Platforms	
Wireless Access Points (Platforms)	163
Ant/Unit	163
WLAN Security Switch 2380	4
Management Software 250 user	4
WLAN Management tools	1
AP Licensing (160 users)	2
Firewall	2
Parking	
Data Network Concentrators (Parking)	28
3rd Party Ticket Agents	
Internet Router	2
Firewall	2
Zone switches	2
System Security	
Locking cabinets for servers	46
Non-Smartcard System equipment	
IVR Servers	2

9.8.6 FUNCTIONAL IMPACTS

Comparing the processes for managing the Central System, Data Transport and Security to the TTC's current requirements exposed the most likely impacts to current operations. The following summarizes the impacts related to the changes in business processes:

- Increased labour as a result in increased database administration activities
- Increased labour as a result in increased system administration activities
- Increased labour for managing and supporting the reports system
- Increased labour for managing and updating Web Services
- Increased labour as a result of network and security administration for each of the following areas:
  - Surface
  - Subway
  - 3rd Party Ticket Agent POS
  - Internal TTC access to Central System
- Increase labour for Technical/Help Desk support
- Increased labour for IT lab support
- Increased labour for increased telecommunications requirements

Functional area cost estimates are featured in Chapter 10, *Cost Impacts*, Section 10.3, *Projected Operating Cost*.

Appendix A, *Equipment Glossary*, presents a consolidated list of the TTC Smartcard System equipment/systems, power requirements, location and quantity.

INTENTIONALLY LEFT BLANK

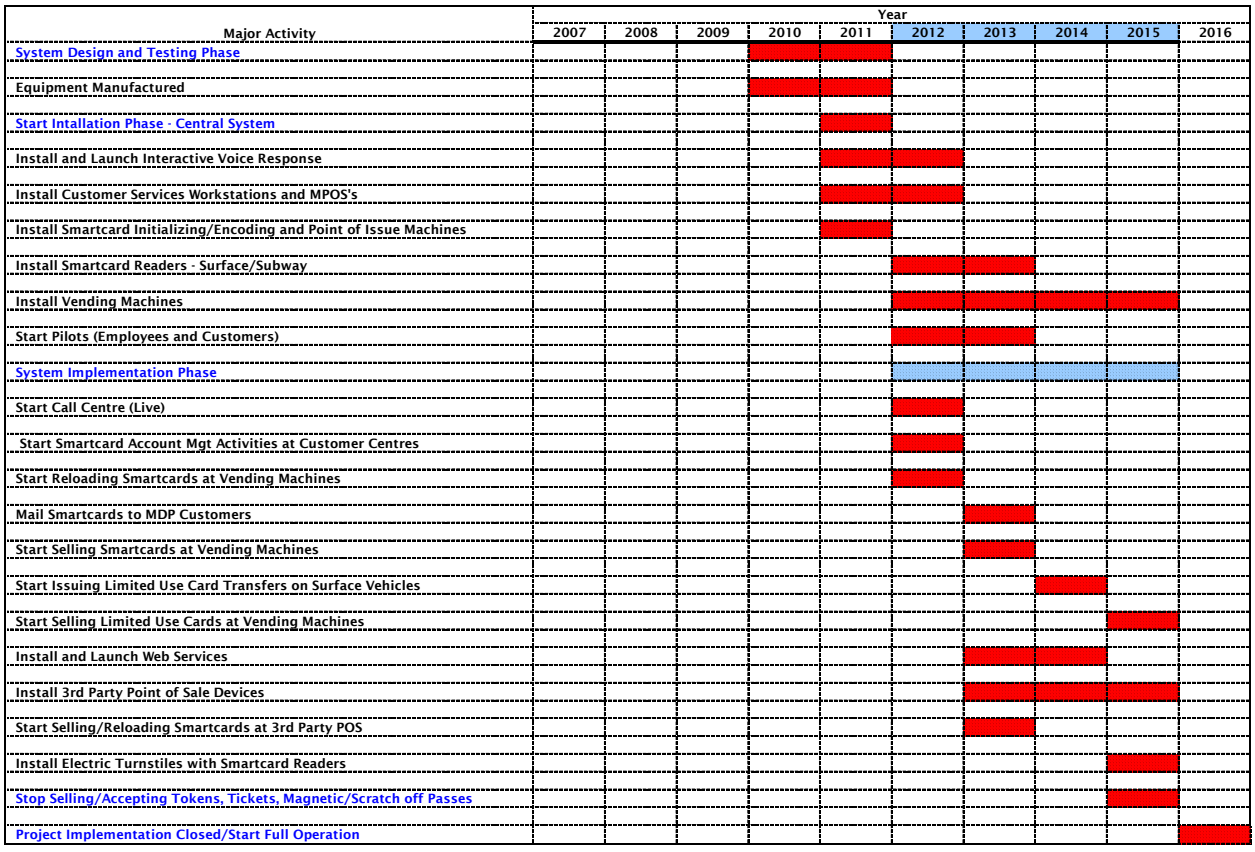
9.9 INSTALLATION AND IMPLEMENTATION SCHEDULE

Chapter 12, *Project Management and Next Steps*, presents a possible schedule of next steps that include enlisting a project management team, hiring professional services, developing the system specifications, issuing the request for proposal, evaluating the bids of equipment provider etc. Unlike the schedule in Chapter 12, this section (9.9) focuses on a possible schedule for *installing the equipment and implementing the system* (rolling the smartcards out to employees and customers). The reason it is discussed here before Chapter 12 is it is the installation and implementation schedule that helps drive the estimates for measuring operating impacts The impacts are reviewed in the next chapter, Chapter 10, *Cost Impacts*.

Table 9.9-1, *Installation and Implementation Schedule – The TTC Smartcard System,* assumes that the TTC Smartcard System is approved this year (2007). It also assumes that the installation and implementation will not be as aggressive as MARTA's 3 years, but not as conservative as CTA's 8 years. It is assumed the schedule will be more in line with the MBTA's 5 years.

The schedule presents milestone events for system design, installation and implementation. Items in blue font indicate distinct phases of the project, years highlighted in light blue indicate the years of system implementation (the roll out of smartcards to employees and customers). It shows equipment/system design starting 2010, installation of field equipment (Smartcard Readers and vending machines) starting 2012 and completing 2015.

Table 9.9-1: Installation and Implementation Schedule – The TTC Smartcard System



System Design and Testing Phase: It is in this phase that the equipment provider will present the proposed design of the system in detail. This will enable the TTC to compare the details of the design to

the TTC's specifications and business requirements. The equipment will then be demonstrated and assessed against performance requirements.

Equipment Manufactured: After approval of major design elements, fare collection equipment will be manufactured.

Start Installation Phase: This is the point at which the installation of fare collection equipment and systems begins.

- **Central System**: This is the first item to be installed because this is the nexus of system functionality, instructions and data.
- **Interactive Voice Response**: This system will provide automated customer service and account management. It needs to be installed and tested prior to the start of pilots.
- **Customer Service Workstations and Multi Purpose Point of Sale Devices**: This equipment enables Call and Customer Centre employees to provide customer service support and smartcard account management services. These need to be installed prior to pilots and launch.
- **Initialization and Encoding and Point of Issue Machines**: These machines are necessary for initializing smartcards with security keys and encoding customer classifications, uploading to the Central System database for tracking and monitoring prior to entering the sales chain.
- **Install Smartcard Readers – Surface and Subway**: Readers will be installed over the course of two years (50% of the total each year).
- **Install Vending Machines**: Full Service Vending and Add Value Machines will be installed over the course of four years (25% of the total each year).

Start Pilots (Customer and Employee): As installation progresses, surface routes and select subway stations will be the focus of customer and employee pilots. Customers and employees will be issued initialized and encoded smartcards to test Smartcard Readers, vending machines, customer services and smartcard account management support.

System Implementation Phase: Once the pilots are completed, evaluated, issues resolved, the TTC will issue smartcards to customers and start collecting fares and managing data through the new system.

- **Start Call Centre – Operator Assisted**: Customer Service Operators will be prepared to respond to general inquiries and perform smartcard account management services.
- **Start Smartcard Account Management Activities at Customer Centres**: Customer Service Representatives will be prepared to provide a full range of smartcard account management services.
- **Start Reloading Smartcards at Vending Machines**: Customers with smartcards may reload E-Purse value and/or E-Passes at any vending machine.
- **Mail Smartcards to MDP Customers**: The first group of customers to be issued smartcards will be the individuals enrolled in the annual Metropass Program.
- **Start Selling Smartcards at Vending Machines**: After the first group of customers is delivered smartcards, Full Service Vending Machines will be enabled to dispense the smartcards.
- **Start Issuing Limited Use Card Transfers on Surface Vehicles**: Once Smartcard Readers are installed and smartcard roll out has begun, paper transfers will be replaced with paper limited use smartcards.
- **Start Selling Limited Use Cards at Vending Machines**: Two full years after the introduction of the smartcard and after all vending machines have been installed; the TTC will begin to sell Single Trip and Day Pass paper limited use smartcards at vending machines.
- **Install and Launch Web Services**: Web Services will be installed and launched as of the third year of implementation.
- **Install 3rd Party Point of Sale Devices**: 3rd Party Point of Sale devices will be installed incrementally over a 3 year period.

- **Start Selling and Reloading Smartcards at 3rd Party Point of Sale Devices**: As 3rd Party sellers receive Point of Sale devices, they will begin to sell and reload smartcards.
- **Install Electric Turnstiles with Smartcard Readers**: New turnstiles, equipped with Smartcard Readers, will replace the existing passimeter adjacent the Collector's booth.

Stop Selling/Accepting Tokens, Tickets, Magnetic and Scratch-off Day Passes: All smartcard equipment has been installed, the system implemented and customers must now use the new fare media.

Project Closed/Start Full Operations: The TTC accepts ownership of the smartcard fare collection system and begins to fully operate this new system.

10.0 COST IMPACTS

This chapter presents the estimated fiscal impacts of procuring, installing and implementing the TTC Smartcard System. It provides the capital and operating cost estimates and the projected.

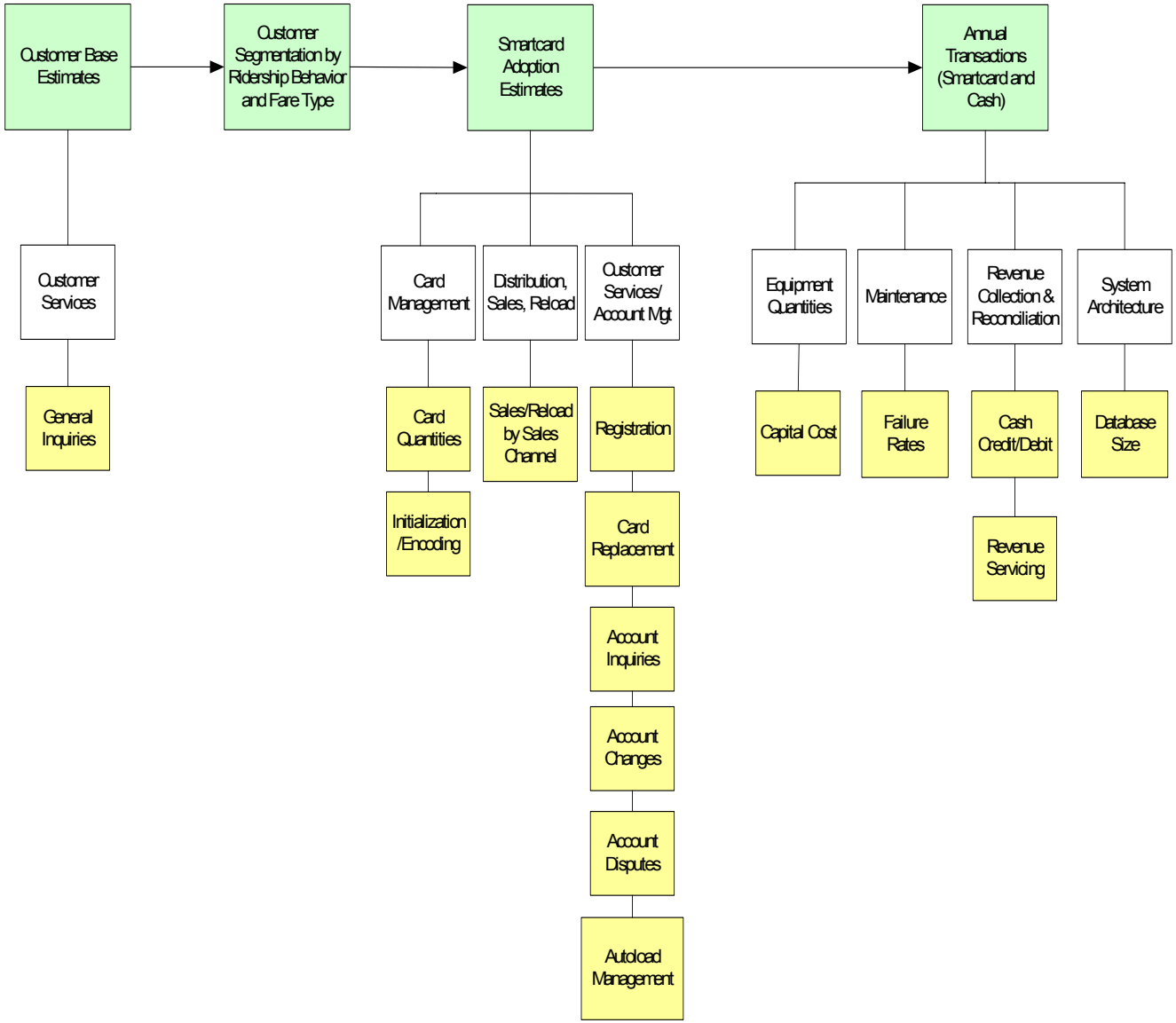
10.1 SUMMARY OF DEMAND ESTIMATES

The financial costs described in sections 10.2 and 10.3 – capital and operating– were built on a foundation of demand estimates. The following section describes these demand estimates, the methodologies and how the estimates were applied to the process of projecting the costs.

Early in the process of this study, first and second level demand estimates were identified -- the first level estimates provide the building blocks for the second level elements. Exhibit 10.1-1, *Demand Estimates – Process Flow*, shows the flow and relationship between the first and second level estimates. The estimates highlighted in green indicate first level and estimates highlighted in yellow indicate second level. The boxes without highlights represent the business functions for which the second level estimates aid with estimating capital and operating cost/savings impacts.

INTENTIONALLY LEFT BLANK

Exhibit 10.1-1: Demand Estimates – Process Flow



10.1.1 FIRST LEVEL DEMAND ESTIMATES

The First Level estimates are the starting points for estimating cost impacts. The essential driver is the TTC's base of customers. Once the number of TTC customers was determined, all other estimates could then follow. The First Level demand estimates and key factors behind each are summarized below.

Customer Base

The TTC's customer base was estimated by applying the results of the most current Market Tracking Study (October 2005 to June 2006). This study provided the percentage of the Toronto population that uses the TTC service. By applying the results of the study to the population of the metropolitan area of Toronto, the totals provided the estimated customer base of **2,324,000 or 83.0%** of the 2.8 million residents. Further, the study enabled segmentation of the base into four distinct ridership behaviors – people who use the TTC service once per month, once per week, daily and occasionally within a year. Exhibit 10.1-2, *TTC Customer Base*, shows how the survey results were applied to estimate the customer base and to segment this base into ridership behavior.

Exhibit 10.1-2: TTC Customer Base

Toronto Population	2,800,000

TTC Customer Segment	Survey Results % of Toronto Population that Rides TTC	Toronto Residents by Frequency of Ridership	As % of Total Customer Base
People who ride once/month	11.0%	308,000	13%
People who ride once/week	35.0%	980,000	42%
People who ride daily	25.0%	700,000	30%
Sub Total	***71.0%***	***1,988,000***	***86%***
People who ride occasionally w/in a year	12.0%	336,000	14%
Total TTC Universe	***83.0%***	***2,324,000***	***100%***

Customer Segmentation by Ridership Behavior and by Fare Type

As described in the previous section, the customer base was segmented by ridership behavior (once per month, once per week, daily and occasionally). Each segment could then be further defined by the types of fares each segment was most likely to use. Once the types of fares for each segment were assumed, the trip multiple for each fare type could be applied and the estimated annual rides by segment calculated.

Smartcard/Limited Use Card Adoption Rates

Once customer segments and the relevant fare types were identified, assumptions could then be made about how likely each group (by type of fare used) was to adopt and use a smartcard or a paper limited use smartcard or continue to use cash. In the TTC Smartcard System, a plastic smartcard will replace tickets, tokens and passes and will be the primary method for paying a fare. Customers will either load

their smartcard with E-Purse value (money value equaling the value of one trip or multiple trips) or with E-Pass (time-based, unlimited trips).

For customers who do not have smartcards (such as cash users), there will be old and new options for paying a single trip fare. Cash will continue to be accepted in fareboxes on Surface Vehicles but in Subway Stations, cash customers will be required to purchase a paper limited use smartcard from a vending machine. This card will enable them to enter a turnstile.

The adoption rates led to the ability to estimate the numbers of customers who will use plastic smartcards, buy paper limited use smartcards or continue to pay by cash (on a Surface Vehicle). The estimated number is **1.7 million** smartcard customers, **260,000** (paper limited use smartcards customers), and **390,000** (cash customers).

Annual Transactions

Once the number of smartcard, paper limited use smartcard and cash customers was estimated, smartcard device transactions could be estimated.

Table 10.1-3, *Annual Device Transactions*, summarizes the transaction estimates. Transactions include:

- Initial purchase of a smartcard or a paper limited use smartcard.
- Replacement for lost, stolen or damaged cards. There is an assumption that a percentage of customers will lose or damage their cards and need replacements. This is counted as a transaction for each replacement card.
- Turnstile entries. Each customer will tap their smartcard or paper limited use smartcard at Smartcard Reader to activate the turnstile and enter.
- Surface Vehicle boardings with a smartcard or paper limited use smartcard.
- Transfers. Customers will use their smartcard or a paper limited use smartcard to transfer from one vehicle or mode to another. The estimated number of transfers is a function of the current TTC experience.
- Reload transactions. This device transaction occurs when a customer's card requires additional E-Purse value or a renewed pass.

Table 10.1-3: Annual Device Transactions

TRANSACTION TYPE	DEVICE TRANSACTIONS (MILLIONS)
Initial purchase of a smartcard or paper limited use smartcard	18.6
Replacement cards	.040
Turnstile entries	177.8
Surface boardings	238.0
Transfers	189.3
Reloads	33.7
Total	**657.4**

10.1.2 SECOND LEVEL DEMAND ESTIMATES

Completing the First Level demand estimates, along with defining the TTC Smartcard System -- its concept of operations (Chapter 9) and installation and implementation schedule (Chapter 9, Section 9.9) -- provided the foundation necessary for estimating operating impacts.

As described in Chapter 9, *Concept of Operations*, in the TTC Smartcard System, current processes and resources will be expanded, redefined or scaled back. In addition, the TTC Smartcard System will require operating activities not currently performed by the TTC. The Second Level demand estimates attempt to define and forecast the relative impacts -- procurement quantities (such as smartcards, paper limited use smartcards, workstations, telephone equipment, etc.), revenue flow through each sales channel and operating impacts (such as labour requirements, telecommunication volumes, credit/debit transaction fees, etc.).

The following provides a summary of each element of the Second Level estimates.

Customer Services – General Inquiries

As customers become more aware of the plan to change to smartcard payment options, the TTC Call Centre will likely receive calls from customers interested in the project and how they will be affected by the change. The process for estimating the annual number of inquiries as well as the average duration of each call was forged from the experience of transit agencies that have recently undergone a similar transition. Estimated call volume for smartcard inquiries is a proportion of the TTC customer base, so this is one of the many reasons estimating the customer base is so critical to the business case. It is estimated that the TTC Call Centre will receive approximately **108,000 calls** annually (during the first four years of implementation). Responding to smartcard (general) inquiries is a new operating activity.

Card Management

Smartcard and Limited Use Card Procurement Quantities: Since lead times for receiving smartcard and paper limited use smartcard orders is generally long (16 weeks or longer) and since the initial order will be capitalized, it is important to carefully estimate the number of cards required for implementing the project without interruption to schedule. Procurement estimates are function of First Level estimates -- Adoption Rates, the TTC's current experience with transfers, as well as replacement and defective card experience of other transit agencies. It is estimated that, through the first four years of implementation, the TTC will require approximately **3.1 million plastic smartcards** and **44.0 million paper limited use smartcards**.

Smartcard Initialization and Encoding: As described in Chapter 9, *Concept of Operation,* Section 9.1, *Smartcard and Limited Use Card Management,* each plastic smartcard will be initialized and encoded with a customer classification (Adult, Senior, Student or Child) before entering the distribution and sales chain. This process formats each card, places the serial number in the Central System and includes the "security keys". These are all necessary for the fare collection system to recognize and to track the card not only through the distribution and sales chain, but also when in use by the customer. The number of cards to initialize each year and the resulting labour requirements are derived from the First Level smartcard adoption rates, replacement card estimates, the installation and implementation schedule, and the number of cards required for stocking vending machines. Initializing and encoding smartcards is a new operating activity.

Distribution, Sales, Reload by Sales Channel

The TTC Smartcard System features many convenient channels for customers to obtain and reload their smartcards including Subway and Platform vending machines, 3rd Party Ticket Agents, TTC Call Centre (operator assisted or IVR) and Customer Centres and by way of the TTC web services. It is important to estimate how many smartcards and paper limited use smartcards will be sold/issued and reloaded

(smartcards only) through each type of sales channel because it drives labour requirements for processing transactions, collecting revenue and maintaining equipment. It also enables the projection of credit/debit transactions and associated fees.

Estimating sales and reload by sales channel is a function of First Level smartcard/paper limited use smartcard adoption, the number of device transactions and the installation and implementation schedule. It is also influenced by other transit agency experience. As a result, it is estimated that after the first four years of implementation, nearly **89 percent** of sales and reload revenue will be collected through new automated channels such as vending machines, IVR, web services, and autoload. Sales of fare media is an existing business function, but sales through some of the existing channels will most likely scale back, replaced by the more convenient and accessible automated channels. Reloading smartcards is a new activity.

Customer Services and Account Management

Smartcard deployments generally include an expansion of customer services to not only support the customers through the transition, but to provide account management services (such as card fulfillment, account registration for Balance/Negative Protection and Autoload, card replacement (if lost, stolen, or damaged), account changes, card reloads, researching and resolving account disputes, as well as a variety of activities supporting Automatic reloads); therefore, the TTC's Smartcard System, with its goal of improving the customer experience, will require a different level of customer support and service than what is currently offered.

The TTC's Call Centre and Customer Centre duties will expand to provide customers with a variety of smartcard related services. Details about these services are described in Chapter 9, *Concept of Operations,* Section 9.4, *Customer Services, Smartcard Account Management*. Estimating the customer service and account management related transactions and resulting labour impacts are driven by the First Level smartcard/paper limited use smartcard adoption, installation and implementation schedule, Second Level sales and reload distribution by sales channel and peer experience. These expanded services are considered new operating activities.

Revenue Collection and Reconciliation

Cash and Credit/Debit Transactions: As described in the previous section regarding Distribution, Sales and Reload by Sales Channel, estimating the number of sales and reload transactions by sales channel [vending machines, 3rd Party Ticket Agents, Call Center (both Operator Assisted and IVR), Customer Centres, Web Services and Autoload] provides the foundation for estimating the number of cash and credit/debit transactions, the revenue generated from each and the associated (credit/debit) fees. These estimates were driven by the First Level demand estimates of transactions, research of current credit/debit use in Canada, peer experience, and the TTC's credit/debit current fee structures. As of year 4 of the Implementation phase, it is estimated that there will be just over **34 million annual credit/debit transactions** for just under **$485 million (CAD)** in revenue and nearly **$6 million (CAD) in fees** (**1.2 percent** of credit/debit revenue)**.** Accepting credit/debit for the purchase of fare media is an existing business function and cost; however, the smartcard system will result in increased volume.

Revenue Collection: First Level demand estimates of transactions led to the ability to project the number of smartcards and paper limited use smartcards dispensed and the amount of cash collected at vending machines. These estimates provided the basis for estimating the number of hours required to service vending machines from collecting cash to restocking fare media and receipt tape. Servicing vending machines is an existing operating activity.

Maintenance

Failure Rates: Each type of field device – vending machine, Smartcard Reader (on each turnstile and on board each Surface Vehicle), Point of Sale (3rd Party), and Driver's Control Unit – has a failure rate tied to either the number of transactions or to the number of service hours. Labour estimates for responding to

equipment failures were derived by applying First Level demand estimates of transactions and the number of field devices against the failure rates of each type of device (per peer experience). Responding and repairing failures of field devices are existing operating activities.

Preventive Maintenance Requirement: In addition to labour required to respond and repair equipment failures, labour is required for preventive maintenance. This estimate was driven by the number of in-the-field devices, estimated frequency and time required to perform this activity. Preventive maintenance is an existing activity.

10.2 CAPITAL COSTS

The estimated capital budget for this project was segmented into three areas – 1) Equipment and Systems, 2) Modifications and 3) Program Planning and Implementation. For *Equipment and Systems* (the primary procurement), Three Point Consulting, Inc. surveyed the transit agencies that had recently procured smartcard systems and collected pricing for each of the system components described and quantified in Chapter 9, *Concept of Operations*. They also compared the functionality of all devices to ensure an apples-to-apples comparison and to help identify the devices most appropriate for the TTC's application. Added to this list of equipment and systems were the services that are typically provided by the selected equipment and systems vendor.

The second area of the capital budget, called *Modifications*, includes estimates for upgrading and/or installing the communications and power necessary for supporting the TTC Smartcard System network, equipment and other related services. Estimates of costs related to facility, network and communication modifications were provided by the TTC Engineering and Construction division. The cost of an Interactive Voice Response (IVR) system was derived by requesting an estimate from a firm specializing in IVR systems, coupled with the TTC's experience with implementing a similar type of system.

The third area of the capital budget, called *Program Planning and Implementation*, includes estimates for TTC labour and professional services dedicated to defining the project's specifications, issuing request for proposals and planning and overseeing the design, testing, training, installation, implementation of the fare collection system. It also includes an estimate for a marketing/communications program to educate and inform customers. These costs were derived by PARSONS by interviewing peer agencies, developing a project management plan and estimating the labour and other costs associated with program planning and implementation.

Equipment and Systems

Table 10.2-1, *Primary Contract - Equipment and Systems*, provides the line items and totals for Equipment and Systems for each of the eight primary business functions. For Equipment and Systems (the primary procurement), Three Point Consulting, Inc. surveyed the industry and collected pricing for each of the equipment/system components described and quantified in each of the eight business functions featured in Chapter 9, *Concept of Operations*. The total estimated cost of Equipment and Systems is **$ 100.23 million (CAD) (**including applicable taxes, mark up, contingency and change order allowance).

Table 10.2-1: Primary Contract – Equipment and Systems
(Millions)

Smartcard/Limited Use Card Management	$	23.50
Distribution, Sales and Reload		42.10
Fare Payment and Enforcement		22.50
Customer Services, Smartcard Account Management		.80
Revenue Collection and Reconciliation		1.00
Operations and Maintenance of Field Devices		.03
System Architecture and Security – Equipment		2.00
System Architecture and Security – Systems		8.30
TOTAL	**$**	**100.23**

Table 10.2-2, *Primary Contract – Other Services*, lists the other services that are typically included in an Equipment and Systems contract of this type. The total estimated cost of Other Services is **$ 42.7 million (CAD).** The grand total capital cost estimate for Equipment and Systems is **$ 142.9 million (CAD)** (including applicable taxes, mark up, contingency and change order allowance).

Table 10.2-2: Primary Contract – Other Services
(Millions)

Warranty		
Program, Project, Quality Management		
Installation		
Training		
System Administration		
Documentation/Manuals		
Field Maintenance		
Equipment and Systems Testing		
Performance Bonds/Insurance		
Non-Recurring Engineering		
Software license/upgrades		
Spares Allowance		
TOTAL	**$**	**42.7**
GRAND TOTAL EQUIPMENT AND SYSTEM	**$**	**142.9**

Service Descriptions[47]

- **Warranty**: This is a guarantee given to the purchaser by a company stating that a product is reliable and free from known defects and that the seller will, without charge, repair or replace defective parts with a given time limit and under certain conditions. The cost is a percentage of the total Equipment and Systems cost, minus fare media, with taxes and mark ups.
- **Program, Project Quality, Management**: Activities that include supervision of the vendor's project team, coordination of resources, planning, monitoring and reporting of ongoing activities to

[47] Most descriptions provided by Three Point Consulting, Inc., Toronto Transit Commission, Farecard Project, Fare Collection System Components.

the transit agency. It also includes cost/schedule tracking, clerical, quality assurance and other administrative support duties within a project. The cost is a percentage the total Equipment and Systems cost with taxes and mark ups.

- **Installation**: Activities required to install and/or to integrate the fare collection system components into the agency facilities. The cost is a percentage of the total Equipment and Systems cost, minus fare media, with taxes and mark ups.
- **Training**: Activities required for training agency staff on the use, maintenance and/or operation of the fare collection system. The cost is a fixed fee.
- **System Administration**: Activities required to configure, monitor and trouble shoot the fare collection system hardware and software applications. The cost is a fixed fee.
- **Documentation and Manuals**: Provision of technical documentation, drawings, training materials and manuals that describe how to maintain, operate and configure the system. The cost is a percentage of the total Equipment and Systems cost, minus fare media, with taxes and mark ups.
- **Field Maintenance**: Services to provide for the repair and replacement of devices for a specified window of time. The cost is a fixed fee.
- **Testing**: Performance of defined and very specific evaluations (tests) of the system components to demonstrate performance and functionality in accordance with the performance standards defined in the contract. The cost is a percentage of the total Equipment cost with taxes and mark ups.
- **Performance Bonds/Insurance**: A bond issued by an insurance company to guarantee satisfactory completion of a project by a contractor. The cost is a percentage the total Equipment and Systems cost with taxes and mark ups.
- **Non Recurring Engineering**: One-time, software development and system integration tasks which are considered to be unique for a specific project. The cost is a percentage of the total Equipment and Systems cost with taxes and mark ups.
- **Software License/Upgrades**: Permissions and rights to use software applications and the agreement to upgrade applications as new versions are released. The cost is a percentage the Systems cost with taxes and mark ups.
- **Spares Allowance**: A budget for procuring parts required for replacement, repairs and maintenance of system equipment. The cost is a percentage of the total Equipment and Systems cost, minus fare media, with taxes and mark ups. The cost is a percentage the total Equipment and Systems cost with taxes and mark ups.
- **Change Order Allowance and Contingency**: Percentage provided by the TTC Engineering and Construction division. The percentage is based on the TTC's experience of other large projects.

Modifications

As described in Chapter 9, *Concept of Operations*, Section 9.8, *System Architecture and Security*, Subway Stations, Surface Vehicle divisions, parking and other TTC facilities (such as the Call and Customer Centres) will require infrastructure upgrades, equipment and office furniture to support communication, power and service requirements of the TTC Smartcard System. Modification estimates were provided by the TTC Engineering and Construction division. The cost of an Interactive Voice Response (IVR) system was derived by requesting an estimate from a firm specializing in IVR systems coupled with the TTC's experience with implementing a similar type of system. Table 10.2-3, *Modifications*, lists the relevant cost estimates for relevant modifications. The total estimated cost of modifications is **$ 91.3 (CAD) (**including applicable contingency and allowance for change orders)

Table 10.2-3: Modifications
(Millions)

Facility modifications and infrastructure	
TTC E&C Project Management	
Performance bonds	
Interactive Voice Response System	
Interactive Voice Response Servers	
Customer Services furniture and office equipment	
Telephone/ACD Equipment	
GRAND TOTAL MODIFICATIONS	**$ 91.3**

Modifications Descriptions

- **Facility Modifications and Infrastructure**: See Chapter 9, *Concept of Operations*, Section 9.8, *System Architecture and Security*, for further information. This is the cost of infrastructure upgrades, equipment and office furniture to support communication, power and service requirements.
- **TTC E&C Project Management**: The estimated cost of managing the facility modifications and infrastructure project by the TTC's Engineering and Construction division.
- **Performance Bonds**: A bond issued by an insurance company to guarantee satisfactory completion of a project by a contractor. The cost is a percentage the Facility Modifications and Infrastructure cost.
- **Interactive Voice Response System**: The design of this automated call center system as described in Chapter 9, *Concept of Operations*, Section 9.4, *Customer Services, Smartcard Account Management.* The cost was estimated by a company specializing in IVRs, plus additional cost provided by the TTC communications division of IT.
- **Interactive Voice Response Servers**: Servers dedicated to supporting the IVR application. The cost reflects the experience of the TTC Information Technology (IT) division.
- **Customer Services furniture and office equipment**: Furniture and office equipment for the expanded Call and Customer Centres. Estimation is a fixed amount per employee.
- **Telephone and ACD Equipment**: Communications equipment for the expanded Call Centre. Estimated cost was supplied by the TTC communications division of IT.

Program Planning and Implementation

This area of the capital project budget provides estimates for the TTC labour and external professional services enlisted to define project specifications, issue the request for proposal and plan and facilitate the design, testing, training, installation and implementation of the fare collection system. It also includes an estimate for a marketing/communications program to educate and inform customers. Table 10.2-4, *Program Planning and Implementation*, lists the relevant cost estimates. The total estimated cost of Program Planning and Implementation is **$ 28.3 (CAD).**

Table 10.2-4: Program Planning and Implementation
(Millions)

Program Management Team	
Train the Trainer	
Contracted IT Support	
Professional Services	
Marketing/Communications	
TTC Forces Supervision on Equipment Installation	
Overhead	
GRAND TOTAL PROGRAM PLANNING AND IMPLEMENTATION	**$ 28.3**

Program Planning and Implementation Descriptions

- **Program Management Team**: Estimates for Project Management Team labour and for training were derived from the best practices of and lessons learned from other transit agencies. More details are provided in Chapter 12, *Project Management and Next Steps*.
- **Train the Trainer**: Estimates were derived from the recommendation provided in Chapter 12, *Project Management and Next Steps.*
- **Contracted IT Support**: Estimates for contracted Information Technology (IT) Support were based on the details of Chapter 9, *Concept of Operations,* Section 9.8, *System Architecture and Security* and provided by the TTC's IT division.
- **Professional Services**: Estimate for professional services was based on surveys of other transit agencies. Services may include providing experienced support, analyses, and guidance throughout the project initiation, planning, design reviews, testing, installation and implementation. More details are provided in Chapter 12, *Project Management and Next Steps*.
- **Marketing/Communications**: Estimate for Marketing/Communications was based on surveys of other transit agencies.
- **TTC Forces Supervision on Equipment Installation**: Estimate for equipment installation and testing oversight by the TTC staff and provided by the TTC's IT division. This estimate is a percentage of equipment installation and testing.
- **Overhead**: Estimate provided by the TTC, based on past experience. Costs may include office space, furniture, utilities, office equipment, services and supplies, etc.

Table 10.2-5, *The TTC Smarcard System – Estimated Capital Cost*, provides the grand total of all three areas of the capital project, including Federal Tax rebate:

Table 10.2-5: The TTC Smartcard System – Estimated Capital Cost
(Millions)

Equipment and Systems	**$ 142.9**
Modifications	**91.3**
Program Planning and Implementation	**28.3**
Sub Total	**$ 262.5**
GST Rebate	**(13.6)**
GRAND TOTAL CAPITAL COSTS	**$ 248.9**

10.3 PROJECTED OPERATING COST

The process for projecting the annual operating costs for the TTC's Smartcard System included documenting the labour and other costs related to operating the TTC's existing fare collection system (see Chapter 6, *Overview of the TTC's Current Fare Collection System)*. The TTC Smartcard System was then framed and the concept of operations defined. From this concept, productivity and other cost metrics were researched, estimates calculated (see Section 10.1, *Summary of Demand Estimates).* The staff evaluated the estimates and augmented or refined. All were compiled to form the fare collection operating costs. These costs could then be compared to the current state.

Table 10.3-1, *Operating Costs of Fare Related Activities and Services – Current State vs. TTC Smartcard System*, compares the current fare collection operating costs with the TTC Smartcard System.

Table 10.3-1: Operating Costs of Fare Related Activities and Services
Current State vs. TTC Smartcard System
(Millions)

CONSOLIDATED ANNUAL OPERATING COSTS - CURRENT			CONSOLIDATED ANNUAL OPERATING COSTS - PROJECTED		
Total	**$**	**53.7**	**Total**	**$**	**65.2**
			Net Change from 2006	**$**	**11.5**

(CAD)

INTENTIONALLY LEFT BLANK

Table 10.3-2, *Operating Costs of Fare Related Activities and Services by Division – Current State vs. TTC Smartcard System*, compares the current fare collection operating costs by division with the estimated costs by division in the TTC Smartcard System. It also includes a comparison of fare media costs.

Table 10.3-2: Operating Costs of Fare Related Activities and Services by Division[48]
Current State vs. TTC Smartcard System
(Millions)

ANNUAL OPERATING COSTS BY DIVISION - CURRENT		ANNUAL OPERATING COSTS BY DIVISION - PROJECTED	
Revenue Operations	$ 9.8	Revenue Operations	$ 7.8
RSEM	0.55	RSEM	3.36
Subway Transportation	32.53	Subway Transportation	28.05
Customer Service	1.23	Customer Service	4.57
IT Services	-	IT Services	4.65
Other Fare Related Costs		Other Fare Related Costs	
Fare Media	6.09	Fare Media	7.66
Financial Services	3.49	Financial Services	8.16
Fare Enforcement	0.04	Fare Enforcement	0.98
Total	**$ 53.7**	**Total**	**$ 65.2**
		Net Change from 2006	**$ 65.2**

(CAD)

The annual operating fare collection costs for the TTC Smartcard System are estimated to be approximately $ 11.5 million *greater* than the current fare collection costs. The following describes the most significant impacts:

Revenue Operations: It is projected that the annual budget of this division will be *reduced* by $ 2.0 million. The reasons include the following:

- Decreased labour for supplying the sales chain with fare media. If Collectors no longer sell fare media and/or reload smartcards, labour requirements for delivering fare media will be reduced.

[48] Only budget items affected by implementing a smartcard system were included in this analysis.

- Decreased labour for picking up unsold fare media. Smartcards have no shelf-life like the current monthly and weekly Metropasses; therefore, the TTC will not have to collect unsold fare media as they do today.
- Decreased labour for shredding unsold fare media. Since smartcards have no shelf-life, there will be no need to shred smartcards.
- Decreased labour as a result of the reduction in the numbers of Subway equipment (Token Vending Machines, Turnstiles and Collector Booth fareboxes) requiring revenue and token collection.
- Decreased labour as a result of the reduction in cash processing due to increase in credit/debit transactions.
- Decreased labour as a result of reduction in the number of Subway equipment requiring cash, currency and token collections.

Revenue Security and Equipment Maintenance (RSEM): It is projected that the annual budget of this division will *increase* by $ 2.8 million. The primary reason includes maintenance and repairs on a greater number of field devices. Additional equipment will include Driver Control Units**,** 3rd Party Ticket Agent Point of Sale devices, vending machines, Smartcard Readers (includes parking), Multipurpose Point of Sale devices, and high speed Smartcard Initialization and Encoding and Point of Issue Machine. There will be approximately 7,000 field devices (not including fareboxes) in the TTC Smartcard System versus approximately 800 (not including fareboxes) now.

Subway Transportation: It is projected that the annual budget of this division will *decrease* by $ 4.5 million. The introduction of additional purchase options (web services, autoload, vending machines, etc.) should virtually eliminate the long line ups currently experienced at the end of the month for Metropass sales. Demand estimates show that there should no longer be a need for "second sales booths" to be staffed at the end of the month. Also, the elimination of tickets and the introduction of the paper limited use smartcard will enable all customers to use all turnstiles thereby eliminating the need for "crash" gates. If Collectors are no longer required to sell fare media, travel balance and shortage allowances will no longer be required.

Customer Services: It is projected that the annual budget of this division will *increase* by $ 3.3 million. The increase represents the expansion of Call and Customer Centre services to support smartcard account management activities as described in Chapter 9, *Concept of Operations*, Section 9.4, *Customer Service, Smartcard Account Management*.

Information Technology (IT): It is projected that the annual budget of this division will *increase* by $ 4.6 million. The reasons for this increase include managing the Central System and the data communications network as described in Chapter 9, *Concept of Operations*, Section 9.8, *System Architecture and Security*. Additional positions will include system/database administration, server management, web development, network, system security and telecommunications administration, help desk and lab support.

Other Related Costs:

- *Fare Media*: It is projected that the annual budget of this operating expense will *increase* by $ 1.6 million. This increase represents the combined effect of the decrease of the cost of eliminating the current fare media with the higher cost of plastic smartcards and paper limited use smartcards (annual cost of paper limited use smartcards is estimated to be nearly $6 million).
- *Financial Services*: It is projected that the annual budget of this division will *increase* by $ 4.7 million. The increase is primarily related to the estimated $6 million in annual bankcard fees associated with credit/debit sales transactions and reviewing bank settlement reports. These costs are offset some by expected decreases in 3rd Party commissions and Armoured Car services no longer necessary. Currently, the TTC accepts credit and debit at only four Subway booths and debit card at only 10 Pass Vending Machines. In the TTC Smartcard System

credit/debit cards will be accepted at all vending machines, through the Call and Customer Centres, Web and Autoload services.

- *Fare Enforcement*: It is projected that the annual budget of this division will *increase* by $936 thousand. The increased risk of misuse of Concession fares may require a higher level of fare enforcement than now. Currently, approximately 20 percent of fares are paid at turnstiles (i.e. no visual inspection); however, in the TTC Smartcard System this could rise to 40 to 50 percent. Also, the TTC is investigating new low-floor streetcars, with multiple door access, and this would also result in additional enforcement requirements.

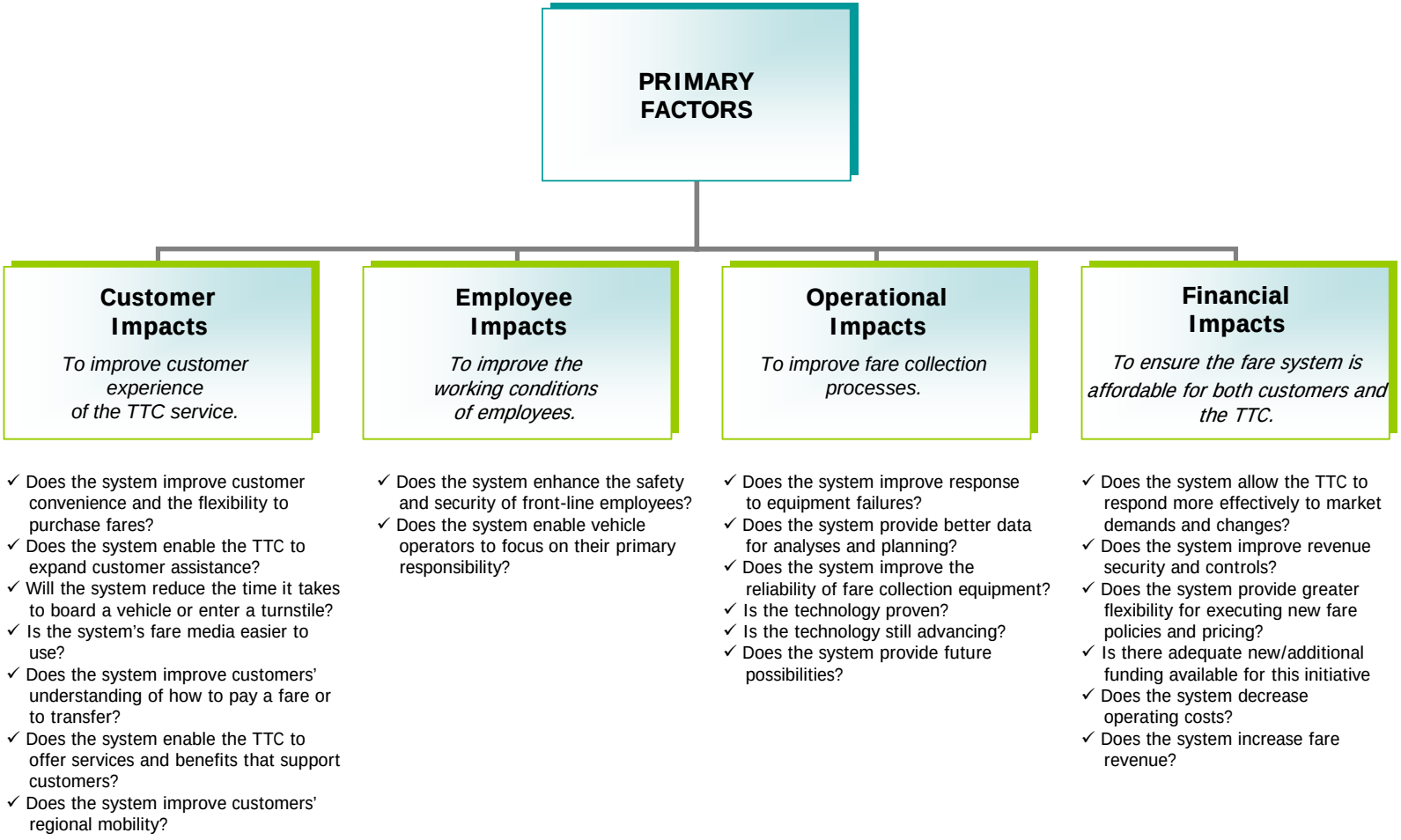
Chapter 11, *The TTC Smartcard System Assessment*, weighs the TTC Smartcard System against the goals and criteria listed in Chapter 7, *Goals and Evaluation Criteria of the TTC Smartcard System*.

11.0 THE TTC SMARTCARD SYSTEM ASSESSMENT

This chapter assesses the TTC Smartcard System by each of the criteria introduced in Chapter 7, *Goals and Evaluation Criteria of the TTC Smartcard System.* As discussed in Chapter 7, the factors for assessing the model, along with each factor's related criteria, were developed and defined jointly by the Smartcard Project Team and other TTC staff as well as from information drawn from interviews and reviews of the peer agencies presented in Chapter 4, *Experience of Other Cities and Transit Agencies.* They reflect the desired goals of the TTC. Exhibit 11.0-1, *Primary Evaluation Factors and Related Criteria*, presents an overview of the primary factors and their criteria.

INTENTIONALLY LEFT BLANK

Exhibit 11.0-1: Primary Evaluation Factors and Related Criteria



Tables 11.0-2 – 5, *The TTC Smartcard System Assessment*, presents an assessment of each primary factor – *Customer Impacts, Employee Impacts, Operational Impacts and Financial Impacts* -- by answering the relevant questions.

Table 11.0-2: The TTC Smartcard System Assessment – Customer Impacts

CUSTOMER IMPACTS				
TO IMPROVE CUSTOMER EXPERIENCE OF THE TTC SERVICE.	**YES**	**NO**	**NOT KNOWN**	**COMMENTS**
Does the system improve customer convenience and flexibility to purchase a fare?	√			The system will expand channels for customers to obtain and reload a card. These will include debit and credit accepting vending machines in all Subway Stations and Surface Platforms, Call and Customer Centres, Web Services and Automatic Reload services. The automated reload channels will be especially more convenient for people with disabilities. They may reload their card from their phone or by web or authorize automatic reloads instead of interacting with a vending machine or traveling to a sales outlet. Debit/credit capability will be a significant improvement to customer convenience, because this is a very limited option at TTC. Both CTA and MARTA offer all of these services. MBTA will offer all within the next year.
Does the system enable the TTC to expand customer assistance?	√			Installing vending machines in all Subway Stations enables the TTC to redefine the duties of the Station Collectors from selling and inspecting fare media to providing customer assistance in other ways. In addition, the TTC plans to expand Call and Customer Centre services. Both CTA and MBTA redefined the duties of in-station ticket sellers to more customer-focused responsibilities. The ticket sellers now assist customers at the vending machines and turnstiles.
Will the system reduce the time it takes to board a vehicle or enter a turnstile?	√			Studies have shown that using smartcards can speed boarding time and throughput at turnstiles. A smartcard can be read in a fraction of a second compared to swiping a magnetic card (like a TTC Metropass) or inserting a token into turnstile. Customers will no longer need to line up at a Collector's booth to pay with a ticket and/or show a paper transfer, they can use any turnstile, so subway boarding should be faster. Smartcards and paper limited use smartcards will enable multiple-door boarding on surface vehicles and this will also speed up boarding time.
Is the system's fare media easier to use?	√			Tapping a smartcard to a reader is easier than trying to orient a magnetic pass through a swipe reader or taking coins/tokens out of a purse or pocket to drop in acceptors. CTA found that people with disabilities prefer using a smartcard over magnetic fare media, tokens and even cash.

CUSTOMER IMPACTS				
TO IMPROVE CUSTOMER EXPERIENCE OF THE TTC SERVICE.	**YES**	**NO**	**NOT KNOWN**	**COMMENTS**
Does the system improve customers' understanding of how to pay a fare or to transfer?	√			The current TTC fare payment processes are very easy to understand. Transition to a smartcard system will require effective information and outreach campaigns to teach customers how to use smartcards. This will take time and effort; however, transit agencies, with smartcard systems, have executed very effective tactics for communicating how to use a smartcard. "*Tap and go*" is a simple process compared to "tickets go in the farebox, tokens go in farebox and/or turnstile, pass is swiped or flashed". Plus, the current paper transfers can be confusing. Electronically encoding a transfer's validity period on a smartcard should be easier for customers.
Does the system enable the TTC to offer services and benefits that support customers?	√			The TTC Smartcard System will give customers the security of Balance and Negative Protection and the convenience of Automatic Reloads. Balance protection upon loss of smartcard will be a significant bonus for customers. Plus, the system will make more customers eligible for Federal Tax credits and will generate annual receipts to submit for these credits.
Does the system improve customers' regional mobility?			√	The TTC Smartcard System will present the opportunity to be interoperable with the Greater Toronto Area Fare System which will enable TTC customers to more easily and seamlessly transfer between Transit Providers. However, further discussions/analyses are required to determine if the GTAFS can be modified to meet the TTC's business needs. Smartcard systems can facilitate inter-regional interoperability. MARTA's Breeze system is currently being rolled out to the customers of regional operators.

MARTA recently conducted a survey of Breeze Card (smartcard) customers to measure satisfaction with the new system. The following provides a summary of the key finding as submitted in the executive summary of findings[49]:

[49] MARTA, Breeze Communications, Customer Survey Key Market Findings, March 8, 2007.

Key finding #1: Customers like Breeze!

- On a scale of 1-10 (10 being the best), nearly a third rated Breeze as a 10!
- More than half rated Breeze as an 8, 9 or 10.
  - This holds true across payment type – and is even slightly higher among Half-Fare customers (Senior/Disabled)
  - It holds true for dependent riders
  - It holds true across train and bus-train customers – and 45% of bus-only
  - It holds true across rider frequency
- The number of 8-10 ratings goes up to 75% for those who have used the card more than 10 times
- Nearly 2/3's of the people unhappy with the system (rating of 5 or less) have never used the card
- Features customers like most (unaided) are, in order, no need to carry cash/exact change, ease of use, speed, reliability and security of gates.
- Nearly 1/3 got a Breeze Card because it is a more convenient way to pay.
- Of customers who have used the card, nearly 50% have used it more than 10 times.
- 35% could not think of one negative about the Breeze system – and 53% could not think of any feature they would add to the system.

Conclusion: ***Will the TTC Smartcard System improve the customers' experience?*** **YES**

Table 11.0-3: The TTC Smartcard System Assessment – Employee Impacts

EMPLOYEE IMPACTS				
TO IMPROVE THE WORKING CONDITIONS OF EMPLOYEES.	**YES**	**NO**	**NOT KNOWN**	**COMMENTS**
Does the system enhance the safety and security of front-line employees?	√			Currently Surface Vehicle operators must validate Metropasses, Day Passes and Transfers visually. In the TTC Smartcard System, these products will be encoded on smartcard. As a customer boards, they will tap the card to the Smartcard Reader. The reader will validate the product, not the operator. This validation will no longer rest on the Operator, thereby reducing intervention and reducing the opportunities for disputes and conflict. The automation of fare payments was one of the recommended improvements identified by the TTC's Operator Assault Task Force. The expanded fare purchase options (Call Centre, Web Services, Autoload) and the introduction of debit/credit accepting vending machines will significantly reduce the amount of cash within the subway system, thereby improving the safety and security of employees. Station Collectors will no longer sell fare media and handle cash. This reduces their risk of assault and robbery.
Does the system enable vehicle operators to focus on their primary responsibility?	√			Reducing visual inspections of fare media will enable vehicle operators to focus on their responsibility of safely transporting people.

Conclusion: ***Will the TTC Smartcard System improve working conditions of employees?*** **YES.** Front-line employee safety is an over-arching benefit that is given greater weight in this assessment. As mentioned in Chapter 6, *Overview of the TTC's Current Fare Collection System,* the 2005 Report on Operator Assaults found that both transfer and fare disputes are the main causes of assaults and that seven out of ten Operators state that they have been assaulted during their career.

Table 11.0-4: The TTC Smartcard System Assessment – Operational Impacts

OPERATIONAL IMPACTS				
TO IMPROVE FARE COLLECTION PROCESSES.	**YES**	**NO**	**NOT KNOWN**	**COMMENTS**
Does the system improve response to equipment failures?	√			The TTC Smartcard System will include a field device monitoring system. This system will provide continuous monitoring, reporting, troubleshooting, and automated response capabilities. The application is generally configured to send an alarm to a pager or e-mail address with the device name, location and error message. Maintenance staff in-the-field can respond immediately to the alarm. In recent interviews with both MARTA and NYCT representatives expressed that the monitoring system has improved the ability to quickly identify and respond to equipment issues. In addition, knowing what type of issue it is aids with preparing and taking the right tools for the job.
Does the system provide better data for analyses and planning?	√			A smartcard system provides automated data collection. Each sale or reload of a card and each fare payment transaction are collected and transmitted to the central system. Reports are available to show what was purchased or reloaded, the amount, what type of fare medium was used, the customer classification, when and where paid, etc. and since smartcard system data collection does not rely on manual entries opportunities for errors are greatly reduced. The automated data collection will improve accuracy and integrity of data and the reporting system will allow service planners and decision-makers to run analyses of many different factors.
Does the system improve the reliability of fare collection equipment?			√	Currently, there are no significant reliability issues with the TTC's existing fare collection equipment. In fact, in the TTC Smartcard System, there will be a significant increase in the number of field devices (vending machines, Point of Sale devices, Smartcard Readers, Driver Control Units). This increase will present many more opportunities for reliability issues and equipment failures than currently. However, the reduction of cash in the system and replacement of older cash-only token vending machines with debit/credit only add-value machines should improve equipment reliability for the longer-term. Current token vending machines can be out-of-service for long periods of time unless a customer reports the failure and/or regular maintenance is required.

OPERATIONAL IMPACTS				
TO IMPROVE FARE COLLECTION PROCESSES.	**YES**	**NO**	**NOT KNOWN**	**COMMENTS**
Is the technology proven?	√			Smartcard fare collection has been applied throughout the industry for 10 years starting with the deployment of Hong Kong's Octopus card. Since then, transit agencies throughout the world have followed suit. There are currently 17 smartcard projects in various stages of planning and deployment in North America alone.
Is the technology still advancing?	√			The technology has evolved over the last decade to better meet the requirements of public transit, but it is now being deployed throughout other industries such as bankcard and wireless. As a result, it is very likely the technology will continue to evolve and advance. There is waning interest in continuing to invest in the advancement of magnetic technologies.
Does the system provide future possibilities?	√			As reviewed in Chapter 5, *Emerging Trends*, transit agencies are piloting new smartcard programs with both bankcard and wireless industries. Building partnership and relationships with these industries hold great promise for improved efficiencies and customer service.

INTENTIONALLY LEFT BLANK

Table 11.0-5: The TTC Smartcard System Assessment – Financial

FINANCIAL IMPACTS				
TO ENSURE THE FARE SYSTEM IS AFFORDABLE FOR BOTH CUSTOMERS AND THE TTC.	**YES**	**NO**	**NOT KNOWN**	**COMMENTS**
Does the system allow the TTC to respond more effectively to market demands and changes?	√			The smartcard infrastructure, an automated, software driven technology, provides the ability to react quickly and to leverage opportunities.
Does the system improve revenue security and controls?	√			Some current forms of evasion and misuse will be eliminated in the smartcard system (such as fare media forgeries, duplication, transfer misuse and pass back of Metropasses); however, the sale of Concession paper limited use smartcard single trips at Full Service Vending Machines may increase the risk of non-qualified Concession fare purchases. There is also the opportunity to misuse Concession smartcards. It will be easier within the smartcard system to misuse concession cards. This is one of the reasons fare enforcement will be stepped up in the smartcard system. The smartcard system will provide mechanisms to protect the TTC from fare misuse and fraudulent transactions. A Fraud Analysis system will analyze transactions collected by the system and report anomalies such as value loads by unauthorized devices, card balance irregularities, card distribution and sales anomalies. The system will also provide the capability of hotlisting (blocking or cancelling) cards in violation of establishing transaction rules.
Does the system provide greater flexibility for executing new fare policies and pricing?	√			Fare table and business rules will reside in the TTC Smartcard Central System. Fare tables and business rules may be changed to execute new strategic initiatives and policies and then downloaded to field equipment in very timely manner. The TTC will no longer have to “purge” the system of fare media products to initiate changes. A change in fare pricing will merely require a change in the system’s fare tables and the new fare will then be deducted from the smartcard E-Purse. In addition, automation and the paper limited use smartcard provide opportunities for offering “special event” ticketing for City-wide and/or localized community events etc and pricing (smog days, Taste of the Danforth) etc.

FINANCIAL IMPACTS				
TO ENSURE THE FARE SYSTEM IS AFFORDABLE FOR BOTH CUSTOMERS AND THE TTC.	**YES**	**NO**	**NOT KNOWN**	**COMMENTS**
Is there adequate new/additional funding available for this initiative			√	In May 2004, all three levels of government (Federal, Provincial and City of Toronto) jointly announced equal 1/3 contributions toward $140 million, ear-marked for an integrated ticketing system for the TTC. The estimated capital cost for this project is $248.9 million, so the question is *will the same funding commitment be made now that a more detailed business case has been completed and the capital cost updated*? This is not known. Further, it was announced that all agencies must "demonstrate participation" in the GTA Fare System project to be eligible to receive Provincial dedicated gas tax refunds. Chapter 4, *Experience of Other Cities and Transit Agencies,* the funding strategies of MARTA, MBTA and Transport of London were reviewed.
Does the system decrease operating costs?		√		It is estimated that there will be an annual increase in the TTC's fare collection operating costs of approximately $11.5 million. MARTA found that the smartcard system required an increase in IT and Customer Service staff, but a reduction in Revenue Collections and Maintenance. The smartcard system delivers significant maintenance savings to MARTA because it is much more reliable and in better condition than the aging magnetic system. As reviewed in Chapter 4, *Experience of Other Cities and Transit Agencies*, faregates, token machines, magnetic readers were all failing – replacement parts were no longer available, vandals could easily break into faregates and token vending machines (and did so quite often), and magnetic transports on the faregates and swipes on the bus failed often. MARTA's operating budget was going to be negatively impacted by the increased cost of fare media; however, the expense will be offset by charging $5.00 for the issuance and/or replacement of a plastic Breeze Card and $0.50 surcharge on the purchase of a paper limited use smartcard (Breeze Ticket).
Does the system increase fare revenue?			√	Both CTA and MARTA claim to have realized increases in revenue since the deployment of their systems. The CTA credits the fare collection system for the increase in revenue, but the basis for this has not been fully disclosed or examined; MARTA stops short of giving the Breeze system credit; however, officials will credit the system for more accurate reporting of ridership.

Conclusion: ***Will the TTC Smartcard System ensure the fare system is affordable for both customers and the TTC?*** **NOT KNOWN,** The TTC Smartcard System will cost approximately $250 million in capital and there is an estimated increase of $11.5 million in annual operating costs. The TTC cannot support this initiative (capital or operating) without additional funding. Political funding partners will need to address this question, to determine if "new/additional" funding is available for this initiative.

11.1 RISKS

There are risks inherent with a smartcard fare collection project. Many of the following risks have been managed/overcome by the other agencies, but, nonetheless, it is important to list them. The following presents a summary of the primary risks:

- **Data security**: Financial and customer data will reside in the Central System. Security of this data will be imperative. The responsibility for staying up-to-date on and executing the appropriate security precautions will need to be managed/addressed by the Information Technology division of the TTC.
- **Privacy**: The TTC will need to consider policies that protect the personal information customers submit.
  - Policies prohibiting employees from accessing or disseminating customer information for non TTC related reasons
  - Policies directing how the TTC can and cannot use customer data
  - Procedures for file management and document control
  - Procedures for how , where and how long transactional data is stored and how is it purged
  - Procedures/policies for providing the information to law enforcement authorities
- **Proprietary Systems:** The complex nature of smartcard systems and the fact that standards have not yet been fully defined for devices and systems, it is important for agencies to be extra vigilant of and make every effort to avoid the pitfalls of getting locked into proprietary technology. This can be very costly and limiting. To the extent possible, systems must be open and interoperable.
- **Banking Rules and Payment Card Standards:** The TTC will need to stay current with rules that regulate stored value and the acceptance of credit and debit card payments. Standards are discussed in Chapter 8, *Overview of the TTC Smartcard System,* Section 8.3*, Summary of Improving the Customer Experience;* Chapter 9, *Concept of Operations*, Sections 9.5 Revenue Collection and Reconciliation and 9.8, System Architecture and Security. The current standards will be made available to the TTC IT division to review.

11.2 FINAL REPORT CARD

Table 11.2-1, *Final Report Card,* presents a summary of the assessment by goal.

Table 11.2-1: Final Report Card

GOAL	YES	NO	MIXED	COMMENT
Will the TTC Smartcard System improve the customer experience of the TTC?	√			It improves customer convenience and the flexibility to purchase fares. It enables the TTC to expand customer assistance. It reduces the time it takes to board a vehicle or enter a turnstile. The fare media is easier to use. If communicated effectively, the system should improve customers' understanding of how to pay a fare or to transfer. It enables the TTC to offer services and benefits that support customers. It could improve customers' regional mobility.
Will the TTC Smartcard System improve working conditions of employees?	√			It enhances the safety and security of front-line employees. It enables vehicle operators to focus on their primary responsibility.
Will the TTC Smartcard System improve fare collection processes?			√	It improves response to equipment failures. It provides better data for analyses and planning. It is not known whether the reliability of fare collection equipment will be improved. The technology is proven. The technology is still advancing. It provides future possibilities.
Will the TTC Smartcard System be affordable for both customers and the TTC?			√	It allows the TTC to respond more effectively to market demands and changes. It improves revenue security and controls. It provides greater flexibility for executing new fare policies and pricing. It is not known whether there is adequate new/additional funding available for this initiative. The system does not decrease operating costs. It is not known whether the system will increase fare revenue.
CONCLUSION				**The TTC Smartcard System achieves the goals of improving customer experience, employee working conditions and fare collection processes; however, it is not known whether new/adequate funding can be obtained.**

12.0 PROJECT MANAGEMENT AND NEXT STEPS

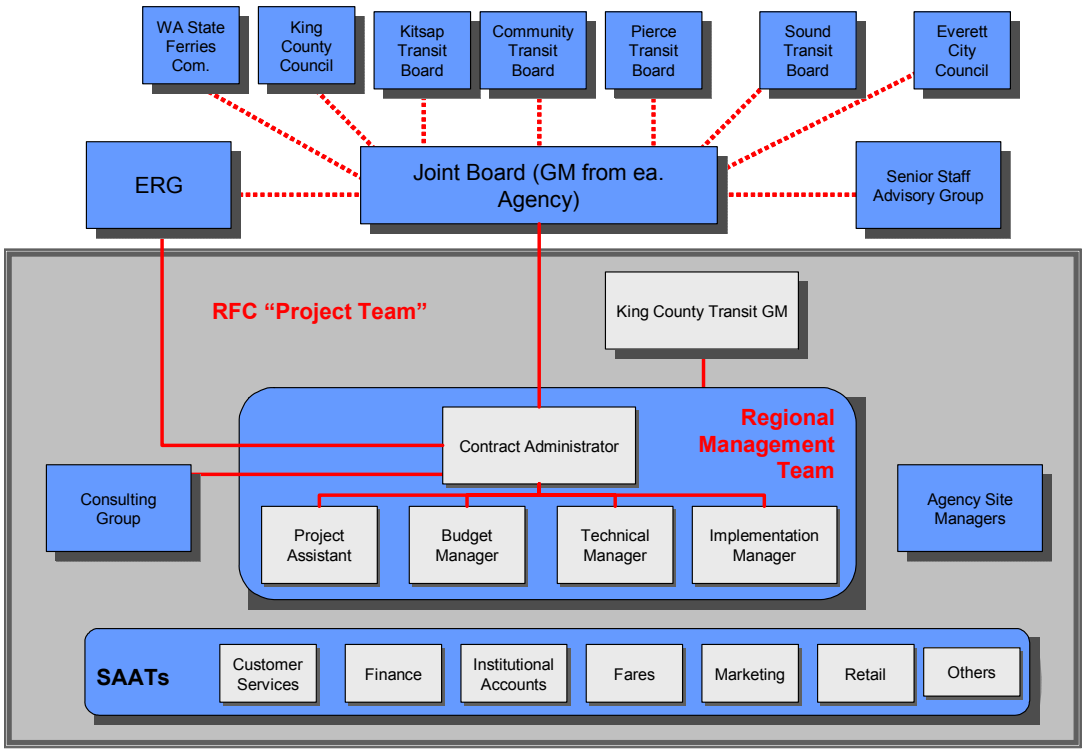
In Chapter 9, *Concept of Operations*, Section 9.9, *Installation and Implementation Schedule,* a schedule outlining a possible time-line for installing equipment and implementing the TTC Smartcard System is presented. In this chapter (Chapter 12), another schedule is presented, but this one represents a project planning schedule which includes next steps. The chapter starts with a review of project management models of three peer agencies and, from their lessons learned and best practices, provides a recommended model for the TTC's consideration. After this recommendation, and assuming the TTC Smartcard System is approved, the chapter closes with likely next steps.

12.1 CENTRAL PUGET SOUND – SPECIAL PROJECT TEAM WITH SUBJECT AREA EXPERTS

Exhibit 12.1-1, *Central Puget Sound Project Management Structure*, provides an overview of the project organizational structure. The members of the Regional Management Team are employed by King County; however, the cost of salaries is shared regionally. Members of the Subject Area Advisory Team (SAAT) are employees of different regional agencies and salaries are paid by each employee's "home" agency. While this structure was set up for planning and implementing a regional system, the model has relevancy for the TTC's consideration.

The way this structure works is that there is a separate and full-time work group called the Regional Management Team. It oversees the planning and implementation of the project. The SAATs support this Management Team by developing and executing process plans for the primary business functions affected by the new fare collection system (and not assumed by the contractor). In addition, the members of the SAATs are involved in reviewing and evaluating system design plans and providing oversight for implementation of the processes. Also providing support to the Regional Management Team a contracted Professional Services (Consulting Group).

Exhibit 12.1-1: Central Puget Sound Project Management Structure



Advantages

- This project management structure features a team of full-time staff dedicated to seeing the project through from start to completion.
- Enlisting Subject Area Advisors for relevant process planning ensures that the changes in business functions are complete and that employee development will be appropriate to these changes.

Disadvantages

- Functional specialization can lead to a fragmented perspective of the whole project.
- It can promote internal rivalries and conflict rather than a strong sense of team and cooperation.
- Functional specialization can make it difficult to set appropriate priorities for the organization. Specialists may attach more importance to what's best for their area than to what's best for the whole business.

The Contract Manager recently gave a presentation about the project, the experience and lessons learned. Below lists the lessons specifically related to the management of this project:

Lessons Learned

- *The technical, procedural, and organization complexity of implementing a regional fare collection project suggests the* ***need to plan for greater time, cost****, and management challenges than might be expected. Allow adequate time for document reviews, legal reviews, meetings, technical integration, interaction with the vendor, and management oversight.* ***Organizational flexibility is a key success factor****.*
- ***Enlist legal advisory team*** *to assist with the many significant legal issues that arise during the course of planning and implementing such a high profile project such as Request for Proposal preparation, contract negotiations, change amendments, intellectual property, indemnification, performance bonds, privacy issues, banking regulations on stored value, escheatment laws, etc.*

During an interview with the Contract Manager for this document, she added/emphasized the following lessons:

- *SAATs expected more support from the Regional Management Team than they had staff and time to adequately provide.*
- *Be flexible enough to allow the project management structure to adjust as necessary.*
- *As changes to business strategies and elements of design are considered,* ***be sure to research and measure the potential impacts to policies before making decisions****.*

12.2 METROPOLITAN AREA RAPID TRANSIT AUTHORITY – PROGRAM MANAGER AND MATRIX MANAGEMENT STRUCTURE

Exhibit 12.2-1, *MARTA Program*[50] *Management Structure*, provides an overview of this authority's organizational structure. Their preferred approach was based on the principles of Matrix Management. Planning and implementation activities were intended to be organized by and allocated to functional area teams, led by the directors of each functional area. The functional directors were to control their area's deliverables and staff resources. The Program Manager, a position of lower authority than the directors, was responsible for overseeing the cross-functional aspects of the project. One of the primary

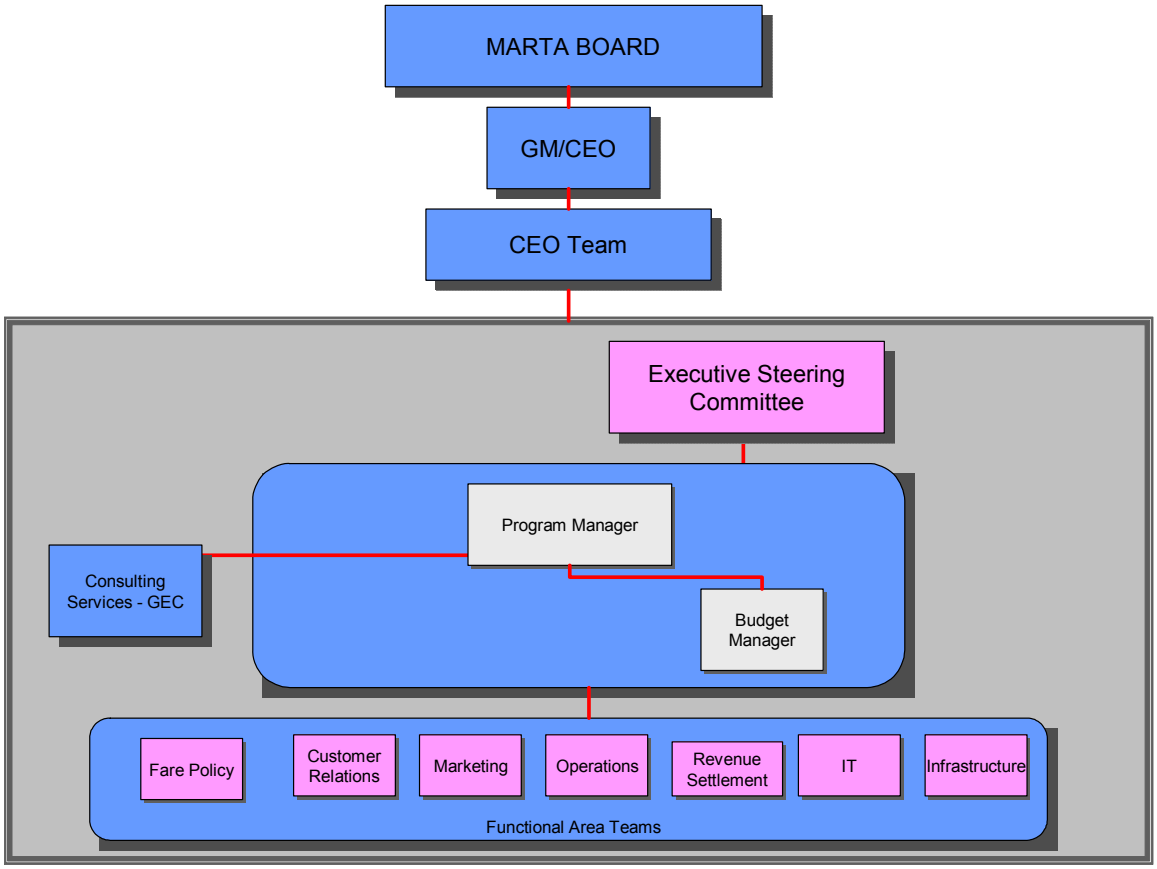
[50] MARTA chose to use the term *program rather than project,* but they are interchangeable.

responsibilities of the Program Manager was to alleviate communication issues between oft competing directors and to track overall project progress.

The Executive Steering Committee was comprised of three appointed directors and its role was to provide program oversight and decision-making support. This Committee intended and perceived the role of the Program Manager to be stronger than perceived by some of the directors of the functional teams. As a result, the Program Manager was seated between two competing and conflicting perceptions. The Executive Steering Committee was later dissolved and replaced by the CEO Team (a group consisting of the GM/CEO and all Assistant General Managers).

The Program Manager and the Budget Manager (white boxes) are the only employees fully dedicated to the project; however, the Program Manager did have access to professional services support from the General Engineering Contractor (GEC).

Exhibit 12.2-1: MARTA Program Management Structure



Advantages

- Matrix Management structure allows each key functional area, impacted by the system, to be given specific attention.
- If the organization's culture is truly built on the Matrix Management principles, many will feel a strong sense of ownership of the project and confident that their concerns, ideas are heard.

Disadvantages

- Matrix Management structure can be complex to manage and difficult to maintain a balance between two lines of authority.
- It can be especially difficult for the Program Manager if s/he is subordinate to chairs of the functional teams.
- It is difficult to move quickly and decisively when it's necessary to get clearance from so many.

Lessons Learned

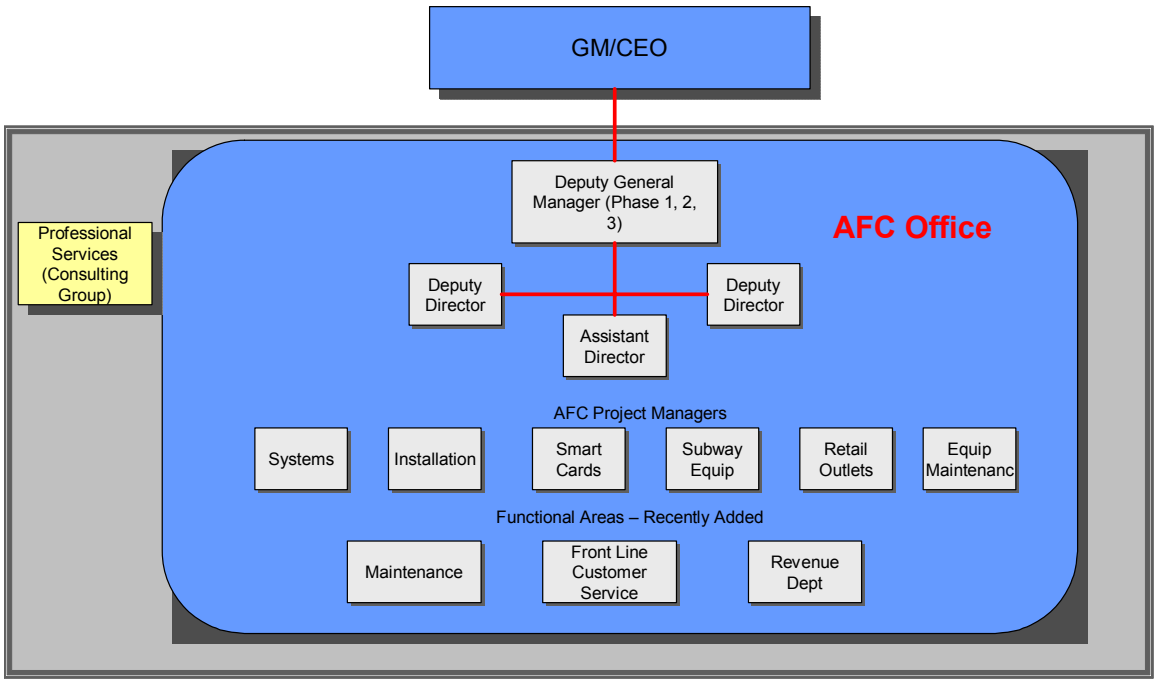
- Business vision and goals should be formed before initiating teams.
- A schedule of tasks cannot be developed without business plans.
- The Executive Steering Committee should hold teams to their commitments. Employee performance on the program should be included in their annual evaluation.
- Record and manage the minutes of every meeting related to the program. Record and track decisions and action items.
- Make informed decisions about changes to equipment/system specifications or business strategy.

12.3 MASSACHUSETTS BAY TRANSPORTATION AUTHORITY – ESTABLISHMENT OF A DEDICATED FARE COLLECTION OFFICE WITH PHASED MANAGEMENT STRATEGY

Exhibit 12.3-1, *MBTA's Project Management Structure*, is a view of MBTA's project organizational structure. This Authority chose to establish a separate Automated Fare Collection (AFC) Office – a self-contained group whose primary mission is to complete the project successfully. The office of 10 full time staff members included employees hired from within MBTA as well as from outside the Authority. This office also recently assumed responsibility and oversight for three functional areas – Maintenance, Front Line customer service staff (individuals with the same responsibilities as Collectors – inside booths before the new system, outside after new system), and Revenue Department (except money processing).

While the AFC Office has dedicated, full-time staff, there are often times when the office requires support and resources from other functional areas. In this case, work orders are prepared and labour and resources are estimated and purchased from these functional areas.

Exhibit 12.3-1: MBTA's Project Management Structure



Three Distinct Phases – Three Distinct Project Managers

MBTA management identified three phases to this fare collection project and, with each phase, installed a manager who had the knowledge and skills appropriate for the phase. In addition, the Authority decided that, given the magnitude and extended reach of a fare collection project, each of these managers would be a high level staff executive (Deputy General Manager) with influential leadership characteristics and decision-making powers. The following summarizes the three phases and relevant skills and knowledge of the Deputy General Manager placed in each phase:

1. *Internal Support, Contractor Selection, Design and Testing*: This phase requires a leader who is not only charismatic and influential but has a strong operational background and a keen understanding of fare collection systems. These characteristics and skills enable informed decisions and the ability to quickly evaluate potential impacts of design changes.
2. *Installation*: This phase requires a leader with a strong background in capital project implementation so they may more effectively manage to the contractual commitments and performance requirements of the equipment/system vendor.
3. *Implementation*: This third (final) phase needs to be grounded by customer driven service, so requires a leader good at planning and delivering quality customer support with the ability to anticipate and manage customer perception and minimize the impacts of the transition.

Advantages

- A core staff of individuals dedicated to the planning, installation and implementation reporting directly to the highest level gives the project focus, necessary resources, and organizational priority.
- Assuming responsibility for overseeing and defining the responsibilities and behavior of front line customer service staff, enables the AFC office to better control the customer experience.
- Requirements and deliverables of functional areas are more clearly defined through the work order process.

Disadvantages

- Change in project leadership can be disruptive to momentum. The new leader often questions/challenges prior decisions.
- Assuming the responsibilities of managing operational areas (such as front-line customer service, maintenance, and revenue servicing) may draw energy away from the mission of planning and implementing the project.
- The work order process slows momentum and responsive action.

Lessons Learned

- Don't switch out leadership purposely. In fact, try to get a 4 year commitment, if possible.
- Don't let schedule compromise quality.
- Grow and develop the project team in ways necessary to meet the unique and often unexpected demands of the project.
- Avoid creating "silos" of knowledge within the team. All skills should overlap.
- Co-locate project team members. Some of the best planning occurred in the common areas of the office.
- A Project Team must have someone good at managing the details of a contract and holding the vendor's feet to the fire. It must also have a full-time technology advisor.

12.4 PROJECT MANAGEMENT RECOMMENDATION

The recommendation of a Project Management structure for the Toronto Transit Commission takes into consideration its current culture and state of the smartcard project, the lessons learned, advantages and disadvantages of each of the three models studied, as well as this consultant's own experience with planning and implementing smartcard projects.

Culture and Current Situation

The TTC's current smartcard project team has effectively opened lines of communication with staff throughout the organization about the goals of the project, assertively and respectfully encouraged participation, opinions, and feedback. As a result of executive endorsement and outreach, there appears to be growing interest in and support for the project.

In addition, the Team has approached the preparation of the study in a very comprehensive manner, so at this very early stage, the system features and functions, the processes and impacts are fairly well-defined.

Relevant Lessons of Project Management Models

- The positioning of the MBTA AFC office is very good -- the project has the full attention of the GM/CEO, its requirements are given priority and its importance is not questioned at any level. Further, the level of fully-dedicated staff is much stronger than any of the other models and the approach to defining three distinct project phases and providing the necessary competencies for each is an important strategy for a project of this scope and complexity. However, given the current TTC efforts to be inclusive of employees, inviting participation and valuing ideas and feedback, if the TTC set up a separate, self-contained fare collection office like MBTA's model, this may be perceived as inconsistent with the current outreach efforts resulting in employee disenchantment and disinterest in the project.

- While MARTA's Matrix Management model promotes staff participation, the culture must be aligned with the Matrix Management principles for this structure to work effectively. If not, the misalignment can impede the progress and the quality of the end product.
- The Central Puget Sound model is generally well-suited for this type of project. It features both full-time dedicated staff reporting directly the GM/CEO and involves functional area experts. It lacks in staff and advisory (such as legal and training) resources.

Consultant's Experience

This consultant's personal experience with planning and implementing such a project echoes the lessons learned. Strong, influential, decisive leadership and fully engaged, capable staff are tantamount to the successful transition of an organization and its customers to this new technology. Everyone involved in the planning, installation and implementation must have a clear vision of the project and understand the path for planning and delivering the system. From the very start, the TTC must take the lead and control planning, schedule, design, testing, installation and implementation. If leadership is weak and indecisive or staff is not fully engage or competencies don't fit, the project schedule, budget, quality is at risk. As a result, the vendor(s) will assume the control necessary to complete the project – and their path to completion will not necessarily be the right direction for the TTC or its customers.

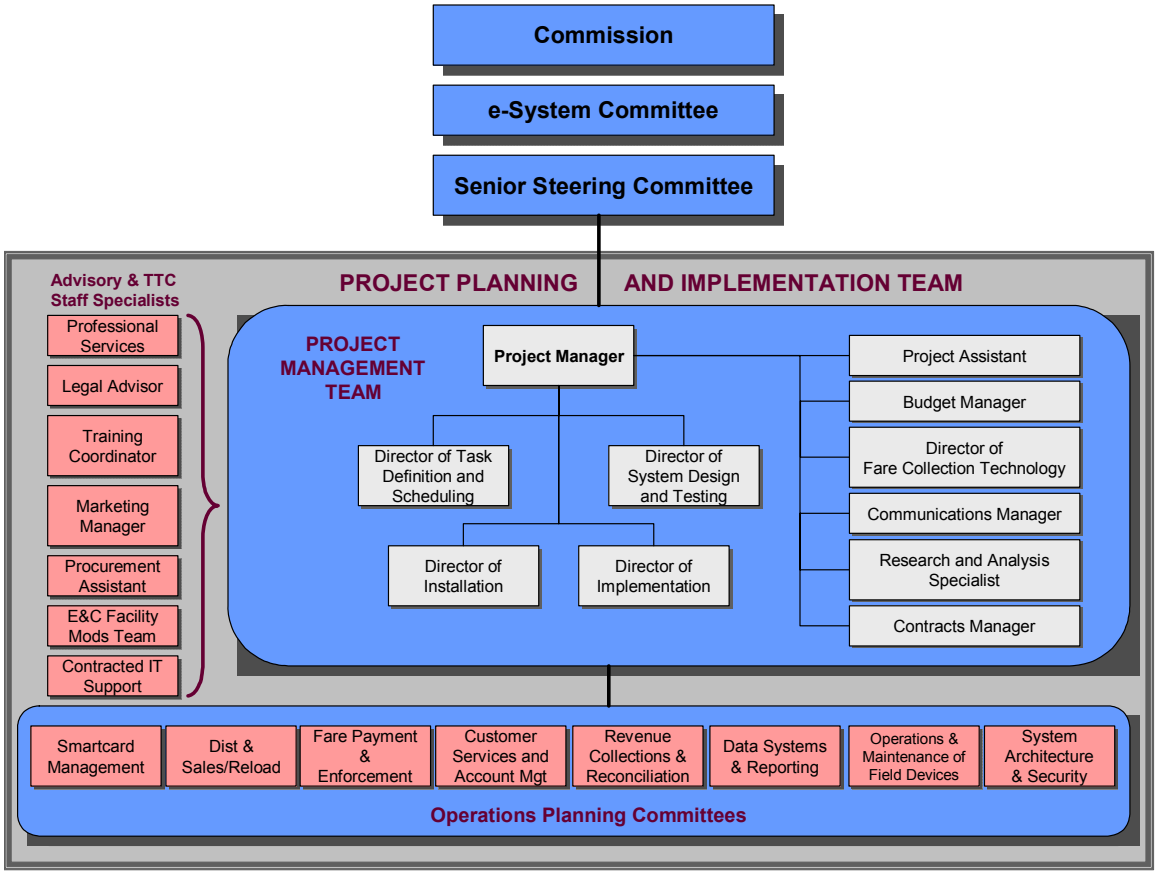
The following describes the recommended project management model for the TTC.

Recommended Model

Exhibit 12.4-1, *Recommended Project Management Model,* provides a top-level view of the project management structure recommended for the TTC.

INTENTIONALLY LEFT BLANK

Exhibit 12.4-1: Recommended Project Management Model



The following lists the key features of this recommended model:

- A strong, influential project leader (Project Manager), selected from the TTC would be preferable or at least an individual with experience leading the planning and implementation of a large scale project/system.
- A Project Management Team of full-time staff who have specialized skills and knowledge
  - Positions dedicated to four key phases of the project
    - Director of Task Definition and Scheduling: Defining planning tasks, deliverables and schedule
    - Director of System Design and Testing: Directing system design reviews and equipment testing
    - Director of Installation: Directing and overseeing equipment and Central System installation
    - Director of Implementation: Directing and overseeing the implementation of the fare collection strategies/fare payment options
  - Positions reflective of special aspects of the project
    - Director of Fare Collection Technology: Providing technical expertise, evaluation, and guidance
    - Contract Manager: Managing contract elements, ensuring compliance and delivery
    - Research and Analysis Specialist: Performing research and analysis necessary for making informed decisions about changes in strategy, policy, technological features and functions

  - Communications Manager: Communicating timely and critical project information, internal and public messages
  - Budget Manager: Auditing, reporting budget status and executing payments per schedule and contract
  - Project Assistant: Performing all administrative duties
- Operations Planning Committees to plan and execute eight smartcard business functions as described in Chapter 8, *Concept of Operations*.
  - Smartcard Management
  - Distribution, Sales and Reload
  - Fare Payment and Enforcement
  - Customer Services, Smartcard Account Management
  - Revenue Collection and Reconciliation
  - Operations and Maintenance of Field Devices
  - Data Systems and Reporting
  - System Architecture and Security
- Advisory staff and specialists who provide advice, guidance, support and/or programs critical to the project or backfill positions required for the project.
- A Senior Steering Committee comprised of the most important strategists, leaders, decision-makers in the Commission.

Senior Steering Committee's Role

The Senior Steering Committee will provide vision, direction and decision-making on critical strategy, policy, capital investment and other budgetary issues. It will guide the Project Manager, monitor and evaluate the Project Management Team, and the project's status. It will also represent the project both internally and in the public and marshal staff and public support. The size of the committee should be small, comprised of members who are the top strategic leaders of the organization and responsible for key business decisions -- who have a very large stake in the success of the project and the reputation of the TTC. It is recommended that members include Chief General Manager, General Manager of Engineering and Construction, General Manager of Operations, and General Manager of Executive.

Project Planning and Implementation Team's Role

This whole team is a consortium of advisors, specialists, and stakeholders, whose mission is *to successfully plan, guide, communicate, manage and implement the smartcard system*. It will be their job to ensure that the vision and plan for the fare collection system is realized. This team has three components: Project Management Team, Operations Planning Committees, and Advisory & TTC Staff Specialists. The following describes the roles and necessary skills of each:

<u>Project Management Team</u>

The mission of the team is *to effectively manage all aspects of the project*. The team manages the project's deliverables to schedule and budget. It provides guidance, resources and support to the Operations Planning Committees' and is the clearinghouse for all business strategy, policy, capital investment issues.

The team is led by a decisive, influential leader. One that is fully engaged and knowledgeable about the project – its vision, plans and technology. It is comprised of full-time, fully dedicated employees specializing in either one of the four phases or key aspects of the project.

Four Phases of the Project

Like MBTA's model, this recommended project management structure focuses on and provides for very special and distinct phases of the project – (1) task definition and scheduling, (2) system design reviews and testing, (3) equipment/systems installation, and (4) implementation. The primary purpose behind identifying distinct phases is such that the TTC can provide the staff capabilities necessary to maintain the strength of leadership and momentum through each phase. Weakness in any give phase provides opportunity for a vendor to deviate from the vision and/or approach the contract directs.

The project management team also includes staff to perform specific aspects of the project.

- The project's budget will not only be significant, but charges and payment schedules for equipment, supplies, facility modifications, and services will be extraordinarily complex. In order for the Project Management Team to stay on budget and to be fiscally responsible, there must be a position dedicated to managing the budget.
- Providing expert interpretation and guidance of technical specifications and design are critical to this project. The technology is state-of-the art, complex and, in some aspects, only recently developed. Functional specifications will be prepared to direct vendor's design and design bulletins and reviews will be prepared and presented. It is absolutely crucial to have a dedicated staff member to review and evaluate the design details and provide opinion and direction.
- Managing vendor communications, the minutes of planning and design meetings and the action items are very significant organizational tasks critical to the momentum of the project. In addition, keeping employees apprised and managing public messages are important to marshalling employee and public support, without which the project is at risk. This is why a communications position is included in the recommendation.
- An individual skilled at research and analysis will take important strategy, policy, technology questions as well as other decision-items raised during design reviews and planning meetings or by the Senior Steering Committee and return with the information, data, and evaluations necessary to make the best possible decision.
- Understanding the details of contracts with vendors is critical to receiving the product the TTC expected. A contracts manager will manage this aspect closely and monitor the deliverables of both vendors and professional services providers.
- There isn't enough that can be said about the value of a project assistant – someone who can manage staff calendars, arrange urgent meetings or travel, design presentations, answer staff questions and perform a myriad of other duties.

Project Manager

The project's manager will be the central point of contact for the equipment vendor, facility modifications' team, advisors and Operations' Planning Committees and report directly to the Senior Steering Committee.

The primary mission of the Project Manager is *to achieve the vision and plan for the project within schedule and budget*. Critical to accomplishing this mission will be the manager's depth of knowledge and understanding of this vision, the project's goals, and business plans. The manager will demonstrate strong leadership, decisive action, and the ability to synchronize project activities, deliverables – all to the project's schedule and budget. The manager must be willing to share vital information about the project, know what issues need to be elevated to a higher level and act quickly/decisively.

The manager will lead the entire Project Planning and Implementation Team in the development and completion of all deliverables associated with the project and will be a senior level manager

empowered to make key decisions as they arise, but also raise key business strategy, policy, capital investment and budgetary decisions to the Senior Steering Committee in a timely manner.

The core competencies and characteristics of this manager should include:

- Excellent leadership and management skills
- Project management experience and skills
- Strategically aggressive
- Ability to communicate a vision
- Decisive
- Respected throughout the organization
- Broad and deep knowledge about fare collection preferred
- Connection to the fare collection community preferred
- Past participation in APTA's Fare Collection workshop preferred
- Comprehensive understanding of the TTC's fare collection plans preferred
- Relationship to and understanding of the GTAFS project preferred
- Articulate speaker
- Budgeting experience
- Not driven by emotion, but by the right information and data

Director of Task Definition and Scheduling

Task definition and schedule is considered the first of the four phases. The primary mission of the Director of Task Definition and Scheduling is *to clearly define all tasks and synchronize the delivery of each.* This individual will assist each committee with defining work packages and deliverables from the plan for their business function (see Chapter 9, *Concept of Operations)*. This individual will identify the cross business functional dependencies, create the project schedule, linking and synchronizing all deliverables and dependencies. It will be this individual's job to manage the schedule, monitor each committee's progress and inform the Project Manager about possible schedule issues.

The core competencies and characteristics of this director should include:

- Decisive
- Able to work effectively with a diverse group of individuals
- Ability to facilitate planning meetings, good at defining tasks
- Critical thinker
- Skilled at project management software such as Primavera or Microsoft Project

Director of System Design and Testing

System design and testing is the second phase of the project. The mission of Director of System Design and Testing is *to direct the design reviews of the equipment/systems vendor to the expectations and requirements of each of the Operations Planning Committees.* This individual will work directly with the vendor and the Operations Planning Committees in coordinating the reviews and equipment/systems testing to meet the expectations of each of the committees. The design reviews and testing will be built around each of the eight activities. This individual will keep the vendor on track, not allowing diversion or changes in the approach. This position will be responsible for scheduling the reviews and testing events and identifying the appropriate staff to attend. Status of the design review and testing will be monitored closely and issues reported to the Project Manager.

The core competencies and characteristics of this director should include:

- Strategically aggressive
- Critical thinker
- Good at problem solving
- Experience with fare collection design reviews preferred
- Knowledge of vendor relationships with clients
- Able to work effectively with a diverse group of individuals
- Able to be an advocate of the expectations of the Operations Planning Committee members

Director of Installation

Installation is the third phase of the project. The mission of the Director of Installation is *to direct and oversee the installation of all equipment and systems.* This individual will be responsible for ensuring that the vendor is prepared to install equipment when expected, that all affected employees are fully informed and prepared, that the facilities and infrastructure are in place and ready to receive the equipment, to oversee and manage the installation and to report and facilitate resolution of any issues. This individual will work closely with all Operations Planning Committees monitor and report progress of installation to the Project Manager.

The core competencies and characteristics of this director should include:

- Strategically aggressive
- Critical thinker
- Good at problem solving
- Knowledgeable about the requirements of technology, hardware and software installations
- Knowledgeable about power, communications
- Able to work effectively with a diverse group of individuals
- Decisive
- Experience with fare collection equipment installations preferred

Director of Implementation

Implementation is the fourth and final phase of the project. The mission of the Director of Implementation is *to coordinate and oversee all implementation activities and to minimize the impacts on customers and frontline employees*. This individual will coordinate customer and employee pilots, compile and identify issues arising from the pilots and facilitate resolution. The individual will also direct and monitor the execution of subsequent implementation activities such as distribution and sales of smartcards, the delivery of quality customer services and account management activities, and customer and employee communications. This individual will work closely with all Operations Planning Committees and monitor and report progress of implementation to the Project Manager.

The core competencies and characteristics of this director should include:

- Strategically aggressive
- Critical thinker
- Good at problem solving
- Customer service focus

- Marketing and/or customer service experience preferred
- Experience with coordinating, facilitating pilots
- Experience with identifying and resolving critical technological issues
- Able to work effectively with a diverse group of individuals
- Decisive

Project Assistant

The mission of the Project Assistant is *to perform all administrative duties for the Management Team.* This individual will perform such duties as preparing correspondence, scheduling meetings, ensuring the presence of a recorder, preparing minutes for distribution, designing presentations and performing other duties as assigned.

The core competencies and characteristics of this manager should include:

- Able to work effectively with a diverse group of individuals
- Excellent organizational skills and follow through
- Professional
- Skilled at a variety of Microsoft Office software programs such as Power Point, Word, Excel, Access, and Visio.

Budget Manager

The mission of the Budget Manager is *to closely manage, execute and report the project's budget*. This position will review and audit vendor charges and monitor and facilitate payment schedules for equipment, supplies, facility modifications, and services. This individual will keep the Project Manager informed about the status of the budget and prepare budget summaries and reports.

The core competencies and characteristics of this manager should include:

- Excellent account management, accounting, budgetary and auditing skills
- Excellent at preparing budget reports
- Effective communicator

Director of Fare Collection Technology

The mission of the Director of Fare Collection Technology is *to provide expertise, evaluation of and guidance on technological design, functionality, and testing.* This individual will assist with the preparation of functional specifications for the Request for Information and Proposal and assist with reviewing and evaluating vendor bids. Once contract is awarded, this individual will review every design review bulletin and attend every design review to provide comments about the viability of the designs, the technological considerations, and the possible unplanned-for-impacts. This individual will alert the Project Manager to possible "fatal flaws" in designs and provide recommendations for changes, if necessary.

The core competencies and characteristics of this director should include:

- Strategically aggressive
- Critical thinker
- Good at problem solving
- Strong technology background -- fare collection technology engineering background preferred

- Work experience with fare collection vendors, if possible
- Able to work effectively with a diverse group of individuals
- Decisive

Communications Manager

The mission of the Communications Manager is *to deliver project information to internal and external stakeholders on a regular basis*. This includes the management and distribution of meeting minutes, coordination of employee orientation and status review meetings, facilitation of releases/letters about milestone and important events, preparation of power point presentations and the management of the Project Management Team's communications' schedule. This individual will provide communication plans/schedules to the Project Manager.

The core competencies and characteristics of this manager should include:

- Public relations
- Document control
- Excellent communications skills
- Excellent organization skills

Research and Analysis Specialist

The mission of Research and Analysis Specialist is *to conduct the research and analysis necessary for making informed and appropriate decisions.* This individual will take direction from any one of the Project Management Team's directors who requires answers to questions, evaluations of possible changes to specifications, business strategies and policies. This individual will research and gather the necessary information, compile the data, perform cost/benefit analysis and provide summaries of findings.

The core competencies and characteristics of this specialist should include:

- Skilled at conducting thorough, comprehensive research
- Skilled at performing cost/benefit analysis and comparisons
- Critical thinker
- Good at problem solving
- Skilled at using analytical software packages such as Excel
- Can work under pressure and to tight schedules

Contracts Manager

The mission of the Contracts Manager is *to confirm that all of the contractual commitments are met*. This individual will have a thorough and comprehensive understanding of every contract related to the project, know and understand the elements of contractual commitment and monitor the delivery of each. This individual will attend design review meetings to compare vendor presentations against contract requirements and consult with the Director of Fare Collection Technology to ensure that the design information bulletins meet the contract specifications. This individual will also consult with the Legal Advisor for opinion and action and alert the Project Manager of critical issues related to contract obligations.

The core competencies and characteristics of this manager should include:

- Strategically aggressive

- Critical thinker
- Experience managing contracts of large projects preferred
- Deep understanding of the specifications
- Involvement in the contract negotiations
- Able to work effectively with a diverse group of individuals

Tenures will vary. The following provides a possible position tenure schedule.

2007 - 2016
- *Project Manager*
- *Project Assistant*
- *Budget Manager*
- *Director of Fare Collection Technology*

2009 - 2015
- *Director of Task Definition and Scheduling*
- *Contracts Manager*
- *Director of Installation*
- *Communications Manager*

2009 - 2012
- *Director of System Design and Testing*

2009 - 2013
- *Research and Analysis Specialist*

2010 - 2015
- *Director of Implementation*

As stated in Chapter 10, *Cost Impacts*, Section 10.2, *Capital Costs*, the estimated cost of this Project Management Team is contained in the third area of the Capital budget called *Program Planning and Implementation*.

Operations Planning Committees

Unlike MARTA' structure in which project planning committees are organized by functional areas, the recommended structure for the TTC is to organize the planning committees by each of the eight smartcard business functions described in Chapter 9, *Concept of Operations*. This structure is similar to Central Puget Sound's SAATs.

The mission of the Operations Planning Committees is *to plan, direct, coordinate and to ensure the successful implementation of their assigned smartcard business function.* The members serving on each committee will be selected by virtue of their expertise, interest/stake and/or future involvement in the smartcard business function. Each committee will be chaired by at least one functional area manager and there will be no more than 5 or 6 staff members enlisted for each committee.

In Phase 1, Task Definition and Scheduling, committee members will be responsible for working with the Director of Task Definition and Scheduling to define the relevant work packages, identify all deliverables and assist with creating schedules.

In Phase 2, System Design Reviews and Testing, committee members will work with the Director of System Design and Testing to ensure that the vendor's design reviews and equipment testing conform and address the specifications related to their smartcard business function. Select members, if not all, of the committees will attend each relevant design review and testing event to evaluate and submit strategic, policy and/or functional issues/questions to the Director of System Design and Testing for research and analysis.

In Phase 3, Equipment/Systems Installation, committee members will participate with the Director of Installation to coordinate and evaluate infrastructure preparations/modifications and equipment/systems installations relevant to their assigned smartcard business function. They will ensure the facilities are ready and employees are adequately prepared.

Finally, in Phase 4, committee members will assist the Director of Implementation with directing and overseeing the implementation of the project relevant to their smartcard business function. They will ensure that all elements of the plans are implemented to schedule with minimal impact to employees and customers.

In addition to their primary responsibilities, committee members will also review training materials and presentations for relevancy and quality, coordinate employee training sessions, and determine further training requirements.

Committee members will report directly to the Project Manager through the Project Management Team Directors and may also be required to report status and updates to Senior Steering Committee.

Advisory & TTC Staff Specialists

Professional Services Group

The primary mission of the contracted consulting team will be *to provide experienced support, analyses, and guidance throughout the project initiation, planning, design reviews, testing, installation and implementation*. The group will assist with preparing the business requirements and developing the specifications, format, forms for the request for information and proposal. Support may also include vendor and system development oversight, configuration management, document control, change order preparation, system security reviews, risk management analysis, employee communications planning and preparation, as well as customer transition and marketing direction and execution. The consulting services will support the Project Planning and Implementation Team at each step of the way.

Legal Advisor

As Central Puget Sound listed in lessons learned, it is prudent to protect this very complex project from possible vendor, banking, and privacy violations. The mission of the Legal Advisor is *to ensure that TTC is protected from liability and risk*. Legal advice will be necessary for protecting the TTC against vendor default, ensuring the TTC has access to software code, reviewing and offering opinion and direction on banking and Provincial regulations, customer privacy and a myriad of other issues that arise.

Training Coordinator

The equipment/systems provider will be responsible for developing training manuals and delivering some training. The mission of the Training Coordinator will be *to ensure that relevant and quality system training is delivered to the TTC*. The TTC's training department will be an integral part of the Project Planning and Implementation Team and work closely with Operations Planning Committees to direct and coordinate smartcard system training programs relevant to business functions and to the participating TTC employees.

Marketing Manager

Key to the success of the transition to new fare payment options is effective customer communications. The mission of the Marketing Manager will be *to plan and execute the smartcard marketing and communications plan*. The marketing staff will need to be knowledgeable about the project vision, the features and functions of the system, and its benefits to the TTC and its customers. They will develop and execute a marketing plan that includes a branding strategy, public and media relations, advertisement, and customer and community outreach.

Procurement Assistant

The Procurement Assistant will oversee the development, format, and final packaging of all requests for information and proposals. This will include the request for proposals for consulting services and equipment/systems. The staff will guide and facilitate the evaluation and selection process and support the final notice to proceed.

Engineering and Construction Facility Modifications Team

This group will be directing and overseeing the modifications necessary for readying the facilities for the fare collection system's power and communications in Subway Stations, Surface Divisions, parking and other facilities. The Project Management Team will work closely with this team to monitor preparations for equipment and systems installation and seek advice and guidance during the Installation phase of the project. This team will provide regular updates to the Project Management Team.

Contracted IT Support

This group of specialists will provide support to the Information Technology division during the planning, design reviews, systems installation and implementation. Technology staff will be required to assist on a full-time basis to assist or lead development of specifications, design reviews, testing, quality assurance, pre-production/production, disaster recovery activities, integration, web interfaces and possible software development for the Central System, Data Transport scheme, and Security. The Contracted IT Support will backfill positions as needed and/or provide unique support related to the project.

12.5 NEXT STEPS

If the smartcard fare collection project is approved, the TTC will start down the path of procurement and planning. Assuming the TTC Smartcard System is approved in 2007, Table 12.5-1, *Procurement and Planning Schedule – The TTC's Next Steps*, provides the timeline for these next steps.

Table 12.5-1: Procurement and Planning Schedule – The TTC's Next Steps

Major Activity	Year							
	2007	2008	2009	2010	2011	2012	2013	2014
Recommendation to Comission								
Recommendation to Council								
Funding Approval: City/Prov/Feds								
Select Project Manager/Set Up Proj Planning and Implmentation Team								
Select Professional Services Group								
Business Requirements Definition								
Request for Information								
Request for Proposal is Released								
Equipment/Systems Contract is Awarded								

Recommendation to the Commission: The TTC Smartcard System is presented to the members of the commission for their review and approval. If the members of the Commission vote to approve the TTC Smartcard System and its funding requirements, the TTC may also refer the study to Toronto City Council for review and approval.

Additional funding will be required to support the proposed the TTC Smartcard System. The TTC staff will need to meet with representatives of both the Federal and Provincial governments to present the findings of the TTC Smartcard Business case and to determine if adequate funding can be provided.

The TTC will also need to begin discussions with the Province to determine if the GTA Fare System can be modified to meet the TTC's business requirements. Potential integration with the GTAFS was not part of the scope of this study, but now that TTC's smartcard business requirements have been defined, TTC will need to work with the Province and the GTAFS Project office to determine the best approach for potential integration and/or system interoperability.

Recommendation to the Council: Upon approval by the Commission, the TTC Smartcard System project will move forward to the City Council for final review and approval.

Funding Approval by the Transport of Canada, the Ontario Ministry of Transport and the City of Toronto: Capital estimates will be presented to the governmental entities for funding review and approval.

Select Project Manager and the Project Planning and Implementation Team: The organization for project management will be established.

- Form the Senior Steering Committee
- Hire the Project Manager
  - Senior Steering Committee interviews and hires
- Enlist the chairs of the Operations Planning Committees
  - Senior Steering Committee and Project Manager select and enlist the best candidates for chairing each of the eight Operations Planning Committees
  - Senior Steering Committee and Project Manager (together) inform the chairs of their mission and the expectations
- Enlist the members of each committee
  - Each of the eight committee chairs selects the best candidates for serving on their committee
- Form the Project Management Team
  - Project Manager interviews and hires

        - Project Assistant
        - Budget Manager
        - Director of Fare Collection Technology
- Select the Advisory & Staff Specialists
    - Project Manager enlists the support and participation of
        - TTC Procurement Assistant
        - TTC Legal Advisor
    - Information Technology management directs the preparation and release of the Request for Proposal or Qualifications for Contracted IT Support
    - Project Manager directs the preparation and release of the Request for Proposal seeking a Professional Services (Consulting) Group

Task Definition and Scheduling Phase: Four distinct phases have been identified for this project. Task Definition and Scheduling is the first of the four. The other three phases are described in Chapter 9, *Concept of Operations*, Section 9.9, *Installation and Implementation Schedule*. They are System Design and Testing, Systems and Equipment Installation, and System Implementation. In this first phase, work packages and deliverables are defined from the project's business plan. A project schedule is then developed linking and synchronizing all deliverables and dependencies. The Project Planning and Implementation Team works to this schedule.

Select a Professional Services Group: As described in the Project Management Recommendation, this group will provide experienced support, analysis, and guidance throughout the project initiation, planning, design reviews, testing, installation, and implementation. In the earliest stage, they will facilitate the definition of business requirements and prepare the request for proposal.

Business Requirements Definition: Chapter 9 presents the concept of operations. These concepts will be further defined and functional specifications prepared for the request for proposal.

Request for Information: The purpose of this document is to gather information to aid with building the function specifications and to identify the companies who are best able to meet the TTC's requirements.

Request for Proposal is Released: The fare collection system functional specifications and requirements are finalized, packaged and publicly released to potential bidders.

Equipment/Systems Contract is Awarded: Bids are reviewed and contract is negotiated and awarded to most responsive fare collection provider.

- Project Manager interviews and hires
    - Director of Task Definition and Scheduling
    - Director of System Design and Testing
    - Director of Installation
    - Contracts Manager
    - Research and Analysis Specialist
    - Communications Manager
    - Director of Implementation
- Project Manager enlists the support and participation of
    - Marketing Manager
    - Training Coordinator

12.6 CONCLUSION

In 2004, the TTC set out to study the feasibility and costs of implementing a smartcard fare collection system by forming a Smartcard Project Team. The mission of the team was to provide a comprehensive analysis that would deliver the information necessary to make an informed decision about whether or not to transition the TTC to smartcard fare collection technology. After an exhaustive exploration and analyses of the state of smartcard technologies, equipment features and functions, lessons learned, best practices, costs and operating impacts and after many internal reviews, the team completed this study.

The study found that the current TTC fare collection system has no significant operating weakness, it is easy to manage, administer, fairly reliable and operating costs are very low compared to the industry. The system is not complex for either front-line employees or customers and there is no extraordinary sense of urgency -- such as aging equipment issues or even high fare evasion -- to transition to a new system. However, there are definite limitations to the current system such as customer service expansion constraints, seamless mobility between transit systems within the GTA, the inability of the system to generate good information for planning and analyses, restricted flexibility to enable quick response to market changes and for leveraging emerging opportunities.

As reviewed and summarized in Chapter 11, *The TTC Smartcard System Assessment,* the proposed TTC Smartcard System, as defined through research, interviews and staff input, builds on the strengths of the existing system, addresses the weakness and delivers compelling strategic and very tangible benefits and advantages to both the TTC customers and the organization, as a whole. It will improve the customer experience of the TTC, improve the working conditions of employees and provide many operational advantages. Yet, even so, there are two very significant barriers -- the large capital cost of preparing for and implementing the system as well as the estimated increase in the annual operational budget after implementation. While operating costs could be addressed with business initiatives, if the capital cost is not solved with new and adequate funding, then the project is not achievable.

The PARSONS Team proudly submits this study to the members of the Toronto Transit Commission on behalf of the TTC Smartcard Project Team and TTC staff and wishes to thank everyone who has so graciously given their time, information and imparted their experience, lessons learned and guidance.

-- END OF REPORT --

APPENDIX A

SMARTCARD EQUIPMENT/SYSTEMS GLOSSARY

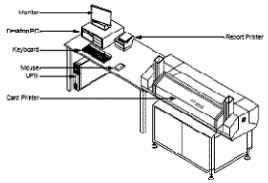
APPENDIX A
SMARTCARD EQUIPMENT/SYSTEMS GLOSSARY

The glossary below lists and describes the primary equipment components of the TTC Smartcard System.

	Name	Function	Power/Other Req.	Report Section	Location(s)	Quantity
	Add Value Machine (AVM) Cashless	To load E-Purse Value or E-Pass to a customer's smartcard. Accepts credit or debit card payment only. Does not dispense smartcards. Will also check card balance.	120 VAC, 60 Hz, 20 amp circuit with heater; LAN connection to local station controller or AFC Network.	Distribution, Sales and Reload	Subway entrances and bus/streetcar platforms.	407*
	Central Controller	To control data to and from wireless access to/from LAN.	100-240 VAC, 50/50 Hz; DC input 22-26 VDC, 1.5 amp	System Architecture and Security	Information Technology	2
	Central System	To control the total functionality of the smartcard system.	Core logic and processing programs, plus • Expanded Fin Mgt • Autoload • Initialization & encoding • Web services • Point of sale • System monitoring	System Architecture and Security	Information Technology	1

	Name	Function	Power/Other Req.	Report Section	Location(s)	Quantity
			• Credit/debit interface/switch • General ledger			
	Data Concentrator	To relay data between the LAN and the parking wireless access points.	120 - 240 VAC, 60 Hz 10-20 amp circuit; UPS and Router to LAN	System Architecture and Security	Commuter parking facilities	28
	Driver Control Unit (DCU)	To monitor all Smartcard Reader processes on the Surface vehicles.	9 to 36 volts, direct current (Vdc) range. Consumption at 12 V = 10 – 14 watts. Direct connect , RS 232 to local device	Fare Payment and Enforcement	Near Surface Operators	2,014*
	Full Service Vending Machine (FSVM)	To dispense and load smartcards and/or limited use cards. Accepts cash and credit or debit card payment. Will also check balance of smartcard or limited use card.	120 VAC, 60 Hz, 20 amp circuit with heater. LAN connection to station controller or AFC network.	Distribution, Sales and Reload	All Subway entrances	203*

	Name	Function	Power/Other Req.	Report Section	Location(s)	Quantity
	Electronic Turnstile	To replace Station Collector freewheel turnstile. Activated w/ valid smartcard or limited use card.	120 VAC, 50/60 HZ with 20 amp circuit with heater. LAN connection to local station controller or AFC Network	Fare Payment and Enforcement	Attended Subway entrances.	134*
	Hand Held Device	To enforce fares. To check smartcards for payment of fares and to decrement from E-Purse value, if necessary.	Battery charger and data com. cradle	Fare Payment and Enforcement	Cradles/handhelds will be installed in subways, surface divisions and Special Constables Department.	460*
	Initializing and Encoding and Point of Issue Machine	To "install" security keys and to record smartcards and limited use cards in Central System before delivery to sales channels. High production machine for large volume.	220/110 VAC 1000 Watts	Smartcard/Limited Use Card Management	Revenue Operations	1

	Name	Function	Power/Other Req.	Report Section	Location(s)	Quantity
	Limited Use Card	To enable cash customers to purchase a single trip or Day Pass in Subway and enable a cash paying customer to transfer from Surface vehicle to either Subway or another Surface vehicle. E-Purse value / E-Pass transactions.	ISO14443 compliant, 512 bits memory, 1,000 read/write transactions	Fare Payment and Enforcement	Full Service Vending Machine Surface Vehicle Transfer Dispenser	44.0 mil Qty is est. reqm't for first four years of implementation. This is not an annual total.
	Multipurpose Point of Sale Device	To perform a variety of customer service and smartcard account management functions.	120VAC, 20 amp circuit - Internet browser with corporate VPN	Customer Services, Smartcard Account Management	Front counter of Customer Centers	31*
	Point of Issue Device	To "install" security keys and to record smartcards and limited use cards in Central System before delivery to sales channels. Low	220/110 VAC 1000 Watts	Smartcard/Limited Use Card Management	Revenue Operations	1

	Name	Function	Power/Other Req.	Report Section	Location(s)	Quantity
		production machine for lower volume of cards.				
	Point of Sale Device	To enable 3rd Party Ticket Agents to sell and reload smartcards.	100-240 VAC, 50/50 Hz; DC input 22-26 VDC, 1.5 amp	Distribution, Sales and Reload	3rd Party Ticket Agents	1,006*
	Internet Router	To join two networks together.	100-240 VAC, 50/50 Hz; DC input 22-26 VDC, 1.5 amp	System Architecture and Security	Information Technology for 3rd Party Point of Sale devices.	2
	Server	To provide applications to other devices and users on the smartcard network.	120VAC, 20 amp circuit	System Architecture and Security	Information Technology	18
	Smartcard	To replace tickets, tokens, passes, and transfers in a TTC Smartcard System.	ISO14443 compliant, 4K memory, 100,000 read/write transactions	Fare Payment and Enforcement	Vending Machines Call Centre Customer Centre 3rd Party Ticket Agents Contractor	3.1 mil Qty is est. reqm't for first four years of implementation. This is not an annual total.

	Name	Function	Power/Other Req.	Report Section	Location(s)	Quantity
	Smartcard Readers on Surface Vehicles (stand alone) and Parking gates	To decrement E-Purse value or check validity of E-Pass or Transfer.	9-36 volts, direct current (Vdc) range. Power at 12 V = 4 watts. Capable of reading ISO14443 Type A, B, or C cards.	Fare Payment and Enforcement	Near all Surface vehicle fareboxes, rear doors of Streetcars and parking gates	2,462*
	Smartcard Reader on Turnstile	To decrement E-Purse value or check validity of E-Pass or electronic Transfer.	120 VAC converter to DC – 1 amp typical - Capable of reading ISO14443 Type A, B, or C cards. – Minimum ability to release turnstile lock mechanism; LAN connection (hard wired or wireless) to local station controller or AFC Network.	Fare Payment and Enforcement	On all turnstiles, plus additional for testing and Q.A. environments	368*
	Switch	To connect field devices to the LAN. Typically used to connect end devices to a Local Area Network (LAN)	120 VAC converter to 12 VDC – 1 amp typical; LAN connection to local controller/division computer system	System Architecture and Security	Divisions, Information Technology	17

	Name	Function	Power/Other Req.	Report Section	Location(s)	Quantity
	Wireless Access Point	To relay data between wireless devices such as Smartcard Readers in-the-field and wired devices such as the Local Area Network.	120 VAC converter to 12 VDC – 1 amp typical; LAN connection to local controller/division computer system	System Architecture and Security	Bus/streetcar divisions and platforms	252
	Workstation	To access the Central System for the purpose of performing specific smartcard system related tasks.	Internet browser with corporate Ethernet connection	• Smartcard Management • Revenue Collections • Customer Services/Account Management • Operations and Maintenance • System Architecture and Security	Revenue Ops Call Centre Customer Centre Revenue Maint. Transit Control Info Technology	46

* Includes an additional 6 for IT labs and TTC employee training.

-- END OF DOCUMENT --